HURRICANE PROTECTION PROJECT

# NEW LONDON HURRICANE BARRIER

NEW LONDON, CONNECTICUT

# DESIGN MEMORANDUM NO. 6

## EMBANKMENTS AND FOUNDATIONS STRUCTURES, CATHODIC PROTECTION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

APRIL 1978

59

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED-E

28 April 1978

SUBJECT: New London Hurricane Protection Project
New London, Connecticut

HQDA (DAEN-CWE-B)
WASH DC 20314

In accordance with ER 1110-2-1150, there is submitted for review and approval Design Memorandum No. 6, Embankments and Foundations, Structures, Cathodic Protection for the New London Hurricane Protection Project.

FOR THE DIVISION ENGINEER:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

Incl (10 cys)
as

NEW LONDON HURRICANE PROTECTION PROJECT

NEW LONDON, CONNECTICUT

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|---|---|---|---|---|
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| 2 | General Design (Incl Site Geology) | | 12 Jan 66 | 15 Mar 66 |
| 2 | General Design (Revised) | | 28 Jul 77 | 18 Nov 77 |
| 3 | Concrete Materials | | 2 Nov 65 | 16 Dec 65 |
| 4 | Real Estate | | 2 Mar 70 | 1 May 70 |
| 5 | Bentleys Creek Barrier | | 10 Mar 70 | 1 Jun 70 |
| 6 | Embankments and Foundations Structures, Cathodic Protection | | 28 Apr 78 | |

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DESIGN MEMORANDUM NO. 6

EMBANKMENTS AND FOUNDATIONS, STRUCTURES, CATHODIC PROTECTION

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NEW LONDON
HURRICANE PROTECTION PROJECT
NEW LONDON, CONNECTICUT

## A. PERTINENT DATA

| | |
|---|---|
| **PURPOSE** | Hurricane Tidal Protection |
| **LOCATION** | |
| State | Connecticut |
| County | New London |
| City | New London |
| **DESIGN STORM** | |
| Frequency | 100 Year |
| Stillwater Elevation | 10.5 N.G.V.D. |
| Max. Wave Height, Shaw Cove | 2.4 feet |
| Max. Wave Height, Harbor | 5.2 feet (Broken) |
| **FLOODWALLS** | |
| Stations 19+40 to 22+30 | L-type, reinforced concrete on steel cells |
| Top Elevation | 14.5 NGVD |
| Cell Diameter | 27.07 feet |
| Total Height | 32.5 feet |
| Height of Concrete Wall | 11.5 feet |
| Dredge Elevation | -15.0 NGVD |
| Stations 29+80 to 34+60 | I-type, reinforced concrete surmounted on steel sheet piling |
| Top Elevation | 14.5 NGVD |
| Elevation, Bottom of sheeting | -15.0 NGVD |
| **DIKES** | |
| Type | Earthfill with Rock Toe and Facing |
| Top Elevation (Harborside) | 14.5 NGVD |
| Top Elevation (Coveside) | 12.0 NGVD |
| Top Width | Varies |
| Maximum Height | 10 feet |
| Slopes | 1 on 2 |
| Total Length | 2700 feet |
| Slope Protection | Yes |

National Geodetic Vertical Datum

## SHAW COVE PUMPING STATION

| | |
|---|---|
| Substructure, Type | Reinforced Concrete, 40' x 48' |
| Superstructure, Type | Structural Steel Framed Metal Panel Roof with Masonry Walls 31' x 48' |
| Foundation | Steel bearing piles |
| Area Controlled, Acres | 215 |
| Runoff Controlled, inches per hour | 2.8 |
| Type of Pumps | Vertical Axial Flow |
| Capacity, each | 70 c.f.s. |
| Engines | Diesel |
| Sluice gates, each | 4 |
| Discharge Conduit | 3-36" pipes |
| Gavity Conduit (gated) | 6'-6" x 6'-6" |

## PRESSURE CONDUIT

| | |
|---|---|
| Diameter, inches | 96 |
| Length under this Contract | 900 |
| Total Length | 2750 |

## ESTIMATED PROJECT COST

| | | |
|---|---|---|
| Lands and Damages | | $ 970,000 |
| Relocations | | |
| Utilities | | 65,000 |
| Construction | | |
| Levees and Floodwalls | $2,750,000 | |
| Pumping Station | 950,000 | |
| Pressure Conduit | 1,700,000 | |
| Sub-Total | | 5,400,000 |
| Engineering and Design | | 615,000 |
| Supervision and Administration | | 500,000 |
| Total Project Cost | | $7,550,000 |
| Federal Contribution 70% | | $5,285,000 |
| Local Contribution 30% | | $2,265,000 |

## B. INTRODUCTION

1. PURPOSE. The purpose of this memorandum is to present for review and approval the basic features of and the design criteria to be used in the design of structures, embankments, foundations and corrosion mitigation to be included in the New London Hurricane Protection Project. The basic criteria, typical design computations, definitive drawings and other pertinent data are presented.

2. SCOPE. This memorandum covers the design of the dikes, floodwalls, conduits and pumping station including foundation, structural, architectural, mechanical and electrical features pertaining to each.

3. LOCATION. The project is located in New London County, State of Connecticut, on the west side of the Thames River estuary approximately 45 miles southeast of Hartford, Connecticut, and 50 miles southwest of Providence, Rhode Island. The project will start at the intersection of Shaw and Hamilton Streets along the west side of Shaw Cove and terminate at high ground at Bank Street approximately 300 feet north of Spar Yard Street. Plate 6-1 is a general plan of the project.

4. DESCRIPTION OF PROJECT. The project consists of slope protection of embankment on west side of Shaw Cove, construction of an "L" type floodwall which is supported by a cellular steel pile wall, construction of a section of "I" type floodwall at the east end of the project and construction of rock faced dikes at the north shore of Shaw Cove and at the south end of the project in vicinity of Hamilton Street. Also included in the project is a pumping station to handle interior drainage during times of storm tides and the upper reach of the 96" diameter pressure conduit which conveys Truman Brook from Grand Street to Bank Street where it will join the first phase of the conduit which will have been constructed from Bank Street to its outfall at Shaw Cove.

5. PREVIOUS REPORTS. A detailed report on design of the project features outlined in the previous paragraph has not previously been submitted. The latest previous description of the adopted project is contained in Design Memorandum No. 2, General Design (Revised) submitted 28 July 1977 and approved 18 November 1977. A decision by the Redevelopment Agency to regrade the area west of Shaw Cove by filling to the required protection elevation negates the need for the dike along the west shore of the cove. Stone protection will be constructed on the cove side of this embankment. An "I" type floodwall, stiffened with battered H-piles has been substituted for the L-type wall previously proposed for the reach of protection between Station 29+80 and Station 32+98. The I-type wall was selected due to the low height of protection and the impracticality of removing unsuitable foundation material below the relatively wide base of the originally proposed L-type wall.

## C. HYDROLOGY AND INTERIOR DRAINAGE

6. GENERAL. Approved Design Memorandum No. 2, General Design (Revised), contains the hydrology and required provisions for interior drainage for

the adopted project criteria. That memorandum also summarizes the hurricane hydraulics for the 100-year frequency stillwater level storm which is the adopted project design criteria. That criteria is developed from data presented in Design Memorandum No. 1, Hurricane Tidal Hydraulics, approved 14 January 1966.

