CONNECTICUT RIVER FLOOD CONTROL

CHICOPEE FALLS
LOCAL PROTECTION PROJECT

CHICOPEE RIVER, MASSACHUSETTS

DESIGN MEMORANDUM NO. 7

DETAILED DESIGN OF STRUCTURES

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

MARCH 1963

Mr. Whittemore/mg

MEDGB (13 Mar 63) 4th Ind
SUBJECT: Chicopee Falls Local Protection Project, Chicopee River, Massachusetts - Design Memorandum No. 7 - Detailed Design of Structures

U. S. Army Engr Div, New England, Waltham, Mass. 24 October 1963

TO: Chief of Engineers, ATTN: ENGCW-EZ, Washington, D. C.

Action suggested in previous indorsement for Wall Type E is concurred with. The #14 bars at 6"oc have been changed to two layers of #10 bars spaced 6"oc each layer. Splices have been staggered in both layers.

FOR THE DIVISION ENGINEER:

JOHN WM. LESLIE
Chief, Engineering Division

cc: Mr. Leslie
Mr. Groden
Mr. Coffin
Eng. Div. File

[illegible] 2nd Ind

[illegible] Chicopee Falls Local Protection Project, Chicopee River, Massachusetts - Design Memorandum No. 7 - Detailed Design of Structures

[illegible] Chief of Engineers, Washington D. C. 20315, 19 August [illegible]

[illegible] Division Engineer, U. S. Army Engineer Division, New England

The action taken on the preceding 2nd Indorsement relative to Design Memorandum No. 7 is satisfactory subject to the following comment:

Wall Type E, Sheet 9. Consideration should be given to [illegible] smaller bars in two rows, say #11 bars at 6"oc and #10 bars at [illegible] in lieu of the [illegible] bars at 6"oc shown at the bottom of the [illegible] item. If the bar size exceeds #11, a welded splice should be specified in accordance with the recommendations of the Proposed Revision of [illegible] Requirements for Reinforced Concrete, February 1962.

FOR THE CHIEF OF ENGINEERS:

[illegible]

WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

NEDED (13 Mar 63) 2nd Ind
SUBJECT: Chicopee Falls Local Protection Project, Chicopee River, Massachusetts - Design Memorandum No. 7 - Detailed Design of Structures

U.S. Army Engineer Division, New England, Waltham, Mass. 23 July 1963

TO: Chief of Engineers, ATTN: ENGCW-Z, Washington 25, D. C.

Design Memorandum No. 7. The following action has been taken on the 1st Indorsement comments using the same paragraph notations:

a. Plate No. 12 - The wall section at Sta. 17+60 has been corrected and is now designated as a Type [illegible] wall with base elevation at 6[illegible].00 and with a base width of 40'-0". A new foundation stability analysis (Incl. No. 1) and structural computations (Incl. No. 2) are included herewith for review.

b. Plate No. 13 - Since the interior drainage lines leading to the pumping station carry industrial and sanitary waste as well as storm drainage, a discharge line over the dike would require full time pumping operations. The additional cost for such operations is not considered justified. A gate structure has been added to the conduit and is shown on the contract plans.

c. Appendix [illegible] - The computations requested are included herewith as stated in paragraph a.

d. Appendix C - The wall sections from Sta. 4+13 to Sta. 6+00 have been reevaluated to determine if rock anchors can be eliminated by dropping the base further into the rock. This cannot be accomplished without removing a considerable amount of rock. In accordance with discussion with Mr. Tracy at [illegible] on April 1[illegible] a foundation stability analysis has been made for the Type C wall with base elevation at 74.0, 2 feet lower than the anchored wall shown on the contract drawings. This analysis is included herewith (Incl. No. 3) and indicates a safety factor of only 1.0[illegible]. Therefore this stretch of wall has been left as an anchored wall. There is also included herewith structural computations on a new Type C wall with base elevation at 76.[illegible] (Incl. No. 4).

e. Appendix [illegible] - Rock bolts have been eliminated for this section (now Type [illegible] on the contract drawings) with the exception of a section between Sta. 21+40 to Sta. 22+60 (Type [illegible] on contract drawings) where an existing structure lies close to the wall foundation and the anchors have been retained as a precautionary measure. Computations are not resubmitted on this section as the original design is satisfactory whether with or without anchors.

f. Resubmittal. Revised calculations are enclosed as indicated above.

FOR THE DIVISION ENGINEER:

4 Incls (in dupe)
1. Type [illegible] all-Stability
2. Type [illegible] all-Shape.
3. Type [illegible] all-Stability
4. Type [illegible] all-Shape.

JOHN [illegible]
Chief, Engineering Division

Cc: Mr. Lewis
Mr. Tracy
Mr. Hellstrom
Mr. Collin
Mr. Div. File

ENGCW-[illegible](13 Mar 63) 1st Ind
SUBJECT: Chicopee Falls Local Protection Project, Chicopee River, Massachusetts - Design Memorandum No. 7 - Detailed Design of Structures

Office, Chief of Engineers, Washington 25, D. C. 9 April 1963

TO: Division Engineer, U. S. Army Engineer Division, New England

Design Memorandum No. 7 - Detailed Design of Structures is approved subject to the following comments:

a. Plate No. 12. The uplift item has been omitted in the safety factor calculation at the right side of this plate. When it is included, F. S. = 1.31 in lieu of the 1.75 shown. The wall design at Station 17+60 should be reconsidered to provide deeper embedment or a key at the landside toe to develop increased passive resistance to sliding.

NO

b. Plate No. 13. The pumping station discharge lines should be carried over the top of the levee and terminated in the station closure gate structure to be located on the river side of the levee at the one-third point nearest the toe of the levee. The discharge lines should be free vented at the highest point. This arrangement will eliminate the need for a pressure conduit under the levee.

c. Appendix B. The comment in subparagraph a above is applicable to the wall design of Appendix B and will require coordination with the design calculations in this appendix.

d. Appendix C. Consideration should be given to the provision of a key to develop passive resistance to sliding failure in lieu of anchoring the wall with rock bolts.

e. Appendix D. The wall design in this appendix appears to have a safety factor of 1.79 for Loading Case 1 and 2.4 for Loading Case 2 when an analysis is made which considers only the portion of wall, earth and water above the base of concrete wall. Therefore, rock bolting to the foundation is not required. The design should be reviewed in conjunction with Appendix B to develop the most economical section for this height of wall.

f. Resubmittal. Revised calculations for Appendices B, C, and D should be resubmitted for review.

FOR THE CHIEF OF ENGINEERS:

For

WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

Incl w/d

K. L. Coltrin Ext. 72098
Proj. Planning Branch

9-13-22

ENGCW-EE (13 Mar 63) 1st Ind
SUBJECT: Chicopee Falls Local Protection Project, Chicopee River, Massachusetts - Design Memorandum No. 7 - Detailed Design of Structures

Office, Chief of Engineers, Washington 25, D. C. 9 April 1963

TO: Division Engineer, U. S. Army Engineer Division, New England

Design Memorandum No. 7 - Detailed Design of Structures is approved subject to the following comments:

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b. Plate No. 13. The pumping station discharge lines should be carried over the top of the levee and terminated in the station closure gate structure to be located on the river side of the levee at the one-third point nearest the toe of the levee. The discharge lines should be free vented at the highest point. This arrangement will eliminate the need for a pressure conduit under the levee. Mech WSD Hyd.

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f. Resubmittal. Revised calculations for Appendices B, C, and D should be resubmitted for review.

FOR THE CHIEF OF ENGINEERS:

Incl w/d

WENDELL M. JOHNSON
Chief, Engineering Division
Civil Works

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASS.

RESS REPLY TO:
SION ENGINEER

REFER TO FILE NO.

NEDGW

13 March 1963

SUBJECT: Chicopee Falls Local Protection Project, Chicopee River, Massachusetts - Design Memorandum No. 7 - Detailed Design of Structures

TO: Chief of Engineers
ATTENTION: ENGCW-E
Department of the Army
Washington 25, D. C.

There is submitted, for review and approval, Design Memorandum No. 7 - Detailed Design of Structures, for the Chicopee Falls Local Protection Project, Chicopee River, Massachusetts, in accordance with EM 1110-2-1150. The contract award for construction of this project is scheduled for April 1963, and an early receipt of your review comments will be appreciated in order that the plans and specifications may be completed on schedule.

FOR THE DIVISION ENGINEER:

JOHN WM. LESLIE
Chief, Engineering Division

Incl (10 cys)
Des. Memo No. 7

FLOOD CONTROL PROJECT
CHICOPEE FALLS LOCAL PROTECTION PROJECT
CHICOPEE RIVER
CHICOPEE RIVER BASIN
MASSACHUSETTS

DESIGN MEMORANDA INDEX

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2	General Design, Hydrology, Hydraulics & Geology	21 Dec 1962	22 Jan 1963
3	Real Estate		
4	Concrete Materials	9 Nov 1962	23 Nov 1962
5	Embankment & Foundations	[illegible] Mar 1963	
6	Pumping Stations		
7	Detailed Design of Structures	13 Mar 1963	

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C. Flood Wall Computations - Sta. 5+80

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E. Conduit Design Computations

FLOOD PROTECTION

CHICOPEE FALLS

LOCAL PROTECTION PROJECT

CHICOPEE RIVER, MASSACHUSETTS

DESIGN MEMORANDUM NO. 7

DETAILED DESIGN OF STRUCTURES

February 1963

A. PERTINENT DATA

a.	Purpose	Flood Protection
b.	Location of Structures	On easterly bank of Chicopee River, Chicopee Falls, City of Chicopee, Hampden County, Mass.
c.	Type of Structures	Tee-type flood walls, small reinforced concrete conduits and miscellaneous drainage structures.
d.	Length of Walls	565 feet and 885 feet, approximately.
e.	Height of Walls	Vary between approximately 39 feet and 24 feet.
f.	Foundations	Shale, conglomerate and glacial till.

B. PURPOSE AND SCOPE

1. This design memorandum presents the design criteria, basic data and assumptions used in the structural design of the flood walls, conduits, drainage structures, etc. A brief description of typical structures with loading conditions and assumptions used is included to show the design procedure.

Typical computations are appended. Since the flood walls vary in height over a wide range, additional computations following the same general procedure will be made for two-foot increments of height over the range of heights expected. The structural design, including stability investigations for typical and critical flood walls, is outlined herein, as well as the structural design of conduits and miscellaneous drainage structures. Design of the pumping stations is included in Design Memorandum No. 9, Pumping Stations.

C. DESCRIPTION OF PROJECT

2. General. - The Chicopee Falls Local Protection Project comprises a line of protection of earth dikes and concrete flood walls along the left bank of Chicopee River, extending approximately one mile downstream from the Deady Memorial Bridge in Chicopee Falls, Massachusetts. The location and principal features of the project are shown on Plates 1 and 2.

3. Flood Walls. - Lack of sufficient space for earth dikes caused adoption of concrete flood walls at the former Savage Arms Company plant buildings and at buildings of the Chicopee Manufacturing Company. These walls are shown in plan on Plates 2 thru 7 and typical sections and details are shown on Plates 9 and 10.

4. Conduits. - Small cast-in-place concrete conduits are required to carry flows through the dikes at several locations, for pump station discharge, process water intake and to carry future interceptor sewer lines. These are shown in plan on Plate 2, and typical details are shown on Plate 13.

5. Drainage Structures. - Various junction chambers, manholes, endwalls, etc., are required for the drainage systems. Plate 2 shows these structures. Several drainage structures are complicated by the proximity of branch line tracks of the Boston and Maine R.R., or by factory sidings.

D. DESIGN CRITERIA

6. General. - All working stresses conform to those specified in the Engineering Manual EM 1110-1-2101 "Working Stresses for Structural Design," dated 6 January 1958. Loading conditions, design assumptions and other design criteria are based on the following applicable part, in the Engineer-Manual for Civil Works issued by the Office of the Chief of

Engineers; "Standard Practice for Concrete", (Part CXX, October 1953; "Wall Design, Flood Walls", (EM 1110-2-2501 dated January 1948 and Change 2 dated 15 March 1961); "Retaining Walls", (EM 1110-2-2502 dated 29 May 1961) and "Design of Miscellaneous Structures" (EM 1110-2-2902 dated June 1948). Accepted engineering practice has been employed in cases where the Engineering Manual for Civil Works does not apply.

7. Concrete. - The following table lists the concrete and reinforced concrete stresses used in the design of structures. All stresses are those for hydraulic structures as set forth in the Civil Works Manual.

Flexure	Lbs. per Sq.In.
Extreme fiber stress in compression (except conduits)	1,050
Extreme fiber stress in compression (conduits)	1,350
Extreme fiber stress in tension (plain concrete)	60
Shear - (v)	
Beams - No web reinforcement	90
Beams with properly designed web reinforcement	240
Footings - at critical section	75
Conduits at points of contraflexure - (In accordance with Recommendations For Box Culverts, by University of Illinois)	
Bond - (u) Deformed Bars	
Top bars	210
All others	300
Bearing - fc	
Load on entire area	750
Load on one-third area or less - maximum permissible	1,125
Modular Ratio - (n)	10

8. Reinforcement.

a. Grade and Working Stresses. - All reinforcement in the structures, including temperature and shrinkage reinforcement was designed for the working stresses of new billet steel, intermediate grade, deformed bars, 20,000 p.s.i. in flexural tension. The reinforcement shall conform to the requirements of Federal Specification QQ-5-632, Type II, Grade C and to ASTM Designation A305-56T. Bars for rock anchors shall be 60,000 p.s.i. minimum yield strength, ASTM Designation A432.

b. Spacing. - The clear distance between parallel bars shall not be less than 1-1/2 times the diameter of round bars, except that in no case shall the clear distance between parallel bars be less than 1-inch, or 1-1/2 times the maximum size of the coarse aggregate.

c. Minimum Cover for the Main Reinforcement.

Flood Walls

Bottom of base slab	4 inches
All other steel	3 inches

Conduit and Drainage Structure

Bottom of base slab	4 inches
All other steel	3 inches

The concrete covering of stirrups, spacer rods and similar reinforcement may be reduced by the diameter of such rods.

d. Splices. - Splices will be lapped 24 diameters to develop by bond the total working strength of the bars.

e. Temperature and Shrinkage Reinforcement. - Temperature and shrinkage reinforcement will be provided where the main reinforcement extends in only one direction. Such reinforcement will provde for a ratio of steel area to concrete area (bd) of 0.002 with a minimum of .001 in each face up to a maximum of #6 bars at 12 inches on centers in thick sections.

f. Increase in Normal Working Stresses. - Allowable working stresses were increased 33-1/3% for Case 1, loading on flood walls (water at top of wall).

g. Waterstops. - Rubber or polyvinyl waterstops will be used in all flood wall joints; 2-inch center bulb Y-type for wall stems and U-type for base slabs. Conduits will utilize 3/4-inch center bulb type at all construction joints.

E. BASIC DATA AND ASSUMPTIONS

9. Controlling Elevations. - Design water level is three feet below the top of the wall, as shown on Plates 3 thru 7. The design also considered water level at the top of the wall and no water in front of the wall. Footing elevations were fixed by the requirement that footings be set into impervious material below the random fills occurring along the left bank. Footings on ledge were set on sound ledge, which required removal of deteriorated weathered material.

10. Dead Loads. - The following unit weights for materials were used:

Material	Unit Weight (lbs./cu/ft.)			
	Dry	Moist	Saturated	Submerged
Random	125	130	135	72.5
Impervious	125	135	140	77.5
Concrete	150			
Steel	490			

11. The following live loads have been used:

Water	62.5 lbs./cu. ft.
Wind	50 lbs./sq. ft.

12. External Water Pressure. - In cases where hydrostatic pressure affects the structure it has been considered as acting over the entire area under the full head available. Uplift beneath flood walls has been computed by the path of creep method assuming full head at the riverside base of the footing and zero at the ground surface on the land side. Where rock anchors were used, uplift was also considered on a plane at the bottom of the anchors.

13. Earth Pressure. - Earth pressures used against the structures have been determined in general in accordance with EM 1110-2-2502, Retaining Walls. Pressures are assumed to be

active pressures, Ka=0.33. Where landside backfills act to resist movements due to the applied riverside loadings, sliding block and wedge analyses were made, and rock anchors used where sliding stability did not show a safety factor of approximately 1.5.

14. Rock. - The following design data were determined for the shale rock foundations:

Compression (unconfined test 75% Saturated)	2200 p.s.i.
Coefficient of friction	f=0.2, 0.3*
Percent swell after drying	1.0%
Unit Weight	170 p.c.f.

*0.3 at bottom of rock anchors.

15. Earthquake Forces. - Earthquake will not be a factor for the structures and was neglected.

16. Ice Pressure. - Ice effects will be limited to possible impact of ice floating parallel to the wall, and is not expected to be significant.

17. Wind Pressure. - A wind of 50 pounds per square foot was used where applicable.

18. Frost Protection. - Stability and structural consideration will require sufficient depth for all structures for ample frost protection.

19. Position of Resultant. - In the design of structures, the resultant of the horizontal and vertical loads has been held to the middle third with the water at design level and to the middle half with water at the top of the wall.

20. Allowable Soil Bearing. - It is established that the minimum value of allowable soil bearing pressure under the wall will be 4,000 p.s.f.

21. Sliding. - A coefficient of friction of 0.20 was used in computing the stability against sliding of unanchored walls founded on bedrock and the plane of sliding was assumed to be at the bottom of the wall base. A coefficient of 0.30 was used in compacting the stability against sliding of anchored walls and the plane of sliding was assumed to be at the bottom of the anchor.

F. TEE-TYPE FLOOD WALLS, WITHOUT ANCHORS

22. General. - While most of the flood walls on this project were anchored to shale bedrock as discussed in Section H, "Foundation Stability - Floodwalls" hereafter, two sections were designed without anchors. Between Station 8+00 and 9+77 the rock dips too low for its use as foundation to be feasible. This reach of wall was founded on glacial till. Between Station 16+75 and Station 19+0, the wall was founded on shale but has sufficient backfill on the landside so that rock anchors are not required.

23. Stability. - Loading conditions considered were those set forth in EM 1110-2-2501; Case 1 with water at the top of the wall, resultant in the mid-half of the base, 33-1/3% overstress allowed; Case 2 with water three feet below the top of the wall and the resultant in the middle third, and Case 3 with water level in front of the wall at the riverbed 50 p.s.f. wind from the landside, resultant in the middle third. Computations for walls at Station 8+40 and at 17+60 are appended as Appendix A and B.

24. Reinforcing Steel. - Steel was designed for the worst cases which could reasonably be expected to occur. Stem moments were determined without consideration of passive earth pressure. Footing moments were distributed by consideration of base pressures, with total moments at root of toe and heel commensurate with the stem moment.

G. ROCK-ANCHORED TEE WALLS

25. General. - The peculiarities of the shale rock, discussed in paragraph 14 above and paragraph 29 below, resulting from the possibility of nearly horizontal clay-filled bedding planes, require that where backfill on the landside is not sufficiently deep to provide passive resistance against sliding, the wall must be anchored to the rock. This design used #11 high-strength bars grouted into 3½ inch bore holes with non-shrink grout.

26. Stability. - Stability was considered along two planes; at the bottom of concrete and at the bottom of the pinned prism of rock which acts as part of the wall footing. Uplift was considered separately at each level, by the line-of-creep

method. Anchors were inclined at 30° to the vertical (15°± to the bedding planes of the shale) and considered to act in tension, with the horizontal component resisting sliding. The riverward anchor was placed vertically to resist overturning. For sliding along the plane at the base of the anchors, lateral rock pressure of 2-3 Kips per sq. ft. were considered acting on the pinned prism to prevent sliding. Computations are shown in Appendix C and D, for walls at Sta. 5+80 and 24+50.

27. Reinforcing Steel. - Reinforcing steel was designed for worst cases due to the normal loadings, with consideration of the effects of the anchors on base pressures. Advantage was taken of the rock anchors to reduce footing concrete quantities.

H. FOUNDATION STABILITY - FLOOD WALLS

28. General. - Foundations present no problems in bearing or settlement, being shale rock for the most part, with approximately 200 feet on sound glacial till. Foundation stability analyses were made of all sections.

29. Walls on Shale. - Walls on shale were analyzed by the sliding block and wedge method where there was sufficient backfill so that the sliding stability was not obviously below acceptable limits (factor of safety equal to 1.5) without rock anchors. The following assumptions were made:

a. River level at the top of the wall.
b. Horizontal loading computed as the full hydrostatic pressure against the wall from the top of the stem to the bottom of the heel. Lateral soil pressures against the heel were neglected on the assumption that a crack had formed.
c. Uplift pressures determined by the line-of-creep method.
d. Toe drains on the land side assumed to be inoperative; tailwater elevation taken to be the ground surface.
e. Any rock embedment at the toe of the base assumed to offer no additional resistance. The failure plane passing through this zone from the toe was treated as passive soil resistance, since this rock is generally weathered and chemically altered.

f. It was assumed that the theoretical sliding failure plane was:

a. Horizontal, along the bottom of the base.
b. Continuous along any 20-foot wall monolith.
c. Had a coefficient of sliding friction equal to 0.2. (Resisting force equals net vertical including uplift x 0.2.)

g. Definition of Factor of Safety:

$$F.S. = \frac{\text{Available Resisting Forces}}{\text{Net Activating Forces}}$$

$$= \frac{(P_N\text{-Uplift})F+P_p^1}{P_W-U_H}$$

Where:

F = Coefficient of sliding friction

P_N = Saturated weight of all materials in the sliding block.

Uplift = total uplift force n base slab.

P_p^1 = Gross passive resistance of sliding wedge less the horizontal seepage pressure.

P_W = Total hydrostatic lateral pressure on river side.

U_H = Horizontal seepage pressure against the wedge.

h. Soil criteria as listed above. Dumped rock slope protection bouyed weight taken as 70 pounds per cubic foot.

These analyses showed that the greater part of the wall required rock anchors for a satisfactory safety factor against sliding. The sliding friction factor of 0.2 for the shale was based on mud-filled bedding planes found in the core borings and was determined numerically as the higher range of several laboratory tests of sound rock cores. A typical analysis for the wall at Station 17+60 is shown on Plate 12.

30. Stability Analysis for Flood Wall on Soil. - The flood wall section at Sta. 8+40 was selected as typical for an analysis of foundation stability along the reach of wall which is founded on soil. The flood wall section, flow net, trial failure circles and a typical analysis for one of the circles are shown on Plate No. 11. The factors of safety against foundation failure for the assumed conditions indicated on the sheet are:

Trial Circle No.	Radius (Ft.)	Factor of Safety
1	66	2.43
2	88	2.50
3	48	2.35
4	88	2.00

From this analysis it is concluded that the design flood wall section is adequately safe against a foundation shear failure, and that additional variations or refinements of the analyses are unwarranted.

I. CONDUITS

31. Basic Data and Assumptions. - Stresses used are listed in paragraphs 7 and 8. Soil weights are given in paragraph 10. Loading was considered for each case of soil pressure, internal and/or external water pressure, etc. Joints will be water-stopped and provided with collars as shown on Plate 13. Conduits for future sewers thru the dike were provided with capped cast iron pipe closures at each end.

32. Design. - Design is based on EM Part CXXIX, Chapter 2, dated June 1948. A typical conduit design is presented in Appendix E.

33. Foundations. - Foundations are natural tills and/or sands, and compacted dike materials. No settlements of a magnitude which would distress the joints are anticipated.

J. DRAINAGE STRUCTURES

34. General. - Drainage structures are of a variety of types and sizes including, gate chambers, junction structures, single and double manholes, drain inlets of various sizes and endwalls. Some structures are close to the railroad loads.

The B & M RR requires design for switching engine with 31,000 lb. wheel loads on 8 foot centers, with trucks 22 feet on centers, plus 25% impact. The railroad requires a 45% stress cone from the ends of 8'-6" ties and allows the 31,00 lb. wheel to be taken as a uniform load over 3 ties.

35. Design. - Design follows applicable parts of EM Part CXXIX, Chapter 2, dated June 1948 and ordinary good practices.

36. Foundations. - No difficulty is anticipated with foundations of drainage structures.

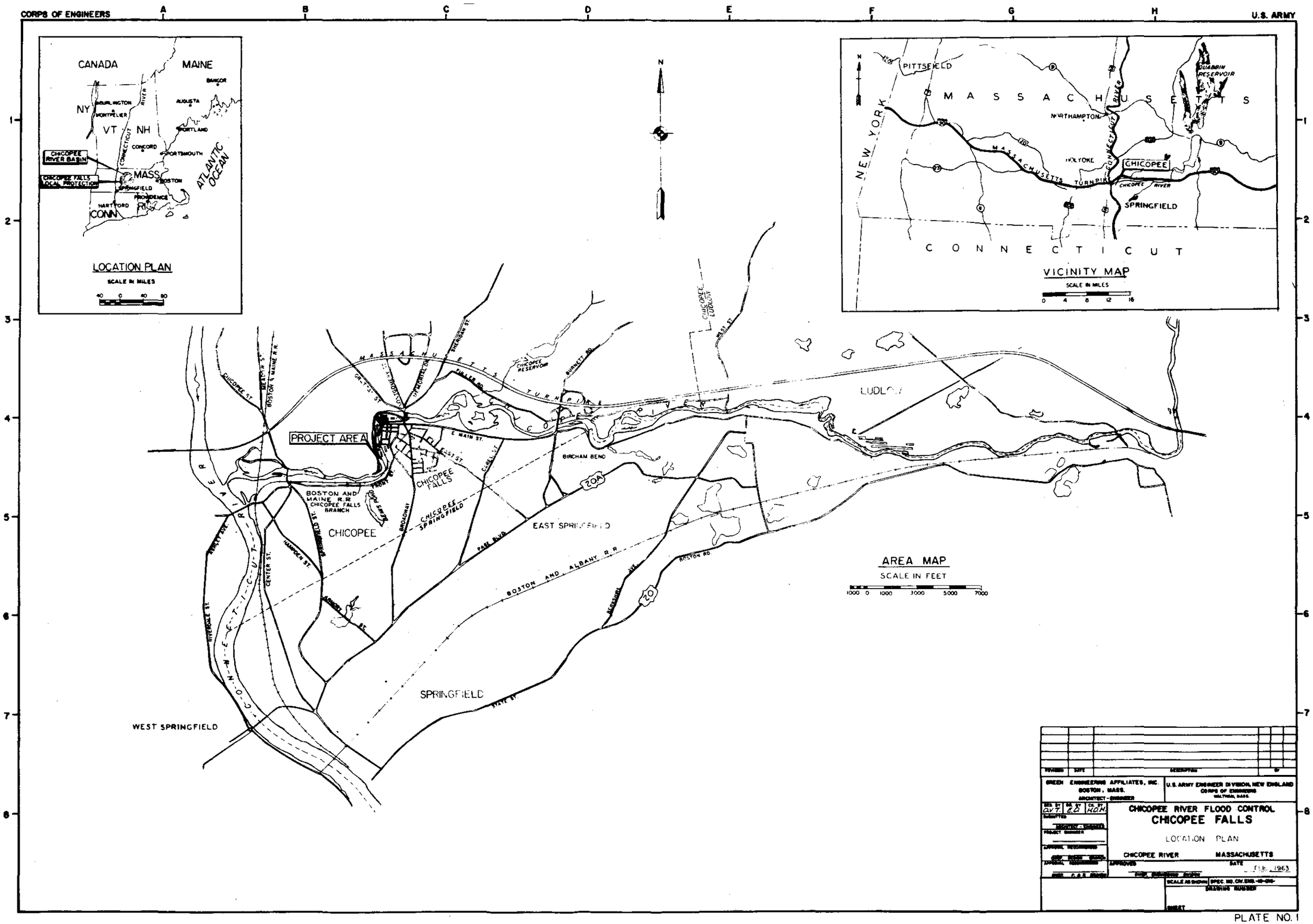

CORPS OF ENGINEERS
U.S. ARMY
CANADA
MAINE
NY
VT
NH
MASS
CONN
RI
ATLANTIC OCEAN
CHICOPEE RIVER BASIN
CHICOPEE FALLS LOCAL PROTECTION
LOCATION PLAN
SCALE IN MILES
PITTSFIELD
MASSACHUSETTS
NEW YORK
NORTHAMPTON
HOLYOKE
CHICOPEE
SPRINGFIELD
CONNECTICUT
QUABBIN RESERVOIR
VICINITY MAP
SCALE IN MILES
PROJECT AREA
CHICOPEE FALLS
CHICOPEE
EAST SPRINGFIELD
SPRINGFIELD
WEST SPRINGFIELD
LUDLOW
BIRCHAM BEND
BOSTON AND MAINE R.R. CHICOPEE FALLS BRANCH
BOSTON AND ALBANY R.R.
CHICOPEE SPRINGFIELD
CHICOPEE RESERVOIR
AREA MAP
SCALE IN FEET
GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.
ARCHITECT-ENGINEER
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
LOCATION PLAN
CHICOPEE RIVER
MASSACHUSETTS
FEB. 1963

PLATE NO. 1

CORPS OF ENGINEERS U.S. ARMY

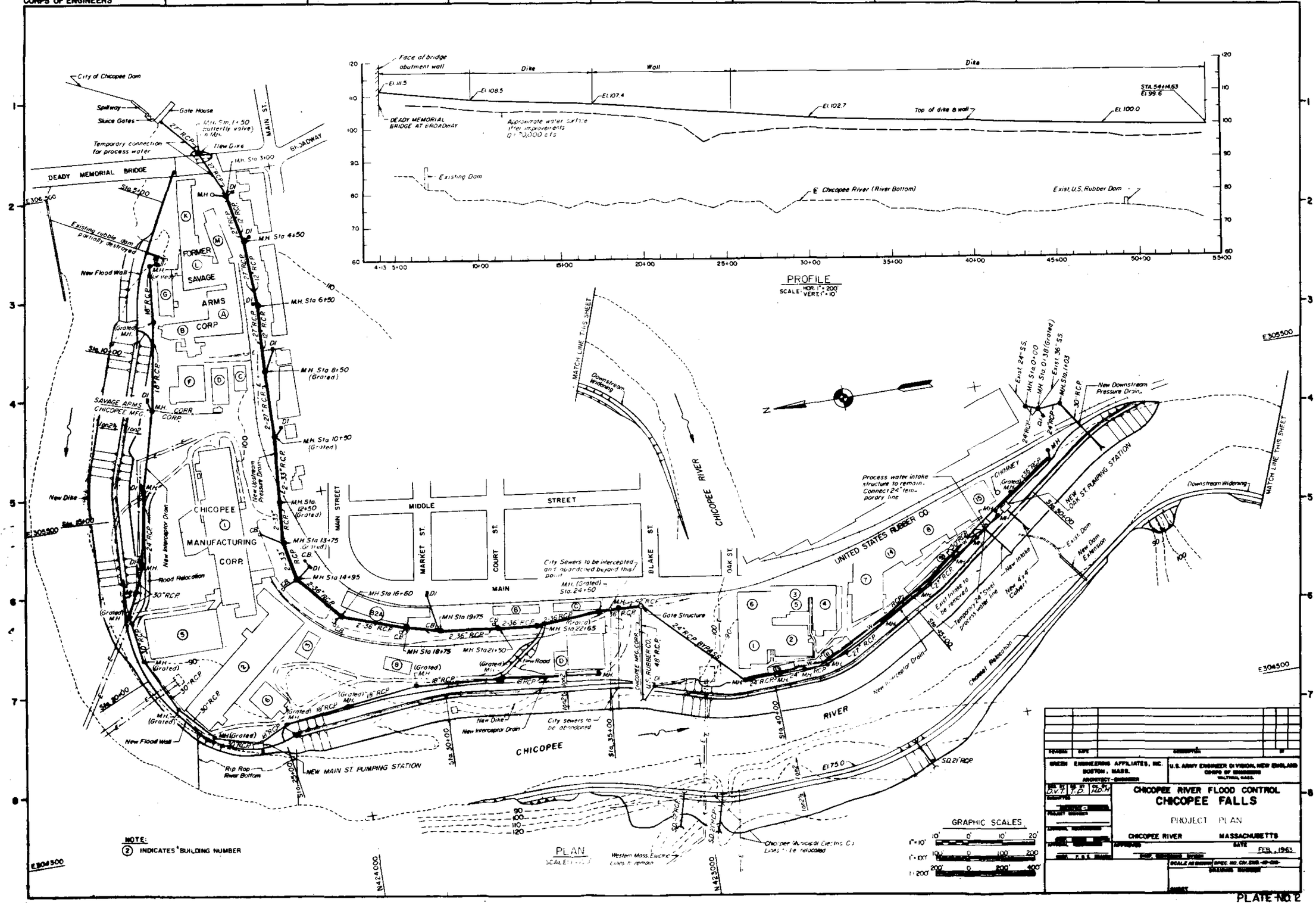
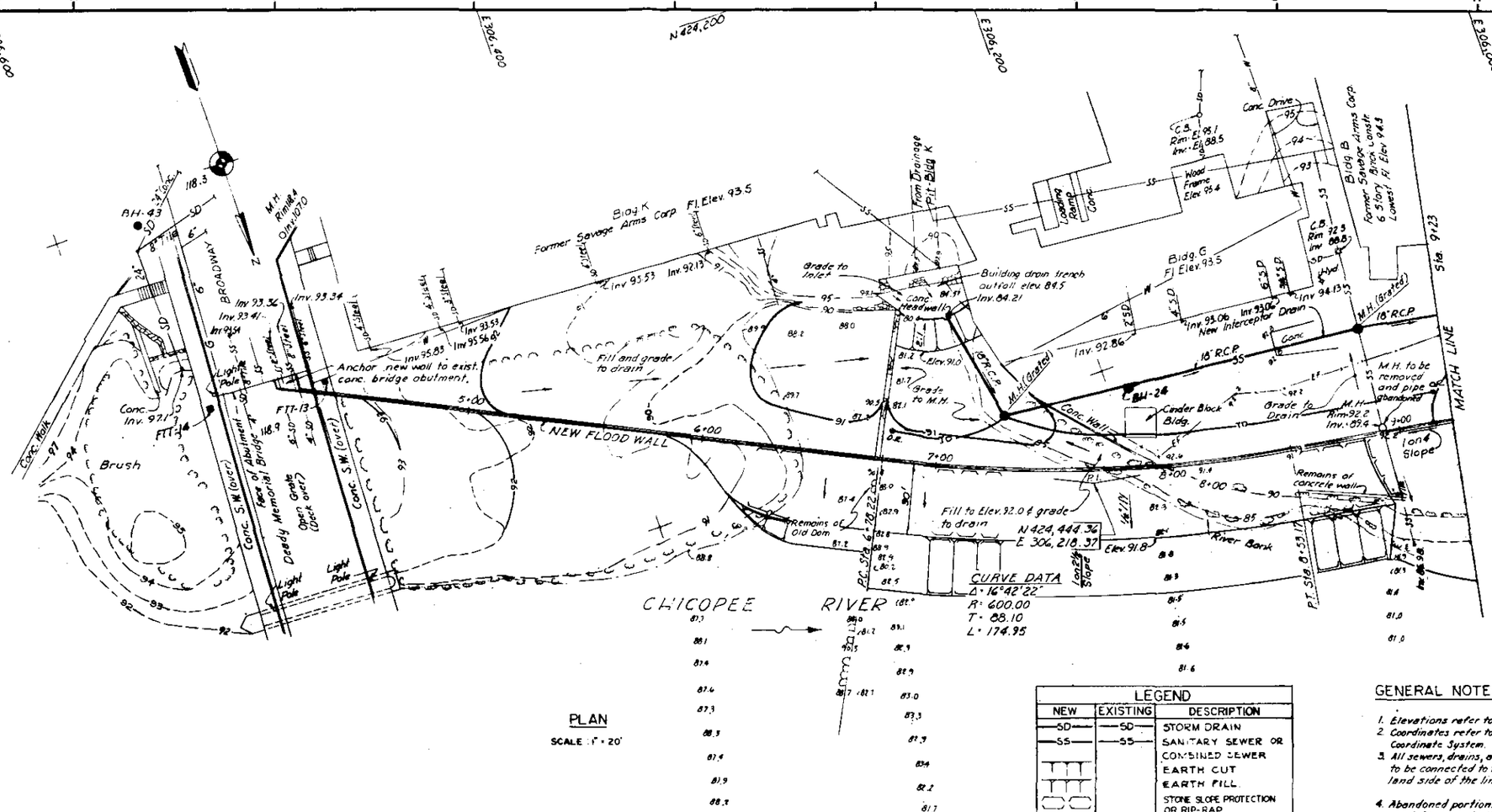


PLATE NO. 2

CORPS OF ENGINEERS U.S. ARMY



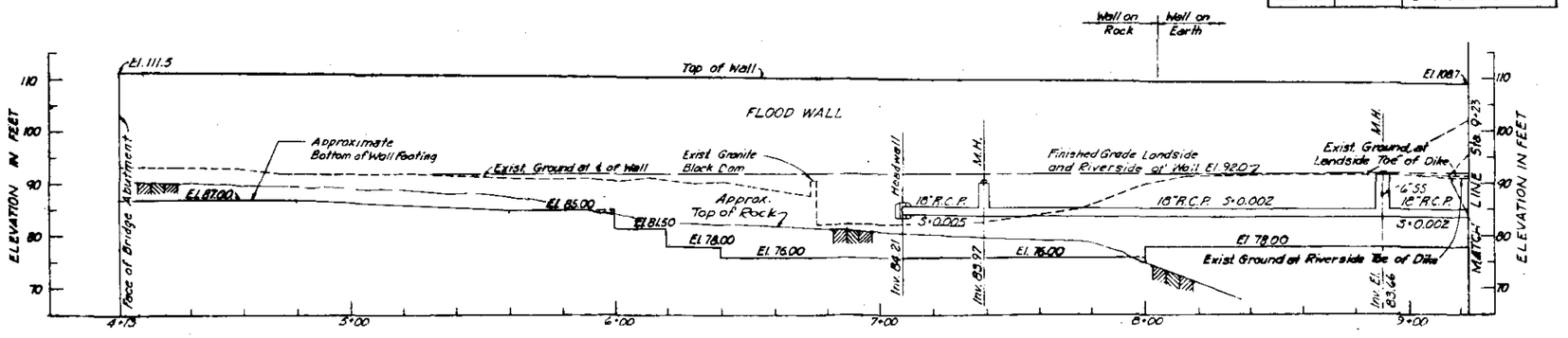
PLAN

SCALE: 1" = 20'

LEGEND		
NEW	EXISTING	DESCRIPTION
—SD—	—SD—	STORM DRAIN
—SS—	—SS—	SANITARY SEWER OR COMBINED SEWER
		EARTH CUT
		EARTH FILL
		STONE SLOPE PROTECTION OR RIP-RAP
—TD—		TOE DRAIN
O.R.		OBSERVATION RISER
—SS—		24" PIPE AND OVER

GENERAL NOTES

1. Elevations refer to Mean Sea Level Datum.
2. Coordinates refer to Massachusetts State Plane Coordinate System.
3. All sewers, drains, and drainage structures are to be connected to the new interceptor on the land side of the line of flood walls and dikes.
4. Abandoned portions of utilities, penstocks, conduits etc. shall be removed at least between points 5 feet beyond the extreme foundation limits of the earth sections of dikes; the remaining ends of utilities shall be plugged in an approved manner.
5. Toe drains to be 8" perforated AB ACCMP.