7. INTERIOR DRAINAGE. The collection system for the major portion of the interior drainage from the "low level area" will be provided by the city of New London, as part of its Urban Renewal Project, and will terminate at the pumping station where a 72-inch diameter pipe will discharge into the station. The remaining area, between Bank Street and the protection, will be collected in a drain line at the landside toe of dike as shown on Plate 2-4, Design Memorandum No. 2, General Design (Revised), July 1977.

8. PRESSURE CONDUIT. The second phase of the 96-inch diameter pressure conduit will convey Truman Brook from an intake structure north of Grand Street, to the end of the first phase at Bank Street east of Jefferson Street. This second phase will be included in the Hurricane Protection Project and will complete the conveyance of Truman Brook to Shaw Cove such that the protected area will no longer be subject to its flooding.

## D. EMBANKMENTS AND FOUNDATIONS

9. SUBSURFACE INVESTIGATIONS. Seventeen drive sample borings were made by the Corps of Engineers in the foundation area of the project. In addition, 48 of the borings made for the New London Redvelopment Agency are applicable to the project foundation. Ten drive-sample borings were ade by the Corps of Engineers in a city-owned impervious fill borrow area. The exploration program has been completed and is considered adequate for project design. The locations of the explorations are shown on Place C-1. The results of laboratory soil tests are summarized in Appendix C. Engineering log profiles of the project foundations are shown on Plates C-2 through C-9.

10. CHARACTERISTICS OF FOUNDATION SOILS.

a. Distribution and Description.

(1) General. The project will be built in an area of made land formed by filling during the last 200 years or so. There is no exact record of the timing and type of filling that has taken place. The filling was generally uncontrolled and the type of fill encountered in this area is very heterogeneous. The project area is the site of an Urban Renewal Project with portions of the area in various stages of filling and dismantling of buildings.

(2) Subsurface Water. Subsurface water levels in the foundation areas fluctuate with the level of the tides. Mean high tide level equals Elevation 1.63 NGVD Mean low tide level equals Elevation -0.97 NGVD.

(3) Foundation Zones. As indicated by the soil profiles on Plates C-2 thru C-7, the foundation soils along the waterfront occur in four fairly distinct zones which are designated in order of depth as Zones I, II, III, and IV. Zone I is a relatively thin surficial zone consisting of miscellaneous fills containing moderate amounts of trash, cinders, ashes, boulders, blocks and other materials but generally of granular character. Zone II is a zone conssting of soft, organic silts which were deposited in shallow waters and generally underlie the entire project area. Zone III is a zone consisting of moderately compact stratified inorganic silts and silty fine sands. Zone IV is the lowest zone and consists mainly of variable gravelly silty sands (glacial till). In general, these zones are horizontally continuous.

(4) Stations 0+00 to 2+00. This reach has been filled to depths between 2 and 8 feet (Zone I). Soft organic silt (Zone II) occurs in portions of this reach in layers of from 3 to 6 feet in thickness. The bedrock surface varies from 10 to 18 feet below existing ground surface.

(5) Stations 2+00 to 12+00. This reach has been filled to depths between 8 and 15 feet with sands and gravels containing moderate amounts of trash, cobbles, cinders and ashes. The fills (Zone I) are underlain by 3 to over 15 feet of Zone II soft organic silts (OL), which are underlain in turn by 5 to over 15 feet of Zone III soils consisting of moderately compact silty fine sands (SM) and silts (ML).

(6) Stations 12+00 to 24+00. This reach has been filled (Zone I) to depths of from 4 to 15 feet. Between Sta 12+00 and 18+00, the fills overlie 5 to over 50 feet of loose to moderately compact silty fine sands (SP and SM). In the remainder of this reach the fills overlie 2 to over 18 feet of soft organic silts (OL) which overlie loose to moderately compact silty fine sands (SP and SM). The top surface of Zone III (Glacial Till) in this reach is generally below Elev. -40, but rises to Elev. -14 near Sta 20+00 and then dips again to Elev. -27 near Sta 22+00. Soils in this deposit Zone IV consist of gray brown, moderately compact to compact silty sandy gravels (GM) and gravelly silty sands (SM, SP-SM) with numerous cobbles and boulders. The top of the bedrock is about Elev. -32 at Sta 20+00 and dips to Elev. -47 at Sta 22+00.

(7) Stations 24+00 to 29+00. This reach has been filled to depths of from 8 to over 22 feet. The fills are underlain intermittently by 5 to 17 feet of soft organic silts (OL). The fills and organic silts are underlain by from 8 to 25 feet of moderately compact inorganic silt (ML) and silty fine sands (SM).

(8) Stations 29+00 to 34+50. This reach has been filled to depths of from 4 to over 14 feet. The fills are underlain by moderately compact silts (ML) and silty fine sands (SM) to depths of up to 50 feet below the present ground surface. Between stations 29+00 and 32+00, a 2 to 7 foot layer of soft organic silt occurs beneath the fill. In this reach, Zone III varies in thickness from 15 to over 40 feet and is composed of moderately compact, stratified inorganic silts (ML) and fine sands (SM). Zone IV (glacial till) rises to about Elev. -20 near Sta 31+00 and dips to Elev. -40 at Sta 32+00. The top of bedrock is about Elev. -30 between Stations 29+00 and 31+00 and dips to Elev. -45 at Sta 33+00.

b. Shear Strengths. Shear tests were not performed on samples of the foundation materials for this project. Visual examination of the samples and their grain size curves, the exploration logs and experience with similar materials indicate that the shear strength parameters for the foundation materials will equal or exceed the following values.

| Material | Ø | C |
|---|---|---|
| Existing Fills (Zone I) | 15 to 25° | 0 |
| Organic Silt (OL)(Zone II) | | |
| On Land | 0 | 400 PSF |
| In Cove | 0 | 200 PSF |
| Inorganic Silt (ML)(Zone III) | 25° | 0 |
| Silty Fine Sand (SM)(Zone III) | 25° | 0 |
| Till (Zone IV) | 35° | 0 |

c. Permability. Permability tests were not performed on samples of the foundation materials for this project. Visual examination of the samples and their grain size curves and experience with similar materials indicate that coefficients of vertical permability will be within the following ranges:

| Material | Coefficient of Vertical Permability, Kv |
|---|---|
| Existing Fills (Zone I) | 1 to 100 x $10^{-4}$ cm/sec |
| Organic Silt (OL) Zone II) | .01 to .1 x $10^{-4}$ cm/sec |
| Inorganic Silt (ML)(Zone III) | 0.1 to 1 x $10^{-4}$ cm/sec |
| Silty Fine Sand (SM)(Zone III) | 1 to 10 x $10^{-4}$ cm/sec |
| Till (Zone IV) | 0.1 to 1 x $10^{-4}$ cm/sec |

d. Consolidation. Consolidation tests were not performed on samples of the foundation materials for this project. Except for the organic silt and fill materials that are mixed with organic silts, the foundation materials exhibit low compressibility and it is anticipated that settlements due to consolidation of the foundation soils will be minor in magnitude and will occur principally during construction. The organic silts (Zone II) will be removed from the foundation only in certain areas such as the gravity outlet and the 36" pump discharge pipes at the pumping station, the circular cells and under the oceanside slope of the dike between Stations 22+40 and 26+00. Elsewhere the organic silts are buried under existing fills and its removal is not practicable.

When the organic silt is left in place the dike height will be increased by the amount of the predicted settlement. Tests on 6 undisturbed samples of organic silt by the New London Redevelopment Agency indicate the material has a Compression Index (Cc) for Primary Compression between 1.1 and 2.9 (averaging 1.39) and an average Compression Ration $\left(\frac{Cc}{1+e_o}\right)$ of 0.29. The Compression Index for Secondary Compression ($C_\alpha$) averages 0.02. The materials has a Coefficient of Consolidation ($C_v$) ranging from 0.11 to 0.46 $Ft^2$/day and averaging 0.21 $Ft^2$/day.

11. AVAILABILITY AND CHARACTERISTICS OF MATERIALS.

a. General. Materials from required excavations will not be suitable for use in the construction of the dike. Reconnaissance was made, therefore, to locate sources of borrow and contractor-furnished materials. A glacial till deposit on land owned by the City of New London was investigated and selected as a borrow source for impervious fill material. Exposed faces in potential sources of sand and gravel were examined and sampled. Operating and abandoned quarries in the area were inspected as well as undeveloped rock outcrops.

b. Impervious Fill Material.

(1) Distribution and Description. Impervious fill material will be glacial till obtained from a borrow area located on city-owned land about 7 miles north of the project as shown on Plate No. C-10. The area is heavily wooded and covered with about a foot of topsoil and forest debris. The depth of the glacial till material in this area ranges from 20 to over 40 feet. The material consists of brown, brown to gray brown and gray, compact, nonplastic, gravelly silty medium to fine sand with cobbles. Gravel contents are generally between 5 and 20 percent. Silt contents range from 25 to 40 percent of the component passing the No. 4 Sieve.

(2) Characteristics. Testing of samples of impervious fill material was limited to mechanical analyses, determinations of plasticity, water contents and visual classification procedures. On the basis of the results of this testing and experience with similar materials, it is estimated that a compacted fill of this material will develop an angle of internal friction of at least 35 degrees within the anticipated stress range, will have a coefficient of permeability of less than $1 \times 10^{-4}$ cm/sec and will be only slightly compressible. On the same basis, it is estimated that dumped fill of this material will develop an angle of internal friction of at least 25 degrees, will have a coefficient of permeability of less than $5 \times 10^{-4}$ cm/sec and will be moderately compressible.

c. Gravel Fill, Gravel Filter, Gravel Bedding, Cell Fill and Sand Fill Materials.

(1) General. Several potential sources of gravel fill, gravel filter, gravel bedding, cell fill and sand fill materials were found within a 25-mile haul of the project. In view of the commercial aspects of the larger sources, it was decided to have the contractor furnish these materials. Investigations of the faces of open pits in the probable sources of these materials indicate that clean, cobbly, sandy gravel, gravelly sand, and sand are available in ample quantity for this project. The following gradation specifications for these materials have been established on the basis of the gradation of available sands and gravels and, in the cases of the gravel fill and gravel filter materials, on the basis of providing an adequate filter against dumped rock fill material having a D15 size of 6 inches or less. The gravel fill and gravel filter specifications, as established, exceed the usual filter requirements since placement methods for these materials and the adjoining dumped rock fill material are such that a conservative approach is indicated.

(2) Gradation Specifications.

(a) Gravel Bedding and Gravel Filter. Gravel and gravel filter materials shall consist of well-graded sandy gravel composed of tough, durable particles of natural sand and gravel except that particles larger than the 3/8 inch size may be crushed stone. The material shall meet the following gradation limits:

| U.S. Std. Sieve Size | Percent Passing by Dry Weight |
|---|---|
| 9 inch | 100 |
| 2 inch | 60-85 |
| No. 4 | 15-45 |
| No. 70 | 2-10 |
| No. 200 | 0-5 |

(b) Gravel Fill. Gravel fill material shall consist of well graded sandy gravel composed of tough, durable particles of natural sand and gravel except that particles larger than the 3/8 inch size may be crushed stone. The material shall meet the following gradation limits:

| U.S. Std. Sieve Size | Percent Passing by Dry Weight |
|---|---|
| 6 inch | 100 |
| 1 inch | 50-80 |
| No. 4 | 30-60 |
| No. 40 | 5-20 |
| No. 200 | 0-10 |

(c) Cell Fill. Material for cell fill shall consist of crushed or uncrushed sandy gravel or gravelly sand composed of sound, tough, durable particles, free from soft, thin or elongated pieces, and shall not contain organic matter, sod, roots, brush, debris or soft friable pieces in quantities considered objectionable by the Contracting Officer. The material shall be graded within the following limits:

| U.S. Std. Sieve Size | Percent Passing by Dry Weight |
|---|---|
| 6 inch | 100 |
| 2 inch | 75-100 |
| 1 inch | 50-85 |
| No. 4 | 40-70 |
| No. 40 | 20-50 |
| No. 200 | 0-8 |

(d) Sand Fill. Sand fill material shall consist of well-graded, bank-run sand or gravelly sand meeting the following gradation limits:

| U.S. Std. Sieve Size | Percent Passing by Dry Weight |
|---|---|
| 3 inch | 100 |
| No. 4 | 50-90 |
| No. 10 | 40-85 |
| No. 40 | 5-30 |
| No. 200 | 0-15* |

*In no case shall more than 15 percent, by dry weight, of component passing the No. 4 Sieve pass the No. 200 Sieve.

(3) Characteristics. On the basis of the above gradation specifications it is estimated that gravel fill, gravel filter, gravel bedding, cell fill and sand fill materials will develop angles of internal friction of at least 30 degrees and will have coefficients of permealility $20 \times 10^{-4}$ and $100 \times 10^{-4}$ cm/sec.

d. Concrete Materials.

(1) General. A detailed discussion of concrete materials was submitted in Design Memorandum No. 3, Concrete Materials in November 1965, and updated in March 1970. In October 1977 a new updating was performed. The major changes found in the latest updating are: (1) the reduction of concrete quantity required from 8000 cubic yards to approximately 2200 cubic yards for use in a pumping station, gate structure and floodwalls, both requiring air entrained regular quality concrete. (2) The reduction of four tested and approved sources to three tested and approved sources. (One of the approved sources has gone out of business and another has changed hands.) The three previously approved sources which are listed in TM No. 6-370 Test Data, Concrete Aggregates in Continental United States still operating are as follows:

The Balf Company
Gales Ferry, Connecticut

formerly James Romanella and Sons, Incorporated
formerly Groton Ready Mix Incorporated
Latitude 41°N - Longitude 72°W, Index No. 20 (Rev.)

John J. Doyle Sand and Gravel Company
Uncasville, Connecticut

Latitude 40°N - Longitude 72°W, Index No. 21

NHTR/Tomasso
Wauregan, Connecticut

formerly New Haven Trap Rock Company
formerly Dunning Sand and Gravel Company

Latitude 41°N - Longitude 71°W, Index No. 1 (Suppl.)