PROFILE—WALL

SCALES: HOR 1" = 20' VERT 1" = 10'

GRAPHIC SCALES

1" = 10' 10' 0 10' 20'

1" = 20' 20' 0 20' 40'

GREEN ENGINEERING AFFILIATES, INC. BOSTON, MASS. ARCHITECT-ENGINEER

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

CHICOPEE RIVER FLOOD CONTROL

CHICOPEE FALLS

GENERAL PLAN AND PROFILE

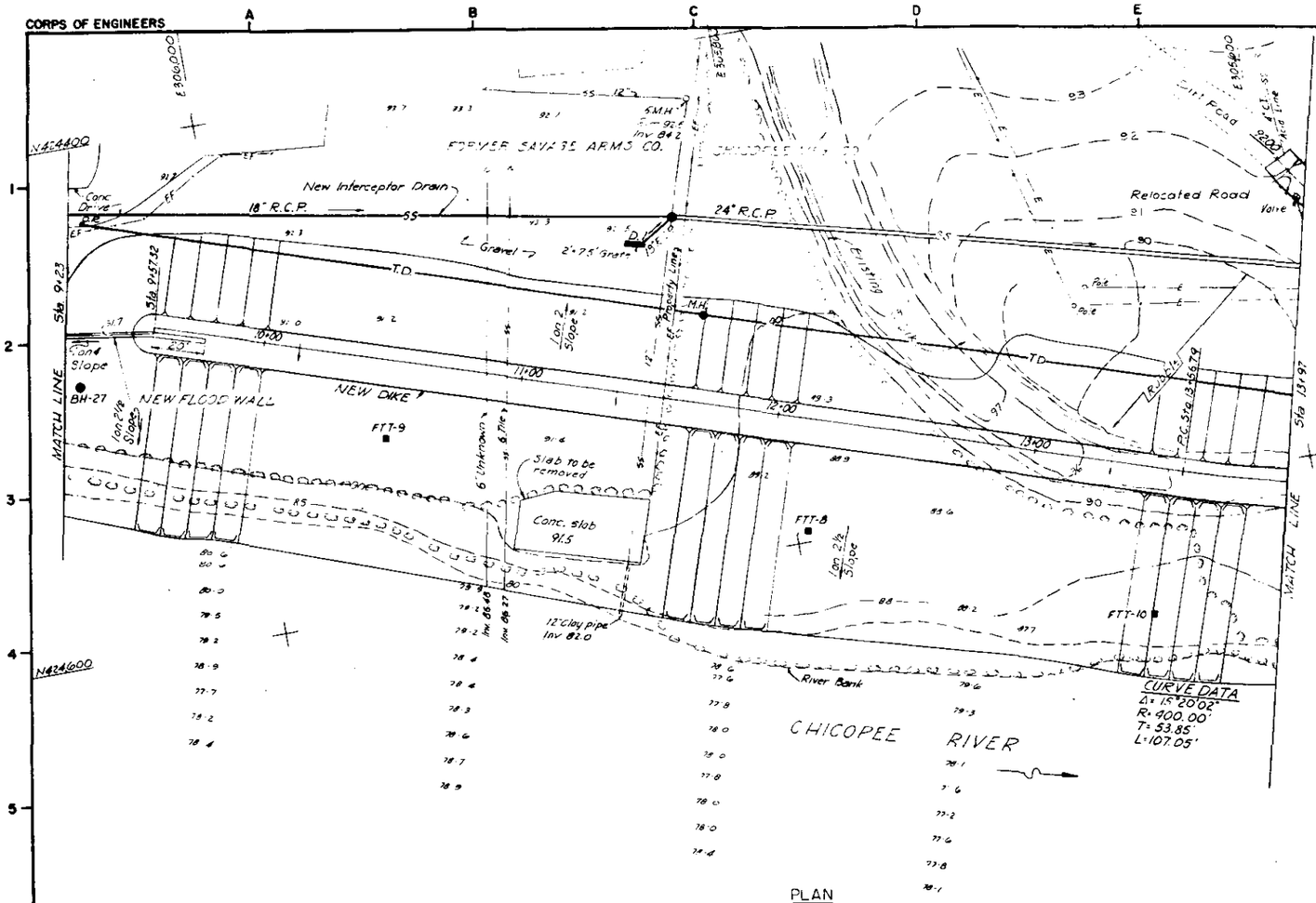
STA. 4+13 TO STA. 9+23

CHICOPEE RIVER MASSACHUSETTS

DATE FEB., 1963

PLATE NO. 3

CORPS OF ENGINEERS — U.S. ARMY

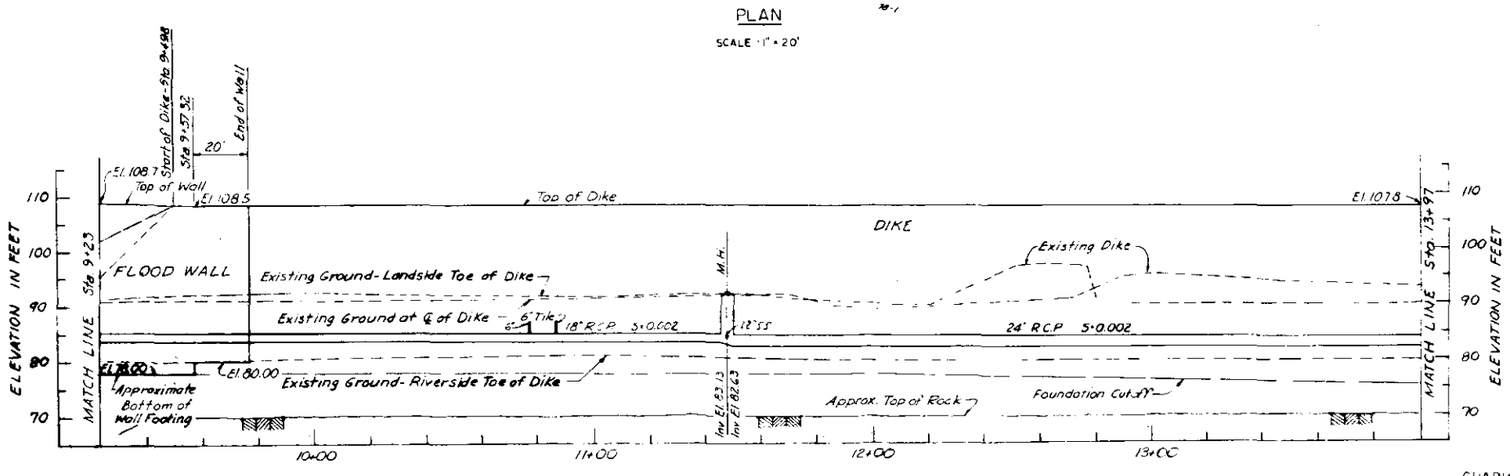


PLAN

SCALE 1" = 20'

NOTES:

1. For General Notes and Legend see Plate No. 3.



PROFILE - WALL AND DIKE

SCALES HOR 1" = 20'
VERT 1" = 10'

GRAPHIC SCALES

1" = 10' 10' 0 10' 20'

1" = 20' 40' 0 20' 40'

REVISION	DATE	DESCRIPTION	BY

GREEN ENGINEERING AFFILIATES, INC. BOSTON, MASS. ARCHITECT - ENGINEER

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

DES. BY D.V.T. | DR. BY H.M. | CK. BY W.D.H.

SUBMITTED

ARCHITECT - ENGINEER

PROJECT ENGINEER

APPROVAL RECOMMENDED

CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED

CHIEF, F. & S. BRANCH

CHICOPEE RIVER FLOOD CONTROL

CHICOPEE FALLS

GENERAL PLAN AND PROFILE

STA 9+23 TO STA 13+97

CHICOPEE RIVER — MASSACHUSETTS

APPROVED

CHIEF, ENGINEERING DIVISION

DATE FEB., 1963

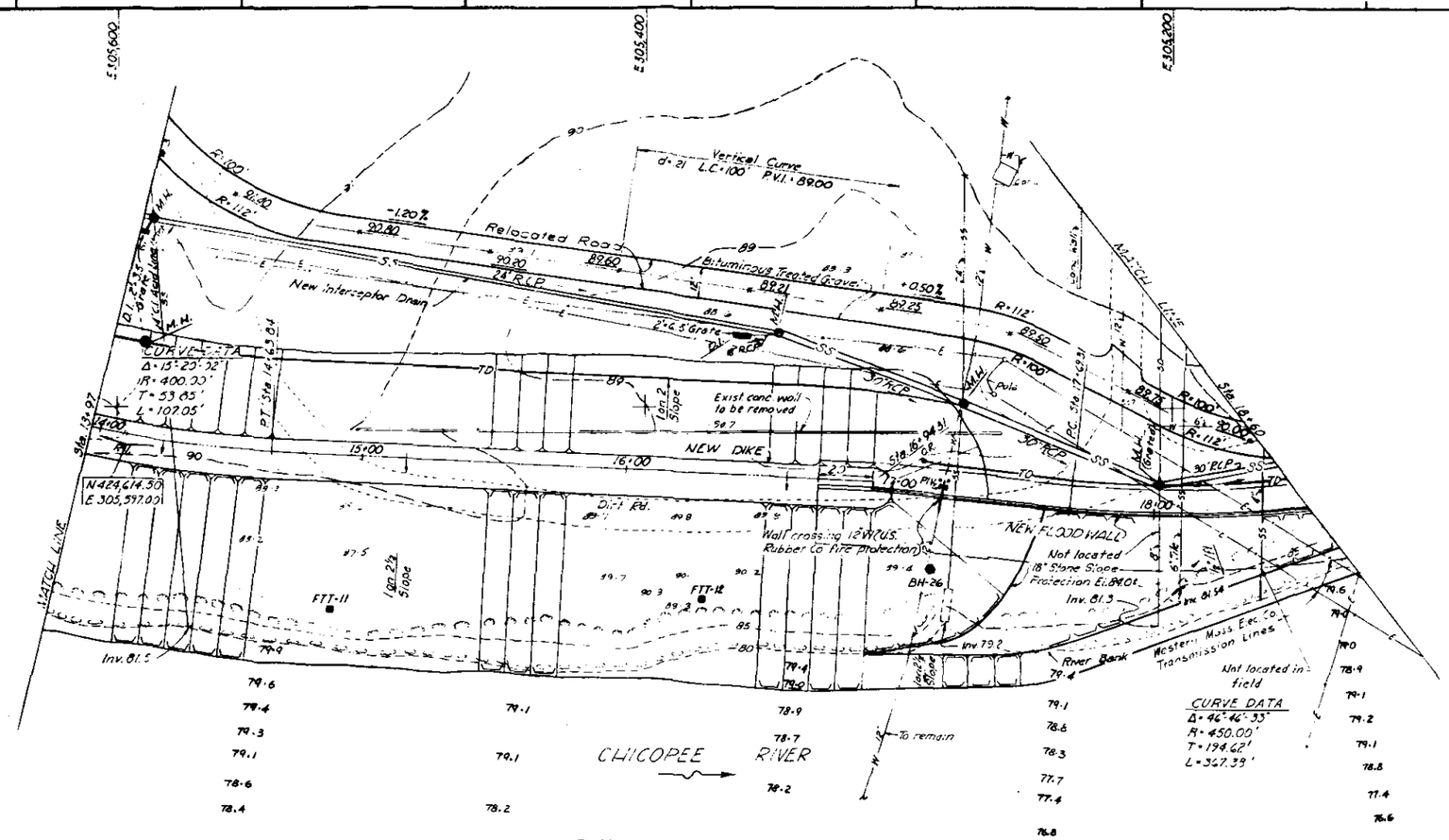
SCALE AS SHOWN | SPEC. NO. CIV. ENG.-10-010

DRAWING NUMBER

SHEET

PLATE NO. 4

CORPS OF ENGINEERS — U.S. ARMY

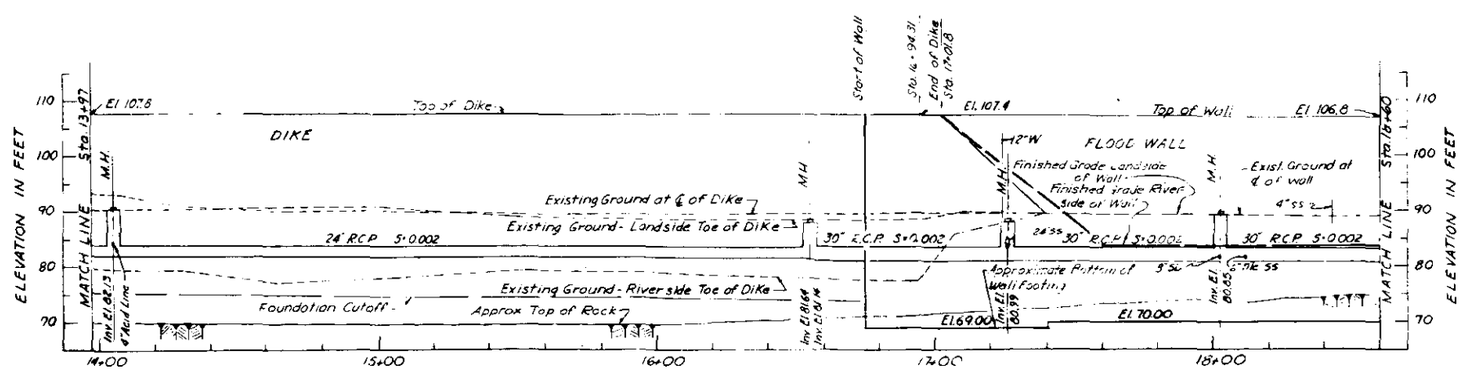


PLAN

SCALE 1" = 20'

NOTES:

1. For General Notes and Legend see Plate No. 3.
2. Stone slope protection of wall to extend 10' beyond heel of footing or to toe of slope, whichever is further.



PROFILE—WALL AND DIKE

SCALES HOR 1" = 20' VERT 1" = 10'

GRAPHIC SCALES

1" = 10' 10' 0 10' 20'

1" = 20' 20' 0 20' 40'

REVISION	DATE	DESCRIPTION	BY

GREEN ENGINEERING AFFILIATES, INC. BOSTON, MASS. ARCHITECT - ENGINEER

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

DES. BY D.V.T. DR. BY H.M. CK. BY H.D.H.

SUBMITTED — ARCHITECT - ENGINEER — PROJECT ENGINEER — APPROVAL RECOMMENDED — CHIEF, DESIGN BRANCH — APPROVAL RECOMMENDED — CHIEF, P.A.D. BRANCH

APPROVED — CHIEF, ENGINEERING DIVISION

CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS

GENERAL PLAN AND PROFILE

STA 13+97 TO STA 18+60

CHICOPEE RIVER — MASSACHUSETTS

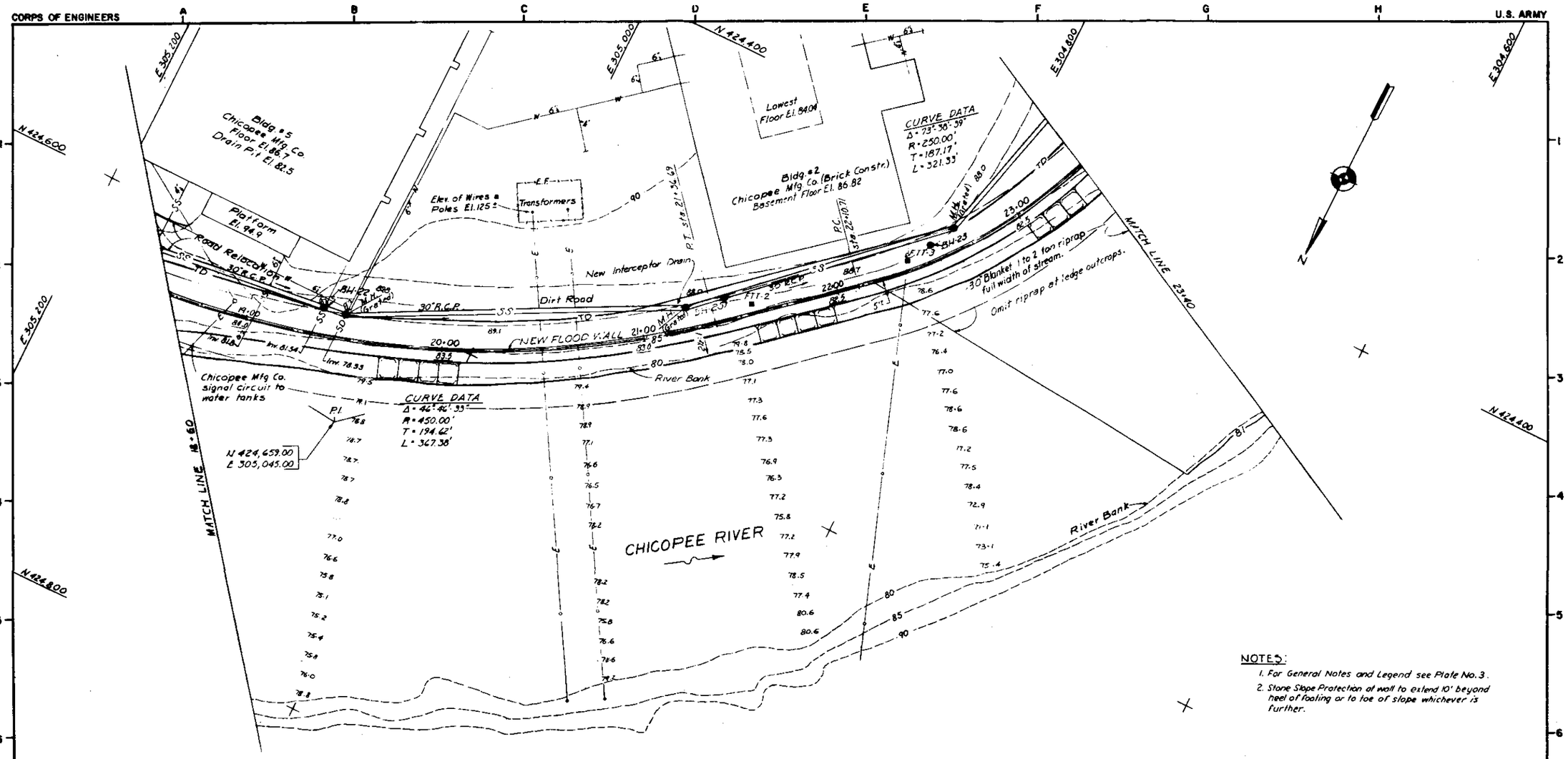
DATE 1 DEC 1963

SCALE AS SHOWN — SPEC. NO. CIV. ENG.-19-010-

DRAWING NUMBER

SHEET

PLATE NO. 5

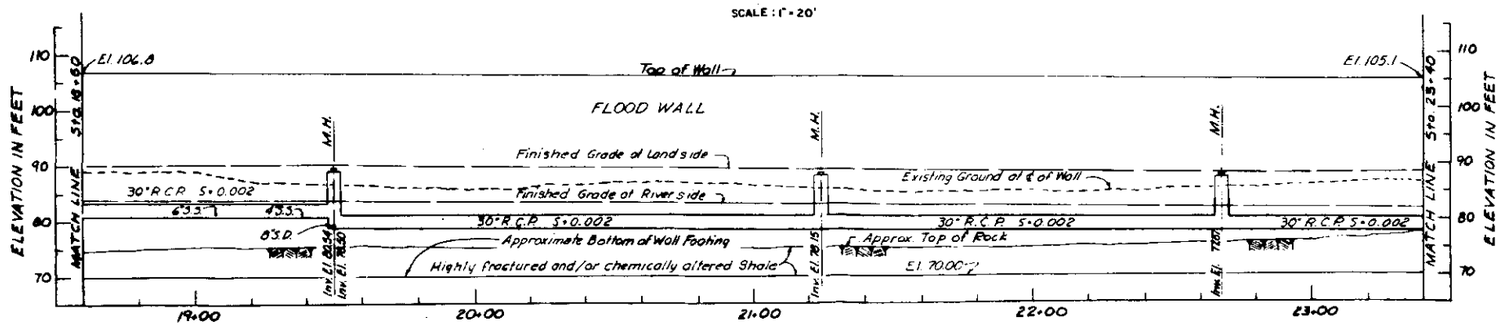


NOTES:

1. For General Notes and Legend see Plate No. 3.
2. Stone Slope Protection at wall to extend 10' beyond heel of footing or to toe of slope whichever is further.

PLAN

SCALE: 1" = 20'



PROFILE-WALL

SCALES: HOR: 1" = 20'
VERT: 1" = 10'

GRAPHIC SCALES

1" = 10'

1" = 20'

GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.
ARCHITECT-ENGINEER

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

CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
GENERAL PLAN AND PROFILE
STA. 18+60 TO STA. 23+40
CHICOPEE RIVER MASSACHUSETTS

DATE FEB., 1963

PLATE NO. 6

CORPS OF ENGINEERS — U.S. ARMY

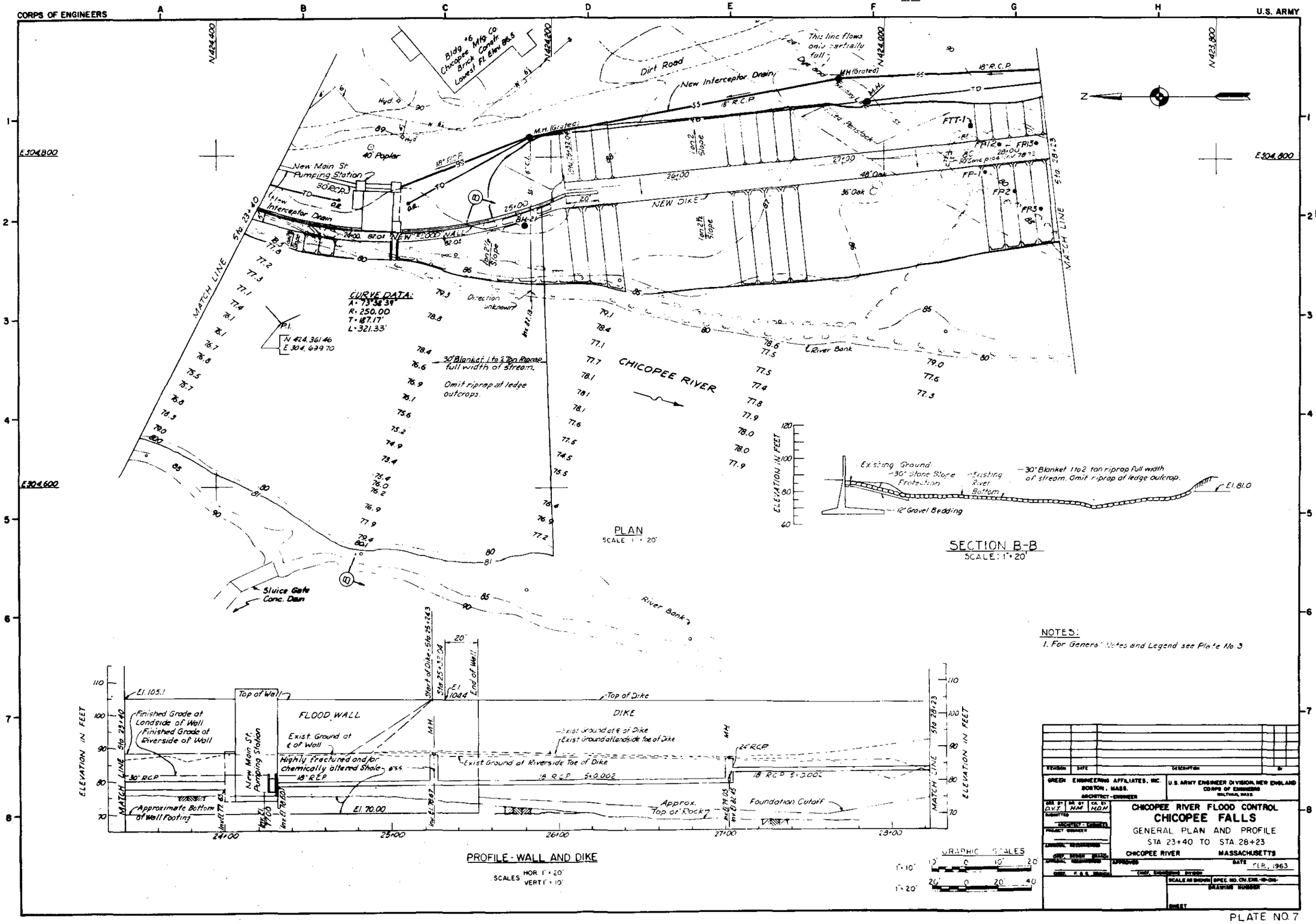
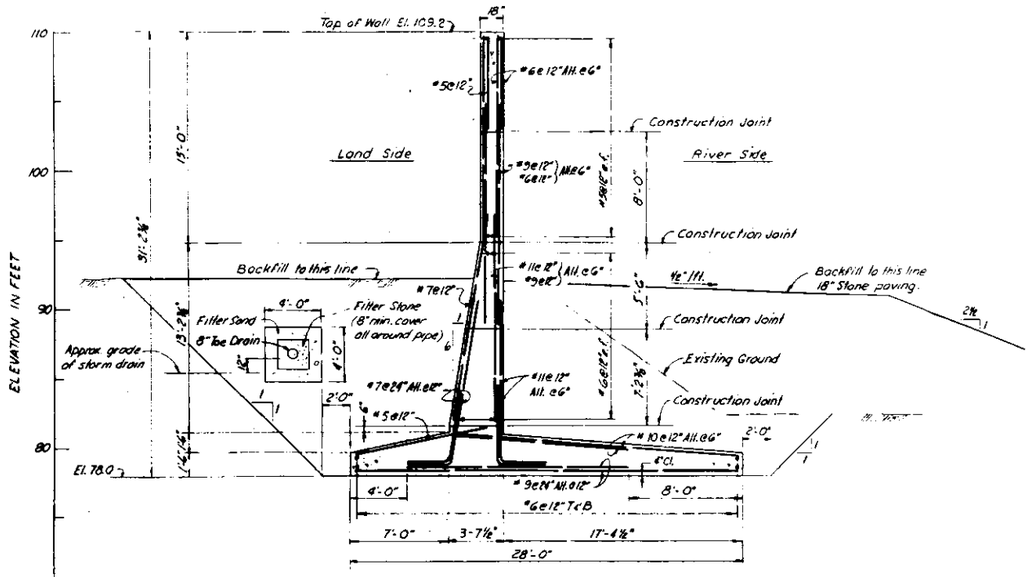


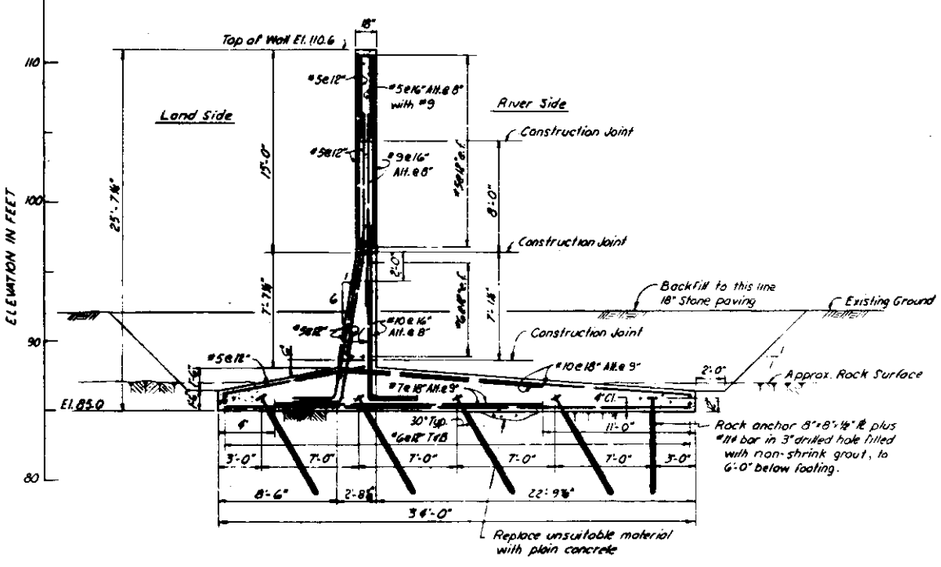
PLATE NO. 7

CORPS OF ENGINEERS — U.S. ARMY



SECTION AT STA. 8 + 40

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



SECTION AT STA. 5+80

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

NOTES:

1. Provide 3" clear cover over main reinforcing except as shown.
2. Walls on rock are set on sound rock; this requires excavation of weathered and deteriorated surface rock.

GRAPHIC SCALE

1/4" = 1'-0" 4 2 0 4 8

REVISION	DATE	DESCRIPTION	BY

GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.
ARCHITECT-ENGINEER

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

DES. BY | DR. BY | CK. BY

SUBMITTED

ARCHITECT-ENGINEER

PROJECT ENGINEER

CHICOPEE RIVER FLOOD CONTROL

CHICOPEE FALLS

TYPICAL SECTIONS

FLOOD WALL

CHICOPEE RIVER — MASSACHUSETTS

APPROVED — DATE

SCALE

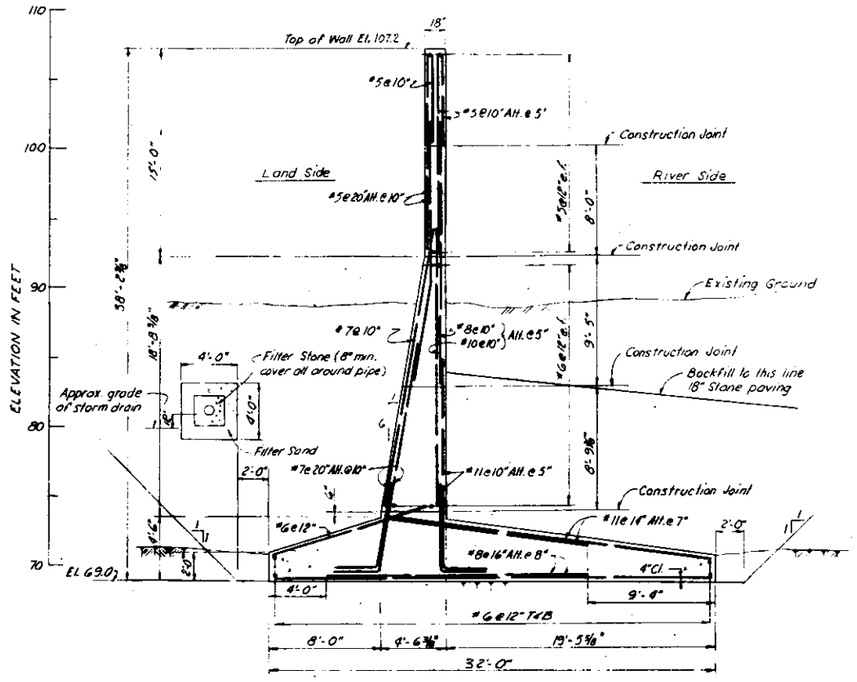
SPEC. NO. CIV. ENG.-10-010-

DRAWING NUMBER

SHEET

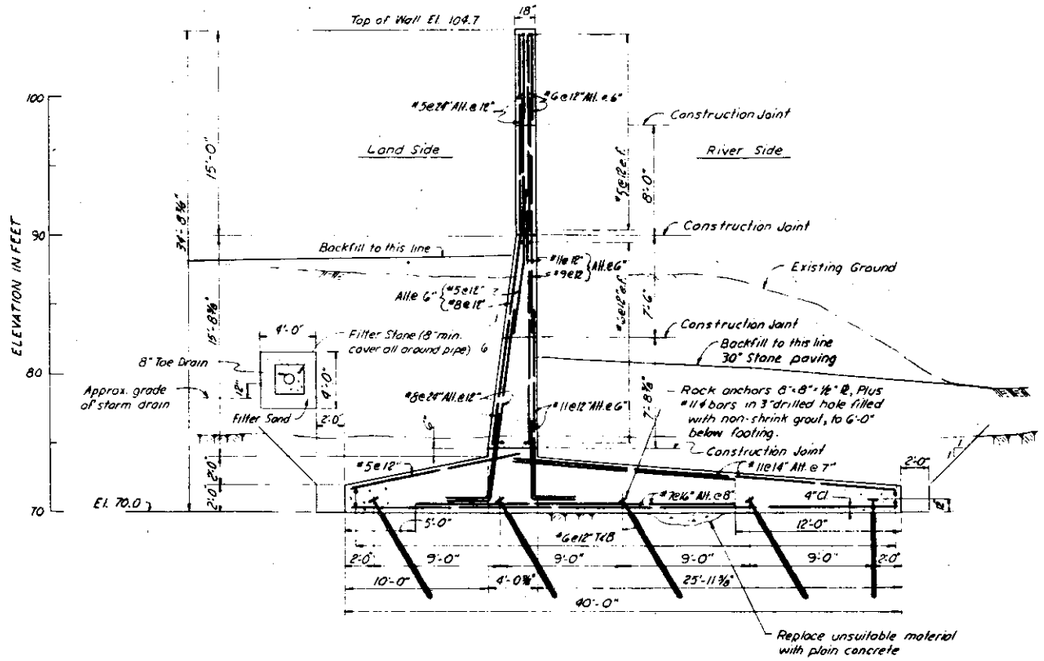
PLATE NO. 8

CORPS OF ENGINEERS U.S. ARMY



SECTION AT STA. 17+60

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



SECTION AT STA. 24+50

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

GRAPHIC SCALE

1/4" = 1'-0"

REVISION	DATE	DESCRIPTION	BY

GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.
ARCHITECT-ENGINEER

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

DES. BY | DR. BY | CK. BY

SUBMITTED
ARCHITECT-ENGINEER
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, F.O.R. BRANCH

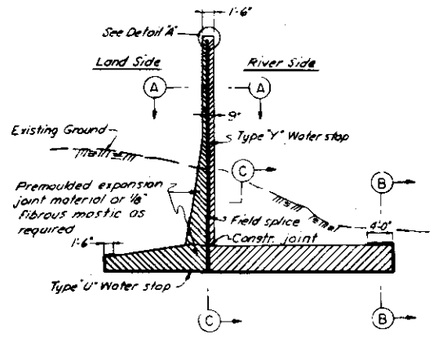
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
TYPICAL SECTIONS
FLOOD WALL
CHICOPEE RIVER MASSACHUSETTS

APPROVED DATE
CHIEF, ENGINEERING DIVISION

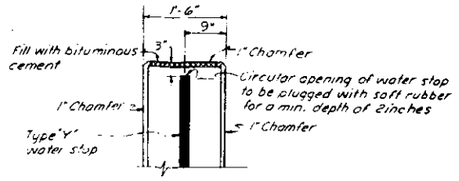
SCALE SPEC NO. CIV.ENG.-10-010-
DRAWING NUMBER
SHEET

PLATE NO. 9

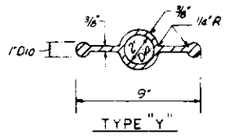
CORPS OF ENGINEERS — U.S. ARMY



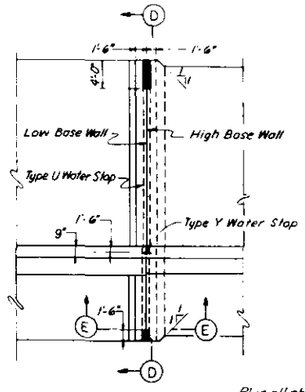
TYPICAL SECTION
SCALE: 1/8" = 1'-0"



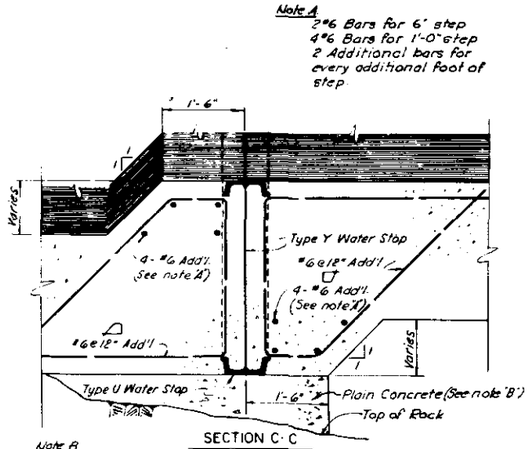
DETAIL "A"
SCALE: 1" = 1'-0"



TYPE "Y"
SCALE: 3" = 1'-0"

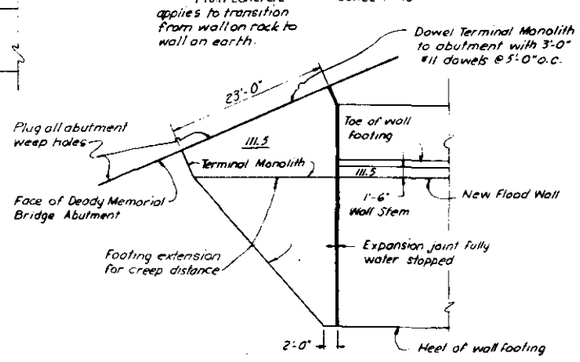


PLAN
SCALE: 1/8" = 1'-0"

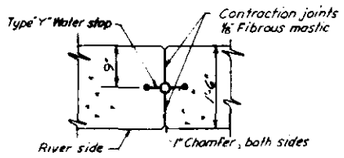


SECTION C-C
SCALE 1" = 10'

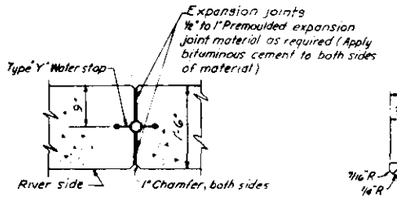
Note B
Plain concrete applies to transition from wall on rock to wall on earth.



PLAN OF TERMINAL MONOLITH
AT DEADY MEMORIAL BRIDGE
SCALE: 1/8" = 1'-0"

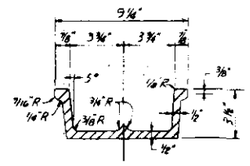


MONOLITH JOINT TYPE "A"

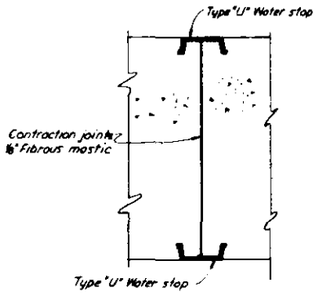


MONOLITH JOINT TYPE "B"

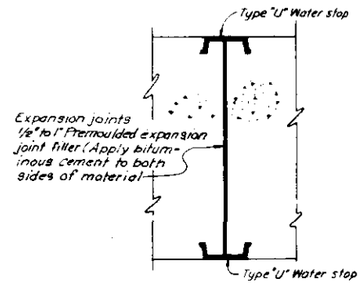
SECTION A-A
SCALE: 1" = 1'-0"



TYPE "U"
SCALE: 3" = 1'-0"



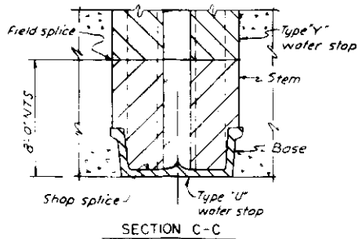
MONOLITH JOINT TYPE "A"



MONOLITH JOINT TYPE "B"

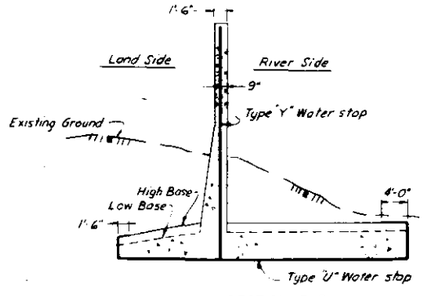
SECTION B-B
SCALE: 1" = 1'-0"

MONOLITH JOINT DETAILS



SECTION C-C
SCALE: 3" = 1'-0"

WATER STOP DETAILS



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

TRANSITIONS AT CHANGES IN WALL HEIGHT

GRAPHIC SCALES
1/8" = 1'-0"
1" = 1'-0"
3" = 1'-0"

REVISION	DATE	DESCRIPTION	BY

GREEN ENGINEERING APPLIATES, INC
BOSTON, MASS.
ARCHITECT - ENGINEER

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

DES. BY D.V.T. | DR. BY W.P. | CK. BY N.D.M.

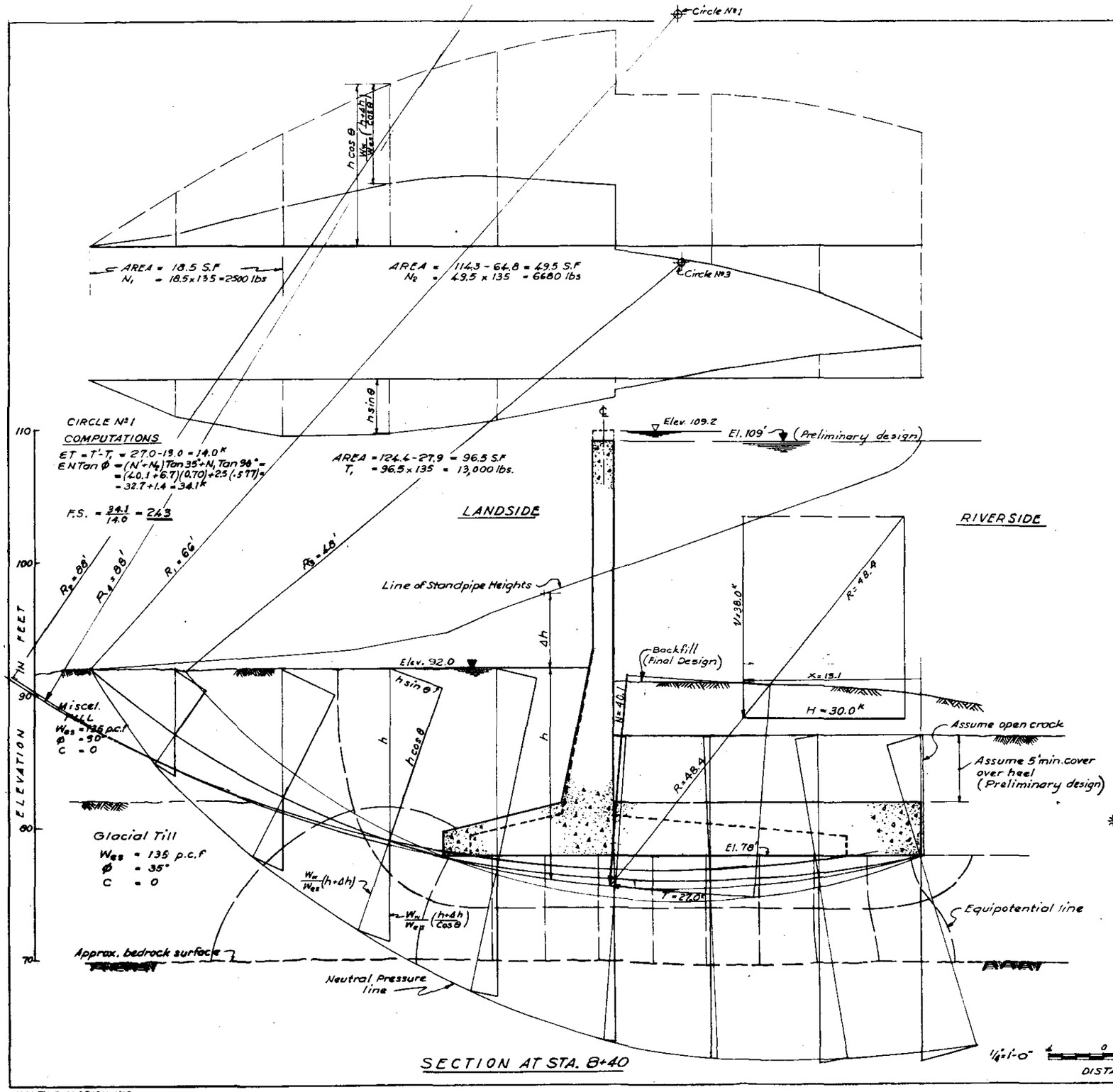
SUBMITTED
ARCHITECT - ENGINEER
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & D. BRANCH

CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
TYPICAL DETAILS
FLOOD WALL
CHICOPEE RIVER — MASSACHUSETTS

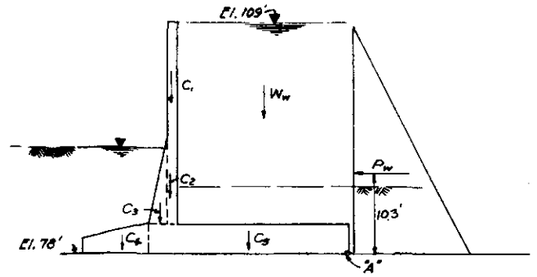
APPROVED — DATE
CHIEF, ENGINEERING DIVISION

SCALE — (SPEC. NO. CIV. ENG. -6-CIS-)
DRAWING NUMBER
SHEET

PLATE NO.10



SECTION AT STA. 8+40



CONSTANT FORCES DIAGRAM

10 0 10

SCALE IN FEET

FORCE SYMBOL	FACTORS	FORCE (lbs.) ↓	FORCE (lbs.) ←	ARM (Ft.)	MOMENT at Pt. "A" (Ft/lbs)
C_1	1.5 x 17 x 150	3820		23.5	90,000
C_2	1.5 x 10 x 20	300		23.5	7,050
C_3	½ x 10 x 25 x 20	250		25.0	6,250
C_4	3 x .9 x 20	540		30.0	16,200
C_5	4 x 26.5 x 20	2120		13.5	28,600
W_w	22.5 x 22 x 62.5	31,000		11.3	350,000
P_w	½ x 31² x 62.5		30,000	10.3	—
		38,030	30,000	ΣM_v	498,100

LOCATION OF RESULTANT FROM Pt. "A"

$$X = \frac{\Sigma M_v}{\Sigma V} = \frac{498}{38} = 13.1'$$

$$y = 10.3'$$

SUMMARY OF STABILITY ANALYSES	
CIRCLE NO.	SAFETY FACTOR
1	2.43
2	2.50
3	2.35
* 4	2.00

NOTES:

The analyses are based on the following assumptions:

1. The river level is at the top of the wall (Case I)
2. The depth of soil above the heel is a minimum of 5 feet and a crack is developed down to the base at the heel, allowing full hydrostatic pressure to develop. No earth pressure acts on the river side.
3. The tailwater level is at the ground surface on the land side.