Samples of material from these three sources were taken and tested and found to be petrographically similar as when originally tested.

(2) Cementitious Materials. The size of the monoliths will not result in excessive thermal stresses and the location of the project structures does not involve sulfate exposure. Therefore, Type I portland cement will satisfy the chemical and physical requirements for this project. The aggregate evaluation did not reveal any potentially deleterious reactive aggregates, therefore low-alkali cement will not be required. Although recent history of cement mills supplying in the project area have shown no problems of false set, false set requirements will be specified. No special investigations of portland cements have been conducted, as cement used in this area is usually supplied by one of eight cement mills located in the Pennsylvania Lehigh Valley or seven cement mills located in the New York Hudson River Valley, or the one mill located in Thomaston, Maine. Some of these mills do not manufacture Type I portland cement but do manufacture Type II, therefore Type I or Type II portland cement will be specified. There are no economically available sources of natural, slag, portland blast-furnace slag or portland-pozzolan cements in this area, so these types of cement will not be specified.

(3) Service Record. Materials from the tested sources have been used in a number of Federal, State and local porjects and the service record of aggregates from all three approved sources is acceptable, although it is noted that the period of record is less than fifteen years. The maximum size concrete aggregate commercially available in this area is 1-1/4 inches produced in accordance with Standard Connecticut State Highway Specifications. The size of the structures and quantity of concrete required do not warrant a larger size, therefore the project specifications will reflect the Connecticut State Specifications for 1-1/4 inch maximum size aggregate.

(4) Sources of Concrete. There are three interested sources of ready-mixed concrete within economical haul distance of the project site. Soneco Service, Incorporated, operates a semi-automatic central mix type concrete plant in Groton, Connecticut approximately a five mile haul distance to the project site. Concrete aggregates are obtained by rail from NHTR/Tomasso in Wauregan, Connecticut. The John J. Doyle Sand and Gravel Company operates a manual transit mix type concrete plant in Uncasville, Connecticut, approximately an eight mile haul distance to the project site.

Aggregates are obtained from their own pits located in various areas near the concrete plant. Seymore Sand and Stone, Incorporated operates a semi-automatic transit mix type concrete plant in Fitchville, Connecticut, a twenty-one mile haul distance to the project site. Aggregates are obtained from their own pits located in various areas near the concrete plant. Coarse aggregates are only screened into two size groups and are not manufactured to conform to State of Connecticut specifications. Project specifications will call for use of a manual type concrete batching plant and transit mixers.

(5) Recommendations. Based on the data presented, it is considered that aggregate from any of the three sources previously tested is acceptable, and it is recommended that fine and coarse aggregate from these three sources be listed in the project specifications as approved sources.

e. Rock Materials. Reference is made to paragraph 18d. of Design Memorandum No. 2 "General Design" for a discussion of the availability and characteristics of rock materials for dike construction. All protection stone and rock fill materials will be furnsihed by the contractor.

## 12. DESIGN OF DIKES

a. General. The still water level for the design tidal surge is at Elev. 10.5 NGVD for the Shaw Cove area. Maximum wave heights range from 2.0 feet to the east of Spar Yard St. (Sta 29+00) to 2.4 feet to the west.

b. Dike Sections.

(1) Stations 0+00 to 9+75. The dike in this reach will be constructed on land to a maximum height of about 6 feet. The section will consist of compacted impervious fill with an outer facing of stone protection. The land behind the dike will be filled by the City of New London after construction of the dike. Existing utility lines which pass through the dike will be provided with emergency closures to prevent tidal water from flowing into the protected area in the event of rupture.

(2) Stations 9+75 to 16+73. The land in this reach is being filled to Elev. plus 12.0 MSL by the City of New London prior to construction of this project. Work under this project in this reach will consist of the construction of stone protection layers on the waterside toe of the fill.

(3) Stations 16+73 to 18+65. The dike in this reach will be constructed on land with the waterside toe at the shore line. The height of the dike will average about 6 feet on the landside and up to about 15 feet on the waterside. The section will consist of zones of compacted impervious and gravel fills with stone protection on both slopes.

(4) Stations 22+40 to 26+35. The dike in this reach will have an off-shore waterside toe. Its height on the landside will average about 8 feet. The section will consist of dumped sand, rock, gravel and impervious fill zones placed in water and compacted impervious fill above high tide level. Stone protection will be placed on both slopes.

(5) Stations 26+35 to 29+49. The dike in this reach will be constructed on land to an average height of about 8 feet. The section will consist of compacted impervious fill with stone protection.

c. Construction Considerations. In the reach between Stations 22+40 and 26+35 the waterside toe of the dike will be constructed offshore. A dumped rock fill toe is being constructed to provide wave protection for the work during construction. Dumped gravel and impervious fills will be placed on the landside of the rock up to mean high water level. The dumped fills will be built by end-dumping from trucks or other land based equipment.

d. Foundation Preparations. All land foundations for dikes will be stripped of topsoil and other unsuitable material. A five foot deep inspection trench will be excavated in the foundation of all dikes on land to assure removal of any buried pipes. In the reach between Stations 22+40 and 26+35 all organic silt in the cove bottom within the oceanside portion of the dike foundation area will be excavated and replaced with dumped sand fill.

e. Construction of Fills.

(1) Dumped Gravel and Impervious Fills. Dumped gravel and impervious fill zones will be constructed to their full heights in one operation by dumping the fill material over the end as the work progresses.

(2) Compacted Impervious Fill. Material for compacted impervious fill will be spread in 6-inch layers and each layer will be compacted by at least 6 coverages of the tread of a crawler-type tractor weighing at least 35,000 pounds and exerting a tread pressure of not less than 9 pound per square inch. Areas of the top of dikes where the width is less than 14 feet shall be compacted by a lighter tractor. This tractor shall weigh between 7,500 and 12,000 pounds and have a width of 5-1/2 feet or less. The moisture content of the material during compaction will be such as to prevent excessive rutting or dust and to permit satisfactory operation of the hauling and compaction equipment. In areas adjacent to concrete structures where the tractor cannot operate, the material will be spread in 4-inch layers and compacted by power tampers to produce a high density and a tight contact with the structure.

(3) Compacted Gravel Fill. Material for compacted gravel fill will be spread in 8 inch layers and each layer will be compacted by at least 6 coverages of the tread of the crawler type tractor described in subparagraph (2) above. In areas adjacent to concrete structures, where the tractor cannot operate, special spreading and compaction methods will be used to obtain high densities.

f. Stone Protection

(1) General. Layers of Class A Stone Protection and gravel bedding will be constructed on the waterside slope of the dike to provide protection against the action of the waves of the design shown. These layers have been designed in accordance with the criteria for graded rip-rap protection set forth in Shore Protection Manual 1973 published by U.S. Army Coastal Engineering Research Center. Layers of Class B Stone Protection will be constructed on the landside slopes of the dikes for protection against erosion due to runoff and to possible overtopping waves from storms greater than the design storm.

(2) Materials

(a) Class A Stone Protection. Class A stone protection material will be furnished by the contractor and will consist of quarried rock fragments well-graded from a maximum size of between 400 and 900 pounds to a minimum size of 2 inches. No more than 10 percent, by weight of the material shall pass the 2 inch screen.

(b) Class B Stone Protection. Class B stone protection material will be furnished by the contractor and will consist of quarried rock fragments well-graded from a maximum size of between 200 and 450 pounds to a minimum size of 2 inches. No more than 10 percent, by weight of the material will pass the 2 inch screen.

(c) Dumped Rockfill. Dumped rockfill material shall be furnished by the contractor andshall consist of quarried rock fragments meeting the gradation requirements for Class B Stone Protection.

13. SEEPAGE CONTROL.

a. General. The design hydrostatic head for the dikes has been taken as that produced by the design stillwater level on the waterside and a water level at the ground surface on the landside. On this basis, the design hydraulic heads will range from 0 to about 6 feet.

b. Through Seepage. Seepage through the dikes will be controlled by the arrangement and permeability differentials of the impervious fill, gravel fill and dumped rock fill zones and the gravel bedding layers, filter cloth layers and protection stone. The gradation specifications for materials in adjacent fill zones have been established so as to satisfy filter gradation requirements.

c. Foundation Seepage. Seepage through the dike foundation will be controlled by the length of the seepage path and in the case of the dikes on land by a 5-foot deep inspection trench filled with compacted impervious fill..

14. DIKE STABILITY. Stability studies indicated that it would be more economical to remove the cove bottom deposits of organic silt to the reach between stations 22+12 and 25+80 than to design and construct a dike section that would be stable with these materials left in place. The dikes have therefore been designed to be stable against shear failure after removal of the organic silts from the foundations of those portions to be built in water. The land side portions of the dikes are designed to be stable with buried layers of organic silt left in place.

15. SELECTION OF DESIGN VALUES. The design unit weights and shear strength parmeters for use in design analyses have been selected on the basis of experience with similar materials on other projects and are tabulated below:

| Material | Unit Weight (pcf) Moist | Unit Weight (pcf) Submerged | Shear Strength Degrees | Shear Strength psf | Net Bearing Cap. TSF |
|---|---|---|---|---|---|
| Existing Fills | 130 | 70 | 25 | 0 | 1.0 |
| Organic Silts | | | | | |
| In Cove | - | 20 | 0 | 200 | -- |
| On Land | - | 20 | 0 | 400 | -- |
| Inorganic Silts | - | 50 | 25 | 0 | 2.0 |
| Till | - | 80 | 35 | 0 | 3.0 |
| Dike Fills | | | | | |
| 1. Comp. Impervious | 135 | 77 | 35 | 0 | -- |
| 2. Comp. Gravel | 130 | 70 | 35 | 0 | -- |
| 3. Dumped Impervious | 125 | 65 | 25 | 0 | -- |
| 4. Dumped Gravel | 120 | 60 | 30 | 0 | -- |
| Cell Fill | 120 to 134 | 58 to 72 | 30 | 0 | -- |
| Dumped Sand Fill | 110 | 60 | 28 | 0 | -- |

16. SETTLEMENTS. Except where buried layers of organic silt are left in place in the foundation, no significant settlements are anticipated as a result of the consolidation of foundation soils or dike fills. Where the organic silts are left in place, settlements due to their consolidation will occur. These settlements will vary up to between 1 and 2 feet depending upon the thickness of the organic silt layer. The dikes will be overbuilt in reaches in which significant settlement is predicted to compensate for the potential loss of protection height.

17. CONCRETE STRUCTURES - EARTH FOUNDATIONS

a. Pumping Station. The foundation soils for the pumping station include about 10 feet of loose fine sand (SP) and silty fine sand (SM) overlying loose fine sand (SP) and silty fine sand (SM) overlying loose to moderately compact sandy silt (ML). In view of potential settlements due to densification of these materials by vibrations during operation of the pumps, it was decided to found this structure on steel bearing piles driven to bedrock. It is estimated that bedrock could be at a depth of as much as 40 to 60 feet below the concrete floor slab of the structure.

b. Gravity Conduit, Gate Structure and Discharge Pipes.

(1) The gravity conduit will be a reinforced concrete 78 inch box conduit with alignment collars at each joint to accommodate settlement of the conduit relative to the pumping station. The foundation grades for the conduit and gate structure for the pumping station will be at about Elev. -10 NGVD. At this depth, foundation soils will consist of loose to moderately compact fine sands (SP) and silty fine sands (SM) overlying loose to moderately compact sandy silt (ML). Above about Elev. -10 NGVD there are pockets and layers of weak and compressible organic silts and loose Zone I fills. These deposits will be removed in their entirety bove -10. Pockets or layers remaining below this elevation will be removed and replaced with compacted gravel fill.

(2) As all the organic silts and loose Zone I fills will be removed from under the discharge pipes over the dike, no significant settlements are anticipated as a result of consolidation of the foundation soils or dike fills. The excavations for these structures will be dewatered. This may require vacuum dewatering with well points to lower the ground water in the fine sands and silts below the excavation.

c. I-Wall - Station 29+80 to Sta. 32+98.

(1) As discussed in paragraph 10.a.8, the foundation materials along this reach of the wall include about 8 to 13 feet of Zone I fill materials extending from ground surface to about Elev. -5 NGVD. These materials consist of very loose to compact fills containing cinders, ashes, bricks, cobbles, blocks, boulders and other foreign materials. Between stations 29+00 and 32+00 the explorations indicate a 2 to 7 foot layer of soft organic silt beneath the fills. Additional pockets and layers of organic materials of unknown thicknesses probably occur throughout the foundation area.

(2) In view of the potential differential settlements due to densification of these Zone I and II materials by static and dynamic loads and placement of future fills by the adjacent property owners, it was decided to found this structure on steel sheet piling driven to a tip elevation of -15 which is within the Zone III materials. Better piles consisting of steel piles will be driven to till and stiffen the wall against the horizontal wave forces.

(3) The presence of boulders and blocks could make the driving of sheeting difficult or impossible; therefore it was decided to move the sheeting farther away from the railroad tracks than shown in GDM No. 2 (Revised). A trench excavation will also be made to Elev. 0.0 in order to remove possible obstructions, to provide greater friction values and to control foundation seepage. The trench will be backfilled with dumped and compacted impervious fill (glacial till) and the sheeting and batter piles will be driven through these fills. Any obstructions remaining below Elev. 0.0 will be split or moved by the steel piling or removed by excavating in short reaches and backfilling to Elev. 0.0 with dumped sand fill. Excavation in short reaches can be accomplished without endangering the adjacent railroad.

d. I-Wall Stations 32+98 to 34+59. This reach of I-wall will be constructed in soils similar to those described in paragraph c. above. The I-wall will be supported by steel sheet piling driven to a tip elevation varying from -15 to -6. Batter piles are not required as the wave forces are small. Sheet piling will be driven within 3 feet of an existing concrete block building which is bearing on loose, m-f sands and silty sands. Vibrations from driving sheeting could cause densification and settlement of the building foundations, hence a vibratory hammer will be specified to reduce these vibrations. An alternate design for a wall adjacent to the existing building consisting of a low L-wall bearing on an earth foundation without piling is being studied.

e. Permanent Cellular Sheet Pile Structure.