* 4. The analyses for circle Nos. 1, 2 & 3 were based on a preliminary wall section. The stability of the final design wall section (Shown in dashed outline) was verified by circle No. 4

1/4" = 1'-0" 4 0 4 8 Ft.

DISTANCE SCALE

CHICOPEE RIVER FLOOD CONTROL

CHICOPEE FALLS

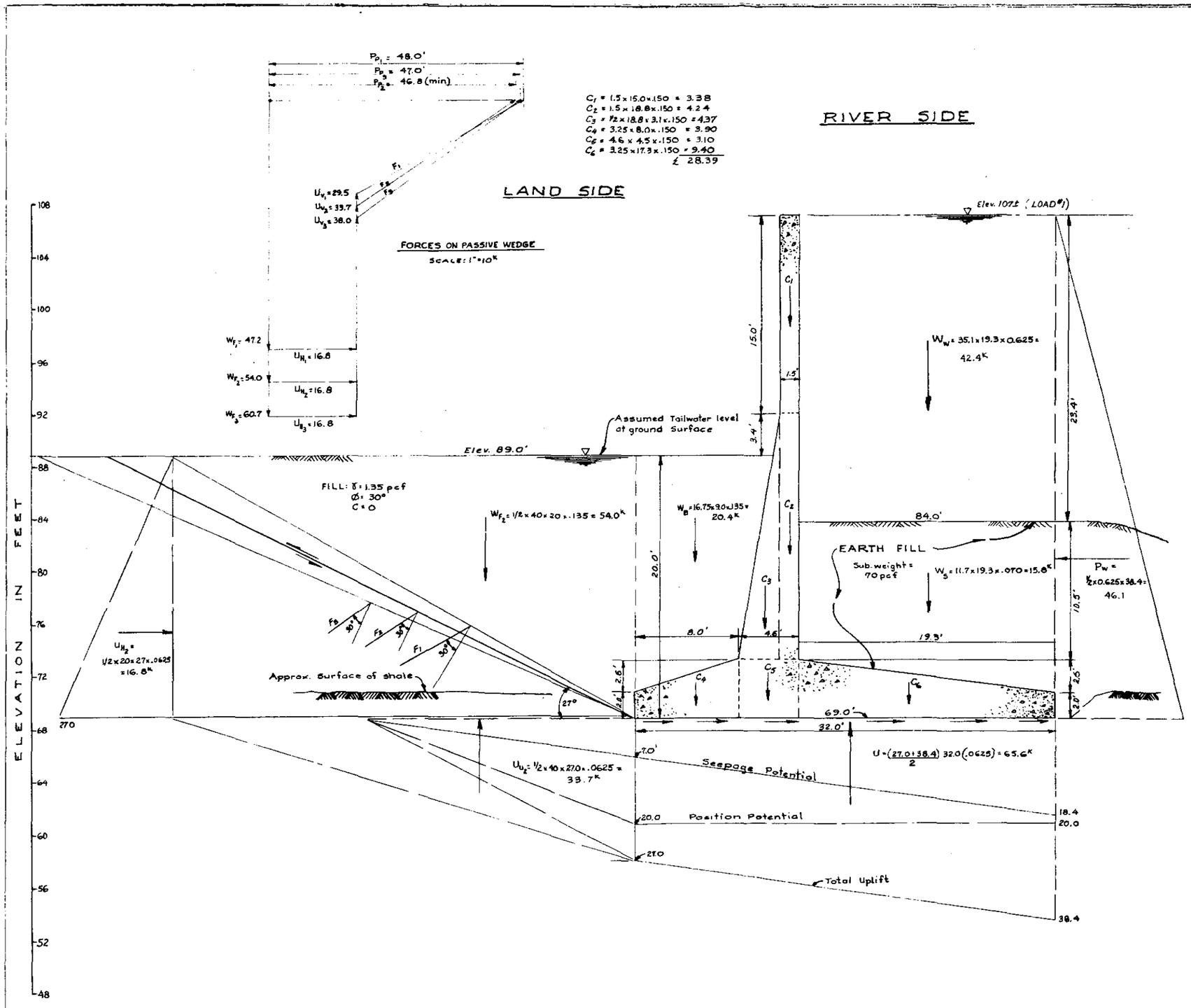
FLOOD WALL - STA. 8+40

SUMMARY OF STABILITY ANALYSES

CHICOPEE RIVER MASSACHUSETTS

HALEY & ALDRICH, INC.
CONSULTING SOIL ENGINEERS

PLATE NO. 11



NOTES

The analysis is based on the following assumptions:

1. The river level is at the top of the wall (Case I.)
2. Full hydrostatic lateral pressure is developed down to the base at the heel.
3. The uplift pressures on the base are the sum of the position potential and the seepage potential.
4. The toe drains on the land side are inoperative. The tailwater level is at the ground surface.
5. The theoretical sliding failure plane in the shale is;
   (a) horizontal, immediately below the base.
   (b) continuous along the full length of the wall section.
   (c) has a coefficient of sliding friction "f", equal to 0.20 (see Geology, General Memorandum).
6. This analysis is typical for all flood wall sections founded on rock.

FACTOR OF SAFETY

$$F.S = \frac{(\Sigma C + W_W + W_B + W_S - U) f + (P_P - U_H)}{P_W - U_H}$$

$$= \frac{(28.4 + 42.4 + 15.8 + 20.4 - 65.6)\,0.20 + (46.8 - 16.8)}{46.1 - 16.8}$$

$$= \frac{(107.0)(.20) + 30.0}{29.3} = \frac{51.4}{29.3} = 1.75 \text{ min}$$

1/4" = 1'-0" 4 0 4 8 12 SCALE IN FEET

CHICOPEE RIVER FLOOD CONTROL

CHICOPEE FALLS

FLOOD WALL - STA. 17+60

STABILITY ANALYSIS

CHICOPEE RIVER MASSACHUSETTS

File No. 62-735

HALEY & ALDRICH, INC
CONSULTING SOIL ENGINEERS

PLATE NO. 12

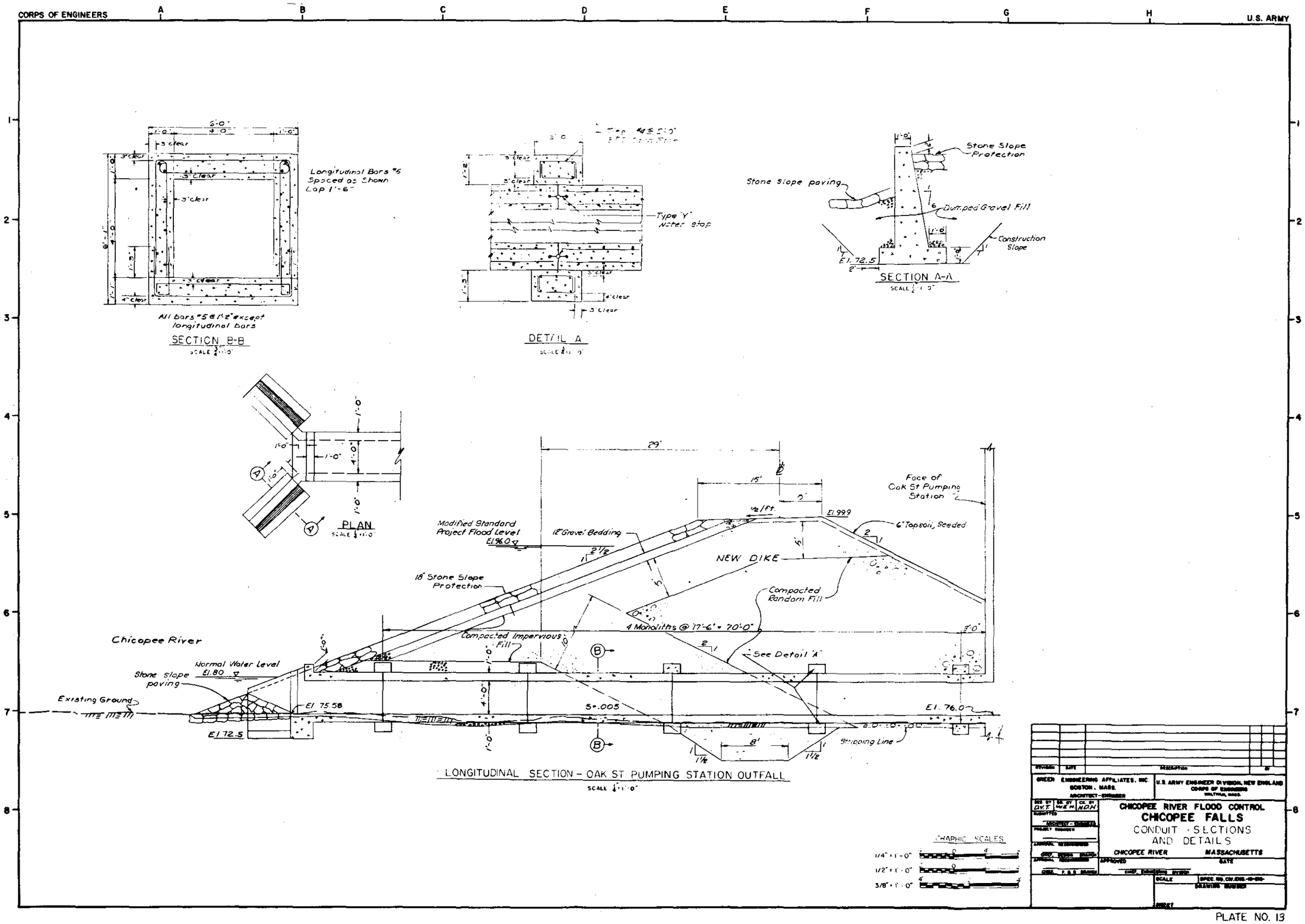
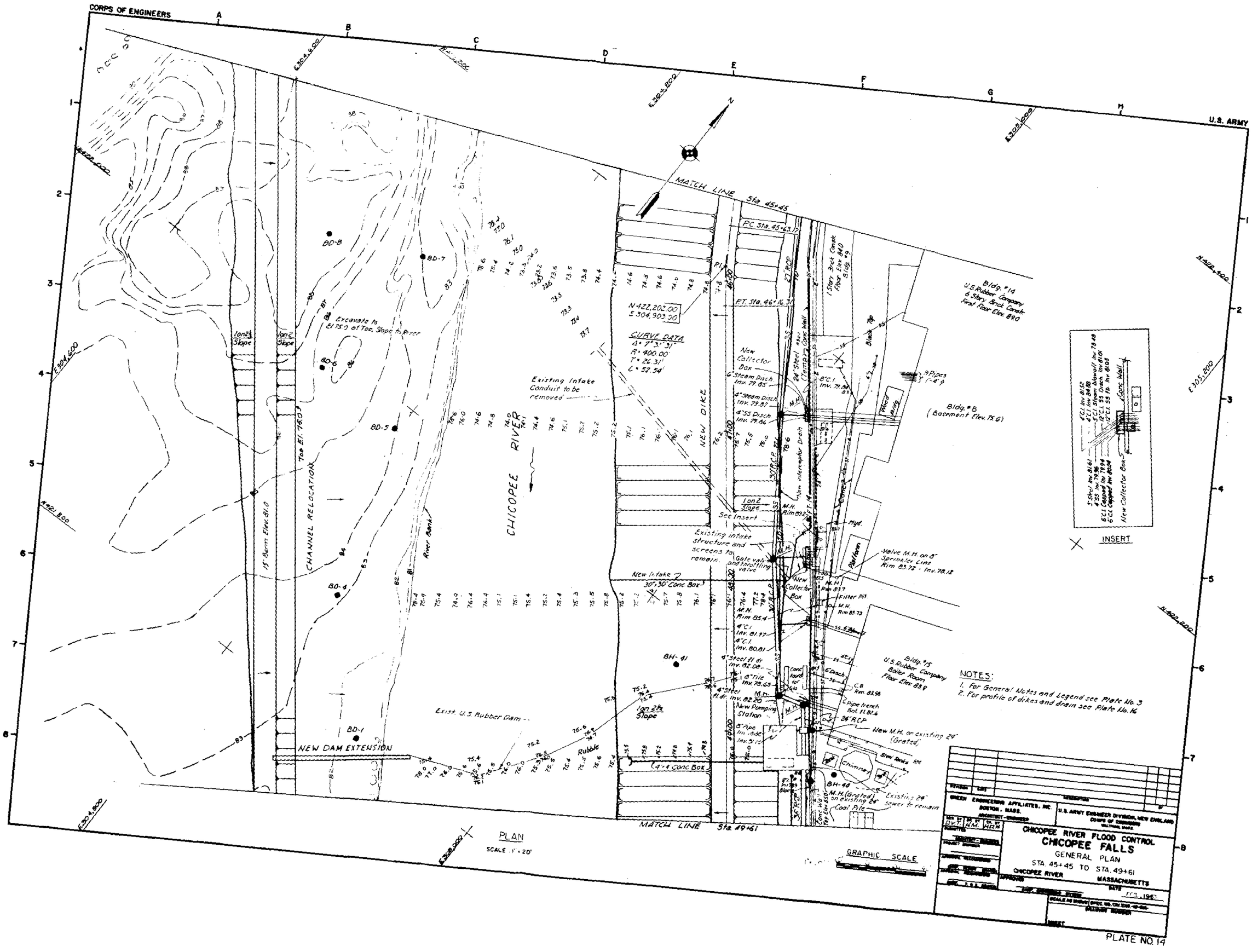
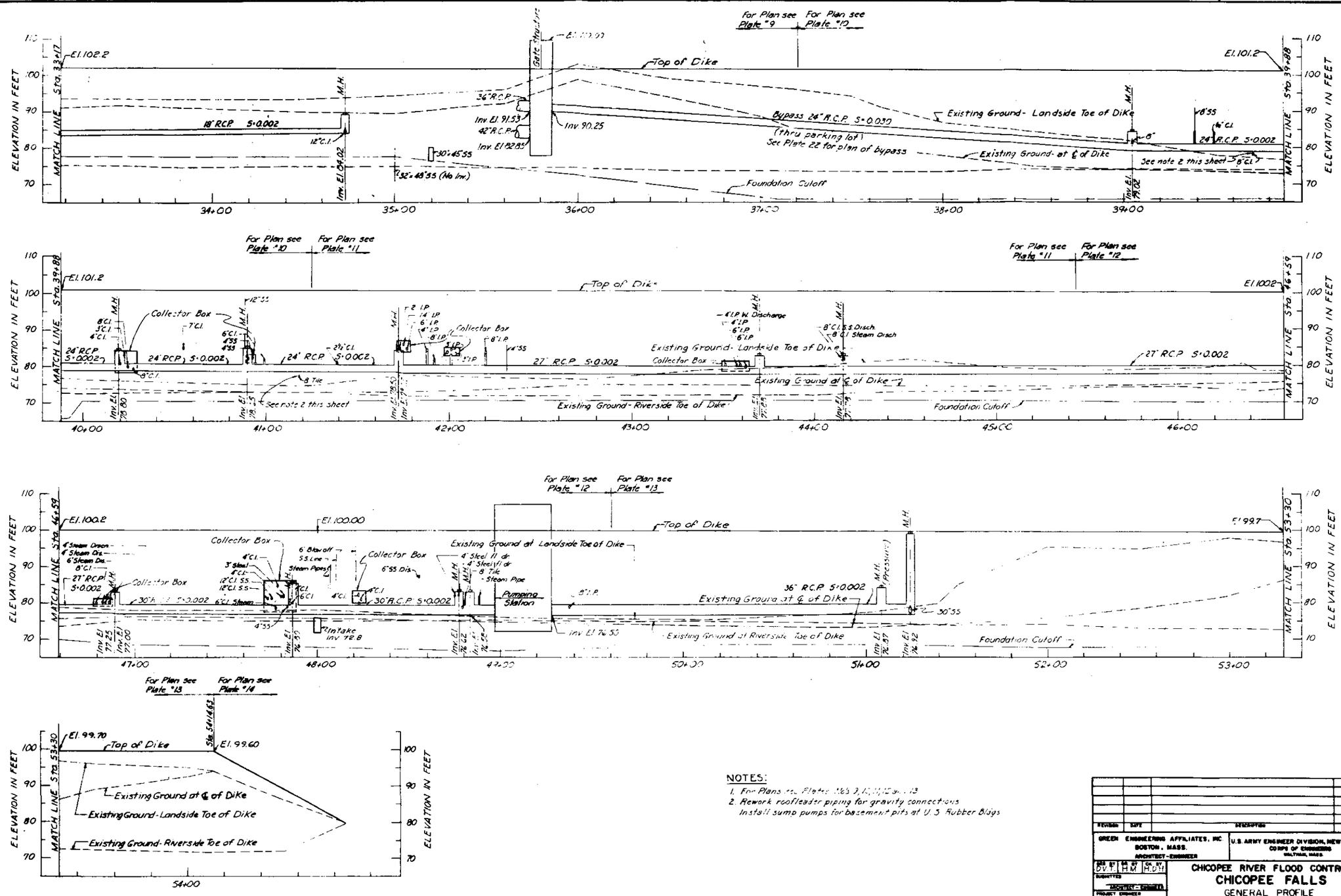

CORPS OF ENGINEERS
U.S. ARMY
Longitudinal Bars #5 Spaced as Shown Lap 1'-6"
All bars #5 @ 1'-2" except longitudinal bars
SECTION B-B
Type "Y" Water stop
DETAIL A
Stone Slope Protection
Stone Slope paving
Dumped Gravel Fill
Construction Slope
El. 72.5
SECTION A-A
PLAN
Face of Oak St Pumping Station
Modified Standard Project Flood Level El. 96.0
12" Gravel Bedding
El. 99.9
6" Topsoil, Seeded
NEW DIKE
18" Stone Slope Protection
Compacted Random Fill
4 Monoliths @ 17'-6" = 70'-0"
Compacted Impervious Fill
See Detail "A"
Chicopee River
Normal Water Level El. 80
Stone slope paving
Existing Ground
El. 75.58
El. 72.5
S=.005
El. 76.0
Stripping Line
LONGITUDINAL SECTION - OAK ST PUMPING STATION OUTFALL
GRAPHIC SCALES
1/4" = 1'-0"
1/2" = 1'-0"
3/8" = 1'-0"
GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.
ARCHITECT-ENGINEER
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
CONDUIT - SECTIONS AND DETAILS
CHICOPEE RIVER
MASSACHUSETTS
DRAWING NUMBER

PLATE NO. 13


CORPS OF ENGINEERS
U.S. ARMY
MATCH LINE Sta 45+45
MATCH LINE Sta 49+61
CHICOPEE RIVER
CHANNEL RELOCATION
NEW DIKE
NEW DAM EXTENSION
Existing Intake Conduit to be removed
Existing intake structure and screens to remain
New Intake 30"x30" Conc. Box
New Collector Box
New Pumping Station
Exist. U.S. Rubber Dam
Excavate to El 75.0 at Toe, Slope to River
CURVE DATA
Δ = 7°31'31"
R = 400.00'
T = 26.31'
L = 52.54'
N 422,202.00
E 304,903.00
P.C. Sta. 45+63.17
P.T. Sta. 46+16.31
Bldg. #14 U.S. Rubber Company 6 Story Brick Constr. First Floor Elev. 89.0
Bldg. #8 (Basement Elev. 75.6)
Bldg. #15 U.S. Rubber Company Boiler Room Floor Elev. 83.9
Valve M.H. on 8" Sprinkler Line Rim 83.72 - Inv. 78.12
New M.H. on existing 24" (Grated)
Existing 24" sewer to remain
Coal Pile
Chimney
Platform
Wood Bldg.
Black Top
Conc. Wall
Steel Tanks
Rubble
Toe El. 75.0
15' Berm Elev. 81.0
River Bank
1 on 2 Slope
1 on 2½ Slope
See Insert
INSERT
NOTES:
1. For General Notes and Legend see Plate No. 3
2. For profile of dikes and drain see Plate No. 16
PLAN
SCALE 1" = 20'
GRAPHIC SCALE
GREEN ENGINEERING AFFILIATES, INC. BOSTON, MASS.
ARCHITECT-ENGINEER
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
GENERAL PLAN
STA. 45+45 TO STA. 49+61
CHICOPEE RIVER
MASSACHUSETTS
DATE FEB. 1967
PLATE NO. 14



NOTES:

1. For Plans see Plates Nos 9, 10, 11, 12 and 13
2. Rework roofleader piping for gravity connections
   Install sump pumps for basement pits at U.S. Rubber Bldgs

PROFILE — DIKE

SCALES HOR. 1"=20' VERT. 1"=10'

GRAPHIC SCALES

REVISION	DATE	DESCRIPTION	BY

GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.
ARCHITECT-ENGINEER

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

DES BY D.V.T. | DR BY H.M. | CK BY H.D.H.

SUBMITTED
ARCHITECT-ENGINEER
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, F. & S. BRANCH

CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
GENERAL PROFILE
STA. 33+17 TO STA. 54+14.63
CHICOPEE RIVER MASSACHUSETTS

APPROVED
CHIEF, ENGINEERING DIVISION
DATE
SCALE AS SHOWN
SPEC. NO. CIV. ENG.-19-016-
DRAWING NUMBER
SHEET

PLATE NO. 15

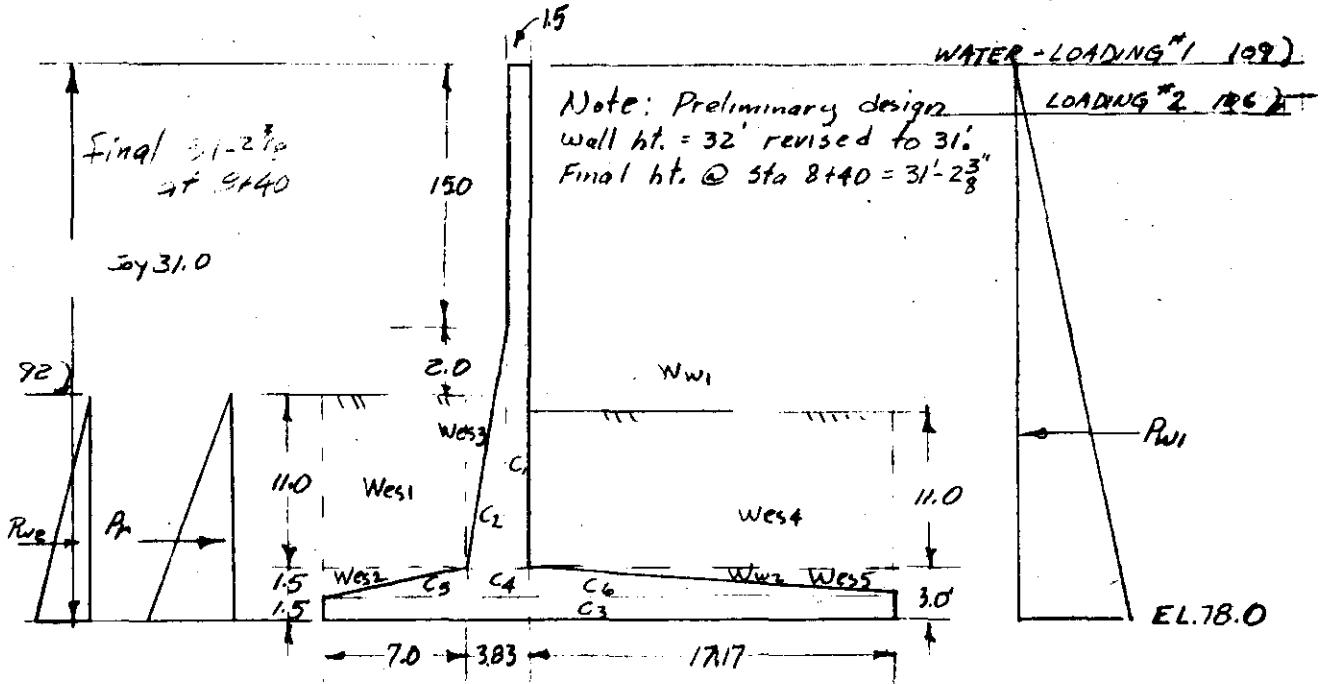
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

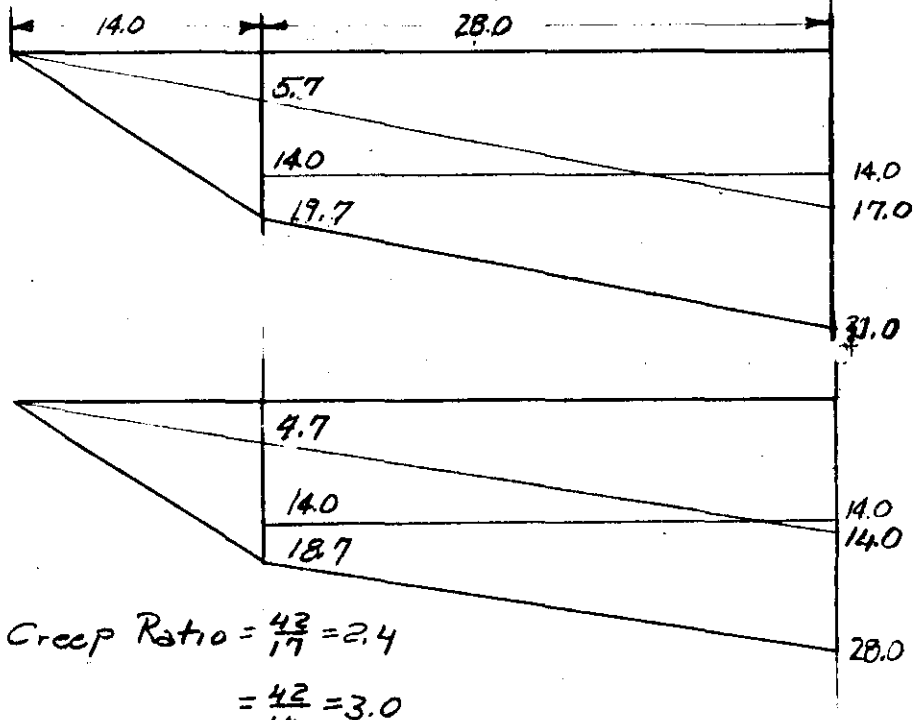
PROJECT NO. 6205-2
SHEET NO. 1 OF
DATE FEB 63
COMPUTED BY DA
CHECKED BY F.N.W

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALLS - NON ANCHORED
32' WALL - 28 BASE

TO BOTTOM OF BASE STA 8+40





Creep Ratio $= \frac{43}{17} = 2.4$

$= \frac{42}{14} = 3.0$

A-1

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS - NON ANCHORED
32' WALL - 28' BASE

PROJECT NO. 6205-2
SHEET NO. 2 OF
DATE FEB 63
COMPUTED BY CDR
CHECKED BY F.N.W

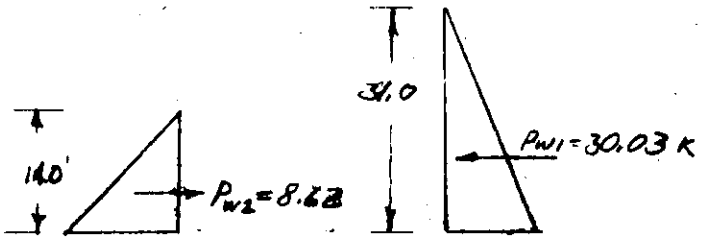
TO BOTTOM OF BASE ΣM @ TOE — LOADING #1

		↓	↑	→	←	ARM	M↓	M↺
C_1	.15 x 28 x 1.5	6.30				10.08	63.5	
C_2	.15 x 1.3 x 2.33 x 0.5	2.27				8.5'	19.4	
C_3	.15 x 28 x 1.5	6.30				14.00	88.3	
C_4	.15 x 3.83 x 1.5	0.86				8.91	7.7	
C_5	.15 x 7.0 x 1.5 x 0.5	0.79				4.66	3.7	
C_6	.15 x 17.17 x 1.5 x 0.5	1.93				16.55	32.0	
W_{w1}	.0625 x 28 x 17.17	30.05				19.42	583.5	
W_{w2}	.0625 x 1.5 x 17.17 x 0.5	0.80				22.28	17.8	
W_{es1}	.135 x 7 x 11.0	10.40				3.50	36.4	
W_{es2}	.135 x 7 x 1.5 x 0.5	0.71				2.33	1.65	
W_{es3}	.135 x 11.0 x 1.97 x 0.5	1.46				7.66	11.2	
W_{es4}	.0725 x 11.0 x 17.17	13.69				19.42	265.9	
W_{es5}	.0725 x 1.5 x 17.17 x 0.5	0.93				22.28	20.8	
U_1	.0625 x 17.7 x 28.0		34.40			14.00		482.6
U_2	.0625 x 12.3 x 28.0 x 0.5		9.88			18.67		184.6
P_{w1}	.0625 x 31² x 0.5				30.03	10.33		310.2
P_v	———			21.41		4.67	100.0	
P_{w2}	.0625 x 17.7 x 14.0 x 1/2			8.62		4.67	40.3	
		76.49	44.36	30.03	30.03		1292.3	977.4
		44.36					977.4	
		32.13					314.9	

RESULTANT AT: $\frac{314.9}{32.13} = 9.8$ FT. > 9.33 < 18.67
∴ falls in mid 1/3

e = 4.2

PASSIVE RESISTANCE:



SEEPAGE:

P_{w2} = .0625 x 14 x 14 x 0.5
P_{w2} = 8.62K

WATER

P_{w1} = 30.03 K

HORIZONTAL NEEDED:

30.03 − 8.62 = 21.41 K

$K_a \times .0725 \times \frac{14^2}{2} = 21.41$

$K_p = 3.01$

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT NO. 6205-2
SHEET NO. 3 OF
DATE FEB 63
COMPUTED BY OR
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALLS - NON ANCHORED
3½' WALL - 28' BASE

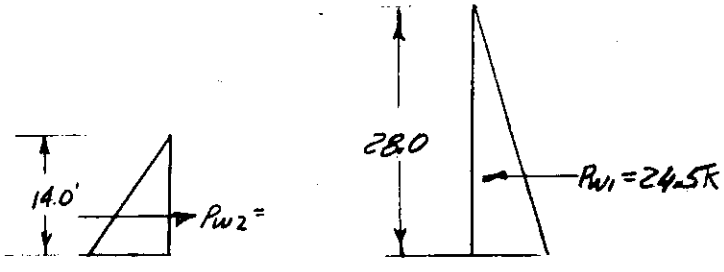
TO BOTTOM OF BASE ΣM @ TOE - LOADING #2

		↓	↑	→	←	ARM	M↓	M↑
$C_1 \to C_6$		18.45				—	214.6	
W_{w1}	.0625 x 25 x 17.17	26.82				19.42	521.0	
W_{w2}		0.80				—	17.9	
$W_{es1} \to W_{es5}$		27.19				—	336.0	
U_1	.0625 x 18.7 x 28.0		32.73			14.00		458.2
U_2	.0625 x 9.3 x 28.0 x 0.5		8.14			18.67		151.9
P_{w1}	.0625 x 28^2 x 0.5				24.5	9.67		228.6
P_Y				16.32		4.67	76.2	
P_{w2}	0.0625 x 14.0 x 18.7 x ½			8.18		4.67	38.2	
		73.27	40.87	24.5	24.5		1203.9	838.7
		40.87					838.7	
		32.40					365.2	

RESULTANT AT: $\frac{365.2}{32.40} = 11.27 > 9.33$ $e = 2.73'$

SINCE WALLS NEAR THIS NON ANCHORED WALL HAVE BASES AS LARGE OR LARGER THIS BASE WILL NOT BE REDUCED WITH THIS AMOUNT OF BACK FILL THE BASE COULD BE REDUCED CONSIDERABLY — AS PROVEN BY TRIAL COMPS.

PASSIVE RESISTANCE



SEEPAGE

$P_{w2} = .0625 \times 14 \times 18.7 \times 0.5$

$P_{w2} = 8.18$ K

WATER

$P_{w2} = 24.5$K

HORIZONTAL NEEDED

$24.5 - 8.2 = 16.3$K

$K_p \times .0725 \times \frac{14^2}{2} = 16.3$

$K_p = 2.29$

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

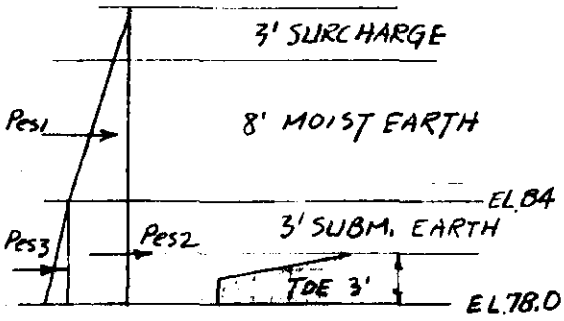
PROJECT NO. 6205-2
SHEET NO. 4 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALLS - NON ANCHORED

32' WALL - 28' BASE

LOADING #3



(REFER SYMBOLS P1): (ALSO P2) &

(1) WATER EL. AT 84 ±
∴ 6 FT UPLIFT
∴ 3FT SUBMERGED EARTH OVER HEEL & TOE

(2) WIND - 50 #/FT²

(3) 3 FT SURCHARGE - (INCL. IN PRESSURE.)

(4) HORIZONTAL UNBALANCE BY FRICTION

		↓	↑	→	←	ARM	M↻	M↺
$C_1 \to C_6$		18.86				—	218.3	
Wes3A	≈ Wes3	1.36				—	10.3	
Wes1A	= 3/11 Wes1 = 3/11 × 10.40	2.84				3.5	10.0	
Wes1B	= 7/11 Wes1 = 7.56 × .130/.135	7.28				3.5	25.5	
Wes2A	= Wes2	0.66				—	1.5	
SURCH.	3 × 8.83 × .130	3.44				4.41	15.1	
Wes4A	= 3/10 Wes4 = 3/10 × 12.40	3.72				19.42	72.3	
Wes4B	= 7/10 Wes4 = 8.68 × .130/.135	8.38				19.42	163.0	
Wes5A	= Wes5	0.93				—	20.7	
Ww1	.0625 × 3 × 17.17	3.22				19.42	62.6	
Ww2		0.80				—	17.8	
Pes1	.130 × 11² × 1/2 × 1/3			2.62		9.67	25.3	
Pes2	.130 × 11 × 6 × 1/3			2.86		3.00	8.6	
Pes3	.0925 × 6² × 1/2 × 1/3			0.44		2.00	0.9	
WIND	.05 × 18			0.90		23.00	20.7	
W	.0625 × 6 × 28		10.50			14.00		147.0
		51.49	10.50	6.82			672.6	147.0
		10.50					147.0	
		40.99					525.6	

RESULTANT AT: $\frac{525.6}{40.99} = 12.85$ FT e = 1.15 FT

$$\Sigma \frac{H}{V} = \frac{6.82}{41.18} = .165 < 0.2$$

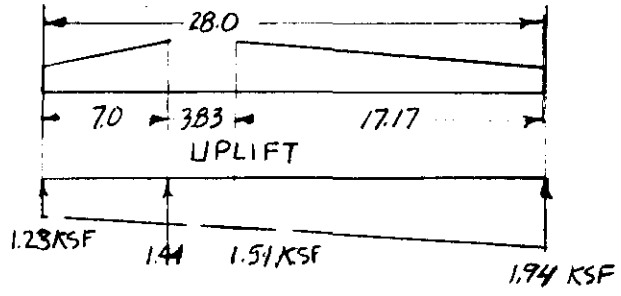
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS - NON ANCHORED
32' WALL - 28' BASE

PROJECT NO. 6205-2
SHEET NO. 5 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

PRESSURES

LOADING #1 (REFER P1,2)



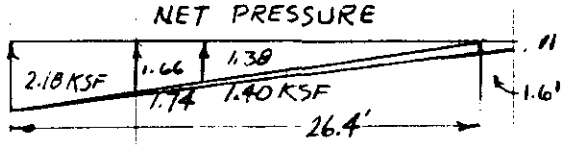
NET PRESSURE WITH P_r (P.2)

$P.\Delta = 8.8' \times 3 = 26.4'$ BASE

$\frac{1}{2} \times 26.4 \times P = 31.06$

$P = 2.37$ KSF

$S.B.P = \frac{32.13}{28}\left(1 \pm 6 \times \frac{4.2}{28}\right) = 2.18$, $.11$



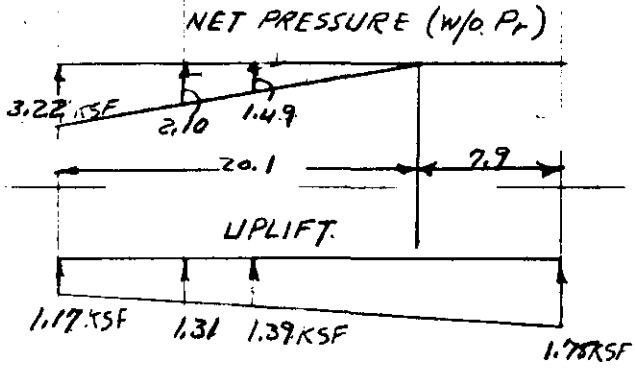
NET PRESSURE WITHOUT P_r (P2)

$$\bar{X} = \frac{314.9 - 106.0}{32.13} = 6.7$$

$P.\Delta = 6.7 \times 3 = 20.1'$ BASE

$\frac{1}{2} \times 20.1 \times P = 32.4$

$P = 3.22$ KSF



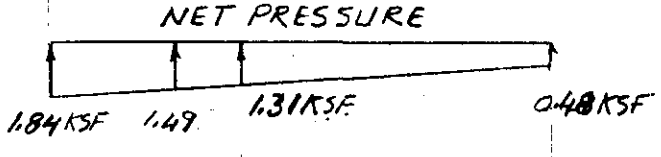
LOADING #2 (REFER P1,3)

NET PRESSURE with P_r (P.3)

$$p = \frac{32.4}{28}\left(1 \pm \frac{6 \times 2.73}{28}\right)$$

$= 1.16\,(1 \pm .58)$

$= 1.83$ KSF, 0.48 KSF



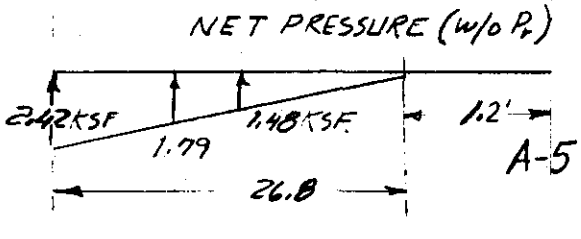
NET PRESSURE (w/o P_r) (P.3)

$$\bar{X} = \frac{365.2 - 76.2}{32.4} = 8.92$$

$P.\Delta = 3 \times 8.92 = 26.8'$ BASE

$\frac{1}{2} \times 26.8 \times P = 32.4$

$P = 2.42$ KSF



GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

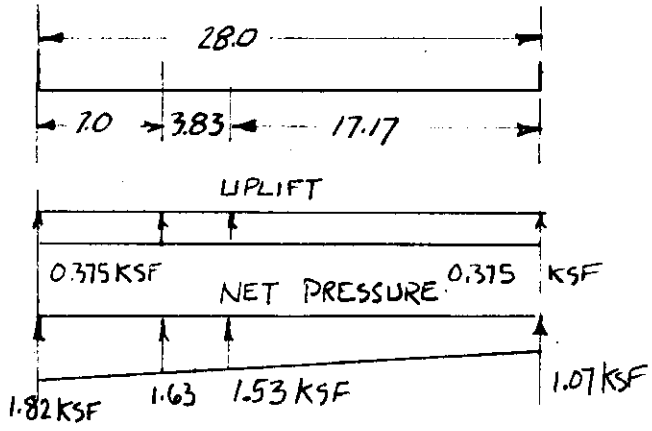
PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS – NONANCHORED
32' WALL – 28' BASE

PROJECT NO. 6205-2
SHEET NO. 6 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

PRESSURES:

LOADING #3 (P.4) $e = 1.15$ FT

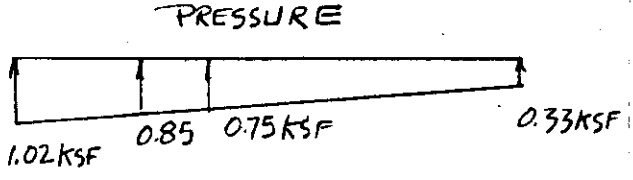
$$p = \frac{40.99}{28.0}\left(1 \pm \frac{6 \times 1.15}{28.0}\right)$$
$$= 1.46\,(1 \pm .247)$$
$$= 1.82\text{ KSF},\ 1.07\text{ KSF}$$



CONSTRUCTION (P.3) (CONCRETE ONLY)

$$x = \frac{218.3}{18.86} = 11.6\text{ FT.} \quad e = 2.4\text{ FT.}$$

$$p = \frac{18.86}{28}\left(1 \pm \frac{6 \times 2.4}{28}\right)$$
$$= .672\,(1 \pm .514)$$
$$= 1.02\text{ KSF},\ 0.33\text{ KSF}$$

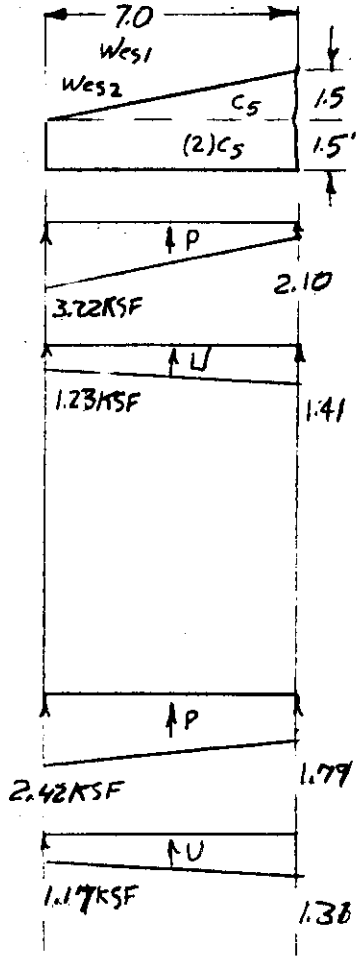


GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS - NON ANCHORED
32' WALL - 28' BASE

PROJECT NO. 6205-2
SHEET NO. 7 OF
DATE FEB 63
COMPUTED BY
CHECKED BY F.N.W.

TOE : BOTTOM STEEL



LOADING #1 (REFER P1,2,5) [USING NO PASSIVE CASE]

	SHEAR		MOMENT
C_5 =	0.79 ↓	x 2.33 =	1.8 ↻
(2) C_5 =	1.58	x 3.50 =	5.5 ↻
W_{es1} =	10.40	x 3.50 =	36.4 ↻
W_{es2} =	0.71	x 4.67 =	3.1 ↻
2.10 x 7.0 = P_1 =	14.70 ↑	x 3.50 =	51.4 ↻
7.12 x 7.0 x .5 = P_2 =	3.92	x 4.67 =	18.3 ↻
1.23 x 7.0 = U_1 =	8.67	x 3.50 =	30.1 ↻
0.18 x 7.0 x .5 = U_2 =	0.63	x 2.33 =	1.5 ↻
	14.38 ↑		54.3 K ↻

LOADING #2 (P1,3,5) [USING NO PASSIVE CASE]

	SHEAR		MOMENT
C_1 & W_{es} =	13.48 ↓	— =	47.0 ↻
1.79 x 7.0 = P_1 =	12.53 ↑	x 3.50 =	43.9 ↻
0.63 x 7.0 x .5 = P_2 =	2.20	x 4.67 =	10.3 ↻
1.17 x 7.0 = U_1 =	8.19	x 3.50 =	28.7 ↻
0.14 x 7.0 x .5 = U_2 =	0.49	x 2.33 =	1.1 ↻
	9.93 ↑		37.0 K ↻

LOADING #1 $A_s = \frac{54,300}{(1.975)(31.5)} = 0.87$ IN²/IN

LOADING #2 $A_s = \frac{37.0}{(1.475)(31.5)} = 0.80$ IN²/IN

AT STEM: USE: #6 - 6" c-c (.88 IN²/IN) (BOTTOM)

AT MID TOE: USE: #6 - 1'-0" c-c (BOTTOM)

A-7

$\Sigma o = \frac{14,380}{300 \times j \times 31.5} = 1.7$ IN²

$v = \frac{14,380}{12 \times 31.5 \times .907} = 42$ psi OK < 90 psi

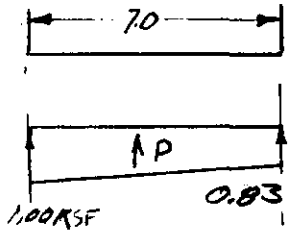
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS – NON ANCHORED
32' WALL – 28' BASE

PROJECT NO. 6205-2
SHEET NO. 8 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

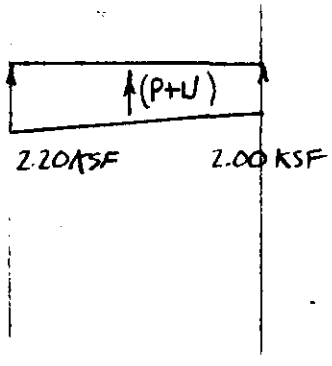
TOE – TOP STEEL

CONSTRUCTION: (REFER P6)



	SHEAR		MOMENT
$(3)C_5$ =	2.37 ↓	— =	7.3 ↑
0.85 × 7.0 = P_1 =	5.81 ↑	× 3.5 =	20.3 ↓
0.17 × 7.0 × .5 = P_2 =	0.59 ↑	× 4.67 =	2.8 ↓
	8.77		15.8 ↓ ∴ NO STEEL (TOP)

LOADING #3 (REFER P6,4)



	SHEAR		MOMENT
$(3)C_5$ =	2.37	— =	7.3 ↑
W_{es1A} =	2.84	× 3.50 =	10.0 ↑
W_{es1B} =	7.28	× 3.50 =	25.4 ↑
W_{es2A} =	0.66	× 4.67 =	3.1 ↑
.130 × 3 × 7 = SURCH. =	2.73 ↓	× 3.50 =	9.6 ↑
2.00 × 7.0 = (P_1+U_1) =	14.00 ↑	× 3.50 =	49.0 ↓
0.20 × 7.0 × .5 = (P_2+U_2) =	0.70 ↑	× 4.67 =	3.3 ↓
	1.18 ↓		3.1 'k ↑

LOADING #3:

$$A_s = \frac{3{,}100}{(.885)(20{,}000)(32)} = .0055 \text{ in}^2/\text{in}$$

TOE: USE #5-12" C-C (.027 in²/in) (TOP)

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

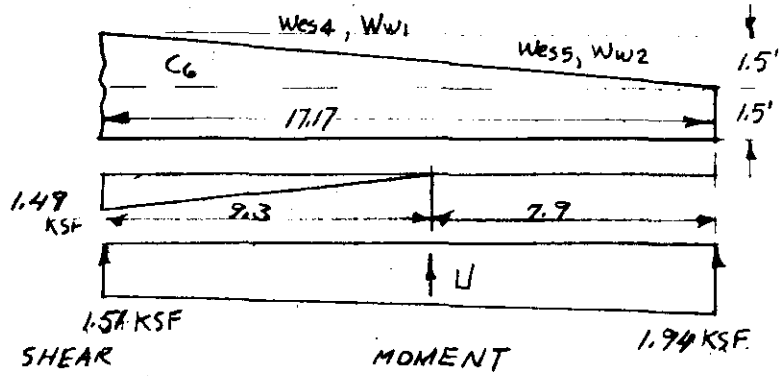
PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS – NON ANCHORED
32' WALL – 28' BASE

PROJECT NO. 6205-2
SHEET NO. 9 OF
DATE FEB 63
COMPUTED BY DP
CHECKED BY F.N.W.

HEEL TOP STEEL

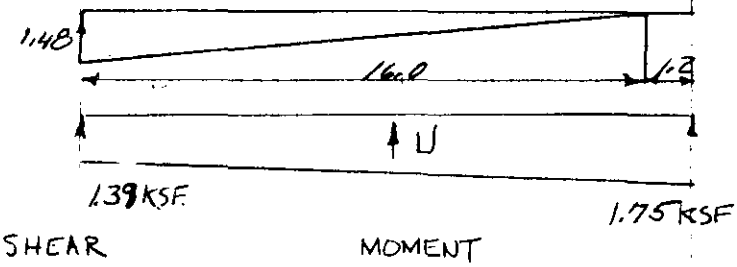
LOADING #1 (REFER P2,5)

(WITHOUT P_f ACTING)



	SHEAR		MOMENT
	C_6 = 1.93	× 5.72 =	11.0
	(2)C_6 = 3.86	× 8.58 =	33.2
	W_{w1} = 30.05	× 8.58 =	257.8
	W_{w2} = 0.80	× 11.45 =	9.2
	W_{es4} = 13.69	× 8.58 =	117.5
	W_{es5} = 0.93	× 11.45 =	10.6
1.49 × 9.3 × .5	= P = 6.93	× 3.1 =	21.5
1.51 × 17.17	= U_1 = 25.93	× 8.58 =	222.5
0.43 × 17.17 × .5	= U_2 = 3.69	× 11.45 =	42.3
	14.71		153.0'K

LOADING #2 (REFER P3,5)



	SHEAR		MOMENT
	C_5, W_{es} = 20.41	—	= 172.3
	W_{w1} = 26.83	× 8.58	= 230.2
	W_{w2} = 0.80	—	= 9.2
1.48 × 16.0 × 1/2	= P = 11.84	× 5.33	= 63.1
1.39 × 17.17	= U_1 = 23.87	× 8.58	= 204.8
0.36 × 17.17 × .5	= U_2 = 3.09	× 11.45	= 35.4
	9.24		108.4'K

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PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS - NON ANCHORED
32' WALL - 28' BASE

PROJECT NO. 6205-2
SHEET NO. 10 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

HEEL TOP STEEL (cont.)

$v = \frac{14710}{12 \times j \times 32.5} = 43$

$\Sigma o = \frac{14710}{210 \times j \times 32.5} = 2.4$

LOADING #1

$$A_s = \frac{153{,}000}{(.907)(27{,}000)(32)} = 2.38 \text{ in}^2/\text{in}$$

LOADING #2

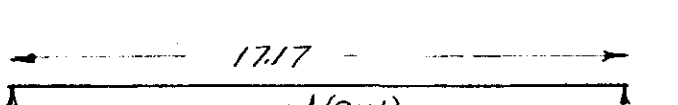
$$A_s = \frac{108{,}400}{(.885)(20{,}000)(32)} = 2.26 \text{ in}^2/\text{in}$$

AT STEM : USE #10-@6" C-C (2.54 in²/in) (TOP)

AT MIDHEEL : USE #10 @ 1'-0" C-C (TOP)

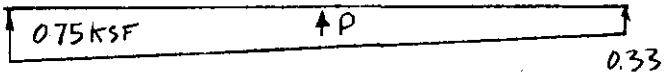
HEEL - BOTTOM STEEL

LOADING #3 (REFER PG)



	SHEAR		MOMENT
$(3)C_6 =$	5.79	———	= 44.2 ↓
$W_{w1} =$	3.22	× 8.58	= 27.7 ↓
$W_{w2} =$	0.80	———	= 9.2 ↓
$W_{es4A}, W_{es4B} =$	12.10	× 8.58	= 101.8 ↓
$W_{es5A} =$	0.93	× 11.44	= 10.6 ↓
$1.45 \times 17.17 = (P+U)_1 =$	24.90	× 8.58	= 214.0 ↑
$0.45 \times 17.17 \times .5 = (P+U)_2 =$	3.87	× 5.72	= 22.2 ↑
	5.93 ↑		42.7 ↑ 'K

CONSTRUCTION :



$3C_6 =$	5.79 ↓	———	= 44.2 ↓
$0.33 \times 17.17 = P_1 =$	5.66 ↑	× 8.58	= 48.6 ↑
$0.42 \times 17.17 \times .5 = P_2 =$	3.61	× 5.72	= 20.7 ↑
	3.48 ↑		25.1 ↑ 'K

$$A_s = \frac{42{,}700}{(.885)(20{,}000)(31)} = .0778 \text{ in}^2/\text{in}$$

AT STEM : USE : #8-10" C-C (0.785 in²/in) (BOTTOM)

AT MIDHEEL : USE : #8-20" C-C (BOTTOM)

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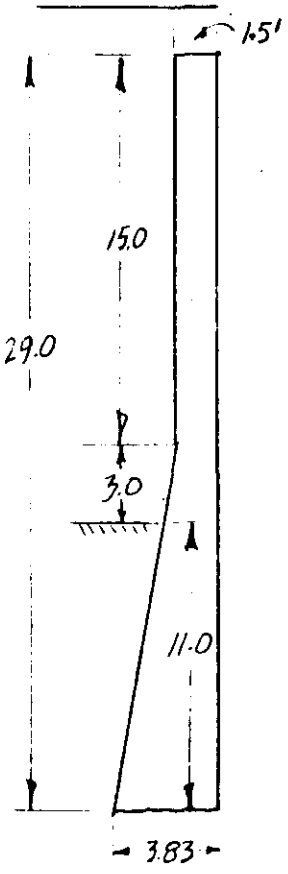
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS - NON ANCHORED
32' WALL - 28' BASE

PROJECT NO. 6205-2
SHEET NO. 11 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

STEM RIVERSIDE



29' WATER: LOADING #1 $M = .0625 \times 29^3 \times 1/6 = 254'K$

26' WATER: LOADING #2 $M = .0625 \times 26^3 \times 1/6 = 183'K$

$3/4 \times 254 = 190.5 > 183'K$ ∴ USE LOADING #1

29 FT WATER (LOADING #1) (GOVERNING)

WT CONC. $= .15 \times 1.5 \times 29 = 6.52 \times .75 = 4.89$
$= .15 \times 2.33 \times 14 \times .5 = 2.45 \times 2.28 = 5.60$
8.97K 10.5

dist. from RIVER $= \frac{10.5}{8.97} = 1.18$ FT. $- 0.33$
$= 0.85$ FT FROM STEEL

$M_{WATER} = 254'K$
$8.97 \times 0.85 = M_{STEM} = 7.6'K$
262 'K

$e = \frac{M}{N} = \frac{262}{8.97} = 29.2'$ $\frac{e}{d} = \frac{29.2}{3.50} = 8.35$

$NE = \underset{(262)}{8.97 \times 29.2} < \underset{(372)}{212 \times 1.76}$

$A_s = \frac{262}{2.00 \times 42 \times 1.12} = 2.78 \text{ IN}^2/\text{FT}$

AT BOTTOM: USE: #11-6" C-C (3.12 IN²/FT.)

WATER AT 23': $M = .0625 \times 23^3 \times 1/6 = 126.6'K$

$d = 3.83 - .33 - 1.0 = 2.5'$

$A_s = \frac{126,600}{(.907)(27,000)(30)} = .1725 \text{ IN}^2/\text{IN}$

AT 6 FT. FROM BOTTOM: USE #9-6" = [.167 IN²/IN + AXIAL HELP]

WATER AT 13': $M = .0625 \times 13^3 \times 1/6 = 22.8'K$

$A_s = .0665 \text{ IN}^2/\text{IN}$

AT 16' FROM BOTTOM: USE: #6-6" C-C. (.073 IN²/IN)

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PROJECT: CHICOPEE FALLS

SUBJECT: FLOOD WALLS - NON ANCHORED
32' WALL - 28' BASE

PROJECT NO. 6205-2
SHEET NO. 12 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

STEM: LANDSIDE (LOADING #3)

(REFER P4)
AT BOTTOM

P_{es1} =	2.62	x	6.67	=	17.4 ↓
½ P_{es2} =	1.43	x	1.50	=	2.1 ↓
¼ P_{es3} =	0.11	x	1.00	=	0.1 ↓
WIND =	0.90	x	20.00	=	18.0 ↓
					37.6'K ↓

$$A_s = \frac{37.600}{(.885)(20.000)(42)} = .0503 \text{ IN}^2/\text{IN}$$

AT BOTTOM — USE #7-12"C-C (.050 IN²/IN)

AT 14 FT FROM BOTTOM — USE #5-12" C-C

[ALL OTHER WALLS: REFER TO ANCHORED WALLS ETC]

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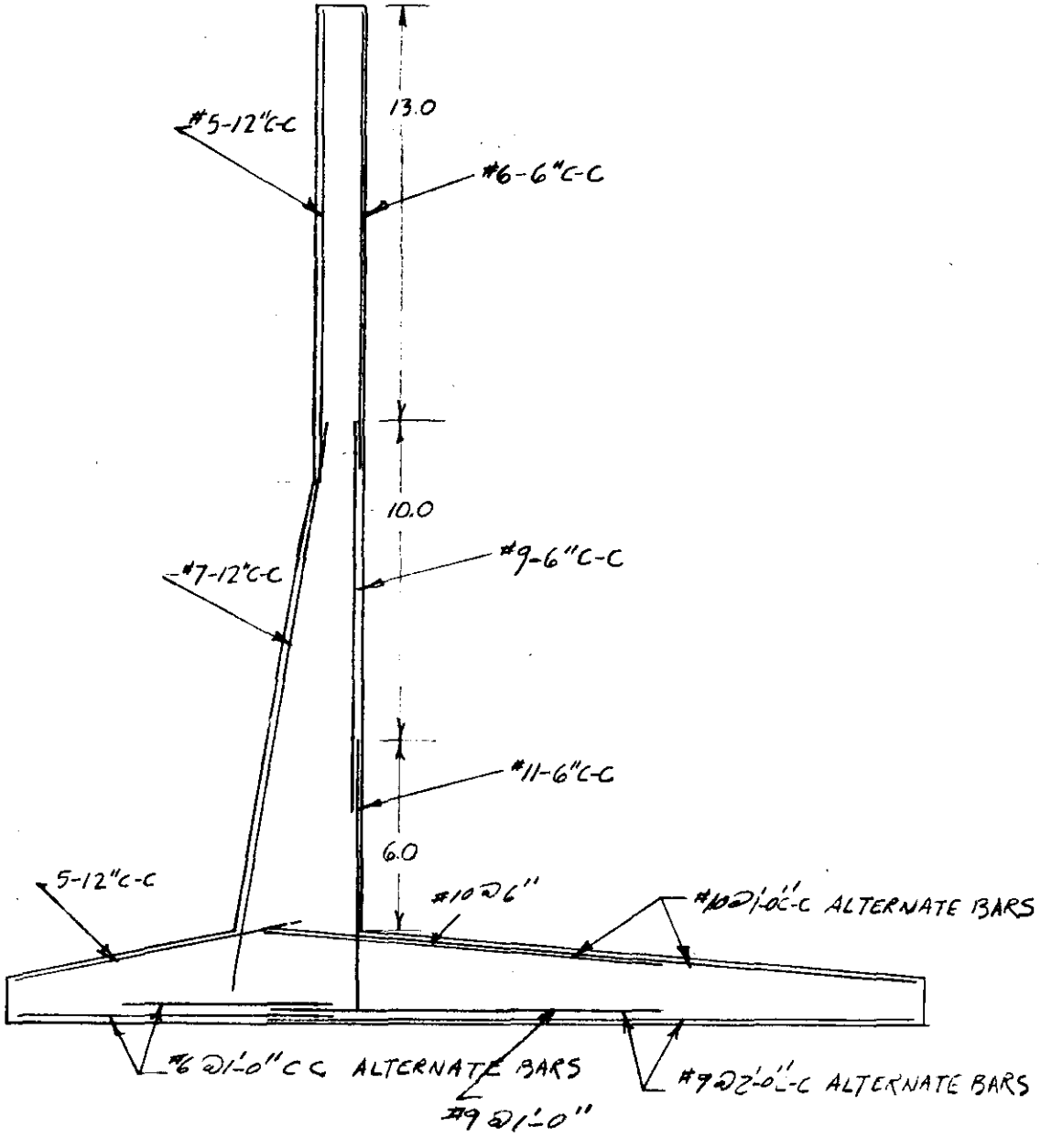
PROJECT NO. 6205-2
SHEET NO. 13 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALLS - NON ANCHORED
32' WALL - 28' BASE

STEEL

EMBED & LAP 24 DIA.
SHRINKAGE STEEL : #5-12"
SCALE 1"=5'.



A-13

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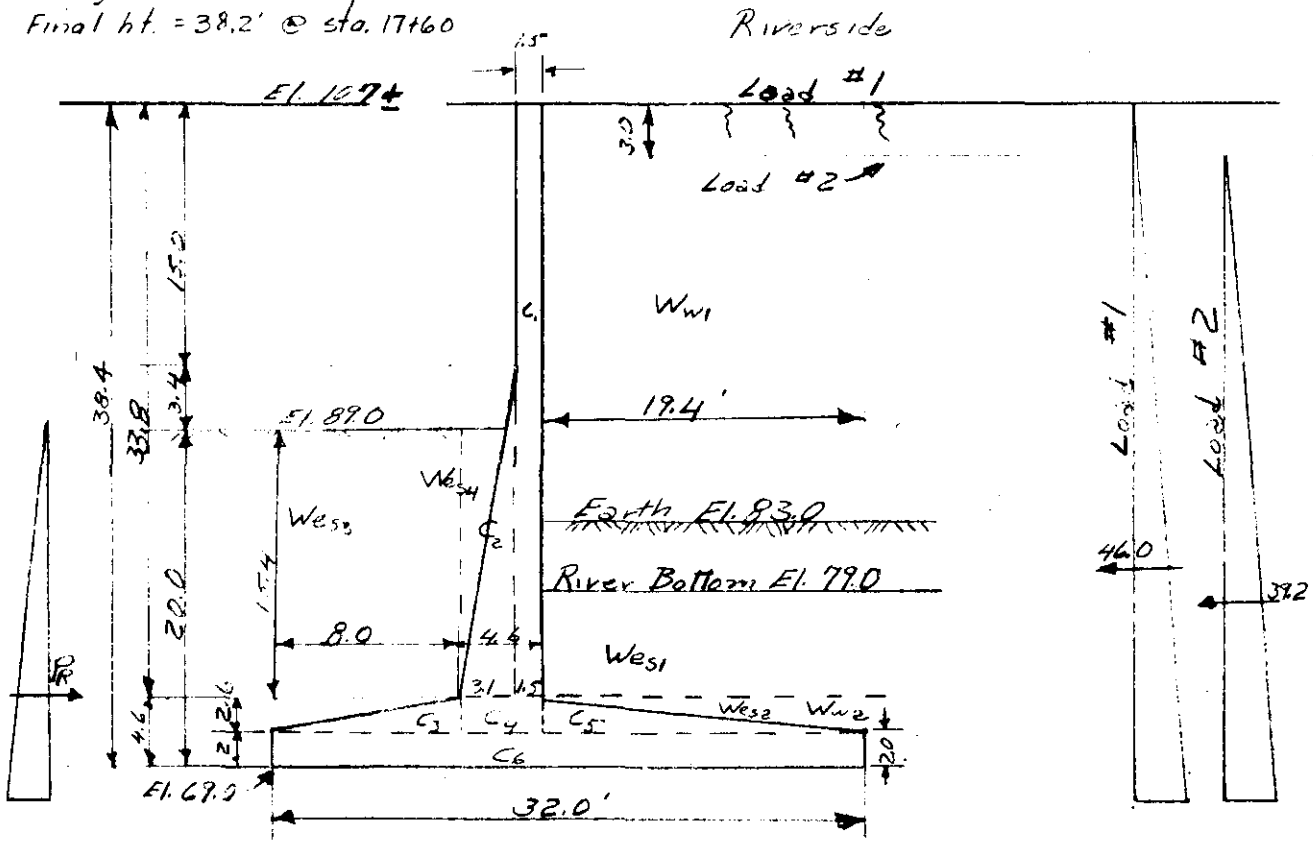
PROJECT NO. 6607-2
SHEET NO. 1 OF
DATE Jan. 24, 1963
COMPUTED BY F.M.W.
CHECKED BY W.R.

PROJECT Chicopee Falls

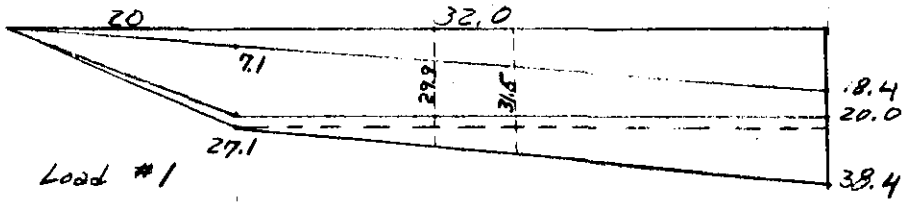
SUBJECT Flood Walls - NON ANCHORED
38.4' Wall

Note :- Preliminary design ht. = 38.4'
Final ht. = 38.2' @ sta. 17+60

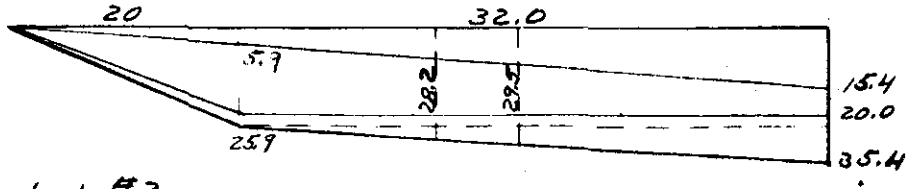
Sta. 17+60



Uplift



Load #1



Load #2

1.61 KSF

2.21

B-1

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PROJECT Chicopee Falls

SUBJECT Flood Walls
38.4' Wall

PROJECT NO. 6205-2
SHEET NO. 2 OF
DATE Jan 28, 1963
COMPUTED BY FNW
CHECKED BY WR

sta. 17+60

Loading #1

Symbol	Factors	↓	↑	→	←	Arm	M↻	M↺
C_1	0.15 × 1.5 × 33.8	7.6				11.85	90	
C_2	0.15 × 18.8 × 3.1/2	4.4				10.1	44	
C_3	0.15 × 8.0 × 2.6/2	1.6				5.3	8	
C_4	0.15 × 4.6 × 2.6	1.8				10.3	18	
C_5	0.15 × 19.4 × 2.6/2	3.8				19.1	73	
C_6	0.15 × 2.0 × 32.0	9.6	28.8			16.0	154	387
W_{w1}	0.0625 × 19.4 × 33.8	41.0				22.3	915	
W_{w2}	0.0625 × 19.4 × 2.6/2	1.6	—			25.5	41	—
W_{es1}	0.0725 × 19.4 × 9.4	13.2				22.3	297	
W_{es2}	0.0725 × 19.4 × 2.6/2	1.8				25.5	47	
W_{es3}	0.135 × 8.0 × 15.4	16.6				4.0	66	
W_{es4}	0.135 × 15.4 × 2.6/2	2.7				8.9	24	
W_{es5}	0.135 × 8.0 × 2.6/2	1.4	35.7			2.7	4	438
σ_1	0.0625 × 27.1 × 32.0		54.0			16.0		865
σ_2	0.0625 × 11.3 × 32.0/2		11.3			21.3		241
P_w	0.0625 × (38.4)²/2				46.0	12.8		590
P_R				46.0		6.7	308	
		107.1	65.3				2089	1696
		65.3					1696	
		41.8					393	

$$\bar{x} = \frac{393}{41.8} = 9.4 > \frac{32}{4} = 8.0$$

$$\text{Horiz.} = 46 - 27.1 \times 0.0625 \times \frac{20}{2} = 29$$

$$K_p \times 0.0725 \times \frac{\overline{20}^2}{2} = 29 \qquad K_p = 2.0$$

Note: K_p in terms of $0.0625 = 2.3$

GREEN ENGINEERING AFFILIATES
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PROJECT Chicopee Falls

SUBJECT Flood Walls
38.4' Wall

PROJECT NO. 6205-2
SHEET NO. 3 OF
DATE Jan. 28, 1963
COMPUTED BY E.N.W.
CHECKED BY WR

Loading #2 Sta 17+60

Symbol	Factors	↓	↑	→	←	Arm	M↻	M↺
C_1-C_6		28.8					387	
W_{e3} 1-5		35.7					438	
W_{w2}	0.0625×19.4×2.6/2	1.6				25.5	41	
W_{w1}	0.0625×19.4×30.8	37.4				22.3	833	
σ_1	0.0625×25.9×32.0		51.6			16.0		825
σ_2	0.0625×9.5×32.0/2		9.5			21.3		202
P_w	0.0625×35.4²/2				39.2	11.9		462
P_R				39.2		6.7	262	
		103.5	61.1				1961	1489
		61.1					1489	
		42.4					472	

$$\bar{x} = \frac{472}{42.4} = 11.1 > \frac{32}{3} = 10.7 \qquad E_{cc} = 4.9$$

Note: 30.0' base computed and not adequate.
Use base 32.0'

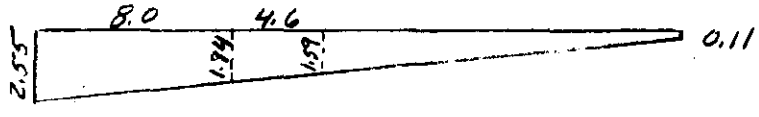
$$\text{Horiz.} = 39.2 - 25.9 \times 0.0625 \times \frac{20}{2} = 23$$

$$K_p \times 0.0725 \times \frac{20^2}{2} = 23$$

$$K_p = 1.59$$

Note: K_p in terms of 0.0625 = 1.85

$$P = \frac{42.4}{32}\left(1 \pm 6 \times \frac{4.9}{32}\right) = 1.33(1 \pm 0.92) = \begin{matrix} 2.55 \\ 0.106 \end{matrix}$$



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PROJECT Chicopee Falls

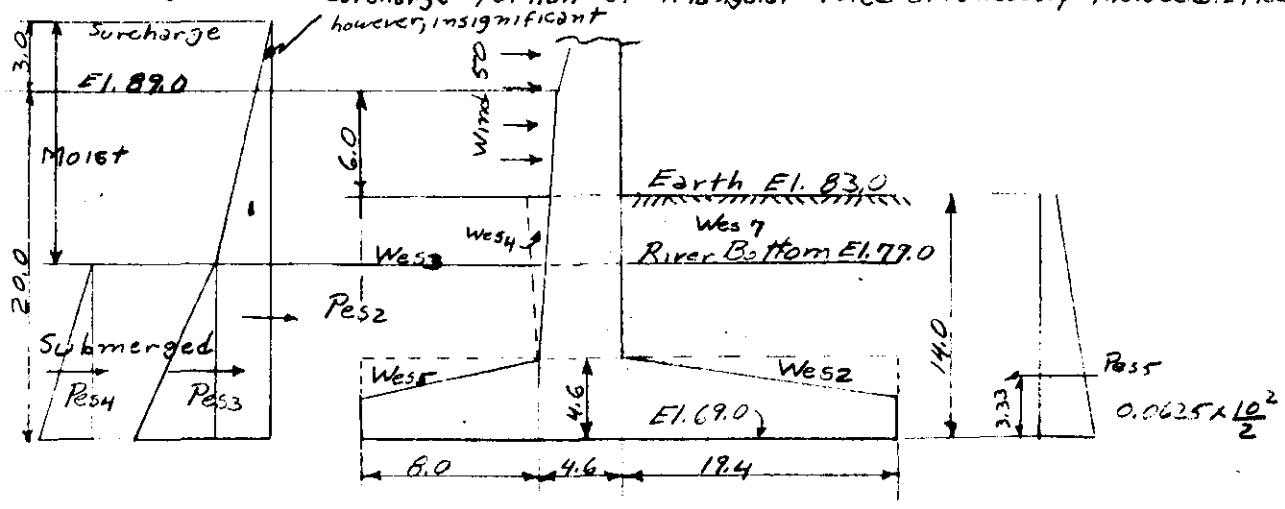
SUBJECT Flood Walls
38.4' Wall

PROJECT NO. 6205-2
SHEET NO. 4 OF
DATE Feb. 5, 1963
COMPUTED BY FMW
CHECKED BY WR

Sta. 17+60

Loading #3

Surcharge Portion of triangular force erroneously included. Effect, however, insignificant

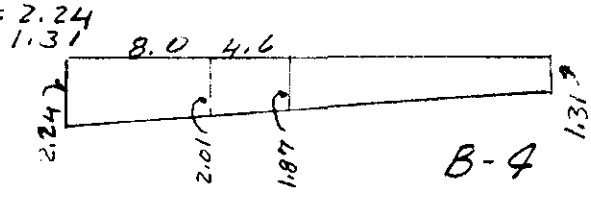


$P_{es4} = P_{es5}$

Symbol	Factors	↓	↑	→	←	Arm	M ↻	M ↺
C_1-C_6		28.8					387	
Wes_{1-5}		35.7	±				438	
W_{w1}	0.0625 × 19.4 × 5.4	6.5				22.3	145	
W_{w2}	0.0625 × 19.4 × 2.6/2	1.6				25.5	41	
V	0.0625 × 10 × 32		20.0			16.0		320
P_{es1}	$0.130 \times 13^2 \times \frac{1}{2} \times \frac{1}{3}$			3.66		14.33	52.4	
P_{es2}	$0.130 \times \frac{13}{3} \times 10$			5.65		5.0	28.3	
P_{es3}	$0.0625 \times 10^2 \times \frac{1}{2} \times \frac{1}{3}$			1.20		3.3	4.0	
Wind	0.05 × 15.4			0.92		29.2	27.0	
Surchg	3 × 0.130 × 10.6	4.1				5.3	21.8	
		76.7	20.0	11.43			1144.5	320
		20.0					320.0	
		56.7					824.5	

$\bar{x} = \frac{824.5}{56.7} = 14.6 \qquad E_{cc} = 1.4$

$P = \frac{56.7}{32}\left(1 \pm \frac{6 \times 1.4}{32}\right) = 1.78\,(1 \pm 0.263) = 2.24$



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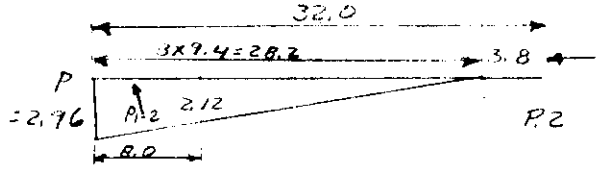
PROJECT Chicopee Falls
SUBJECT Flood Walls
39.4' Wall

PROJECT NO. 6205-2
SHEET NO. 5 OF
DATE Feb 5, 1967
COMPUTED BY FHW
CHECKED BY WR

Toe Rein Steel



$P = \frac{2 \times 41.8}{28.2} = 2.96$

P.1.
$27.1 \times 0.0625 = 1.69$
$29.9 \times 0.0625 = 1.86$

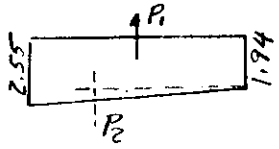
$A_s = \frac{55400 \times 12}{27000 \times 0.907 \times 50} = 0.54$

Load #1

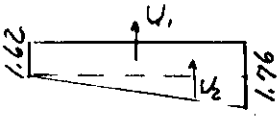
Wess	16.6	x 4.	66.3 ↑
Wess	1.4	x 5.3	7.4 ↑
C3	1.6	x 2.7	4.3 ↑
C6A, 2x8x0.15	2.4	4.	9.6 ↑
P1 2.1x8	17.6	4.	68. ↓
P2 0.84x8/2	3.4	5.3	18. ↓
U 1.78x8	14.2	4.	57. ↓
	12.6 ↑		55.4 ↓

Load #2

Wess	16.6	66. ↑
Wess	1.4	7. ↑
C3	1.6	4. ↑
C6A	2.4	9.6 ↑
P1 1.94x8.0	15.5	62.0 ↓
P2 0.61x8/2	2.4	13. ↓
U1 1.6x8	12.8	51. ↓
U2 0.14x8/2	0.6	1.6 ↓
	9.3 ↑	41.0 ↓



Net Pressure P.3



Uplift

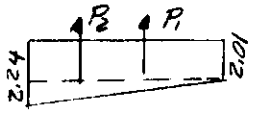
$25.9 \times 0.0625 = 1.62$
$28.2 \times 0.0625 = 1.76$

$A_s = \frac{41.0}{1.44 \times 50} = 0.57''$

Governs
#6 @ 9"

Load #3

We & C	22.0 ↓	86.6 ↑
P1 2.01x8.0	16.1	64.4 ↓
P2 0.23x8/2	0.9	4.7 ↓
U 0.625x8.0	5.0	20.0 ↓
	00.0	2.5 ↓



Uplift Const. $= 10 \times 0.0625 = 0.625$

Shear & Bend in Ftgs & Walls is less than required.

Use #5 @ 12 top of toe
Shrinkage

B-5

See P. 6A.

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BOSTON, MASS.

PROJECT NO. 6205-2
SHEET NO. 6 OF
DATE Feb. 5, 1963
COMPUTED BY ENW
CHECKED BY WR

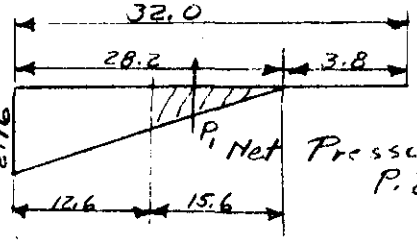
PROJECT Chicopee Falls

SUBJECT Flood Walls
38.4' Wall

Heel top Steel

Load #1

C_S	3.8	6.5	24.7
C_{CA} 2.0×19.4×0.15 =	5.8	9.7	56.0
W_{W1}	41.0	9.7	397.
W_{W2}	1.6	12.9	21.
W_{ES1}	13.2	9.7	128.
W_{ES2}	1.8	12.9	23.3
P_1 1.64×15.6/2	12.8	5.2	66.5
U_1 1.98×19.4	38.4	9.7	372.
U_2 0.43×19.4/2	4.2	12.9	54.
	11.8		157.5



Net Pressure P. 2

Uplift

31.5×0.0625 = 1.98

38.4×0.0625 = 2.41

P. 1

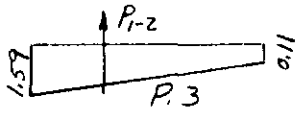
$A_s = \frac{157{,}500 \times 12}{27{,}000 \times 0.907 \times 51}$

= 1.50 □"

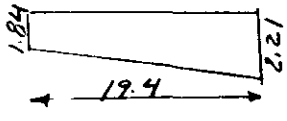
#9 @ 8

Load #2

C_S & C_{CA}	9.6		80.7
W_{W1}	37.4	9.7	362.
W_{W2}	1.6	12.9	21.
$W_{ES\,1-2}$	15.0		151.
P_1 0.11×19.4	2.1	9.7	20.
P_2 1.48×19.4/2	14.3	6.5	93.
U_1 1.84×19.4	35.6	9.7	346.
U_2 0.37×19.4/2	3.6	12.9	46.
	8.0		109.7



Net Pres



Uplift P. 1

29.5×0.0625 = 1.84

35.4×0.0625 = 2.21

$A_s = \frac{109.7}{1.44 \times 51} = 1.5$

#9 @ 8

See P. 6B

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

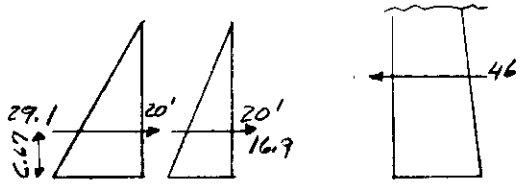
PROJECT Chicopee Falls
SUBJECT Flood Walls
38.4' Wall

PROJECT NO. 6205-2
SHEET NO. 6A OF
DATE Feb. 11, 1963
COMPUTED BY FNW
CHECKED BY WR

Sta. 17+60

For design of toe and heel, consider that no Passive Pressure is acting, i.e. friction must produce horiz equilibrium.

Toe
Load #1



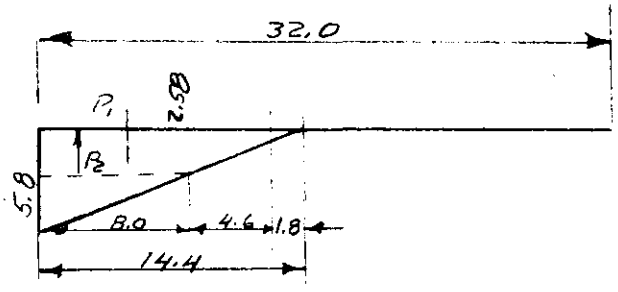
46.0
16.9
29.1 Unbalanced

$27.1 \times 0.0625 \times \frac{20}{2} = 16.9$

Mom was 393
-29.1×6.67 193
200

New $\bar{x} = \frac{200}{41.8} = 4.8'$

$P \times \frac{3 \times 4.8}{2} = 41.8$
$P = 5.8$



See Page 5

Wes & C	22.0 ↓		86.6 ↓
P_1 $2.58 \times 8.0 =$	20.6 ↑	4.0	82.4 ↓
P_2 $3.22 \times \frac{8}{2} \times 12.9 =$	12.9 ↑	5.33	69.0 ↓
U_1 & U_2	14.2 ↑		57.0 ↓
	25.7 ↑		121.8 ↓

[was 57.4]

$A_s = \frac{121{,}800 \times 12}{27000 \times 0.907 \times 50} = 1.2$ Governs

Use #8 @ 8

Heel Load #1 See p6

Omit P_1, $M = 157.5 + 66.5 = 224$

$A_s = \frac{224{,}000 \times 12}{27{,}000 \times 0.907 \times 51} = 2.1$

Load #2 Governs
$A_s = 2.6$ See 6B

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT Chicopee Falls
SUBJECT Flood Walls
38.4' Wall

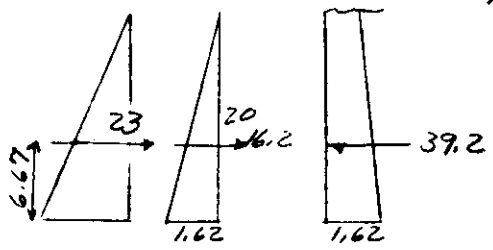
PROJECT NO. 6205-2
SHEET NO. 6B OF
DATE Feb. 11, 1963
COMPUTED BY FNW
CHECKED BY WR

Sta 17+60

With No Passive Pressure (Cont.)