(1) Foundation Materials - As discussed in paragraph 10a(6), the foundation materials along the reach of the permanent cells include about 3 to 20 feet of Zone I fills and Zone II organic silts extending from ground surface to about Elev. -15 in the vicinity of Cell No. 2. and then sloping downward to Elev. -24 near Cell No. 8. About 2 to 4 feet of Zone III silts and fine sands underlie the cells except at the westerly end near Cells Nos. 1 and 2 where this zone is about 15 feet in thickness. The top surface of the Zone IV glacial till is at Elev. -14 under Cell No. 3 and dips in an easterly direction to about Elev. -27 under Cell No. 8. The irregular bedrock surface is generally below Elev. -30 in this reach but dips to elevations of -41 to -65 just beyond the westerly end of the structure.

(2) Location Restraints. The cellular structures are located close to existing structures which must be protected and kept in operation during construction of the cells. At the west end, the cells are located within 3 to 10 feet of an old, partially decayed wood pile bulkhead of unknown depth. This bulkhead supports the foundation of a concrete containmant wall for a fuel oil storage tank farm. Cells No. 5 thru 8 parallel a wood pile supported unloading dock. The elevations of the wood pile tips are unknown. The existing wood deck will be removed and the piles pulled or cut off at the elevation of existing ground surface.

(3) Removal of Unsuitable Materials. The fills and organic silts are considered unsuitable foundation materials and will be removed completely from the foundation areas of the permanent cellular sheet pile structure. The underlying Zone III sands and silts are considered adequate foundation materials. The lateral extent of removal of harbor bottom materials are shown on plates 6-5, 6-10 and 6-22. The vertical extent of removal will be to the bottom of the organic silts and loose fills within the cells and to Elev. -15 on the harbor side of the cells. Plates 6-5 and 6-10 show the estimated depth of removal by the line denoting the requirement of excavation to suitable material. The plans and specifications will provide definite requirements in regard to the horizontal and vertical extent of these excavations. Stage I Excavation will be completed prior to driving the sheet piles for the cells. Stage II excavation will be accomplished from within the cells and arcs by clamshell bucket. Interior bracing may be required during excavation of materials from within cells where differential earth pressures against the outside of the sheeting may cause outward tilting of cells.

(4) Permanent Cells. In general, the sheets of the cells will be driven from 3 to 5 feet into the glacial till (Zone IV or 11 feet in the Zone III sands and silts.

(5) Cell Filling. Cell fill material will consist of natural gravelly sand or sandy gravel. The specifications will also permit the use of gravel fill and gravel bedding. Interconnecting arcs will not be filled prior to filling of adjacent circular cells. The contractor will not be restricted to any specific method for placement of cell fill. Dumped sand fill on the landside of cells shall not be placed until after the cells and arcs are filled. The concrete deck slab and L-wall shall not be constructed until after the landside dumped sand fill is placed in order to prevent damage to the slab and wall from tilting of the cell produced by unbalanced lateral loads.

(6) Steel Sheet Piling. Pile length estimates are based upon the assumption that the steel sheeting will penetrate 5 feet below the surface of the till except cell No. 1, where the foundation materials are expected to be silts and sands. Eleven feet penetration is required in the silts and sands to provide the minimum factors of safety. The contractor will be required to drive all piles until the tip elevation is at Elev. -26 or 5 feet into the till, whichever is higher. The contractor will be given the ordering pile lengths and as a result of the large variation in the till surface elevations beneath the cells, many of the sheets will be required to be burned off. In order to more clearly define the top surface of the glacial till, a seismic survey will be performed along the centerline of the cells. It is anticipated that this survey will enable the pile lengths to be more accurately determined.

The steel sheet piling will be installed with the aid of a double deck template. To avoid toe-in or toe-out and to permit easier driving, all sheets will be laced and set prior to start of pile driving and the sheets will be driven progressively deeper (at increments) along the full circle or arc.

Prior to filling of the cells with cell fill material, the interlocks will be inspected by diver and sheeting with open or torn interlocks will be removed and replaced.

(7) Settlements. For the most part, Zone III and IV foundation soils are of low compressibility and no significant settlements are anticipated from these soils. Some minor long term settlements are anticipated after construction of the deck slab and L-wall as a result of densification of cell fill materials. The loss of bearing strength from settlement of the cell fill could result in damage to the concrete deck slab; therefore the slab has been designed assuming no support from the cell fill.

(8) *Construction Considerations*. Construction of the cellular portion of the unloading docks will take place during the summer months when oil unloading requirements are at a minimum. During June through September, oil deliveries are made approximately once a month. The four month period will provide ample time to remove the existing docks; dredge to desired depth, install steel cells and to fill the cells. Once the cells are filled, oil barges will be permitted to tie-up and unload while the remainder of the structure is completed. During the four month cell construction period, the oil barges will tie-up in the vicinity of the cells and unload with the use of a temporary line.

f. Effects of Pile Driving on Existing Oil Tank Farm. Pile driving for the construction of the cellular sheet pile structure and for the pumping station will be as close to the existing oil tanks as 25 feet. The tanks and containment walls are founded on earth according to the owners. While vibrations from the pile driving at distances of 25 feet or more usually are not considered to be critical to adjacent structures, the nature of the tank farm structures requres more than usual caution. The specifications accordingly will require that the pile driving vibrations be monitored and a limit will be placed on the allowable particle velocity measured at the nearest tank.

## E. ARCHITECTURAL DESIGN

18. PUMPING STATION. Subsequent to the completion of the General Design Memorandum, a study of the pumping station facades has been undertaken in cooperation with the Agency Engineer of the Redevelopment Agency of the city of New London. The scheme deemed most aesthetically appropriate for development is shown on Plate 6-14.

The gambrel roof of insulated porcelain enamel panels on steel framing reflects the character of several historic structures in the city, including several in the waterfront area. This roof system, with projected lower eaves, defines the scale of the structure and provides a harmonious relationship with planned development in the adjoining area. Hatches on the roof are provided for removal of the pumps by use of a mobile crane. They are generally similar to an appendage on the roof of the nearby historic Custom House. For valve maintenance or replacement purposes at the north side of the pumping station, the roof panel supports will be omitted at those locations and the panels made removable. Porcelain enamel finish at the roof was selected to minimize the effects of the salt water atmosphere.

Brick walls with concrete masonry unit back-up are located below the eaves at the North and South facades. The East and West walls are smooth formed concrete reflecting the masonry color of some of the stone structures nearby which will be rehabilitated by the city of New London. These walls also add structural stability to the station and portray the fire walls typical of old waterfront structures. Louvers and exhaust fan housing will be clear anodized aluminum. Door and frame and traffic guards will be painted steel. The building identification lettering will be satin finish stainless steel.

A fuel storage tank will be installed adjacent to the pumping station with a concrete enclosure having pierced concrete masonry units in fill panels and chainlink fence gate area above the containment level. The wall parallel to the East wall will have the "buttress" configuration of the lower portion of that wall.