Toe

Load #2



Mom was 472 $\quad 25.9 \times 0.0625 \times \frac{20}{2} = 16.2$

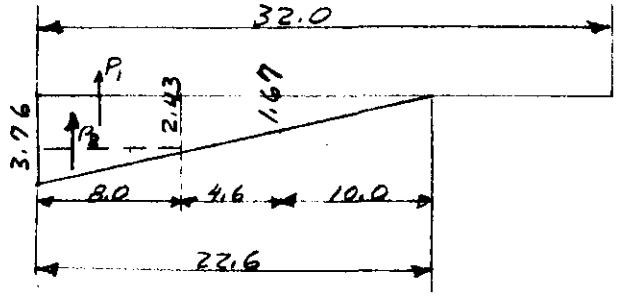
23×6.67 153 $\quad 39.2 - 16.2 = 23.0$

319

New $\bar{x} = \frac{319}{42.4} = 7.53$

$\frac{P \times 3 \times 7.53}{2} = 42.4$

$P = 3.76$



W & C	22.0 ↓		86.6 ↑
P_1 2.43 x 8	19.4	4	77.6 ↓
P_2 1.33 x 8/2	5.3	5.67	30.2 ↓
U_1 & U_2	13.4		52.6 ↓
	16.6		73.8 ↓

[Was 45.4]

Load #1 Governs
Use #8 @ 8

$A_s = \frac{73.8}{1.44 \times 50} = 1.02$

$V = 35$ #/□"

Heel Load #2 See p 6

P_1 & P_2 was 16.4 ↑ $\quad$ Mom was 113 ↑

$1.67 \times 10/2$ Now 8.4 $\quad \times 3.33$ Now 28

Diff 8.0 $\quad$ Diff. 85

$\bar{V} = 8.0 + 8.0 = 16.0$ ↓

Mom = 109.7 + 85 = 194.7

$A_s = \frac{194.7}{1.44 \times 51} = 2.67$ Governs $\quad$ #11 @ 7

[was #9 @ 8]

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

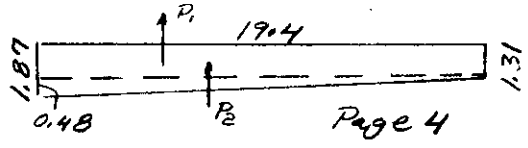
PROJECT Chicopee Falls

SUBJECT Flood Walls
38.4' Wall

PROJECT NO. 6205-2
SHEET NO. 7 OF
DATE Feb. 11, 1963
COMPUTED BY FNW
CHECKED BY WR

Sta. 17+60

Heel Bot. Steel
Load #3



Page 4

Uplift = 10 × 0.0625 = 0.625
= Constant

Symbol	Factors	↓	↑	—	—	Arm	M↻	M↺
$C_5 - C_{6A}$		9.6					80.7	
Wes7	.130 × 19.4 × 4.0	10.1				9.7	98.0	
Wes1	0.135 × 19.4 × 5.4	14.1				9.7	137.0	
Wes2	0.135 × 19.4 × 2.6 × 1/2	3.4				12.9	44.0	
P_1	1.31 × 19.4		25.4			9.7		246
P_2	0.56 × 19.4 × 1/2		5.4			6.5		35
U	0.625 × 19.4		12.1			9.7		117
							359.7	398
								359.7
								38.3

$$A_s = \frac{38.3}{1.44 \times 50} = 0.534 \text{ in}^2$$

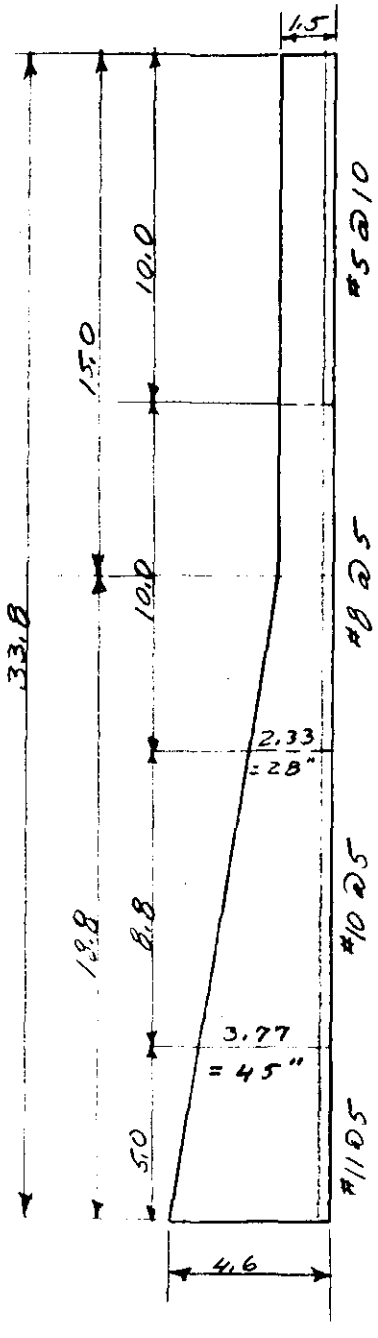
Use #6 @ 8"

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT Chicopee Falls.
SUBJECT Flood Walls
38.4' Wall

PROJECT NO. 6205-2
SHEET NO. 8 OF
DATE Feb. 6, 1963
COMPUTED BY FNW
CHECKED BY WR

Steel in Stem. Riverside



At top of base

Load #1. $M = 0.0625 \times \frac{33.8^2}{2} = 404'^k$

$d = \sqrt{\frac{404{,}000 \times 12}{200 \times 12}} = 44 < 52$

No Comp. Steel needed

wt. & C.G. $1.5 \times 0.15 \times 33.8 = 7.6 \times 0.75 = 5.7$

$0.15 \times 18.8 \times \frac{3.1}{2} = \frac{4.4}{12.0} \times 3.03 = \frac{13.2}{18.9}$

$\bar{x} = \frac{18.9}{12.0} = \frac{1.58}{0.33}$
1.25 to steel

Load #1 $M = 12.0 \times 1.25 = 15$
water 404
NE 419

$e = \frac{419}{12.0} = 35.0'$

$\frac{e}{d} = \frac{35.0 \times 12}{52} = 8.1$

Table 10, $i = 1.13$

Table 1. $f_s = 27{,}000$ $a = 2.00$

$A_s = \frac{NE}{adi} = \frac{419}{2.0 \times 51 \times 1.13} = 3.6$

[$A_s = 3.9$ neglecting axial load]

Load #2 $M = 12.0 \times 1.25 = 15$
$+ 304$
NE. 319

$e = \frac{319}{12.0} = 26.6$

$\frac{e}{d} = \frac{26.6 \times 12}{52} = 6.2$

Table 10. $i = 1.17$

Table 1. $f_s = 20{,}000$ $a = 1.44$

$A_s = \frac{NE}{adi} = \frac{319}{1.44 \times 51 \times 1.17} = 3.7$

#11 @ 5"

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT Chicopee Falls
SUBJECT Flood Walls
384' Wall

PROJECT NO. 6205-2
SHEET NO. 9 OF
DATE Feb. 6, 1963
COMPUTED BY FNW
CHECKED BY WR

Steel in Stem. Riverside (Cont.)

5.0' from top of base. Load #2 governs

$M = 0.0625 \times \frac{25.8^3}{6} = 179$ $\qquad d = \sqrt{\frac{179{,}000}{160}} = 34 < 42$

$A_s = \frac{179}{1.44 \times 42} = 2.98^{\square''}$

Use #10 @ 5"

20.0' from top of wall. Load #1 governs.

$M = 0.0625 \times \frac{20^3}{6} = 83.4$

$A_s = \frac{83.4}{2.0 \times 24} = 1.74^{\square''} = (\#8.5\ 1/4)$

Use #8 @ 5"

10.0' from top of wall. Load #1 governs.

$M = 0.0625 \times \frac{10^3}{6} = 10.4'^k$

$A_s = \frac{10.4}{2.0 \times 15} = 0.35^{\square''}$

Try #5. $\quad s = \frac{0.31 \times 12}{0.35} = 10.7$

Use #5 @ 10"

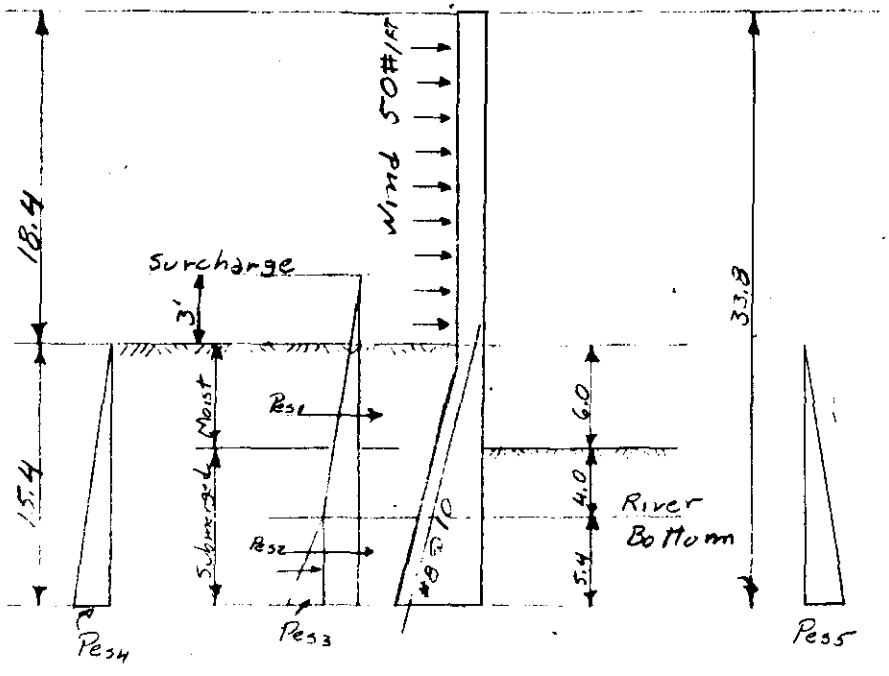
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT Chicopee Falls

SUBJECT Flood Walls
38.4' Wall

PROJECT NO. 6205-2
SHEET NO. 10 OF
DATE Feb. 6, 1963
COMPUTED BY FNW
CHECKED BY WR

Steel in Stem Landside P.4



$Pe_{s4} = Pe_{s5}$

$Pe_{s1} = 0.130 \times 13^2 \times \frac{1}{2} \times \frac{1}{3} = 3.66 \times 9.73 = 35.6$

$Pe_{s2} = 0.130 \times 13 \times \frac{5.4}{3} = 3.04 \times 2.7 = 8.2$

$Pe_{s3} = 0.0725 \times 5.4^2 \times \frac{1}{2} \times \frac{1}{3} = 0.35 \times 1.8 = 0.6$

$Wind = 0.05 \times 18.4 = 0.92 \times 24.6 = 22.6$

7.97 67.0 44.4

$A_s = \frac{44.4}{1.44 \times 51} = 0.6$

$A_s = \frac{67.0}{2.0 \times 51} = 0.66$ Use #7 @ 10 $A_s = 0.72$
or #8 @ 12 $A_s = 0.79$

At 18.4' From top

$M = 0.05 \times 18.4 \times 9.2 = 8.5$

$A_s = \frac{8.5}{2.0 \times 22} = 0.28$ Use #6 @ 12 (0.44)
#5 @ 12 = 0.31
#5 @ 10 = 0.37

B-12

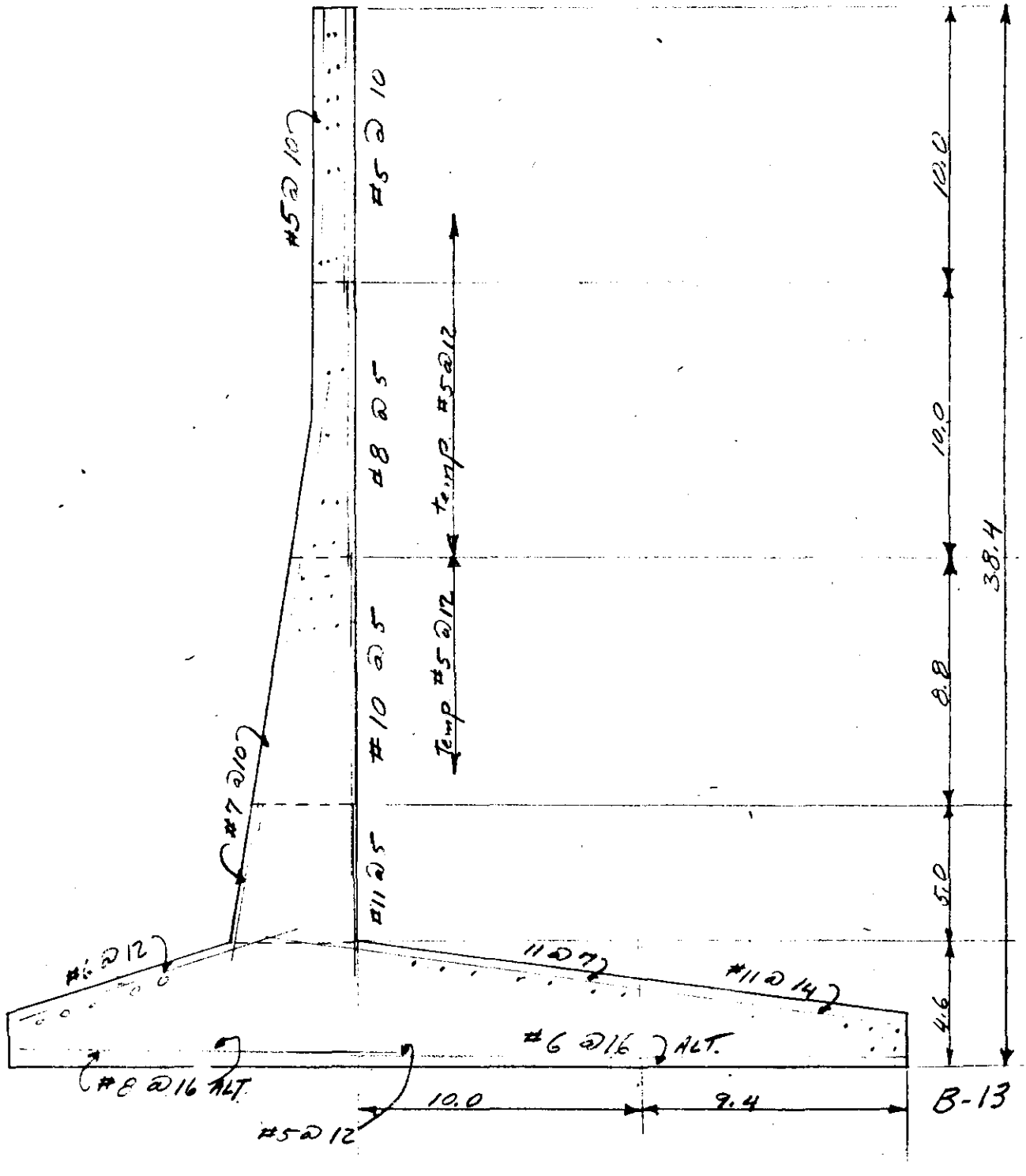
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT Chicopee Falls

SUBJECT Flood Walls
38.4' Wall

PROJECT NO. 6205-2
SHEET NO. 11 OF
DATE Feb. 6, 1963
COMPUTED BY FHW
CHECKED BY WR

24 dia. embedment and lap.
Temp. & shrinkage steel #5 @ 12 unless noted



B-13

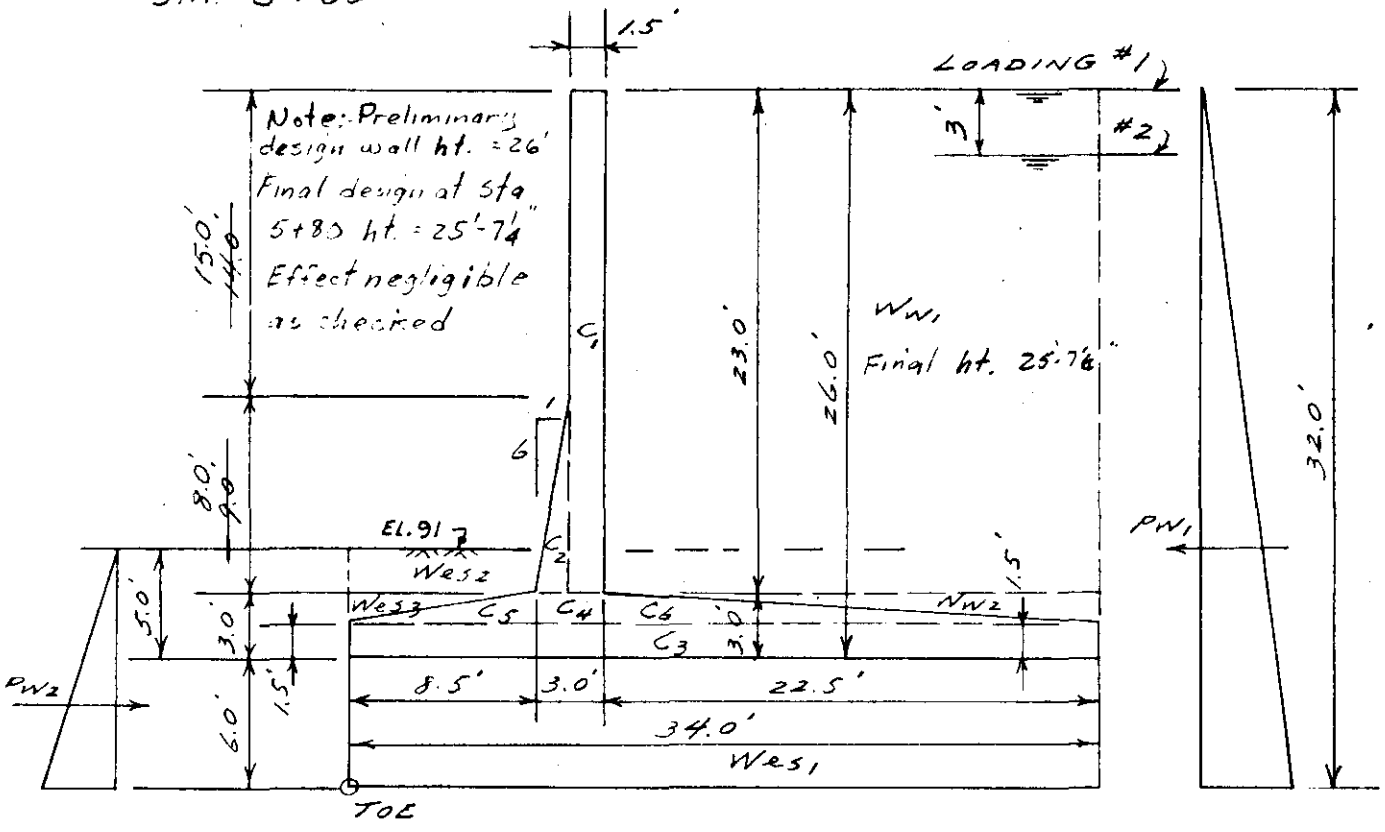
GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS
BOSTON, MASS.

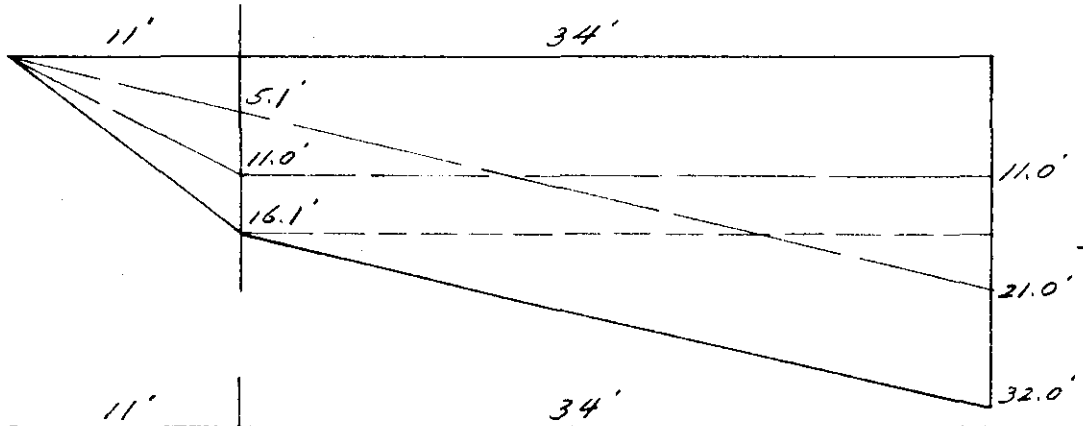
PROJECT: CHICOPEE FALLS

SUBJECT: FLOOD WALL - ANCHORED
26' WALL - 34' BASE

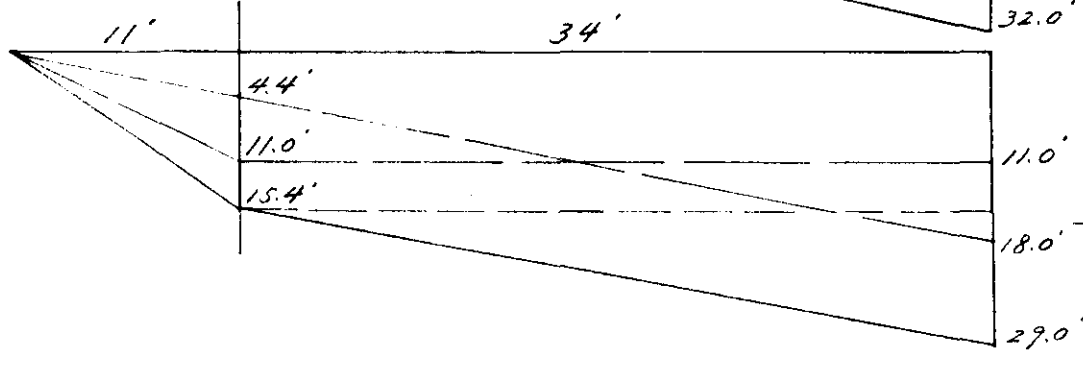
PROJECT NO. 6205
SHEET NO. 1 OF
DATE DEC. 1962
COMPUTED BY J.K.
CHECKED BY F.N.W

STA. 5+80





UPLIFT LOADING 1



UPLIFT LOADING 2

C-1

GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205
SHEET NO. 2 OF
DATE DEC. 1962
COMPUTED BY J Ku
CHECKED BY FNW.

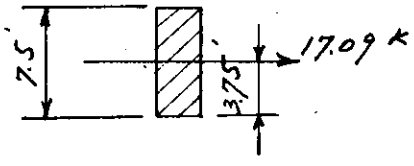
LOADING #1 — NO FILL OVER HEEL USED IN CASE 1 & 2 (conservative)
(THE AVERAGE IS 3' ± FILL - $\bar{x}$ MOVE NEGLIBLE

		↓	↑	→	←	ARM	$\overset{\curvearrowright}{M}$	$\overset{\curvearrowleft}{M}$
C_1	23.0 x 1.5 x 0.15	5.18				10.75'	55.7	
C_2	9.0 x 1.5 x 0.5 x .15	1.01				9.50	9.6	
C_3	34.0 x 1.5 x 0.15	7.65				17.00	130.1	
C_4	3.0 x 1.5 x 0.15	0.68				10.00	6.8	
C_5	8.5 x 1.5 x .5 x .15	0.96				5.67	5.4	
C_6	22.5 x 1.5 x .5 x .15	2.53				19.00	48.1	
W_{W1}	23.0 x 22.5 x .0625	32.34				22.75	735.7	
W_{W2}	22.5 x 1.5 x .5 x .0625	1.06				26.50	28.1	
W_{es1}	34.0 x 6.0 x 0.17	34.68				17.00	589.6	
W_{es2}	8.5 x 2.0 x 0.135	2.29				4.25	9.7	
W_{es3}	8.5 x 1.5 x .5 x .135	0.86				2.83	2.4	
P_{W1}	.0625 x $32^2/2$				32.00	10.67		341.4
P_{W2}	.0625 x 11/2 x 16.1			5.54		3.67	20.3	
U_1	16.1 x .0625 x 34.0		34.21			17.00		581.6
U_2	15.9 x .0625 x .5 x 34		16.89			22.67		382.9
	Σ	89.24	51.10	5.54	32.00		1641.4	1305.9
		51.10					1305.9	
		38.14 K					335.5 K'	

RESULTANT @ $\frac{335.5}{38.14}$ = 8.78' FROM TOE

$\frac{34.0}{4}$ = 8.50' ∴ ok.

HORIZ. FORCE (UNBALANCED) = 32.00 - 5.54 - (0.3 x 38.14)
= 14.98 K



ADD'L M = 14.98 x 3.75 = 56.2 K'
M = 335.5 + 56.2 = 391.7 K'

$\bar{x} = \frac{391.7}{38.14}$ = 10.3' > 8.5'

o.k.

C-2

GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS

SUBJECT: FLOOD WALL - ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205
SHEET NO. 3 OF
DATE DEC. 1962
COMPUTED BY J Ku
CHECKED BY FNW

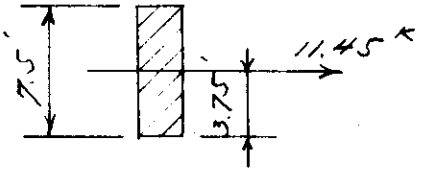
LOADING #2 (W.S. AT 3' BELOW TOP OF WALL)

		↓	↑	→	←	ARM	$\overset{\curvearrowright}{M}$	$\overset{\curvearrowleft}{M}$
C_1, C_2, C_3, C_4, C_5, C_6		18.01					255.7	
W_{W1}	20.0 x 22.5 x .0625	28.13				22.75	639.9	
W_{W2}		1.06					28.1	
W_{es1}		34.68					589.6	
W_{es2}		2.29					9.7	
W_{es3}		0.86					2.4	
P_{W1}	.0625 x 29²/2				26.28	9.67		254.1
P_{W2}				5.54			20.3	
U_1	15.4 x .0625 x 34.0		32.73			17.00		556.4
U_2	13.6 x .0625 x ½ x 34		14.45			22.67		327.6
	Σ	85.03	47.18	5.54	26.84		1545.7	1138.1
		47.18					1139.5	
		37.85 K					406.2 K'	

RESULTANT @ $\frac{406.2}{37.85} = 10.7'$ FROM TOE

$\frac{34.0}{3} = 11.3'$ ∴ OUTSIDE ⅓ PT.

HORIZ. FORCE (UNBALANCED) = 26.84 - 5.54 - 0.3 x 37.85
= 26.84 - 5.54 - 11.35
= 9.95 K



ADD'L M = 9.95 x 3.75 = 37.3 K'

M = 406.2 + 37.3 = 446.1 K'

$\bar{x} = \frac{443.5}{37.85} = 11.7' > 11.3'$

O.K.

C-3

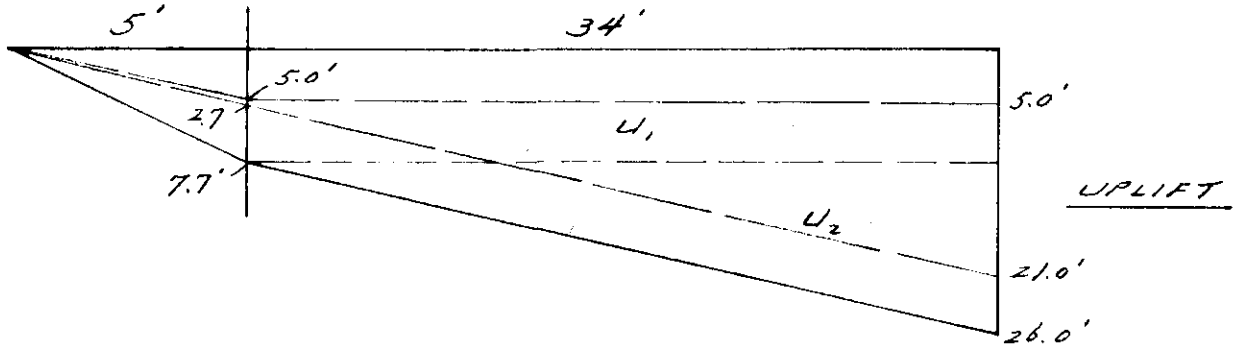
GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS
BOSTON, MASS.

PROJECT NO. 6205
SHEET NO. 4 OF
DATE DEC. 1962
COMPUTED BY J Ku
CHECKED BY FNW

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALL - ANCHORED
26' WALL - 34' BASE

LOADING #1 AT BOTTOM OF CONCRETE



		↓	↑	→	←	ARM	↻ M	↺ M
C_1, C_2, C_3, C_4, C_5, C_6		18.01					255.7	
W_{W1}		32.34					735.7	
W_{W2}		1.06					28.1	
W_{es2}		2.29					9.7	
W_{es3}		0.86					2.4	
P_{W1}	$.0625 \times 26^2/2$				21.13	8.67		183.2
P_{W2}	$.0625 \times 5/2 \times 7.7$			1.20		1.67	2.0	
U_1	$7.7 \times 34.0 \times .0625$		16.36			17.00		278.1
U_2	$18.3 \times \frac{34.0}{2} \times .0625$		19.44			22.67		440.7
	Σ	54.56	35.80	1.20	21.13		1033.6	902.0
		35.80					902.0	
		18.76 K					131.6 K'	

RESULTANT AT $\frac{131.6}{18.76}$ = 7.00' FROM TOE

$\frac{34.0}{4}$ = 8.50' (OUTSIDE 1/4 PT.)

[SEE NEXT SH.]

GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205
SHEET NO. 5 OF
DATE DEC. 1962
COMPUTED BY J Ku
CHECKED BY F.N.W.

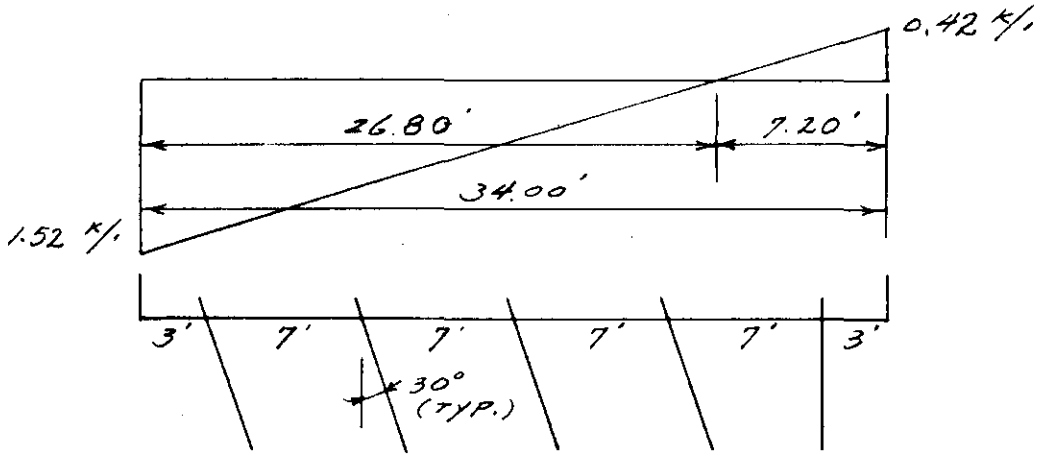
LOADING #1 AT BOTTOM OF CONCRETE (CONT.)

RESULTANT AT 7.00' FROM TOE

$e = 17.00' - 7.00' = 10.00'$

$$p = \frac{18.76}{34}\left(1 \pm \frac{6 \times 10.00}{34}\right) = 0.552\,(1 \pm 1.76)$$

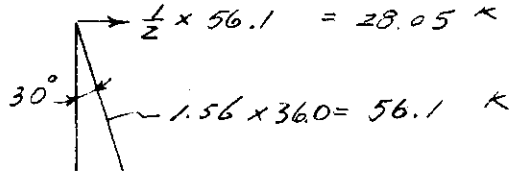
$= 1.52$ K/□'	-0.42 K/□' NET uplift
0.48	1.62
2.00 K/□'	1.20 K/□'



UNBALANCED HORIZ. FORCE

$= 21.13 - 1.20 - 0.2 \times 18.76 = 21.13 - 4.95 = 16.12$ K

USE #11 ANCHORS SPACED AS SHOWN



ALLOWABLE $f = 36$

USE 7'-0" SP'G

SPACING IN OTHER DIRECTION

$$= \frac{28.05 \times 4}{16.12} = 6.97'$$

TENSION $= 0.42 \times 7.20 \times \frac{1}{2} = 1.51$ K/'

VERT. ANCHOR TAKES $\frac{56.1}{7} = 8.0$ K/'

Shear $= \frac{16{,}120 \times 7.00}{5 \times 1.56} = 14500$ PSI

C-5

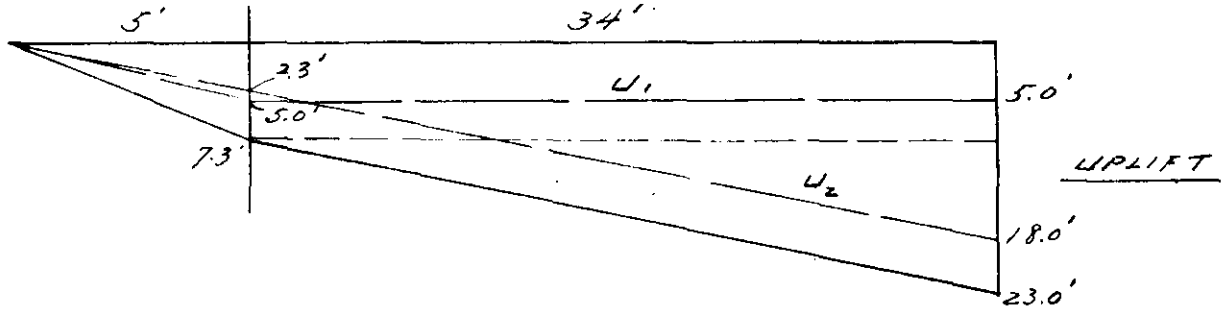
GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS
BOSTON, MASS.

PROJECT NO. 6205
SHEET NO. 6 OF
DATE DEC. 1962
COMPUTED BY J Kim
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALL - ANCHORED
26' WALL - 34' BASE

LOADING #2 AT BOTTOM OF CONCRETE



		↓	↑	→	←	ARM	↻ M	↺ M
C_1								
C_2								
C_3		18.01					255.7	
C_4								
C_5								
C_6								
W_{W1}	20.0 x 22.5 x .0625	28.13				22.75	639.9	
W_{W2}		1.06					28.1	
W_{es2}		2.29					9.7	
W_{es3}		0.86					2.4	
P_{W1}	.0625 x $23^2/2$				16.53	7.69		126.8
P_{W2}	.0625 x $5/2$ x 7.3			1.14		1.67	1.9	
U_1	7.3' x 34.0' x .0625		15.51			17.00		263.7
U_2	15.7' x 34.0' x $\frac{1}{2}$ x .0625		16.68			22.67		378.1
	Σ	50.35	32.19	.78	16.53		937.7	768.6
		32.19					768.6	
		18.16 k					169.1 k'	

RESULTANT AT $\frac{169.1}{18.16}$ = 9.33' FROM TOE

$\frac{34.0}{3}$ = 11.3' (OUTSIDE $\frac{1}{3}$ PT.)

[SEE NEXT SH.]

GREEN ENGINEERING AFFILIATES, INC.
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205
SHEET NO. 7 OF
DATE DEC. 1962
COMPUTED BY J Ku
CHECKED BY F.N.W.

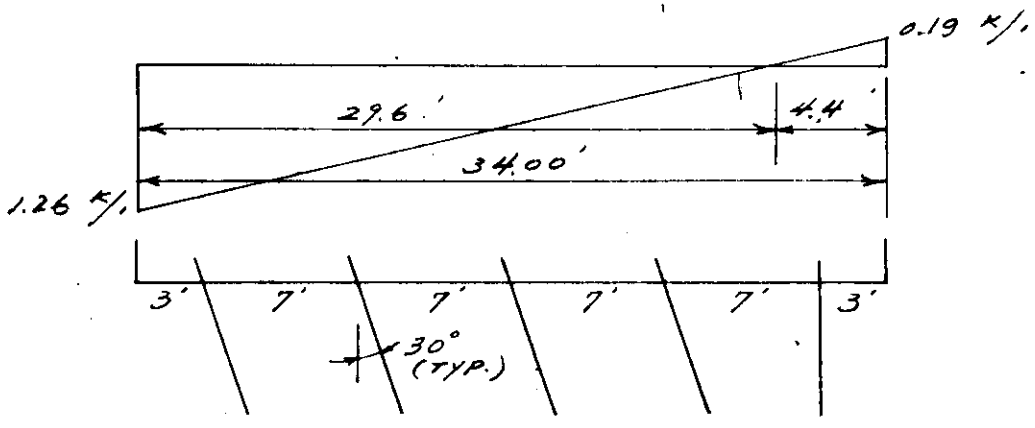
LOADING #2 AT BOTTOM OF CONCRETE (CONT.)

RESULTANT AT 9.33' FROM TOE

$e = 17.00' - 9.33' = 7.67'$

$$p = \frac{18.16}{34}\left(1 \pm \frac{6 \times 7.67}{34}\right) = 0.534\,(1 \pm 1.353)$$

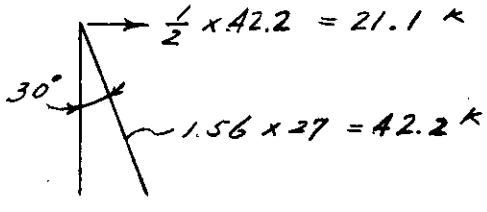
$= 1.26$ k/□'	-0.19 k/□' NET uplift
0.46	1.44
1.72 k/□'	1.25 k/□'



UNBALANCED HORIZ. FORCE

$= 16.53 - 1.14 - 0.2 \times 18.16 = 16.53 - 4.76 = 11.76^k$

USE #11 ANCHORS AS SHOWN



ALLOWABLE $f = 27$

USE 7'-0" SP'G

SPACING IN OTHER DIRECTION

$$= \frac{21.1 \times 4}{11.76} = 7.15'$$

USE 7' SPACING (AS BEFORE LD. #1)

TENSION $= 0.19 \times 4.40 \times \frac{1}{2} = 0.42$ k/'

VERT. ANCHOR TAKES $\frac{42.2}{7} = 6.0$ k/'

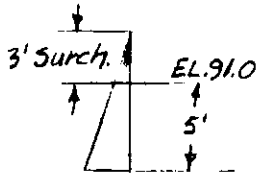
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS

SUBJECT: FLOOD WALLS - ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205-2
SHEET NO. 8 OF
DATE JAN 63
COMPUTED BY WR
CHECKED BY F.N.W.

LOADING #3



(1) 2 FT. WATER AT RIVERSIDE - NEGLIBLE EFFECT ON WATER PRESSURES
(2) WIND LOAD 50#/□' AT LAND
(3) 2 FT. UPLIFT
(4) 3' SURCHARGE
(5) MOIST EARTH (EL.91) ON RIVER SIDE - ($W_{ES4,5}$)
(6) HORIZONTAL UNIBALANCE IS TAKEN by f. and ANCHORS

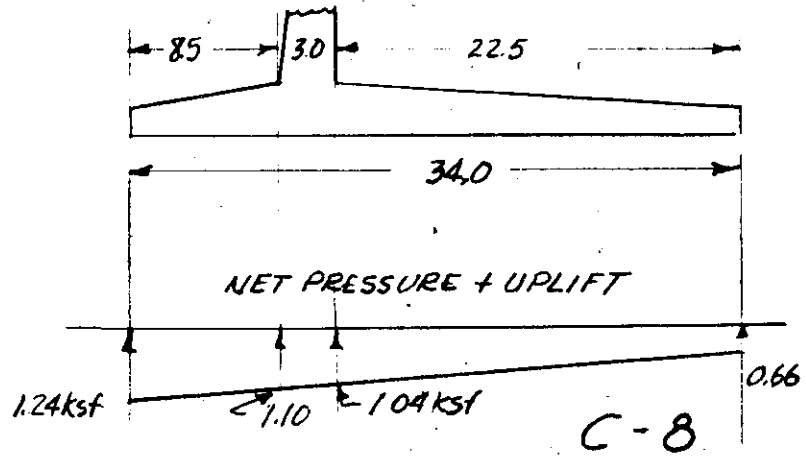
		↓	↑	→	←	ARM	M ↻	M ↺
$C_1 - C_6$		18.01					255.7	
W_{ES2}		2.29					9.7	
W_{ES3}		0.86					2.4	
W_{ES4}	22.5 x 2.0 x .130	5.85				22.75	133.0	
W_{ES5}	22.5 x 1.5/2 x .130	2.19				26.5	58.0	
UPLIFT	.0625 x 2 x 34		4.25			17.0		72.2
WIND	.05 x 21.0			1.05		15.5	16.3	
P_{ES1}	8^2 x .130/6			1.39		2.67	3.7	
SURCH.	3' x 8.5 x .125	3.19				4.25	13.5	
		32.39	4.25	2.44	Frict.		492.3	72.2
		4.25					72.2	
		28.14					420.1	

RESULTANT AT: $\frac{420.1}{28.14} = 15.0$ FT. ∴ e = 2.0 FT.

$$p = \frac{28.14}{34}\left(1 \pm \frac{6 \times 2.0}{34}\right) = 0.83\,(1 \pm .353)$$

= 1.12 ksf	0.54 ksf
0.12 ksf	0.12 ksf uplift
1.24 ksf	0.66 ksf

LOADING 3:

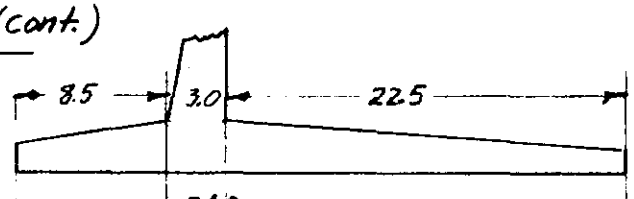


GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

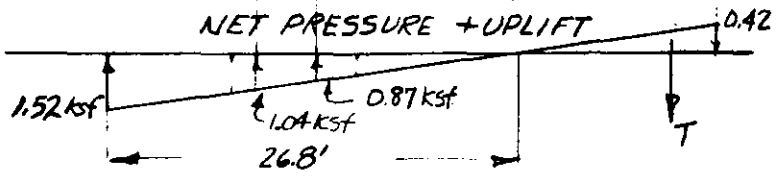
PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS - ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205
SHEET NO. 9 OF
DATE JAN 63
COMPUTED BY DOR
CHECKED BY F.N.W.

PRESSURES (cont.)



LOADING 2:
(REFER Pg 5)



LOADING 1 : NO UPLIFT

WT = 54.56 k ↓ (REFER Pg 4)

M = 1033.6 − 183.2 = 850.4 'k

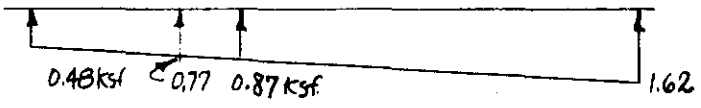
$\bar{x} = \frac{850.4}{54.56} = 15.5$ FT.

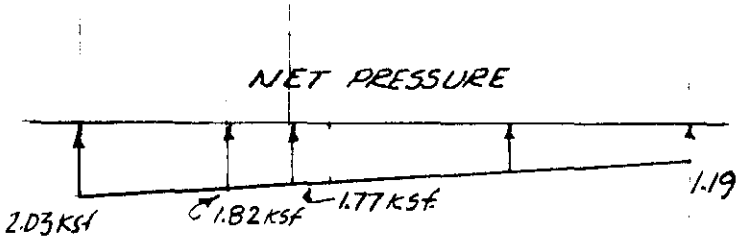
$e = 1.5$ FT

$p = \frac{54.56}{34}\left(1 \pm \frac{6 \times 1.5}{34}\right)$

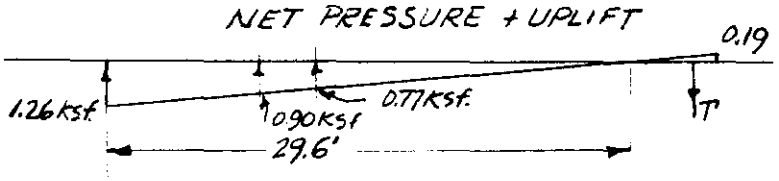
$= 1.61\,(1 \pm 0.26)$

$= 2.03$ ksf, 1.19 ksf





LOADING 2:
(REFER Pg 7)



LOADING 2: NO UPLIFT

WT. = 50.35 ↓

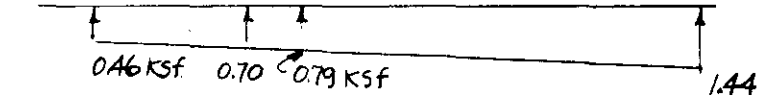
M = 937.7 − 126.8 = 810.9

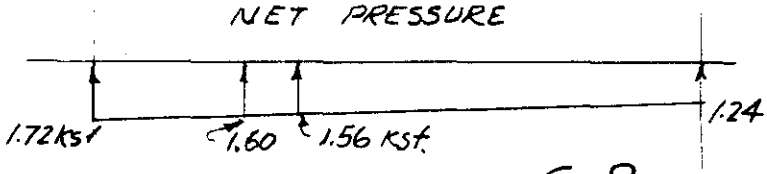
$\bar{x} = \frac{810.9}{50.35} = 16.1$; $e = 0.9$

$p = \frac{50.35}{34}\left(1 \pm \frac{6 \times 0.9}{34}\right)$

$= 1.48\,(1 \pm .159)$

$= 1.72,\ 1.24$



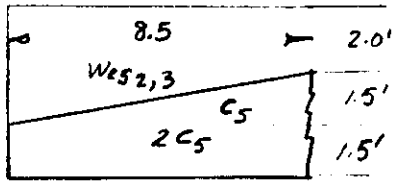


GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

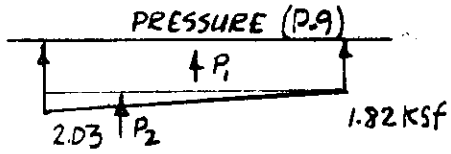
PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS – ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205-2
SHEET NO. 10 OF
DATE JAN 63
COMPUTED BY DR
CHECKED BY FNW

TOE: Bottom steel

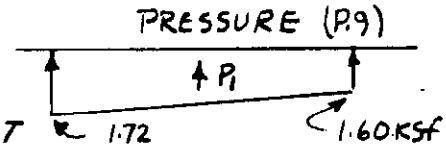


LOADING 1 (REFER P's 2 & 9)
NO UPLIFT GOVERNS (P.9)



		SHEAR		MOMENT
$(2)C_5$	=	1.92	× 4.25 =	8.2
C_5	=	0.96	× 2.83 =	2.7
Wes_2	=	2.29	× 4.25 =	9.8
Wes_3	=	0.86	× 5.67 =	4.9
$(1.82)(8.5) = P_1$	=	15.50	× 4.25 =	65.9
$(0.21)(8.5)(1/2) = P_2$	=	0.89	× 5.67 =	5.1
		10.36		45.4 'K

LOADING 2 (REFER P's 9,10)
NO UPLIFT = UPLIFT CASE (P.9)



		SHEAR		MOMENT
DEAD LOADS	=	6.03	—	= 25.6
$(1.60)(8.5) = P_1$	=	13.60	× 4.25 =	57.8
$(0.12)(8.5)(1/2) = P_2$	=	0.51	× 5.67 =	2.9
		8.08		35.1 'K

LOADING 1 $A_s = \dfrac{45{,}400}{(27{,}000)(.907)(31)} = .061\ in^2/in$

LOADING 2 $A_s = \dfrac{35{,}100}{(20{,}000)(.885)(31)} = .064\ in^2/in$

AT STEM: USE: #7 @ 9" c-c (.067 in^2/in) (BOTTOM)

AT MID TOE: USE #7 @ 18" c-c (BOTTOM)

Shear & Bond in Ftgs. & Wall is less than required.

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205-2
SHEET NO. 11 OF
DATE JAN 63
COMPUTED BY D.R.
CHECKED BY FNW.

TOE: Top Steel:

for construction: (REFER C_1-C_6)

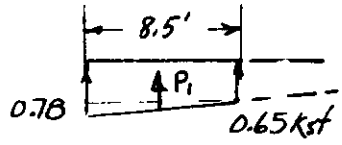
$$\bar{x} = \frac{255.7}{18.01} = 14.2 \text{ ft}$$

$$e = 2.8 \text{ ft}$$

$$p = \frac{18.01}{34}\left(1 \pm \frac{6 \times 2.8}{34}\right)$$

$$p = .53\,(1 \pm .49)$$

NET P = 0.78 ksf$_L$, 0.27 ksf$_{RT}$.



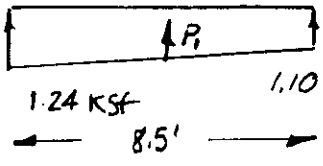
PRESSURE

CONSTRUCTION:

	SHEAR		MOMENT
(2) C_5 =	1.92 ↓	× 4.25 =	8.2 ↻
C_5 =	0.96 ↓	× 2.83 =	2.7 ↻
(0.65)(8.5) = P_1 =	5.52	× 4.25 =	23.4 ↻
(0.13)(8.5)(½) = P_2 =	0.55	× 5.67 =	3.1 ↻
			15.6 ↻

∴ NO TOP STEEL

LOADING 3 (REFER P's 8,10)



SURCHARGE =	3.19 ↓	× 4.25 =	13.6 ↻
DEAD LOADS =	6.03 ↓	=	25.6 ↻
(1.10)(8.5) = P_1 =	9.36 ↑	× 4.25 =	39.8 ↻
(0.14)(8.5)(½) = P_2 =	0.60 ↑	× 5.67 =	3.4 ↻
			4.0 ↻

∴ NO TOP STEEL

TOE ∴ USE SHRINKAGE STEEL (top)

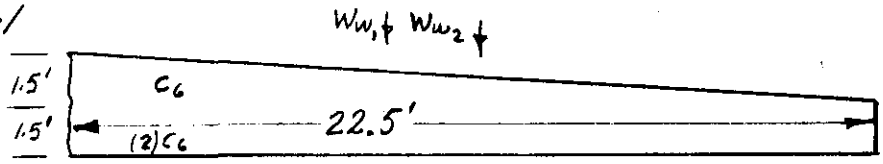
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT NO. 6205-2
SHEET NO. 12 OF
DATE JAN 63
COMPUTED BY DR
CHECKED BY F.N.W.

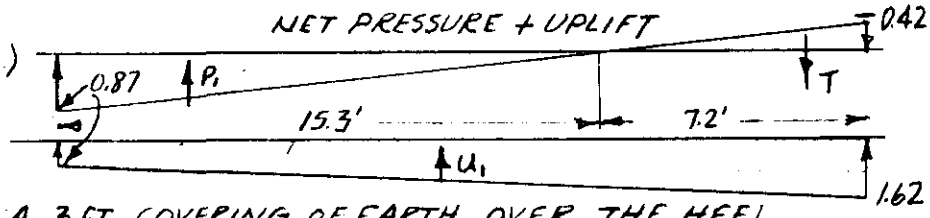
PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALLS - ANCHORED
26' WALL - 34' BASE

HEEL : Top steel



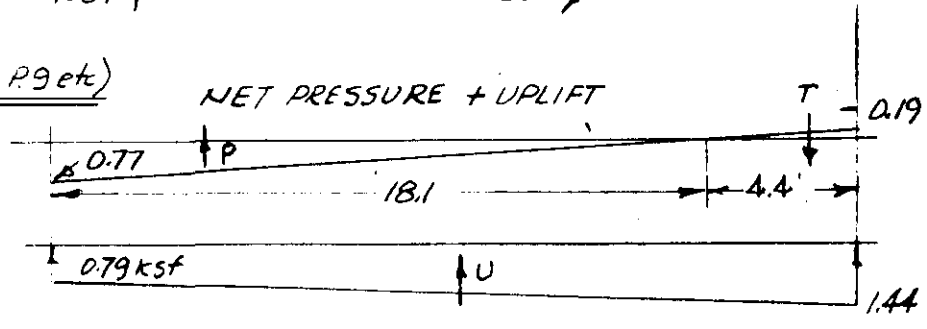
LOADING 1 (REFER P9 ETC)
WITH UPLIFT



NOTE : SINCE A 3 FT. COVERING OF EARTH OVER THE HEEL WILL ADD NO NET W.T. AND SMALL MOVEMENT OF THE RESULTANT (thus pressure change of small value), THESE EFFECTS HAVE BEEN NEGLECTED IN CASE 1 and CASE 2,

		SHEAR			MOMENT
	C_6	= 2.53	x 7.5	=	19.0
	$2\ C_6$	= 5.06	x 11.25	=	57.0
	W_{w_1}	= 32.34	x 11.25	=	364.0
	W_{w_2}	= 1.06	x 15.0	=	15.9
$(0.42)(7.2)(1/2)$ =	T	= 1.51	x 19.8	=	29.9
$(0.87)(15.3)(1/2)$ =	P_1	= 6.65	x 5.1	=	33.9
$(0.87)(22.5)$ =	U_1	= 19.52	x 11.25	=	220.0
$(0.75)(22.5)(1/2)$ =	U_2	= 8.46	x 1500	=	126.7
		7.87			105.2 'k

LOADING 2 (REFER P9 etc)
WITH UPLIFT



GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS – ANCHORED
26' WALL – 34' BASE

PROJECT NO. 6205-2
SHEET NO. 13 OF
DATE JAN 63
COMPUTED BY DR
CHECKED BY F.N.W.

HEEL: TOP steel (cont.)

(LOADING 2)

		SHEAR			MOMENT
	(3)C_6	= 7.59	———	=	76.0 ↓
	W_1	= 28.13	× 11.25	=	317.0 ↓
	W_2	= 1.06	× 15.00	=	15.9 ↓
(0.19)(4.4)(½)	= T	= 0.42 ↓	× 21.00	=	8.8 ↓
(0.77)(18.1)(½)	= P	= 6.98 ↑	× 6.03	=	42.2 ↑
(0.79)(22.5)	= U_1	= 17.80	× 11.25	=	201.0 ↑
(0.65)(22.5)(½)	= U_2	= 7.32	× 15.00	=	109.7 ↑
		5.10 ↓			648 ↓

LOADING 1

$$A_s = \frac{105{,}200}{(27{,}000)(.907)(32)} = 0.134 \text{ in}^2/\text{in}$$

LOADING 2

$$A_s = \frac{64{,}800}{(20{,}000)(.885)(32)} = 0.114 \text{ in}^2/\text{in}$$

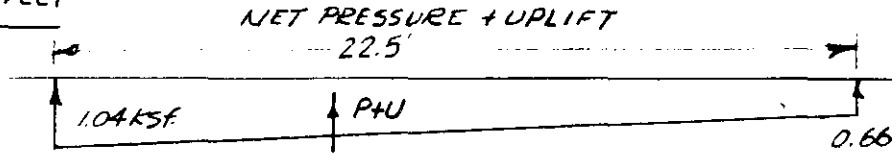
AT STEM: USE: #10 @ 9" C-C (0.141 in²/in) (TOP)

AT MID HEEL: USE: #10 @ 18" C-C (TOP)

HEEL Bottom Steel

LOADING 3

(REFER P's 8 ETC)

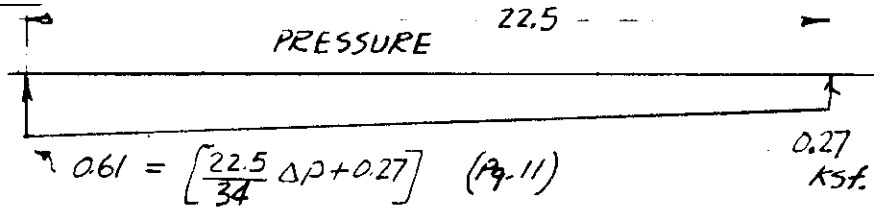


		SHEAR			MOMENT
	$3C_6$	= 7.59	———	=	76.0 ↓
	W_{es4}	= 5.85	× 11.25	=	66.0 ↓
	W_{es5}	= 2.19 ↓	× 15.00	=	32.9 ↓
(0.66)(22.5)	= $(P+U)_1$	= 14.34 ↑	× 11.25	=	162.0 ↑
(0.38)(22.5)(½)	= $(P+U)_2$	= 4.29 ↑	× 7.50	=	32.2 ↑
		3.00 ↑			19.3 ↑ 'K

HEEL: Bottom Steel (cont.)

CONSTRUCTION

(REFER P11 ETC.)



	SHEAR		MOMENT
	(3)C_6 = 7.59 ↓	———	= 76.0 ↓
(0.27)(22.5)	= P_1 = 6.08	× 11.25	= 68.5 ↓
(0.34)(22.5)(½)	= P_2 = 3.83	× 7.50	= 28.7 ↓
			21.2 ↓'k

$$A_s = \frac{21{,}200}{(20{,}000)(.885)(31)} = 0.0387 \text{ in}^2/\text{in}$$

AT STEM: USE: #6 @ 9" C-C (0.05 in²/in) (BOTTOM)

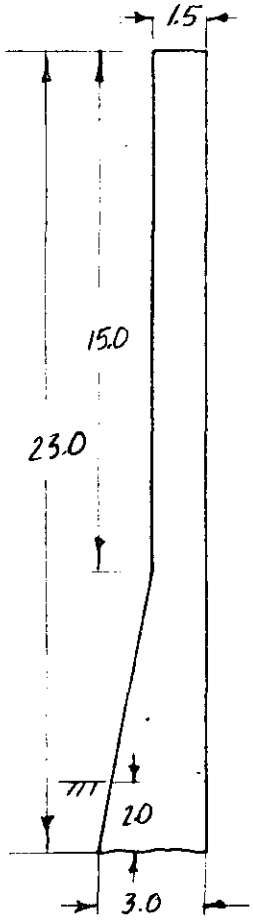
AT MID HEEL: USE: #6 @ 18" C-C (BOTTOM)

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205-2
SHEET NO. 15 OF
DATE JAN 63
COMPUTED BY DR
CHECKED BY F.N.W

STEM : Riverside



WATER AT 23.0' : $M = .0625 \times 23^3 \times 1/6 = 127'k$

WATER AT 20.0' : $M = .0625 \times 20^3 \times 1/6 = 83.3'k$

LOADING 1 : $A_s = \frac{127{,}000}{(.907)(27{,}000)(32)} = 0.162\ in^2/in$

LOADING 2 : $A_s = \frac{83{,}300}{(.885)(20{,}000)(32)} = 0.146\ in^2/in$

AT BOTTOM : SEE P15A (#10-8"c-c) (0.159 in^2/in)

WATER AT 17.0' : $M = .0625 \times 17^3 \times 1/6 = 51.2'k$

LOADING 1 : $A_s = \frac{51{,}200}{(.907)(27{,}000)(18.0)} = 0.121\ in^2/in$

∴ 9 FT FROM BOTTOM : USE : #9 @ 8"c-c (0.129 in^2/in)

WATER AT 10.0' : $M = .0625 \times 10^3 \times 1/6 = 10.4'k$

LOADING 1 : $A_s = \frac{10{,}400}{(.907)(27{,}000)(14)} = 0.031\ in^2/in$

∴ 13 FT FROM BOTTOM : USE : #5 @ 8"c-c (0.039 in^2/in)

GREEN ENGINEERING AFFILIATES
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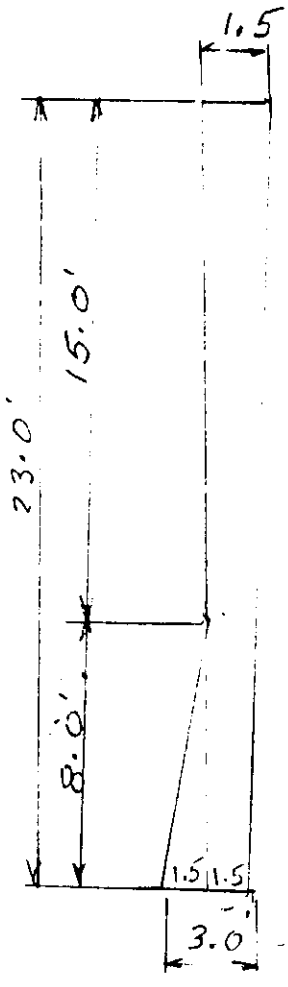
BOSTON, MASS.

PROJECT CHICOPEE FALLS
SUBJECT FLOOD WALL - ANCHORED
26' Wall. 34' Base.

PROJECT NO. 6205-2
SHEET NO. 15A OF
DATE Jan. 31. 1963
COMPUTED BY FNW
CHECKED BY SR

STEM - Riverside.



Loading #1.
$M = .0625 \times 23^3 \times \frac{1}{6} = 127$ 'k
$f_s = 27,000$
$f_c = \cancel{1400}\ 1350$
$n = 10$

Loading #2.
$M = .0625 \times 20^3/6 = 83.5$
$f_s = 20,000$
$f_c = 1050$
$n = 10$

Wt. + C.G. $0.15 \times 23 \times 1.5 = 5.18 \times .75 = 3.88$
$0.15 \times 8.0 \times 1.5 \times \frac{1}{2} \cdot \frac{0.90}{} \times 2.0$ 1.8
$N = 6.08$ 5.68

$\bar{x} = \frac{5.68}{6.08} = 0.936'$
$0.936' \times 12 = 11.23''$ $d = 36 - 4 = 32''$
Axial mom. from steel $= 6.08 \times \frac{7.23}{12} = 3.66$
$M = 127 + 3.7 = 130.7$ 'k

Conc. Handbook, p. 6.
$e = \frac{130,700 \times 12}{6,080} = 259''$
$\frac{e}{d} = \frac{259}{32} = 8.1$ $E = \frac{259}{12} = 21.6$

Table 1, 27,000/10/1350. $K = 200$, $a = 2.0$
" 4. $bd = 12 \times 32 = 384$, $F = 1.02$
$NE = 6.08 \times 21.6 = 131$
$KF = 2000 \times 1.02 = 204$
$NE - KF$ is negative. No pos. steel needed

Table 10. $\frac{e}{d} = \frac{259}{32} = 8.1$, $j = .889$, $c = 1.13$
$a = 2.00$

$A_s = \frac{NE}{adc} = \frac{131}{2.0 \times 32.0 \times 1.13} = 1.82$ □" Use #10 @ 8"

Neglecting axial load. $A_s = \frac{127,000 \times 12}{27000 \times 0.9 \times 32} = 1.96$ □"

Note: Loading #2 computed = 1.61 □" per ft.
i.e. Does not govern.

GREEN ENGINEERING AFFILIATES
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BOSTON, MASS.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALL – ANCHORED
26' WALL - 34' BASE

PROJECT NO. 6205-2
SHEET NO. 16 OF
DATE JAN 63
COMPUTED BY (DR)
CHECKED BY F.N.W.

STEM: Landside

(REFER Ps 8,15)

AT BOTTOM:

$2 \times .135 \times 1/6 = P_{es_1} = 0.09 \times 2/3 = 0.1$ ↑
$21 \times .05 = WIND = 1.05 \times [23' - 2\frac{1}{2}] = 12.1$ ↑
$12.2'k$ ↑

LOADING 3: $A_s = \frac{12.200}{(20{,}000)(.885)(31)} = .0224 \ in^2/in.$

AT BOTTOM: USE: #5-12" C-C (0.028 in²/in)

AT 8' FROM BOTTOM: USE #5-12" C-C $M < 12.2'k$

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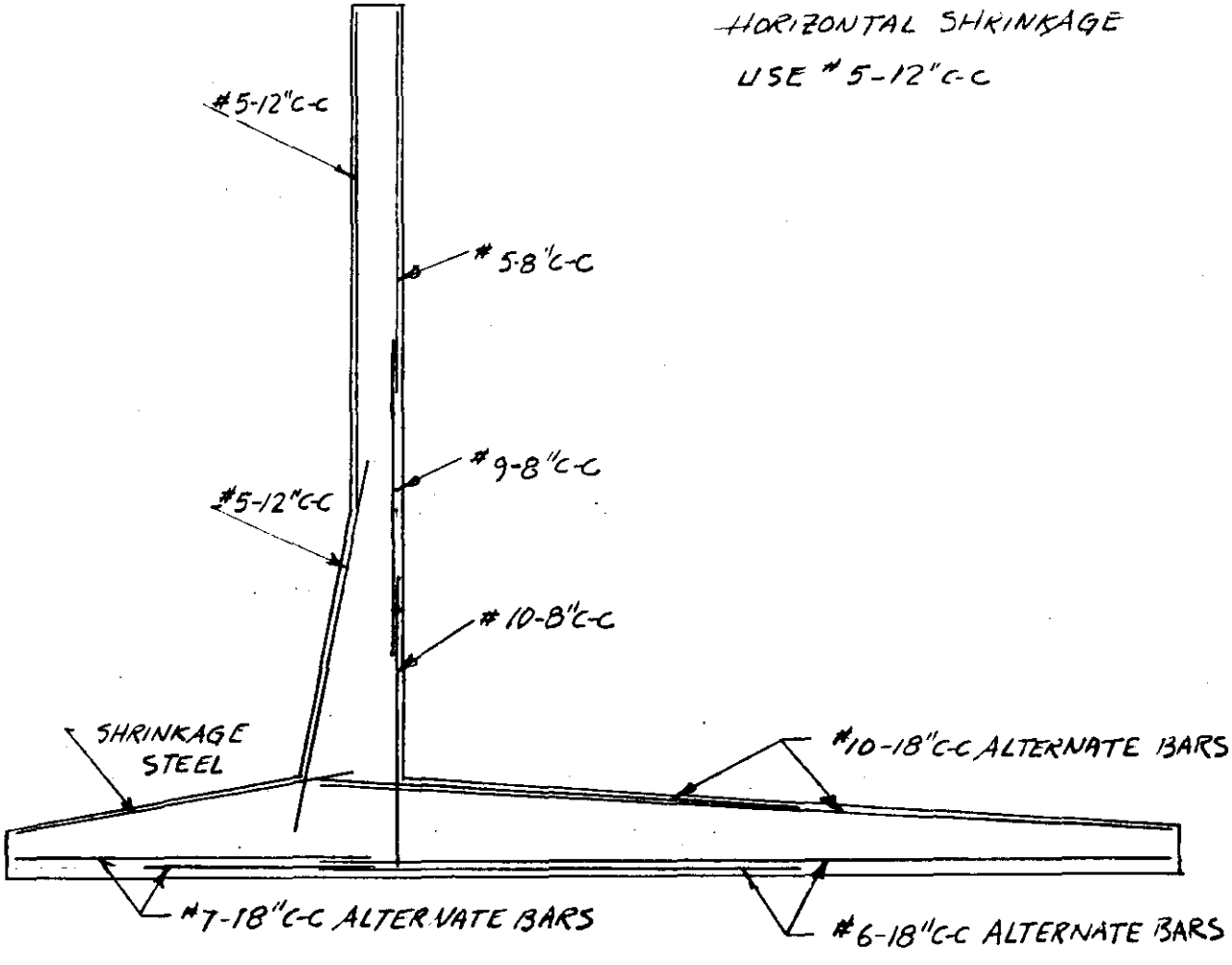
PROJECT NO. 6205-2
SHEET NO. 17 OF
DATE JAN 63
COMPUTED BY DR
CHECKED BY

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALL - ANCHORED
26' WALL - 34' BASE

STEEL LAP + EMBED 24 DIA. 1" = 5' SCALE



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BOSTON, MASS.

PROJECT NO. 6205-2
SHEET NO. 1 OF
DATE JAN 63
COMPUTED BY DR
CHECKED BY F.N.W

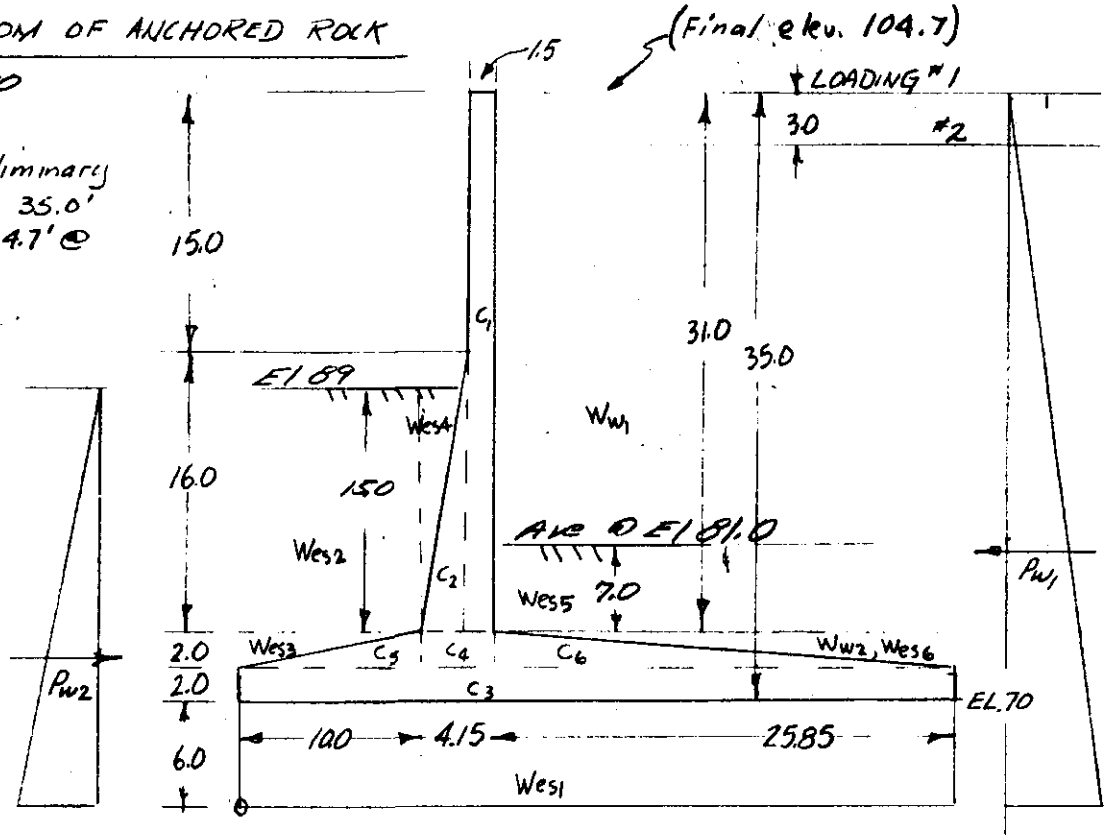
PROJECT CHICOPEE FALLS.

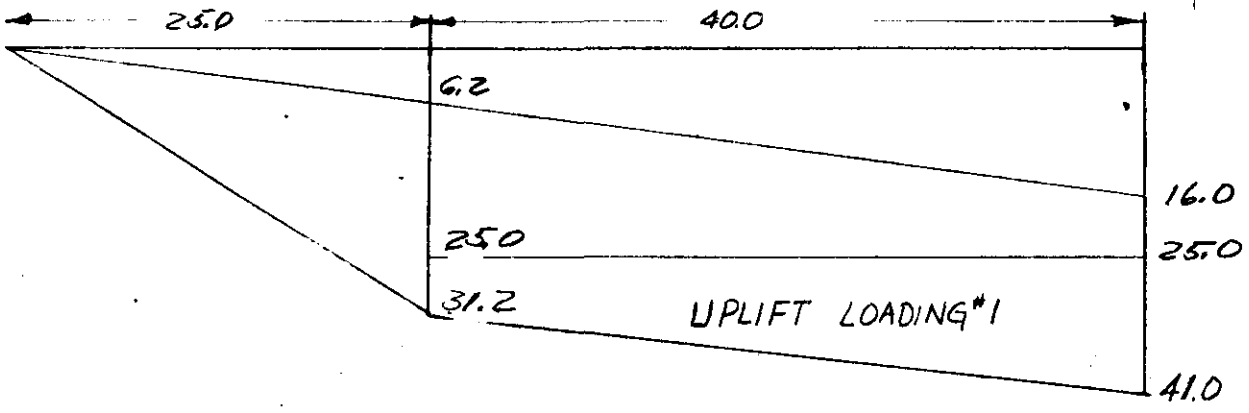
SUBJECT FLOOD WALL - ANCHORED
35' WALL - 40' BASE

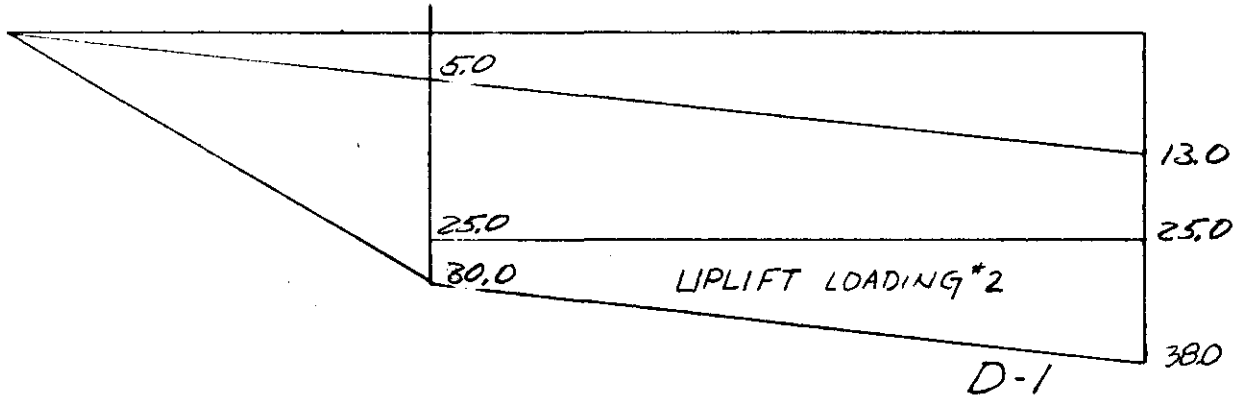
TO BOTTOM OF ANCHORED ROCK

STA 24+50

Note: Preliminary design ht = 35.0'
Final ht = 34.7' @ sta 24+50







D-1

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
35' WALL - 40' BASE

PROJECT NO. 6205-2
SHEET NO. 2 OF
DATE JAN 63
COMPUTED BY DR
CHECKED BY F.N.W

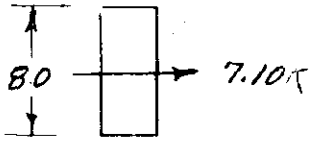
LOADING #1 BOTTOM OF ROCK

		↓	↑	→	←	ARM	M ↻	M ↺
C_1	.15 × 31 × 1.5	7.00				13.40	94.0	
C_2	.15 × 16 × 2.65 × .5	3.18				11.77	37.5	
C_3	.15 × 2 × 40.0	12.00				20.00	240.0	
C_4	.15 × 2 × 4.15	1.25				12.07	15.1	
C_5	.15 × 10 × 2 × .5	1.50				6.67	10.0	
C_6	.15 × 25.85 × 2 × .5	3.88				22.77	88.5	
Wes1	.170 × 40 × 6	40.80				20.00	816.0	
Wes2	.135 × 10 × 1.5	28.25				5.00	101.3	
Wes3	.135 × 10 × 2 × .5	1.35				3.33	4.5	
Wes4	.135 × 15 × 2.48 × .5	2.51				10.83	27.2	
Wes5	.0725 × 25.85 × 7	13.12				27.08	355.3	
Wes6	.0725 × 25.85 × 2 × .5	1.87				31.38	58.6	
Ww1	.0625 × 25.85 × 31	50.00				27.08	1354.0	
Ww2	.0625 × 25.85 × 2 × .5	1.61				31.38	50.5	
Pw1	.0625 × 41² × .5				52.50	13.67		718.0
Pw2	.0625 × 25 × 31.2 × .5			24.38		8.33	203.0	
U1	.0625 × 31.2 × 40		78.00			20.00		1560.0
U2	.0625 × 9.8 × 40 × .5		12.25			26.67		326.7
		160.32	90.25	24.38	52.50		3455.5	2604.7
		90.25					2604.7	
		70.07					850.8	

RESULTANT AT: $\frac{850.8}{70.07} = 12.14 > \frac{40}{4} = 10.0$

UNBALANCED HORIZONTAL FORCES

$52.50 - 24.38 - 0.3 \times 70.07 = 7.10$



$M_{\circlearrowleft} = 7.10 \times 8/2 = 28.4$

$\frac{10.01}{75} = 1.33$ ksf

$\bar{x} = \frac{850.8 + 28.4}{70.07} = 12.55$ (O.K.)

D-2

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT NO. 6205-2
SHEET NO. 3 OF
DATE JAN 63
COMPUTED BY GR
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALL – ANCHORED
35' WALL – 40' BASE

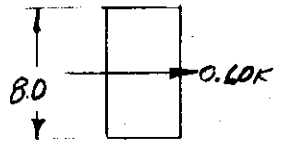
LOADING #2 BOTTOM OF ROCK

		↓	↑	→	←	ARM	M ↻	M ↺
$C_1 \to C_6$		28.81				—	485.1	
$W_{es1} \to W_{es6}$		79.90				—	1362.9	
W_{w1}	.0625 × 28 × 25.85	45.20				27.08	1225.0	
W_{w2}		1.61				31.38	50.5	
P_{w1}	.0625 × 38² × .5				45.20	12.67		573.0
P_{w2}	.0625 × 30.0 × 25 × 1.5			23.44		8.33	195.2	
U_1	.0625 × 30.0 × 40		75.00			20.00		1500.0
U_2	.0625 × 8.0 × 40 × .5		10.00			26.67		266.7
		155.52	85.00	23.44	45.20		3318.7	2339.7
		85.00					2339.7	
		70.52					979.0	

RESULTANT AT: $\frac{979.0}{70.52} = 13.88 > \frac{40}{3} = 13.3$

UNBALANCED HORIZONTAL FORCES

$45.20 - 23.44 - 0.3 \times 70.52 = 0.60\ K$



$M_{\circlearrowleft} = 0.60 \times 8/2 = 2.4\ 'K$

$\bar{x} = \frac{979.0 + 2.4}{70.52} = 13.92 > \frac{40}{3} = 13.33$

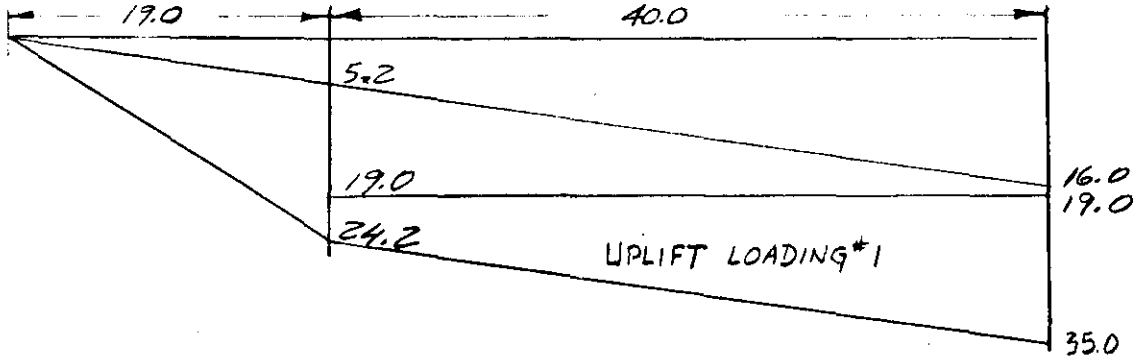
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT NO. 6205-2
SHEET NO. 4 OF
DATE FEB 63
COMPUTED BY DAR
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALLS - ANCHORED
35' WALL - 40' BASE

LOADING #1 BOTTOM OF CONCRETE



		↓	↑	→	←	ARM	M↻	M↺
$C_1 \to C_6$		28.81				—	485.1	
$W_{es2} \to W_{es6}$		39.10				—	546.9	
W_{w1}		50.00				—	1354.0	
W_{w2}		1.61				—	50.5	
P_{w1}	$.0625 \times 35^2 \times .5$				38.30	11.67		446.0
P_{w2}	$.0625 \times 19 \times 24.2 \cdot 5$			14.37		6.33	91.0	
U_1	$.0625 \times 40 \times 24.2$		60.5			20.00		1210.0
U_2	$.0625 \times 10.8 \times 40 \times .5$		13.5			26.67		360.0
		119.52	74.0	14.37	38.30		2527.5	2016.0
		74.0					2016.0	
		45.52					511.5	

RESULTANT AT: $\frac{511.5}{45.52} = 11.24$ FT.

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
35' WALL - 40' BASE

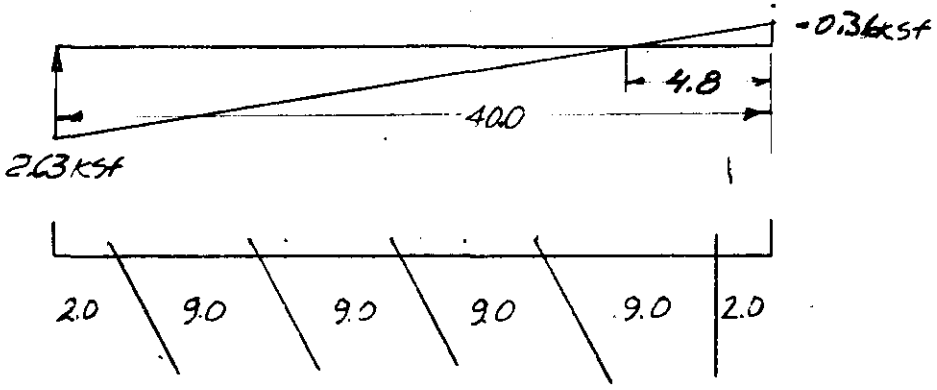
PROJECT NO. 6205-2
SHEET NO. 5 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

LOADING #1 BOTTOM OF CONCRETE

RESULTANT @ 11.24 from TOE ∴ e = 8.76 FT

$$p = \frac{45.52}{40.0}\left(1 \pm \frac{6 \times 8.76}{40}\right) = 1.138(1 \pm 1.314)$$

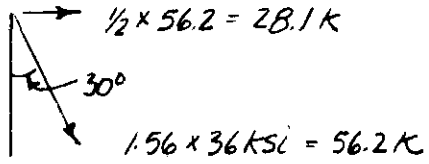
$$= 2.63 \text{ KSF} - 0.36 \text{ KSF} \quad \text{NET}$$
$$1.51 \text{ KSF} \quad 2.19 \text{ KSF} \quad \text{UPLIFT}$$
$$4.14 \text{ KSF} \quad 1.83 \text{ KSF}$$



UNBALANCED HORIZONTAL FORCES (P.4)

$$38.30 - 14.37 - 0.2 \times 45.52 = 14.83 \text{ K}$$

USE #11 ANCHORS:



FOR 4 BATTERED BARS

$$\text{SPACING} = \frac{4 \times 28.1}{14.83} = 7.58'$$

USE 7'-6" SPACING

TENSION: VERTICAL = 0.36 × 4.8 × .5 = 0.86 K/FT.