19. FLOODWALLS. The I-type floodwall between stations 29+80 and 34+59 will have sloped faces and will have feature strips to outline rectangular panels within the approximate twenty foot spacings of the monolith joints.

## F. STRUCTURAL DESIGN

20. GENERAL. This section presents the design criteria, basic data, and the assumptions used in the structural design of the floodwalls, cellular wall and pumping station. Stability analysis, typical computations, maximum loading conditions and designs of critical features are included in Appendix A.

21. DESIGN CRITERIA.

a. General. Working stresses conform to those specified in Engineering Manual EM 1110-1-2101 "Working Stresses for Structural Design," dated 1 November 1963. General loading conditions design assumptions and other design criteria are based on the following applicable parts of the Engineering Manual for Civil Works: Standard Practice for Concrete (EM 1110-2-2000, Nov. 1971), Retaining Walls (EM 1110-2-2502, May 1961), Wall Design (EM 1110-2-2501, Change 3, 18 June 1962), Design of Pile Structures and Foundations (EM 1110-2-2906, Appendix A to Draft, 16 Nov 1970), Details of Reinforcement - Hydraulic Structures (EM 1110-2-2103, 21 May 1971), Conduits, Culverts and Pipes (EM 1110-2-2902, 3 March 1969), Structural Design of Pumping Stations (EM 1110-2-3104, 9 June 1958), Shore Protection Manual (Coastal Engineering Research Center, 1973).

b. Concrete. Concrete working stresses are in general accordance with ACl Standard Building Code Requirements for Reinforced Concrete (ACl-318-63), as modified by EM 1110-2-2103, using concrete with a minimum ultimate compressive strength of 3,000 lbs. per square inch.

| Flexture (Exreme fiber stresses in compression) | - P.S.I. |
|---|---|
| Floodwalls, Gate Structure and Pumping Station Substructure | - 1050 |
| Operating Floor of Pumping Station | - 1350 |

c. Reinforcement.

(1) General. Details and placement of steel reinforcement will be in accordance with EM 1110-2-2103.

(2) Grade and Working Stress. All reinforcement is designed for a working stress of 20,000 p.s.i. in flextural tension. The reinforcement will be deformed bars made of new billet steel, intermediate grade (ASTM A-615, Grade 40), conforming to the requirements of Federal Specification QQ-S-632C, Type II, Class B40.

(3) Spacing. The clear distance between parallel bars will not be less than 1-1/2 times the nominal diameter of the bars, nor less than 1-1/2 times the maximum size of the coarse aggregate.

(4) Minimum Cover for Reinforcement.

| Item | Min. Cover (inches) |
|---|---|
| Interior slabs | 1-1/2" |
| Interior beams | 1-1/2" |
| Concrete exposed to water | 4" |
| Bottom of base slabs | 6" |
| Exterior Walls above grade | 2" |
| Exterior Walls below grade | 3" |

(5) Splices. All lap splices are in accordance with the ACI Building Code. Tension splices will be staggered longitudinally so that no more than half the bars are spliced at any section within the required lap length.

(6) Temperature and Shrinkage Reinforcement. Temperature and shrinkage reinforcement is provided where main reinforcement extends in only one direction. Such reinforcement will be proportioned for the condition of edge restraint of each member as defined by EM 1110-2-2103. The minimum reinforcement for unrestrained members provides a ratio of steel to concrete area of .001 at each face with a minimum of No. 4 bars at 12-inch centers in thin sections and a maximum of No. 6 bars at 12-inch centers in thick sections. In slabs exposed to weather, a minimum ratio of steel area to concrete area of .0025 is provided. Bars will not be spaced farther apart than three times the slab thickness nor more than 18 inches.

(7) Minimum Reinforcement. Principal reinforcement will not be less than that required for shrinkage and temperature. A minimum ratio of positive reinforcement of .005 will be provided in beams and girders.

d. 96-Inch Diameter Pressure Conduit. The pressure conduit will be either reinforced precast concrete pipe conforming to ASTM C76-75 or 14 gage asbestos-treated bituminous coated, fully paved, corrugated steel pipe: Fed. Spec. WW-P-405, Class I, Shape I, with Coating J.

e. Structural Steel. Structural steel is designed in accordance with the American Institute of Steel Construction, "Specifications for the Design, Fabrication and Erection of Structural Steel Buildings (Seventh Edition)" as modified by EM 1110-1-2101. Steel conforming to the requirements of ASTM A36 will be specified. Basic working stress (tension) is 22,000 p.s.i.

f. Masonry. Brick masonry used for the exterior walls of the pumping station will conform to ASTM Specification C216, Type FBS, Grade SW. Hollow concrete masonry units will conform to ASTM Specification C90, Type 1, Grade N-1. The concrete masonry units will be reinforced and adequately attached to the structure to resist lateral loads.

g. Steel Sheet Piling. Steel sheet piling will conform to ASTM Specification A328. Sheet piling used in the cellular wall will be PS-28 sections coated with coal tar epoxy in addition to cathodic protection. The design of the piling used in the I-type walls will be based on an allowable working stress of 20,000 p.s.i. A minimum interlock strength of 16,000 pounds per inch will be specified for the piling used in the cellular wall.

h. Bearing Piles. Steel bearing piles supporting the pumping station will be driven into till overlying bedrock. They will conform to ASTM designation A36 and have a minimum end bearing stress of 8,000 p.s.i. Pile sections have been selected for a design capacity of 50 tons. A test pile will be driven and loaded to twice the design capacity to verify design assumptions. Corrosion protection of the bearing piles is not considered to be necessary.

i. Increase in Working Stresses. Allowable stresses are increased 33-1/3% for those loadings which include wind or earthquake forces.

j. Waterstops. Rubber or polyvinylchloride waterstops will be used in all concrete contraction and expansion joints. A-36 steel waterstops will be used in horizontal construction joints between base slab and walls of the pumping station.

22. BASIC DATA AND ASSUMPTIONS.

a. Loads.

(1) Dead Loads

| | |
|---|---|
| Concrete | 150 p.c.f. |
| Steel | 490 p.c.f. |
| Soil, saturated | 125 p.c.f. |
| Soil, submerged | 62 p.c.f. |
| Masonry (brick) | 120 p.c.f. |

(2) Live Loads

| | |
|---|---|
| Water (interior drainage) | 62.5 p.c.f. |
| Water (sea) | 64.2 p.c.f. |
| Wind (Pump Station) | 20 p.s.f. |
| Wind ("L" & "I" walls) | 50 p.s.f. |
| Pump Station Roof (snow) | 40 p.s.f. |
| Pump Station Operating Floor Slab | 350 p.s.f. (Max. Equip. Ld.) |
| Pump Station Opeating Floor Beams | 100 p.s.f. plus equipment loads in design location |
| Pump Thrust (ea.) | 4000 lbs. |
| Pumps (ea.) | 6500 lbs. |
| Umbrella (ea.) | 900 lbs. |
| Engines (ea.) | 3100 lbs. |
| Gear Units (ea.) | 1400 lbs. |
| Base Slab at Top of Cells | 500 p.s.f. |

b. External Water Pressure.