VERTICAL AT 7.5' TAKES: $\frac{56.2}{7.5} = 7.5$ K/FT (OK)

Shear = $\frac{14830 \times 7.50}{[illegible]}$ = [illegible]

GREEN ENGINEERING AFFILIATES
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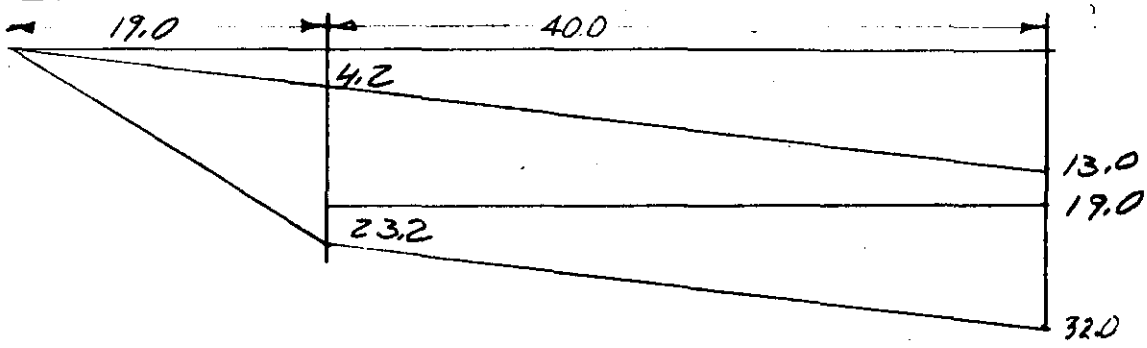
BOSTON, MASS.

PROJECT NO. 6205-2
SHEET NO. 6 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALL - ANCHORED
35' WALL - 40' BASE

LOADING #2 BOTTOM OF CONCRETE



		↓	↑	→	←	ARM	M↺	M↻
$C_1 \to C_6$		28.81				—	485.1	
$Wes_2 \to Wes_6$		39.10				—	546.9	
W_{w1}		45.20				—	1225.0	
W_{w2}		1.61				—	50.5	
P_{w1}	$.0625 \times 32^2 \times .5$				32.00	10.67		342.0
P_{w2}	$.0625 \times 19 \times 23.2 \times .5$			13.78		6.33	87.2	
U_1	$.0625 \times 22.3 \times 40$		55.80			20.00		1160.0
U_2	$.0625 \times 8.8 \times 40 \times .5$		11.00			26.67		293.4
		114.72	69.00	13.78	32.00		2394.7	1795.4
		69.00					1795.4	
		45.72					599.3	

RESULTANT AT: $\frac{599.3}{45.72} = 13.11$ FT.

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
35' WALL - 40' BASE

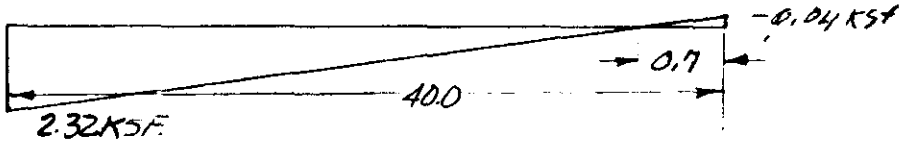
PROJECT NO. 6205-2
SHEET NO. 7 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

LOADING #2 BOTTOM OF CONCRETE

RESULTANT AT 13.11 FT. FROM TOE $e = 6.89$ FT.

$$p = \frac{45.72}{40.0}\left(1 \pm \frac{6 \times 6.89}{40.0}\right) = 1.143\,(1 \pm 1.034)$$

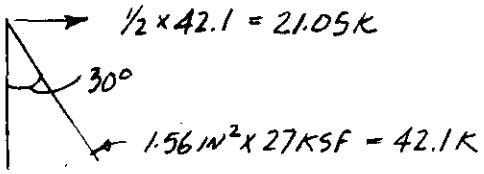
= 2.32 KSF	−0.04 KSF	NET
1.43 KSF	2.00 KSF	UPLIFT
3.77 KSF	1.96 KSF	



UNBALANCED HORIZONTAL FORCES (P.6)

$32.00 - 13.78 - 0.2 \times 45.72 = 9.08$ K

USING #11 ANCHORS



FOR 4 BATTERED BARS

$$\text{SPACING} = \frac{4 \times 21.05}{9.08} = 9.27 \text{ FT.}$$

USE 9' 6" SPACING (LOADING #1 GOVERNS P.5)

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

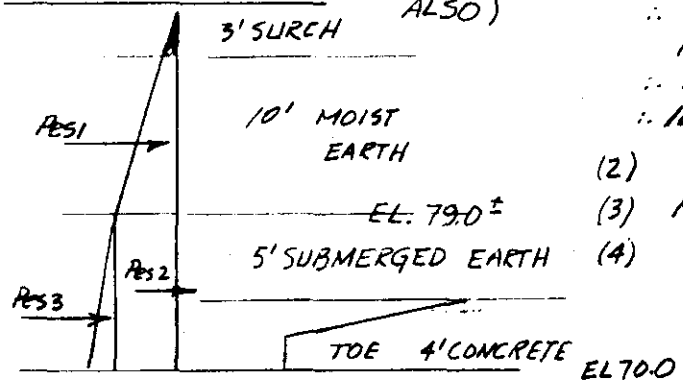
PROJECT NO. 6205-2
SHEET NO. 8 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALL-ANCHORED

35' WALL - 40' BASE

LOADING #3 (REFER P1, ALSO)



(1.) WATER AT 79.0± RIVERSIDE
∴ 5 FT. SUBMERGED EARTH OVER HEEL & TOE
∴ UPLIFT OF 9.0 FT ON BASE
∴ 10' FT MOIST EARTH ON TOE.

(2) WIND LOAD 50#/FT²

(3) HORIZONTAL UNBALANCE IS TAKEN

(4) 3' SURCHARGE

(REFER SYMBOLS P.1.)

		↓	↑	→	←	ARM	M ↻	M ↺
G→C6		28.81				—	485.1	
Wes3A	= Wes3	1.35				—	4.5	
Wes2A	0.135×10×5	6.75				5.00	33.8	
Wes2B	0.130×10×10	13.00				5.00	65.0	
Wes4A	≈ Wes4	2.51				—	27.2	
SURCH.	3×12.65×.130	4.93				6.32	31.2	
Wes5A	= Wes5	9.57				—	254.0	
Wes6A	= Wes6	1.87				—	58.6	
Wes5B	.130×25.8×2	6.72				22.08	182.0	
Ww1	.0625×5×25.85	8.08				27.08	218.5	
Ww2		1.61				—	50.5	
Pes1	.130×1/3×13²×1/2			3.66		13.33	48.8	
Pes2	.130×1/3×13×9			5.07		4.50	22.8	
Pes3	.0725×1/3×9²×1/2			0.98		3.00	2.9	
WIND	.05×16			0.80		27.0	21.6	
U	.0625×9×40		22.50			20.00		450.0
		85.00	22.50	10.51			1506.5	450.0
		22.50					450.0	
		62.50					1056.5	

RESULTANT AT: $\frac{1056.5}{62.5} = 16.90$ $e = 3.10$ FT.

$$p = \frac{62.50}{40}\left(1 \pm \frac{6 \times 3.10}{40}\right) = 1.563\,(1 \pm .465)$$

=	2.29 KSF,	0.84 KSF NET
	0.56	0.56 UPLIFT
	2.85 KSF	1.40 KSF

D-8

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

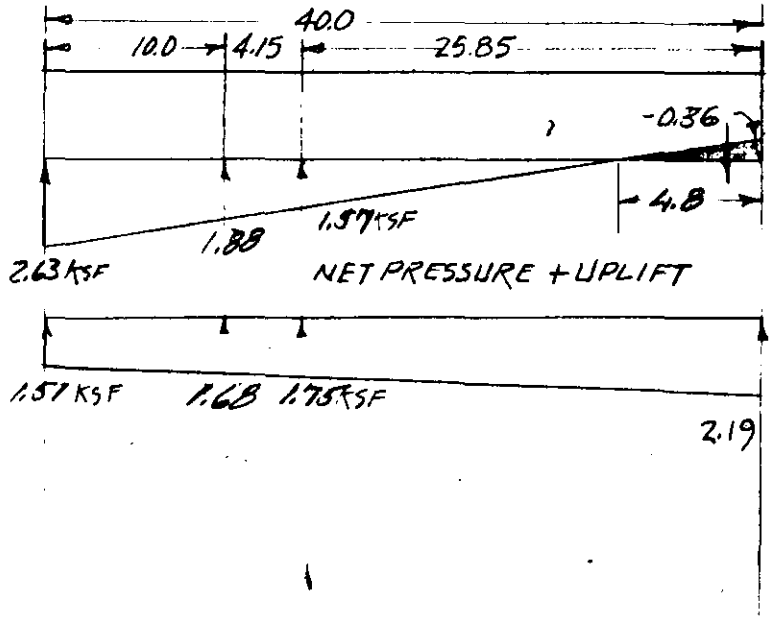
PROJECT NO. 6205-2
SHEET NO. 9 OF
DATE FEB 63
COMPUTED BY DDR
CHECKED BY F.N.W.

PROJECT CHICOPEE FALLS

SUBJECT FLOOD WALL - ANCHORED
35' WALL - 40' BASE

PRESSURES :

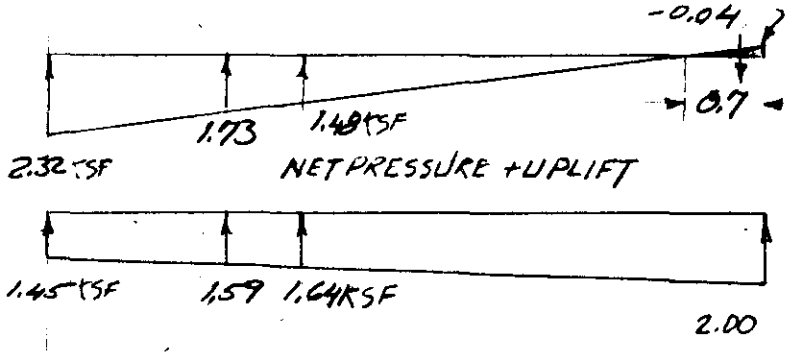
LOADING #1 (REFER P.5)



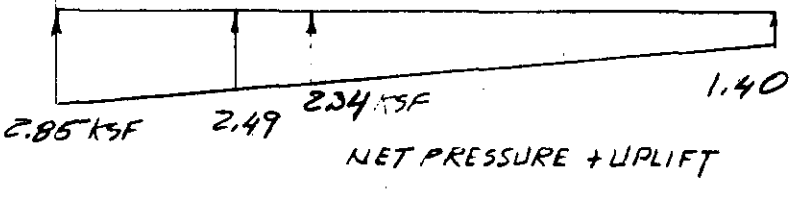
LOADING #1,2 (NO UPLIFT)

WILL BE APPROXIMATELY THE SAME AS THE SUM OF NET PRESSURE AND UPLIFT - REFER 26' & 30' ANCHORED SECTIONS

LOADING #2 (REFER P7)



LOADING #3 (REFER P8)

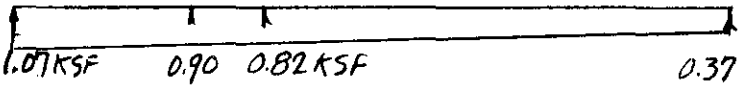


CONSTRUCTION: (REFER P2)

CONCRETE WT = 28.81
M = 485.1

$\bar{x} = \frac{485.1}{28.81} = 16.8'$

$p = \frac{28.81}{40}\left(1 \pm \frac{6 \times 3.2}{40}\right)$



PRESSURE

$\therefore\ P = .720\,(1 \pm .48)\ \therefore\ P = 1.07,\ 0.37$ KSF

D-9

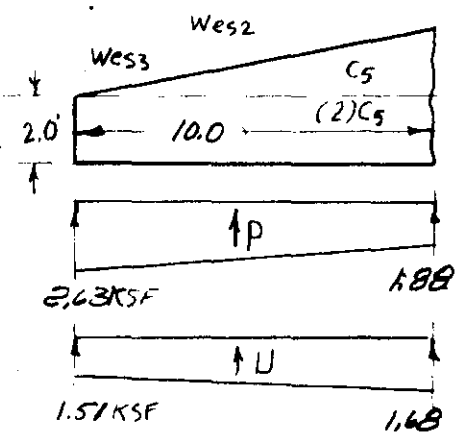
GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL – ANCHORED
35' WALL – 40' BASE

PROJECT NO. 6205-2
SHEET NO. 10 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.R.W.

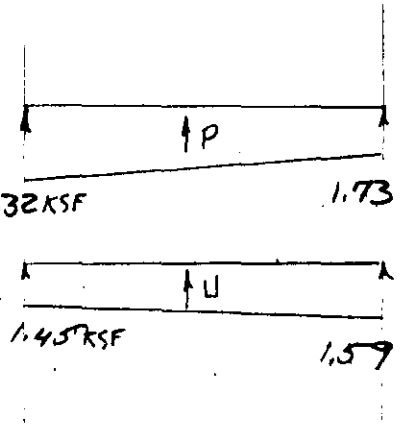
TOE : BOTTOM STEEL : $d = 48 - 5 = 43''$

LOADING #1 (P2,9)



	SHEAR		MOMENT
$(2)C_5 =$	3.00	× 5.00	= 15.0 ↻
$C_5 =$	1.50	× 3.33	= 5.0 ↑
$W_{es2} =$	20.25	× 5.00	= 101.3 ↻
$W_{es3} =$	1.35	× 6.67	= 9.0 ↺
$1.88 \times 10 = P_1 =$	18.80	× 5.00	= 94.0 ↻
$0.75 \times 10 \times .5 = P_2 =$	3.75	× 6.67	= 25.0 ↻
$1.51 \times 10 = U_1 =$	15.10	× 5.00	= 75.5 ↻
$0.17 \times 10 \times .5 = U_2 =$	0.85	× 3.33	= 2.8 ↻
	12.40 ↑		67.0 'K ↻

LOADING #2 (P9,10)



	SHEAR		MOMENT
ABOVE C, W_{es}, LOADS =	26.10 ↑	——	= 130.3 ↻
$1.73 \times 10 = P_1 =$	17.30	× 5.00	= 86.5 ↻
$0.59 \times 10 \times .5 = P_2 =$	2.95	× 6.67	= 19.7 ↻
$1.45 \times 10 = U_1 =$	14.50	× 5.00	= 72.5 ↻
$0.14 \times 10 \times .5 = U_2 =$	0.70	× 3.33	= 2.3 ↻
	9.35 ↑		50.7 K ↻

LOADING #1 $\quad A_s = \dfrac{67{,}000}{(27{,}000)(.885)(43)} = 0.0652\ IN^2/IN$

LOADING #2 $\quad A_s = \dfrac{50{,}700}{(20{,}000)(.885)(43)} = 0.0666\ IN^2/IN = 0.80\ ''/'$

AT STEM : USE #7 – 9" C-C (0.80 IN^2/IN) (BOTTOM)

AT MID TOE : USE #7 – 18" C-C

Shear & Bond in Footing and Walls is less than required

GREEN ENGINEERING AFFILIATES
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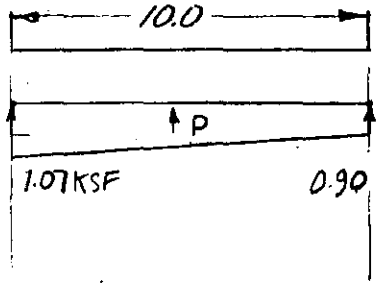
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
35' WALL - 40' BASE

PROJECT NO. 6205-2
SHEET NO. 11 OF
DATE FEB 63
COMPUTED BY HDR
CHECKED BY F.N.W.

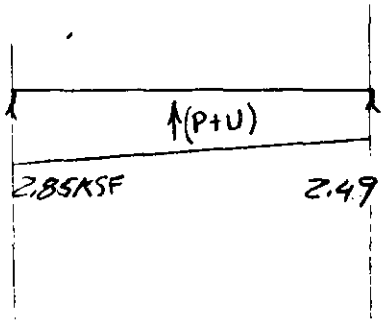
TOE TOP STEEL $d = 48 - 4 = 44''$



CONSTRUCTION (P10,9)

	SHEAR		MOMENT
(3)C_5 =	4.50 ↓	—	= 20.0 ↑
0.90 x 10 = P_1 =	9.00 ↑	x 5.00	= 45.0 ↓
0.17 x 10 x .5 = P_2 =	0.85	x 6.67	= 5.6 ↓
	5.35 ↑		30.6 ↓

∴ NO STEEL



LOADING #3 (P8,9)

	SHEAR		MOMENT
(3)C_5 =	4.50		= 20.0 ↑
W_{es2A} =	6.75	x 5.00	= 33.8 ↑
W_{es2B} =	13.00	x 5.00	= 65.0 ↑
W_{es3A} =	1.35	x 6.67	= 9.0 ↑
3 x .130 x 10 = SURCH =	3.90 ↓	x 5.00	= 19.5 ↑
2.49 x 10 = (P_1+U_1) =	24.9 ↑	x 5.00	= 124.5 ↓
0.36 x 10 x .5 = (P_2+U_2) =	1.80	x 6.67	= 12.0 ↓
	2.8 ↓		10.8 K ↑

LOADING #3

$$A_s = \frac{10{,}800 \times 12}{(20{,}000)(.885)(44)} = .17 \text{ IN}^2/\text{IN}$$

AT STEM: USE #5 - 12" C-C (.027 IN²/IN) (TOP)

GREEN ENGINEERING AFFILIATES
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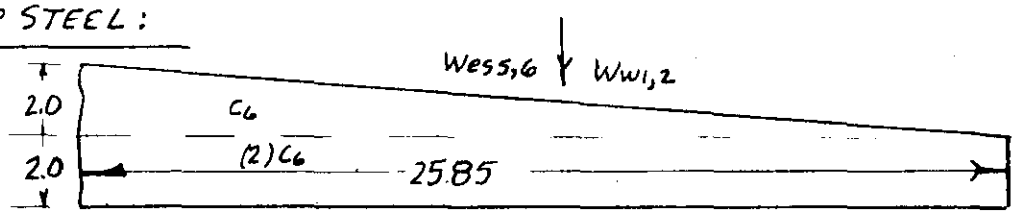
BOSTON, MASS.

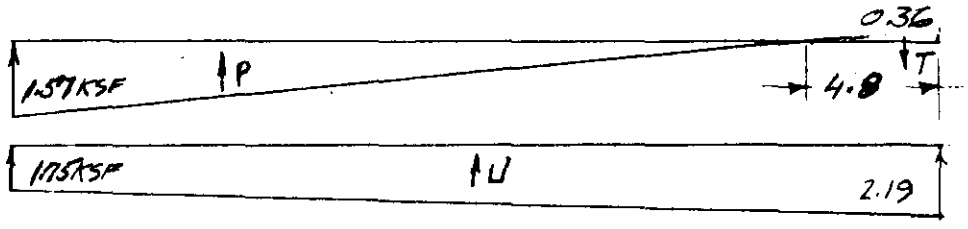
PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALLS - ANCHORED
35' WALL - 40' BASE

PROJECT NO. 6205-2
SHEET NO. 12 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

HEEL TOP STEEL:

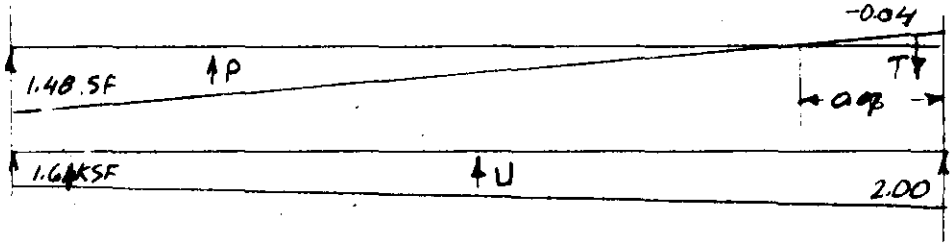


LOADING #1
(REFER P2,9)



	SHEAR		MOMENT
C_6 =	3.88	x 8.62 =	33.4 ↓
(2)C_6 =	7.76	x 12.92 =	100.2 ↓
W_{ess} =	13.12	x 12.92 =	169.5 ↓
W_{es6} =	1.87	x 17.24 =	32.2 ↓
W_{w1} =	50.00	x 12.92 =	646.0 ↓
W_{w2} =	1.61	x 17.24 =	27.8 ↓
0.36x4.8x.5 = T =	.86	x 24.25 =	20.9 ↓
1.57x2.05x.5 = P =	16.52	x 7.02 =	116.0 ↑
1.75x25.85 = U_1 =	45.24	x 12.92 =	584.5 ↑
0.44x25.85x.5 = U_2 =	5.69	x 17.24 =	98.0 ↑
	11.65 ↓		231.5'k ↓

LOADING #2
(REFER 3,9)



	SHEAR		MOMENT
LOADS C, W_{es}; =	26.63	——— =	335.3 ↓
W_{w1} =	45.20	x 12.92 =	583.0 ↓
W_{w2} =	1.61	——— =	27.8 ↓
0.04x0.7x0.5 = T =	0.01	x25.62 =	0.4 ↓
1.48x25.15x0.5 = P_1 =	18.61	x 7.42 =	156.0 ↑
1.64x25.85 = U_1	42.39	x 12.92 =	547.7 ↑
0.36x25.85x.5 = U_2 =	4.65	x 17.24 =	80.2 ↑
	7.80 ↓		162.6'k ↓

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GREEN ENGINEERING AFFILIATES
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BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
35' WALL - 40' BASE

PROJECT NO. 6205-2
SHEET NO. 13 OF
DATE FEB 63
COMPUTED BY LDR
CHECKED BY F.N.W.

HEEL TOP STEEL (cont.)

LOADING #1

$$A_s = \frac{236{,}500}{(.885)(27{,}000)(44)} = 0.220\ in^2/in = 2.64\ \#/ft$$

LOADING #2

$$A_s = \frac{162{,}600}{(.885)(20{,}000)(44)} = 0.209\ in^2/in$$

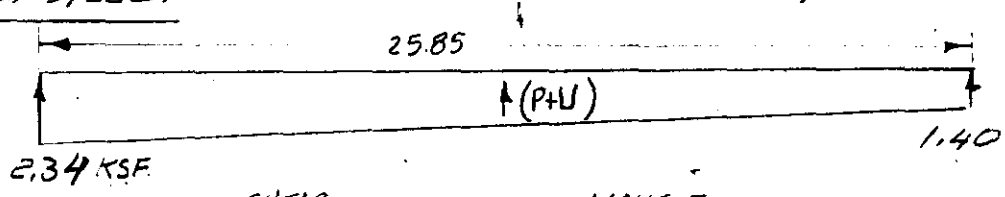
AT STEM: USE #11 - 7" C-C (0.223 in²/in) (TOP)

AT MID HEEL: USE #11 - 14" C-C (TOP)

HEEL BOTTOM STEEL:

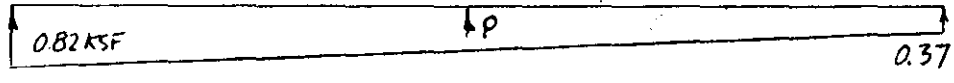
LOADING #3

(REFER PB,9)



	SHEAR		MOMENT
	$(3)C_6 =$ 11.64	—	= 133.6
	$W_{W1} =$ 8.08	× 12.92	= 104.5
	$W_{W2} =$ 1.61	× 17.24	= 27.8
	$W_{es5A} =$ 9.37	× 12.92	= 121.0
	$W_{es6A} =$ 1.87	× 17.24	= 32.2
	$W_{es5B} =$ 6.72	× 12.92	= 86.8
1.40 × 25.85	= $(P+U)_1$ = 36.19	× 12.92	= 467.6
0.94 × 25.85 × .5	= $(P+U)_2$ = 12.15	× 8.62	= 104.7
	9.05		66.4'k

CONSTRUCTION



	SHEAR		MOMENT
	$(3)C_6 =$ 11.64	—	= 133.6
0.37 × 25.85	= P_1 = 9.55	× 12.92	= 124.5
0.45 × 25.85 × .5	= P_2 = 5.83	× 8.62	= 50.2
	3.74		41.1'k

$$A_s = \frac{66{,}400}{(.885)(20{,}000)(43)} = .0872\ in^2/in = 1.05\ \#/ft$$

D-13

AT STEM: USE: #8 @ 9" C-C (1.05 in²/in) & MIDHEEL: #8 @ 18" CC

GREEN ENGINEERING AFFILIATES
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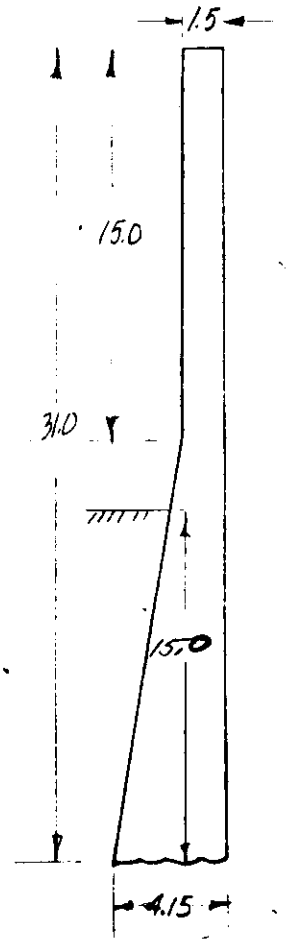
PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
35' WALL — 40' BASE

PROJECT NO. 6205-2
SHEET NO. 14 OF
DATE FEB. 63
COMPUTED BY DR
CHECKED BY FAIM

STEM : RIVERSIDE



WATER 31' HT. AT BASE — LOADING #1

$M = .0625 \times 31^3 \times 1/6 = 310'K$

WATER 28' HT. AT BASE - LOADING #2

$M = .0625 \times 28^3 \times 1/6 = 228'K$

$3/4 \times 310 = 232'K > 228'K$ ∴ USE LOADING #1

WATER 31' (LOADING #1)

WT CONC.: $.15 \times 1.5 \times 31 = 6.98 \times .75 = 5.23$
$.15 \times 2.65 \times 16/2 = 3.18 \times 2.38 = 7.56$
10.16K 12.79'K

dist from RIVERSIDE $= \frac{12.79}{10.16} = 1.26'$

dist. FROM STEEL $= 1.26' - 0.3' = 0.96$

$M_{WATER} = 310'K$
$10.16 \times 0.96 = M_{CONCRETE} = 10.'K$
$320'K$

$e = \frac{M}{N} = \frac{320}{10.16} = 31.5$ $\frac{e}{d} = \frac{31.5}{3.82} = 8.2$

$NE = 10.16 \times 31.5$ (320) $<$ $KF = 212 \times 2.12$ (448)

∴ NO COMPRESSIVE STEEL

$A_s = \frac{NE}{adi} = \frac{322}{2.00 \times 46 \times 1.12} = 3.13\ IN^2/FT.$

AT BOTTOM = USE : #11-6"C-C (3.12 IN²/FT.)

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS
SUBJECT: FLOOD WALL - ANCHORED
35' WALL - 40' BASE

PROJECT NO. 6205-2
SHEET NO. 15 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W

STEM: RIVERSIDE (cont.) (LOADING #1)

WATER AT 23': $M = .0625 \times 23^3 \times 1/6 = 1266'K$

$d = 4.15 - .33 - 1.33 = 2.5'$
$= 30''$

$A_s = \frac{126,600}{(.885)(27,000)(30)} = .1766\ in^2/in$

AT 8 FT FROM BOTTOM USE: #9-6"C-C (.167 in^2/in) [AXIAL HELP ASSUMED FOR THE SLIGHT DISCREPENCY]

WATER AT 13':

$M = .0625 \times 13^3 \times 1/6 = 22.8'K$

$A_s = \frac{22,800}{(.907)(27,000)(14)} = .0665\ in^2/in$

18 FT. FROM BOTTOM : USE: #6 -6"C-C (.073 in^2/in)

$P_{es4} = .21 \times 7 \times .5 = .74$

STEM: LANDSIDE

(REFER P.8)

		P_{es4} =	0.74	× 2.33	=	1.7
		P_{es1} =	3.66	× 9.33	=	34.1
	5/9	P_{es2} =	2.82	× 2.50	=	7.1
$.0725 \times 1/3 \times 5^2 \times 1/2$	=	P_{es3A} =	0.32	× 1.67	=	0.5
	=	WIND =	0.80	× 23.0	=	18.4
						58.4 'K

LOADING #3

$A_s = \frac{58,400}{(20,000)(.885)(46)} = .0717\ in^2/in = .86\ \#/'$

AT BOTTOM : USE: #8-12"C-C (.655 in^2/in)

[SURCHARGE PRESSURE MAKES THE A_s CONSERVATIVE]

16 FT. FROM BOTTOM : USE #5-12"C-C

[REFER 30' WALL WHERE
WIND ONLY → 5.6'K
A_s steel .023 in^2/in
5-12" c-c → .027 in^2/in]

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT: CHICOPEE FALLS

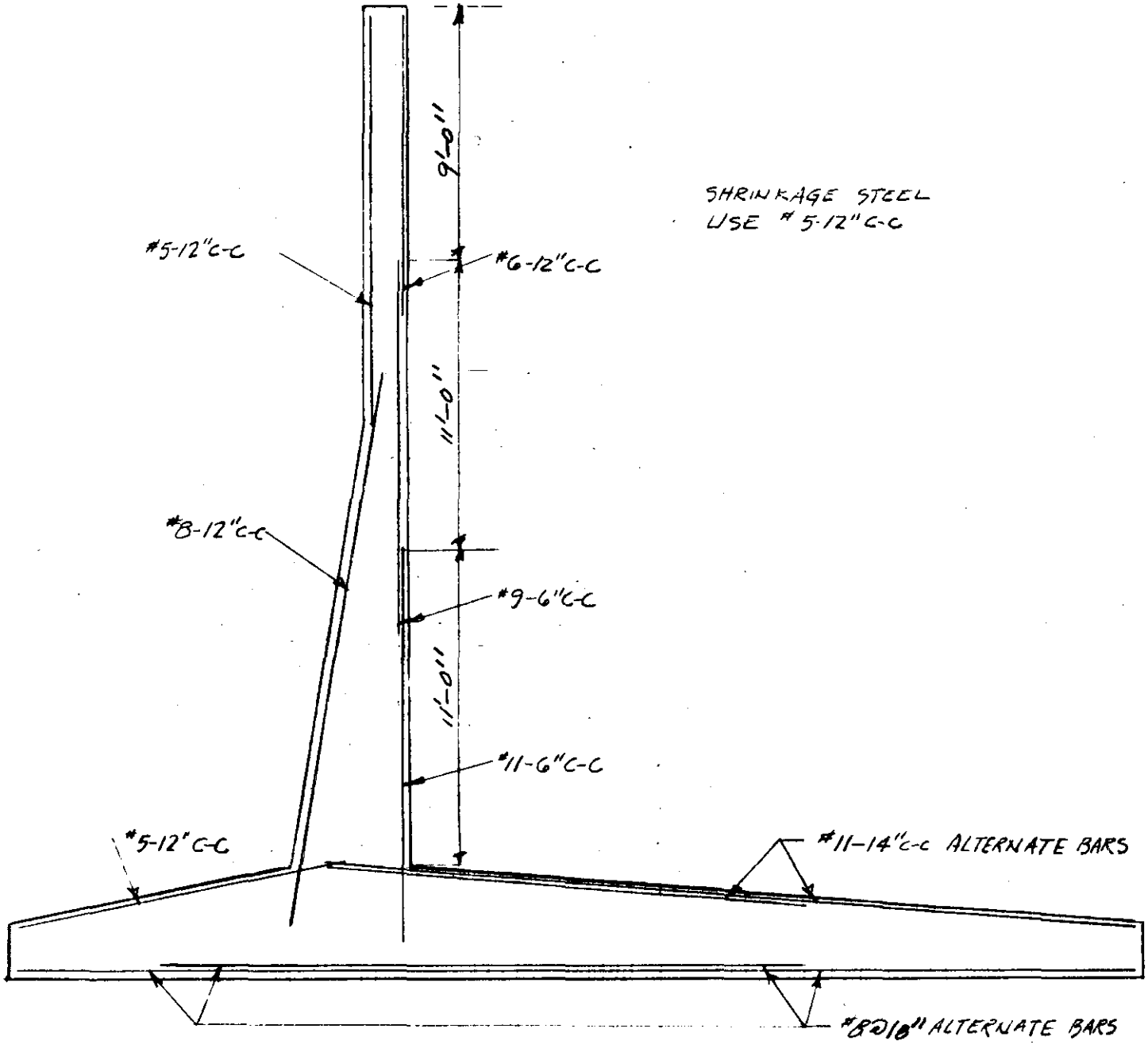
SUBJECT: FLOOD WALL - ANCHORED
55' WALL - 40' BASE

PROJECT NO. 6205-2
SHEET NO. 16 OF
DATE FEB 63
COMPUTED BY DR
CHECKED BY F.N.W.

STEEL

TO SCALE

LAP & EMBED: 24 Dia.
SCALE: 1" = 5'



SHRINKAGE STEEL
USE #5-12" c-c

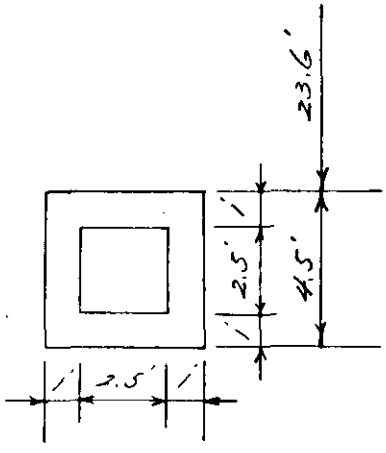
D-16

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT

SUBJECT INTAKE AT U.S. RUBBER CO.

PROJECT NO. 6205-2
SHEET NO. 1 OF
DATE JAN. 1963
COMPUTED BY J. Ku
CHECKED BY M.A.



FOR DRY FILL

$W_e = 1.5 \times 125 \times 23.6 = 4{,}430$ #/'

$P_e = \frac{1}{2} \times 125 \times 25.8 = 1{,}610$ #/'

FOR SUBMERGED FILL

$W_e = (1.5 \times 72.5 + 62.5) \times 23.6$
$= 4{,}050$ #/'

$P_e = (\frac{1}{2} \times 72.5 + 62.5) \times 25.8$
$= 2{,}550$ #/'

CASE I CRUSHING - DRY FILL, NO WATER INSIDE

LOAD ON ROOF = 4,430 + 150 = 4.58 K/'
" SIDES = 1.61 K/'
" BOTTOM = $[4{,}430 \times 4.5 + 150(2.5 + 2 \times 3.5)]\frac{1}{4.5}$
= 4,430 + 320 = 4.75 K/'

CASE II CRUSHING - SUBMERGED FILL, NO WATER INSIDE

LOAD ON ROOF = 4,050 + 150 = 4.20 K/'
" SIDES = 2.55 K/'
" BOTTOM = $[4{,}050 \times 4.5 + 150(2.5 + 2 \times 3.5)]\frac{1}{4.5}$
= 4,050 + 320 = 4.37 K/'

CASE III BURSTING - WATER INSIDE, NO FILL

LOAD ON ROOF = $-62.5 \times 24.6 + 150$
$= -1{,}535 + 150 = -1.38$ K/'
" SIDES = $-62.5 \times 25.8 = -1.61$ K/'
" BOTTOM = $[-1{,}535 \times 2.5 + 150(2.5 + 2 \times 3.5)]\frac{1}{3.5}$
$= (-3{,}840 + 1{,}425)\frac{1}{3.5}$
$= -690$ #/' $= -0.69$ K/'

GREEN ENGINEERING AFFILIATES
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PROJECT

SUBJECT INTAKE AT U.S. RUBBER CO.

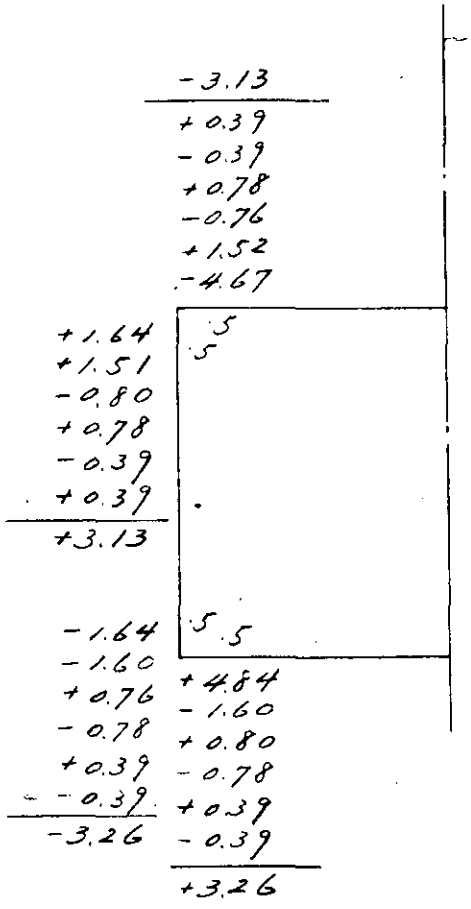
PROJECT NO. 6205-2
SHEET NO. 2 OF
DATE JAN. 1963
COMPUTED BY J Ku
CHECKED BY M.A.

CASE I

FEM'S ROOF $= \frac{1}{12} \times 4.58 \times 3.5^2 = 4.67^{k'}$

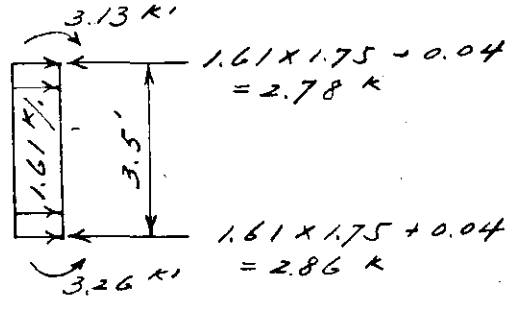
SIDES $= \frac{1}{12} \times 1.61 \times 3.5^2 = 1.64^{k'}$

BOTTOM $= \frac{1}{12} \times 4.75 \times 3.5^2 = 4.84^{k'}$



ROOF $+M = \frac{1}{8} \times 4.58 \times 3.5^2 - 3.13$
$= 7.01 - 3.13 = 3.88^{k'}$

BOTT. $+M = \frac{1}{8} \times 4.75 \times 3.5^2 - 3.26$
$= 7.26 - 3.26 = 4.00^{k'}$

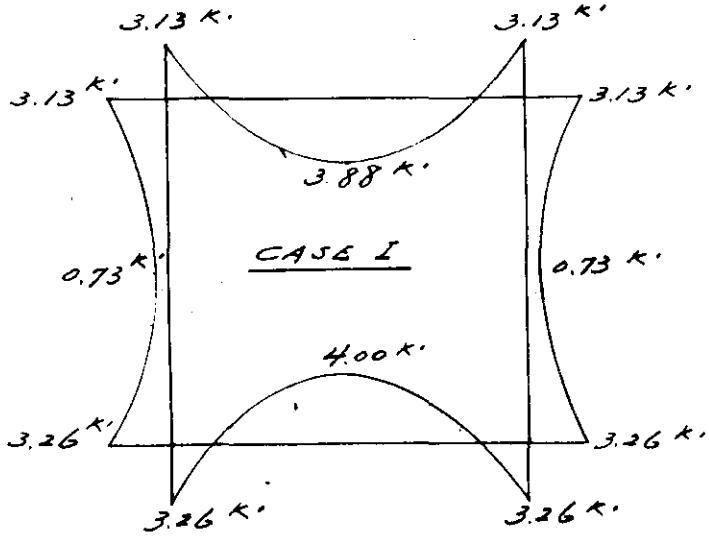


$1.61 \times 1.75 - 0.04$
$= 2.78^{k}$

$1.61 \times 1.75 + 0.04$
$= 2.86^{k}$

$V = 0$ AT $\frac{2.78}{1.61} = 1.73'$ FROM TOP

$+M = 2.78 \times 1.73 - 1.61 \times \frac{1.73^2}{2} - 3.13$
$= 4.81 - 2.41 - 3.13$
$= -0.73^{k'}$



GREEN ENGINEERING AFFILIATES
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BOSTON, MASS.

PROJECT

SUBJECT INTAKE AT U.S. RUBBER Co.

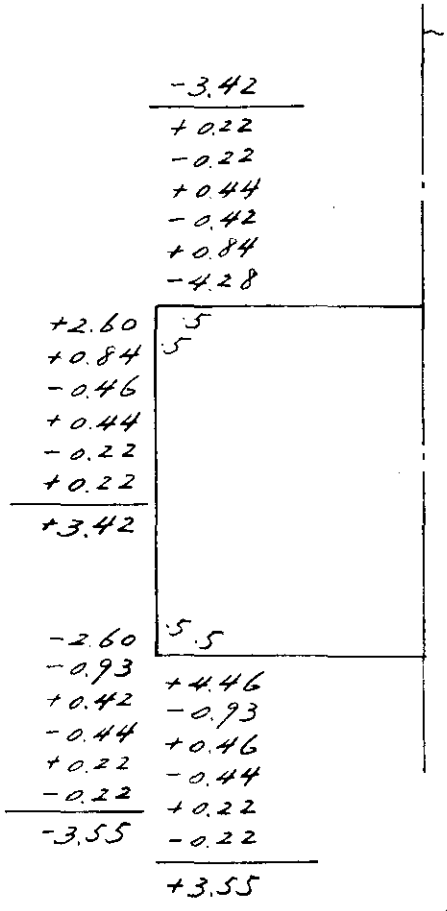
PROJECT NO. 6205-2
SHEET NO. 3 OF
DATE JAN. 1963
COMPUTED BY
CHECKED BY M.A.

CASE II

FEM's, ROOF $= \frac{1}{12} \times 4.20 \times 3.5^2 = 4.28$ K'

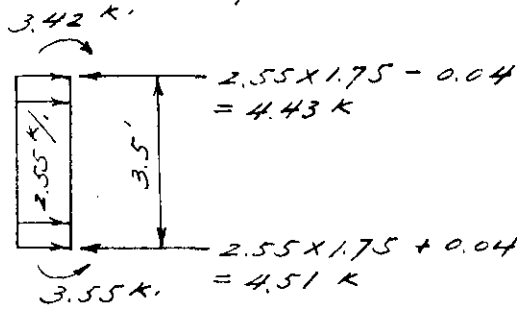
SIDES $= \frac{1}{12} \times 2.55 \times 3.5^2 = 2.60$ K'

BOTTOM $= \frac{1}{12} \times 4.37 \times 3.5^2 = 4.46$ K'



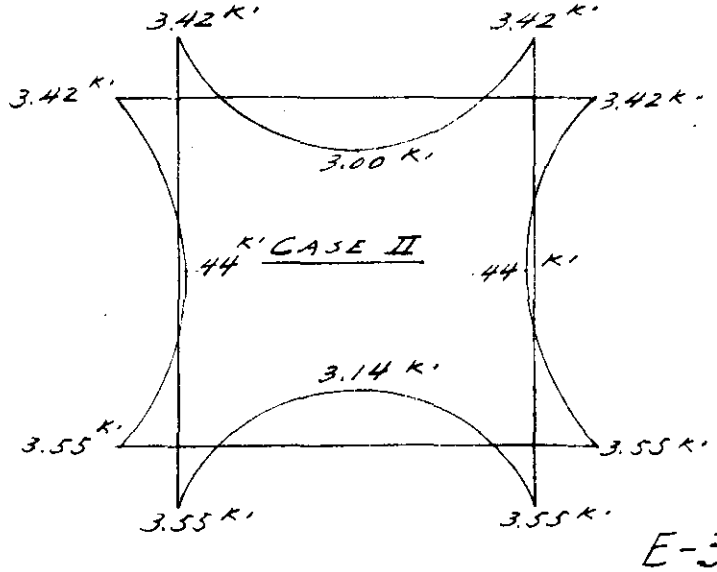
ROOF $+M = \frac{1}{8} \times 4.20 \times 3.5^2 - 3.42$
$= 6.42 - 3.42 = 3.00$ K'

BOTT. $+M = \frac{1}{8} \times 4.37 \times 3.5^2 - 3.55$
$= 6.69 - 3.55 = 3.14$ K'



$V = 0$ AT $\frac{4.43}{2.55} = 1.74'$ FROM TOP

$+M = 4.43 \times 1.74 - 2.55 \times \frac{1.74^2}{2} - 3.42$
$= 7.72 - 3.86 - 3.42$
$= +0.44$ K'



GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT

SUBJECT INTAKE AT U.S. RUBBER CO.

PROJECT NO. 6205-2
SHEET NO. 4 OF
DATE JAN. 1963
COMPUTED BY J Ku
CHECKED BY M.A.

CASE III

FEM'S ROOF $= -\frac{1}{12} \times 1.385 \times 3.5^2 = -1.41^{k'}$

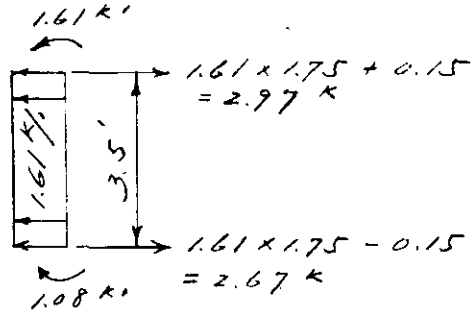
SIDES $= -\frac{1}{12} \times 1.61 \times 3.5^2 = -1.64^{k'}$

BOTTOM $= -\frac{1}{12} \times 0.69 \times 3.5^2 = -0.70^{k'}$

	+1.61	
	+0.07	~℄ sym.
	-0.07	
	+0.15	
	-0.06	
	+0.11	
	+1.41	
-1.64	.5	
+0.12	.5	
-0.24		
+0.15		
-0.07		
+0.07		
-1.61		
+1.64	.5 .5	
-0.47	-0.70	
+0.06	-0.47	
-0.15	+0.24	
+0.07	-0.15	
-0.07	+0.07	
+1.08	-0.07	
	-1.08	

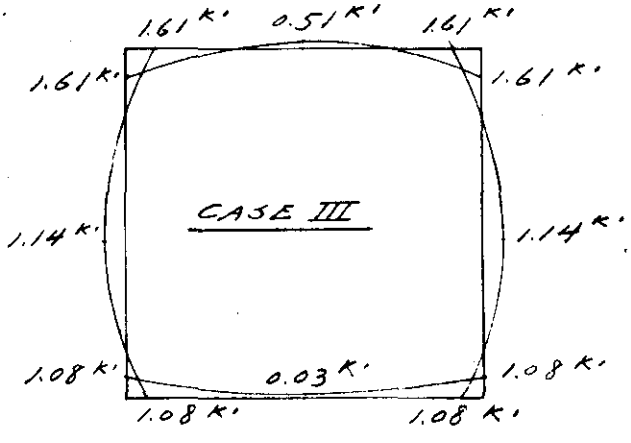
ROOF ℄M $= -\frac{1}{8} \times 1.385 \times 3.5^2 + 1.61$
$= -2.12 + 1.61 = -0.51^{k'}$

BOTT. ℄M $= -\frac{1}{8} \times 0.69 \times 3.5^2 + 1.08$
$= -1.05 + 1.08 = +0.03^{k'}$



V = 0 AT $\frac{2.97}{1.61} = 1.84'$ FROM TOP

$M = -2.97 \times 1.84 + 1.61 \times \frac{1.84^2}{2} + 1.61$
$= -5.48 + 2.73 + 1.61 = -1.14^{k'}$



GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT

SUBJECT INTAKE AT U.S. RUBBER CO.

PROJECT NO. 6205-2
SHEET NO. 5 OF
DATE JAN. 1963
COMPUTED BY J Ku
CHECKED BY M.A.

CRUSHING

MAX. POS. MOM. = 4.00 K'
AXIAL LOAD = 2.86 K COMP.
SHEAR = 4.75 × 1.75 = 8.30 K

BY USING CLEAR SPAN,

$M = 4.00 - \frac{1}{6} \times 8.30 \times 1 = 4.00 - 1.38 = 2.62$ K'

$N = 2.86$ K

$e = \frac{12 \times 2.62}{2.86} + 2.5 = 11.0 + 2.5 = 13.5''$

$E = 1.13'$

$NE = 2.86 \times 1.13 = 3.23$

$e/d = 13.5/8.5 = 1.59 \quad j = .866 \quad i = 2.20$

$A_s = \frac{3.23}{1.44 \times 8.5 \times 2.20} = 0.12 \text{ in}^2$

SHEAR AT EDGE OF WALL = 4.75 × 1.25 = 5.95 K

$v = \frac{5{,}950}{12 \times \frac{7}{8} \times 8.5} = 67 \text{ psi} < 90$

Σ_0 REQ. $= \frac{5{,}950}{300 \times \frac{7}{8} \times 8.5} = .27''$

$A_s = 0.37$

USE #4 @ 6" O.F. ($\Sigma_0 = 2.4''$)
#4 @ 12" I.F.

BURSTING

MAX. MOM. = 1.61 K'
AXIAL LOAD = 2.97 K TENSION
SHEAR = 1.385 × 1.75 = 2.43 K

BY USING CLEAR SPAN

$M = 1.61 - \frac{1}{3} \times 2.43 \times 1 = 1.61 - 0.81 = 0.80$ K

$N = -2.97$ K

$e = \frac{12 \times 0.80}{-2.97} + 2.5 = -3.24 + 2.5 = -0.74''$

$E = -0.06'$

$NE = (-2.97)(-0.06) = 0.18$

$i = \frac{1}{1 - \frac{.866 \times 8.5}{-0.74}} = \frac{1}{1 + 9.95} = 0.091$

$A_s = \frac{0.18}{1.44 \times 8.5 \times 0.091} = 0.16 \text{ in}^2$

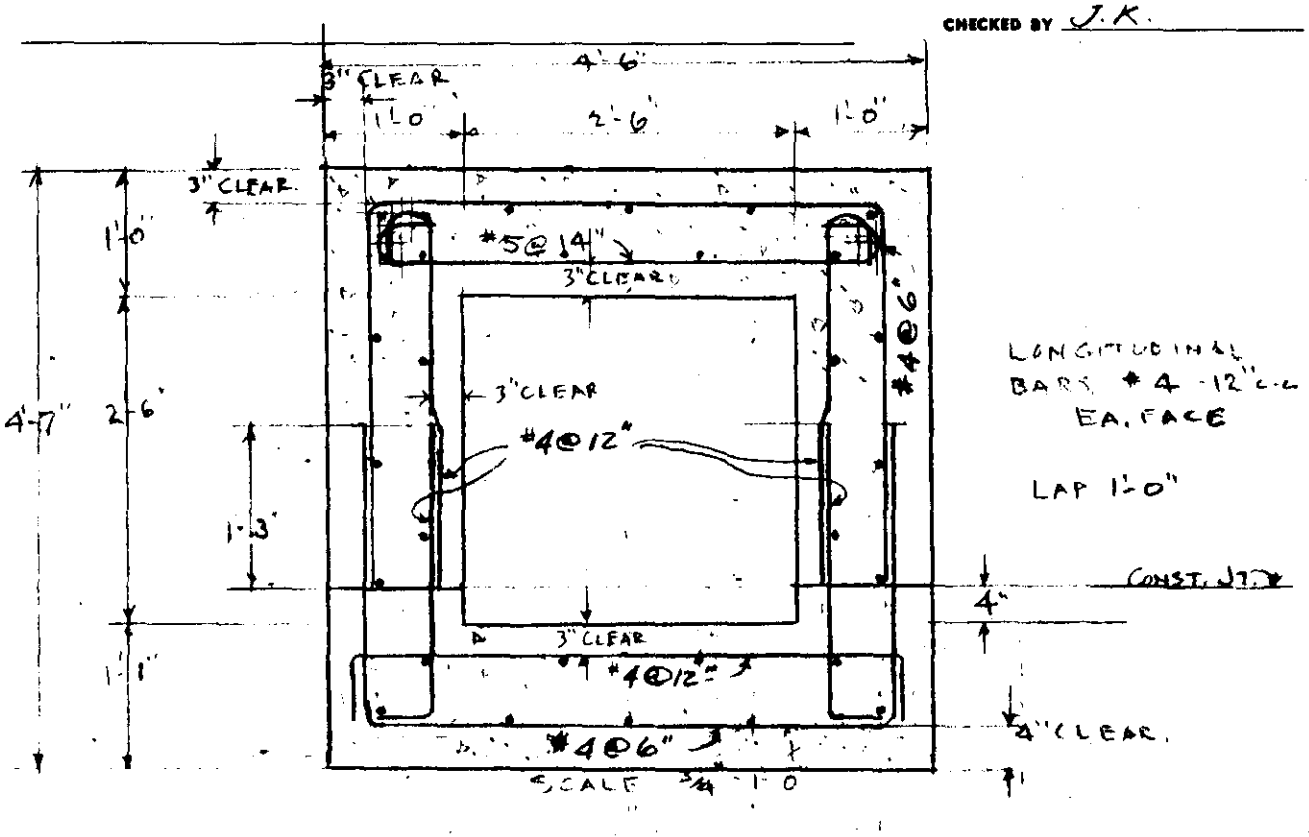
USE #5 @ 14" I.F.

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT NO. 6205-2
SHEET NO. 6 OF
DATE JAN. 24, 1963
COMPUTED BY M.A.
CHECKED BY J.K.

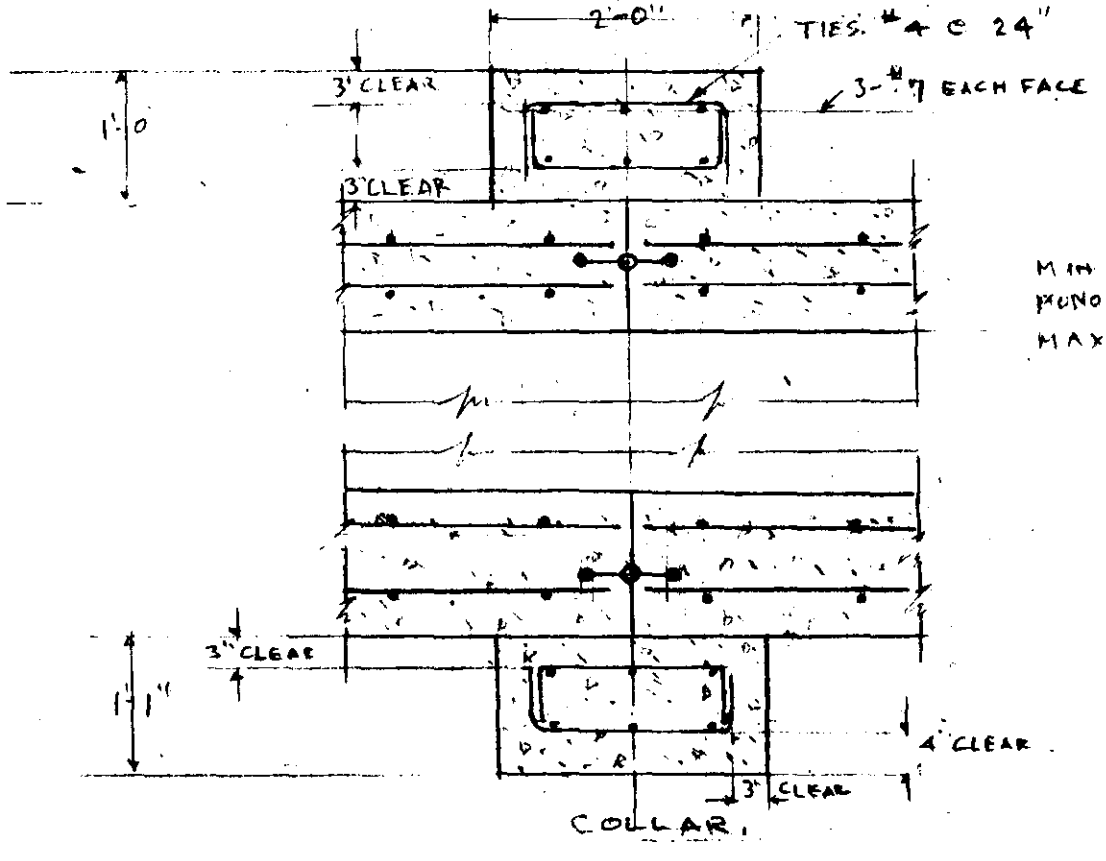
PROJECT MASS - CHICOPEE FALLS

SUBJECT INTAKE U.S. RUBBER CO.



LONGITUDINAL BARS #4 - 12" c-c EA. FACE

LAP 1'-0"



MIN. LENGTH OF MONOLITH = 12'-0".
MAX. 20'-0"

E-6

GREEN ENGINEERING AFFILIATES
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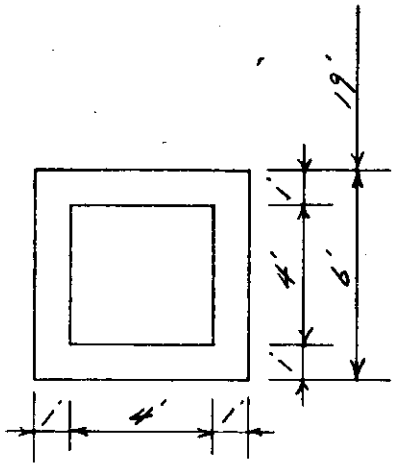
BOSTON, MASS.

PROJECT

SUBJECT INTAKE AT OAK STREET

PROJECT NO. 6205-2
SHEET NO. 7 OF
DATE JAN. 1963
COMPUTED BY J Kn
CHECKED BY M.A.



FOR DRY FILL

$W_e = 1.5 \times 125 \times 19.0 = 3{,}560$ #/'

$P_e = \frac{1}{2} \times 125 \times 22.0 = 1{,}375$ #/'

FOR SUBMERGED FILL

$W_e = (1.5 \times 72.5 + 62.5) \times 19.0$

$= 171.25 \times 19.0 = 3{,}255$ #/'

$P_e = (\frac{1}{2} \times 72.5 + 62.5) \times 22.0$

$= 98.75 \times 22.0 = 2{,}175$ #/'

CASE I CRUSHING - DRY FILL, NO WATER INSIDE

LOAD ON ROOF $= 3{,}560 + 150 = 3.71$ K/'

" SIDES $= 1.38$ K/'

" BOTTOM $= [3{,}560 \times 6 + 150(4 + 2 \times 5)] \frac{1}{6}$

$= 3{,}560 + 350 = 3.91$ K/'

CASE II CRUSHING - SUBMERGED FILL, NO WATER INSIDE

LOAD ON ROOF $= 3{,}255 + 150 = 3.41$ K/'

" SIDES $= 2.17$ K/'

" BOTTOM $= [3{,}255 \times 6 + 150(4 + 2 \times 5)] \frac{1}{6}$

$= 3{,}255 + 350 = 3.61$ K/'

CASE III BURSTING - WATER INSIDE, NO FILL

LOAD ON ROOF $= (-62.5 \times 20.0) + 150$

$= -1{,}250 + 150 = -1.10$ K/'

" SIDES $= -62.5 \times 22.0 = -1.38$ K/'

" BOTTOM $= [-1250 \times 4 + 150(4 + 2 \times 5)] \frac{1}{5}$

$= (-5{,}000 + 2{,}100) \frac{1}{5}$

$= -580$ #/' $= -0.58$ K/'

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT

SUBJECT INTAKE AT OAK STREET

PROJECT NO. 6205-2
SHEET NO. 8 OF
DATE JAN. 1963
COMPUTED BY J. Kn
CHECKED BY M.A.

CASE I

FEM's ROOF $= \frac{1}{12} \times 3.71 \times 5^2 = 7.73$ k'

SIDES $= \frac{1}{12} \times 1.38 \times 5^2 = 2.87$ k'

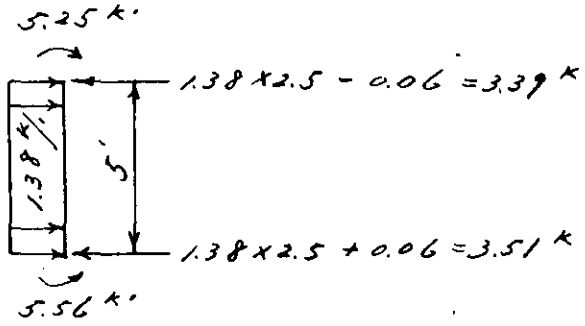
BOTTOM $= \frac{1}{12} \times 3.91 \times 5^2 = 8.15$ k'

	-5.25	
	+0.63	
	-0.63	
	+1.27	
	-1.22	
	+2.43	
	-7.73	
+2.87	.5	.5
+2.43		
-1.32		
+1.27		
-0.63		
+0.63		
+5.25		
-2.87	.5	.5
-2.64	+8.15	
+1.22	-2.64	
-1.27	+1.32	
+0.63	-1.27	
-0.63	+0.63	
-5.56	-0.63	
	+5.56	

℄ SYM.

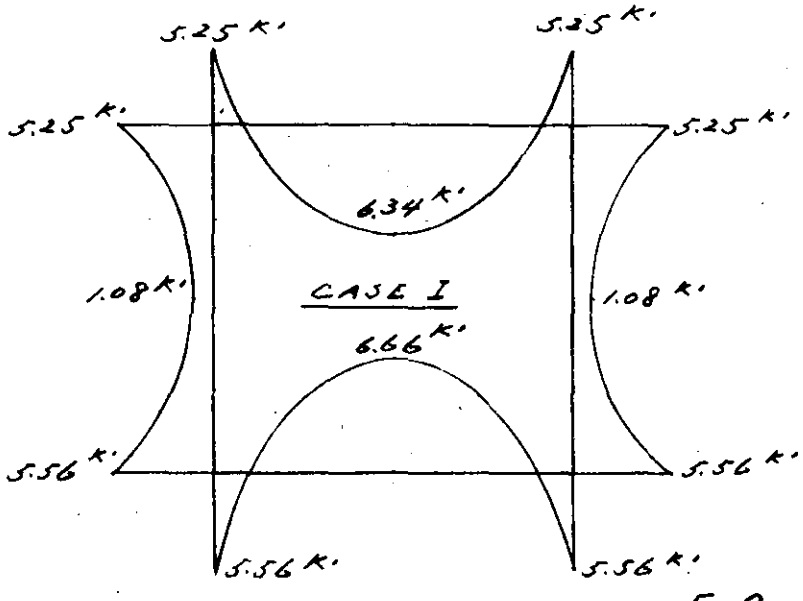
ROOF $+M = \frac{1}{8} \times 3.71 \times 5^2 - 5.25$
$= 11.59 - 5.25 = 6.34$ k'

BOTTOM $+M = \frac{1}{8} \times 3.91 \times 5^2 - 5.56$
$= 12.22 - 5.56 = 6.66$ k'



$V = 0$ AT $\frac{3.39}{1.38} = 2.46'$ FROM TOP

$M = 3.39 \times 2.46 - 1.38 \times \frac{2.46^2}{2} - 5.25$
$= 8.34 - 4.17 - 5.25$
$= -1.08$ k'



GREEN ENGINEERING AFFILIATES
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BOSTON, MASS.

PROJECT

SUBJECT INTAKE AT OAK STREET

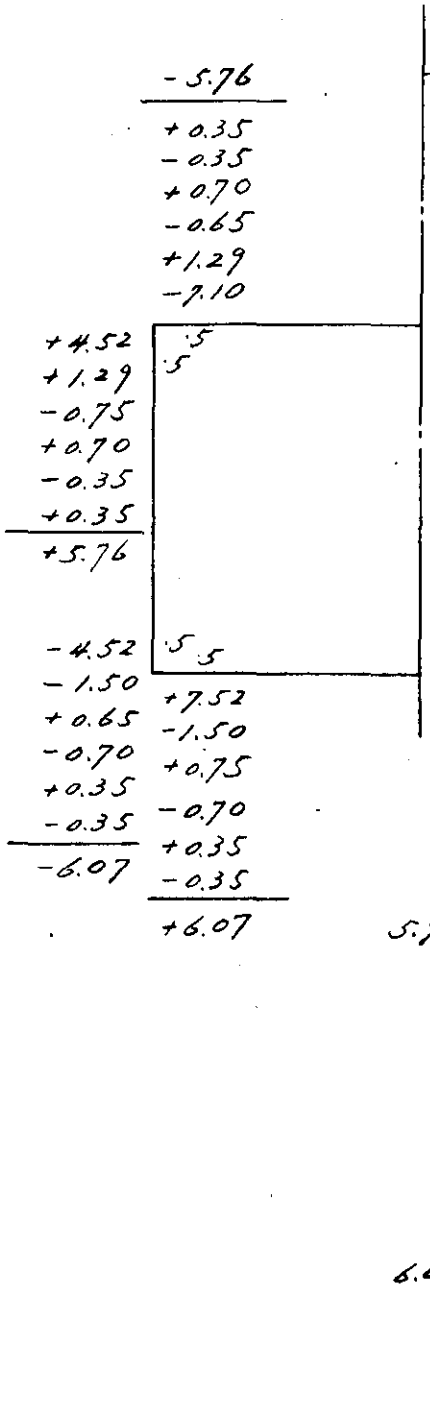
PROJECT NO. 6205-2
SHEET NO. 9 OF
DATE JAN. 1963
COMPUTED BY J.K.
CHECKED BY M.A.

CASE II

FEM's ROOF $= \frac{1}{12} \times 3.41 \times 5^2 = 7.10^{k'}$

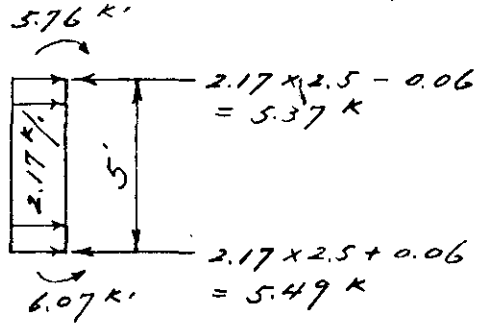
SIDES $\frac{1}{12} \times 2.17 \times 5^2 = 4.52^{k'}$

BOTTOM $\frac{1}{12} \times 3.61 \times 5^2 = 7.52^{k'}$



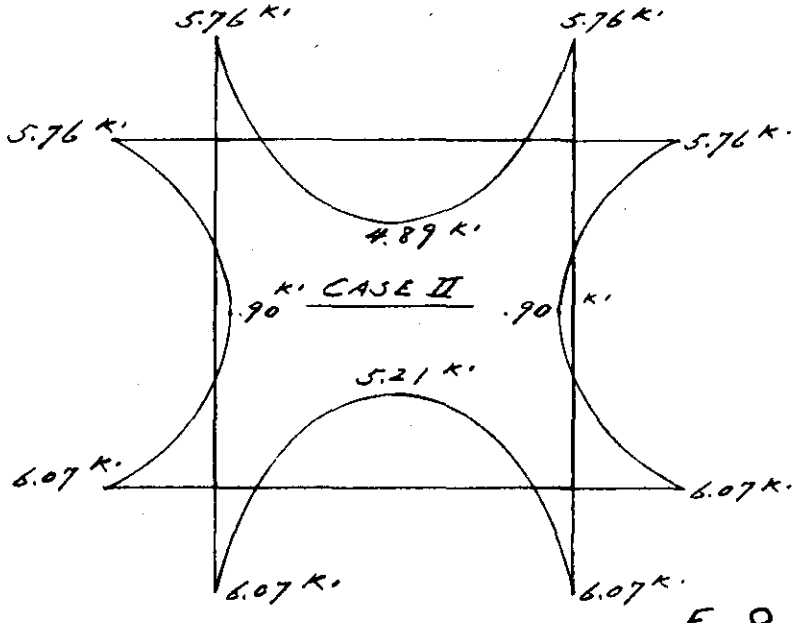
ROOF $+M = \frac{1}{8} \times 3.41 \times 5^2 - 5.76$
$= 10.65 - 5.76 = 4.89^{k'}$

BOTT. $+M = \frac{1}{8} \times 3.61 \times 5^2 - 6.07$
$= 11.28 - 6.07 = 5.21^{k'}$



$V = 0$ AT $\frac{5.37}{2.17} = 2.48'$ FROM TOP

$M = 5.37 \times 2.48 - 2.17 \times \frac{2.48^2}{2} - 5.76$
$= 13.32 - 6.66 - 5.76 = 0.90^{k'}$



GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT

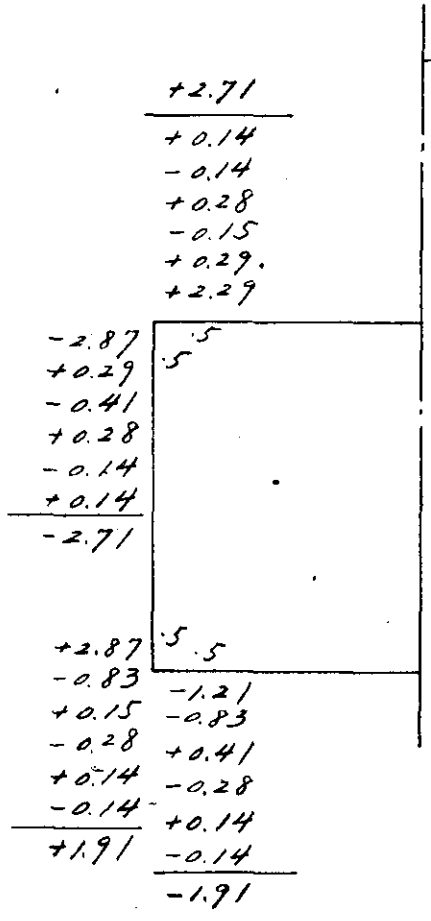
SUBJECT INTAKE AT OAK STREET

PROJECT NO. 6205-2
SHEET NO. 10 OF
DATE JAN. 1963
COMPUTED BY J. Ku
CHECKED BY M.A.

CASE III FEM's ROOF $= -\frac{1}{12} \times 1.10 \times 5^2 = -2.29$ k'

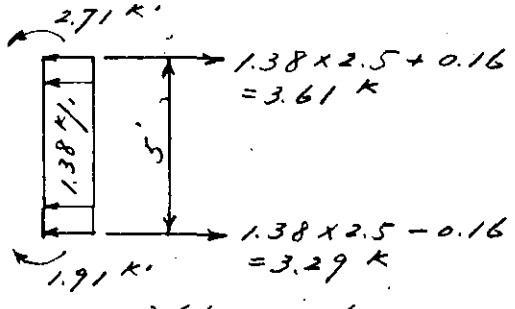
SIDES $= -\frac{1}{12} \times 1.38 \times 5^2 = -2.87$ k'

BOTTOM $= -\frac{1}{12} \times 0.58 \times 5^2 = -1.21$ k'



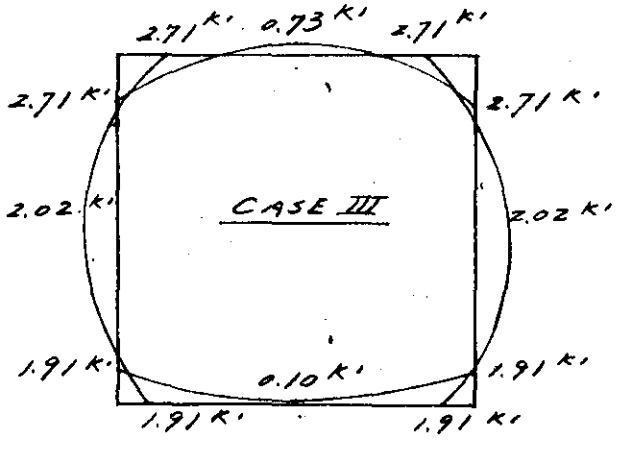
ROOF ℄ M $= -\frac{1}{8} \times 1.10 \times 5^2 + 2.71$
$= -3.44 + 2.71 = -0.73$ k'

BOTT. ℄ M $= -\frac{1}{8} \times 0.58 \times 5^2 + 1.91$
$= -1.81 + 1.91 = +0.10$ k'



V = 0 AT $\frac{3.61}{1.38} = 2.62'$ FROM TOP

$M = -3.61 \times 2.62 + 1.38 \times \frac{2.62^2}{2} + 2.71$
$= -9.46 + 4.73 + 2.71 = -2.02$ k'



GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT

SUBJECT INTAKE AT OAK STREET

PROJECT NO. 6205-2
SHEET NO. 11 OF
DATE JAN. 1963
COMPUTED BY J Ku
CHECKED BY M.A.

CRUSHING

MAX. POS. MOM. = 6.66 K'
AXIAL LOAD = 3.51 K COMP.
SHEAR = 3.91 x 2.5 = 9.77 K

BY USING CLEAR SPAN

$M = 6.66 - \frac{1}{6} \times 9.77 = 6.66 - 1.63 = 5.03$ K'

$N = 3.51$ K

$e = \frac{12 \times 5.03}{3.51} + 2.5 = 17.2 + 2.5 = 19.7''$

$E = 1.64'$

$NE = 3.51 \times 1.64 = 5.76$

$e/d = \frac{19.7}{8.5} = 2.32 \quad j = .866 \quad i = 1.60$

$A_s = \frac{5.76}{1.44 \times 8.5 \times 1.60} = 0.29 \text{ in}^2$

USE #5 @ 13" I.F.
($A_s = 0.29$)

SHEAR AT EDGE OF WALL = 3.91 x 2 = 7.82 K

$v = \frac{7,820}{12 \times \frac{7}{8} \times 8.7} = 86 \text{ psi} < 90$

Σ_o REQ. $= \frac{7,820}{300 \times \frac{7}{8} \times 8.7} = 3.4''$

USE #4 @ 5" O.F.
($\Sigma_o = 3.8''$)
$A_s = .48\square''$

in #4 #4 @ 10 for f_o

BURSTING

MAX. MOM. = 2.71 K'
AXIAL LOAD = 3.61 K TENSION
SHEAR = 1.10 x 2.5 = 2.75 K

BY USING CLEAR SPAN

$M = 2.71 - \frac{1}{3} \times 2.75 = 2.71 - 0.92 = 1.79$ K'

$N = -3.61$ K

$e = \frac{12 \times 1.79}{-3.61} + 2.5 = -5.95 + 2.5 = -3.45''$

$E = -0.29'$

$NE = (-3.61)(-0.29) = 1.05'$

$i = \frac{1}{1 - \frac{.866 \times 8.5}{-3.45}} = \frac{1}{1 + 2.13} = 0.319$

$A_s = \frac{1.05}{1.44 \times 8.5 \times 0.319} = 0.27 \text{ in}^2$

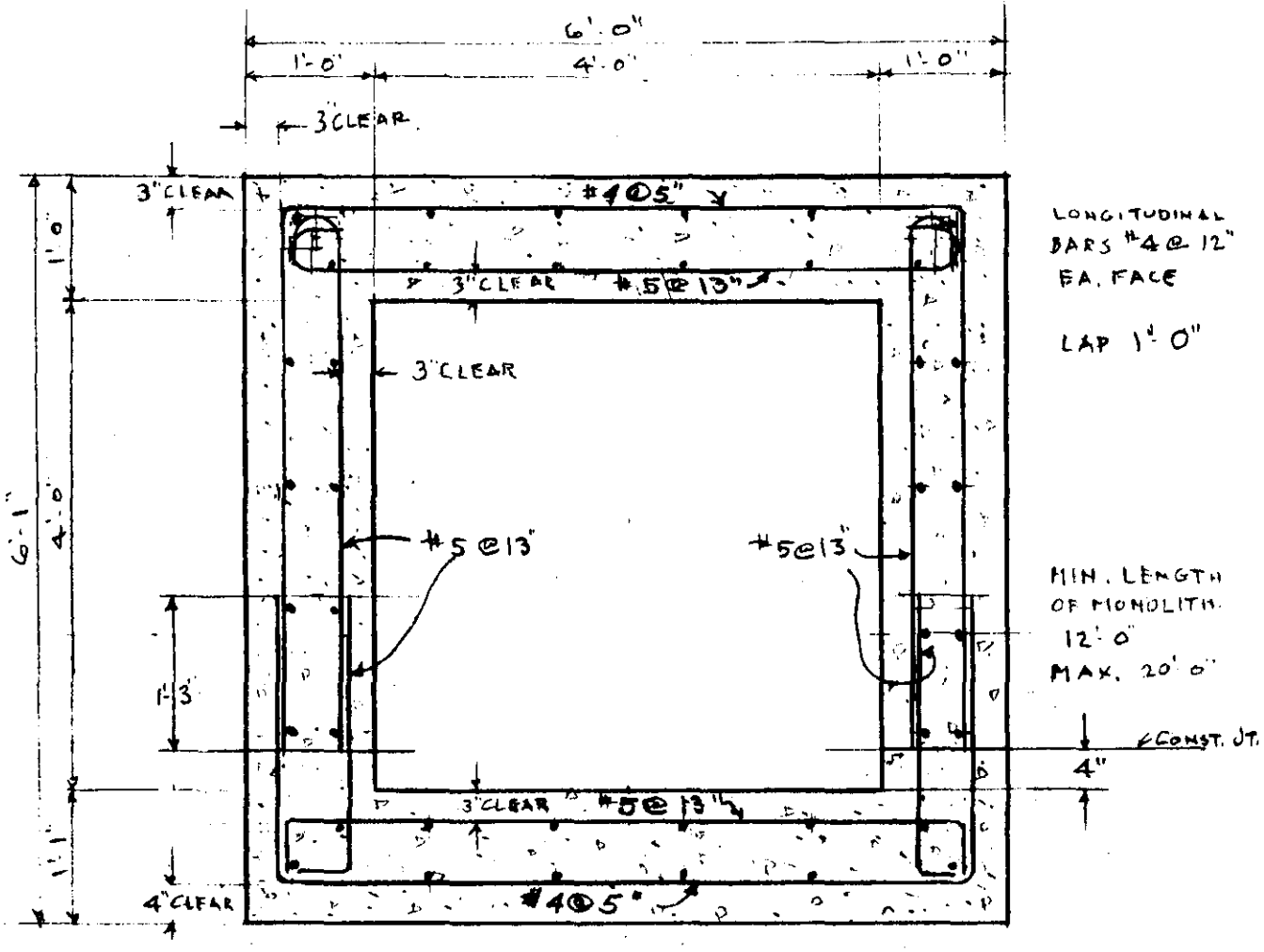
USE #5 @ 13" I.F.

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT MASS. - CHICOPEE FALLS

SUBJECT INTAKE OAK ST. PUMPING STA.

PROJECT NO. 6205 - 2
SHEET NO. 12 OF
DATE JAN. 24, 1963
COMPUTED BY M A
CHECKED BY J.K.



SCALE 3/4" = 1'-0"

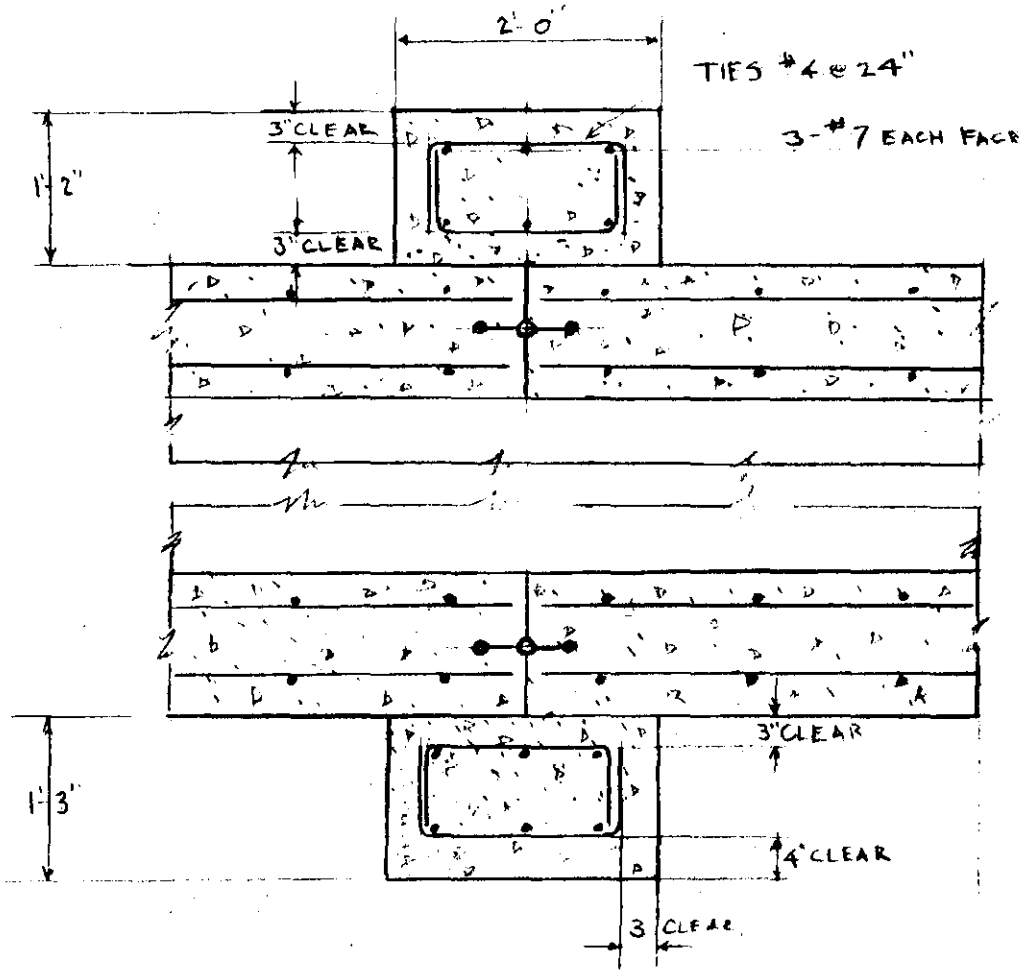
4'-0" x 4'-0" BOX CULVERT.

GREEN ENGINEERING AFFILIATES
ENGINEERS
BOSTON, MASS.

PROJECT MASS. CHICOPEE FALLS

SUBJECT INTAKE OAK ST. PUMPING STA.

PROJECT NO. 6205-2
SHEET NO. 13 OF
DATE JAN. 24, 1963
COMPUTED BY M.A.
CHECKED BY J.K.



COLLAR FOR
4'-0" x 4'-0"
CULVERT.