(1) Pump Station. Hydrostatic pressure is assumed as the head to Elev. 6.5 with the station empty, uniformly distribute over the base slab area. The natural water table in the area of the pump station

varies with the tide stage and the maximum ground water elevation chosen for design lies midway between maximum spring high tide and the still water elevation of the design hurricane. No ponding of interior drainage is contemplated in the design of the project.

(2) Walls. Hydrostatic pressure on the base of walls is taken at the full head of design hurricane on the cove side varying to zero at ground surface landside by the creep method.

c. Internal Water Pressure. The 96" pressure conduit and 78" gravity conduit are designed for an internal pressure of 10 p.s.i. (23 feet). The maximum head to which the conduits will be subjected during the design conditions is 16 feet.

d. Wave Loading.

(1) "I"-Wall in Vicinity of Sta. 31+00. The "I" wall in this reach of the protection is subject to waves from New London Harbor. A maximum wave height of 5.2 feet is consistent with a design still water elevation of 10.6 NGVD (Table 1-4, Design Memorandum No. 1, October 1965). The location of the wall is such that the design wave would break before hitting the wall. The force of a 5.2' high broken wave was assumed in the design of the "I" wall in this reach of the protection.

(2) "L" Wall and Cells in Vicinity of Sta. 21+00. This wall is located at the north end of Shaw Cove which is protected from waves from New London Harbor by the railroad causeway which forms the easterly boundary of the cove. The waves affecting the wall therefore are those generated within the limited reach of the cove with a maximum height of 2.4 feet. The location of the wall is such that this height of wave would not break on its approach to the wall and the wall has been designed for the force of clapotis wave of 2.4 feet maximum height.

e. Earth Pressures. Earth pressures were determined in general accordance with EM 1110-2-2502, Retaining Walls, dated 29 May 1961. An at rest coefficient of 0.5 was assumed for design of the substructure walls of the pump station and gate structure.

f. Earthquake Forces. Earthquake forces of 0.25 times the gravity loads (minor damage - zone 1) will be considered in the design of the superstructure of the pump station and the gate structure (Ref. ER 1110-2-1806, 30 April 1977).

g. Frost Protection. The base of all structures founded on soil will be located a minimum of 3'-6" below final ground elevation.

h. Uplift Factor of Safety. The completed pumping station without equipment and no water in the sump has a factor of safety against uplift of 1.24 assuming groundwater at elevation 6.5, determined as outlined in paragraph 22.b.(1).

i. Location of Resultants. The resultant of horizontal and vertical forces on the "L" wall has been held within the mid-half of the base for the design hurricane loading case and within the mid-third under all other conditions of loading. The resultant of forces at the pump station and gate structure falls within the mid-third of their bases for all conditions of loading.

j. Sliding. Sliding at the "L" wall in the vicinity of station 21+00 is resisted by the attachment of the base slab to the sheet piling of the cell. Sliding stability is not a factor in the design of the pumping station which is founded on piles and is located well behind the line of protection.

23. PREPARATION OF DESIGN COMPUTATIONS. Stability computations have been made for each of the project structures and are included in Appendix A. Representative calculations of typical design calculations are also included in the Appendix.

24. DESIGN OF STRUCTURES.

a. General. The structures required as part of the project include a cellular retaining wall approximately 300 feet in length surmounted by a concrete "L" wall, an "I" wall consisting of steel sheet piling with a concrete section above grade approximately 500 feet in length, two short sections of "I" wall providing the "L" wall to dike transitions, a pumping station approximately 31 feet by 48 feet in plan at and above the operating floor and approximately 40 feet by 48 feet below the operating floor, a 78 inch by 78 inch gravity conduit approximately 100 feet in length extending from the pump station to an outfall on the Shaw Cove side of the dike with a gate structure located within the dike and a 96 inch diameter pressure conduit with attendant structures. The reach of the I-wall between stations 29+80 and 33+0 will be supported by battered H-piles at 10 feet spacing in addition to the continuous sheet piling. The H-piling will reduce movement of the wall under dynamic wave loading and preclude the necessity of removing all of the organic silt strata beneath the wall. A construction cofferdam will be required for construction of the gravity conduit and gate structure. Installation of the pressure conduit and pumping station substructure will require retaining systems for the excavation.

b. "L" Type Floodwall.

(1) General. A typical design section has been developed for the "L" wall. The sheet pile cells supporting the "L" wall will be founded on firm sand after removal of unsuitable material. The sheets will be driven a minimum of 11 feet into the sands and silts or 5 feet into the till, whichever is higher. A dredge elevation 3 feet below actual excavation was assumed for design of the cells.

(2) Loading Conditions.

Wall in Vicinity of Station 21+00 (cell supported).

Loading Case 1 - Design hurricane case, still water elevation 10.5, force of clapotis wave with maximum height of 2.4 feet, water at landside face at mean low water.

Loading Case 2 - Retaining wall case, surcharge loading landside of 250 lbs. per square foot, wind force from landside of 50 lbs. per square foot, water landside at finished ground surface, sea level water side at extreme low water elevation - 4.4.

Loading Case 3 - Construction case, cells in place and filled before "L wall is constructed, finish grade landside at Elev. 4.0, water landside at ground surface, surcharge loading landside of 250 lbs. per square foot, grade at waterside at Elev. -18.0 and tide at -1.0 NGVD (M.L.W.).

(3) Typical Design Sections. Computations are included in Appendix A for the typical design section of the "L" wall. Graphical presentations of the loading conditions and design sections are shown on Plate 6-12. Special monoliths at angle points and sections founded on till will be checked during preparation of contract documents.

c. I-Type Floodwalls.

(1) General. Two types of "I" walls will be used in the project. The first will be used for the two short "L" walls to dike transitions and for the reach between Station 33+0 and 34+59. This type will consist of PZ-32 steel sheet piling driven through dike fills or existing ground to a depth required for stability or seepage considerations. The portion of the walls estending above grade and the top 5'-6" portion below grade will be constructed of reinforced concrete with the sheet piling embedded four feet into the concrete section. The sheeting of the circular cells will be connected to the sheeting of the abutting I-wall transitions. The type used for the section of floodwall between stations 29+70 and 33+0 will be similar except that battered steel H-piles will be driven on the landside of the vertical sheet piling and be connected to the bottom of the reinforced concrete portion of the wall.

(2) Loading Conditions.

Sta. 33+0 to 34+59 -

Water to top of tide side and at ground surface landside. Ground surface is assumed at the same level both sides of the wall.

Sta. 29+70 to 33+0 -

Case 1 - Design hurricane case, water on harbor side at wave crest elevation of 14.24, force of 5.2 feet high broken wave applied at harbor side, water landside at ground surface with full uplift on base.

Case 2 - 250 lbs. per square foot surfcharge landside, 50 lbs. per square foot wind force from landside, water level same on both sides of the wall below elevation 3.5 NGVD.

(3) Typical design Sections. The design computations for the I-type floodwalls are included in Appendix A. Graphical presentation of the loading conditions and design sections are shown on Plate 6-12.

d. Pumping Station.

(1) General. The pumping station is located landside of the protection line. The operating floor and portions below grade will be constructed of reinforced concrete. Two superstructure walls will be constructed of 4-inch face brick backed by 8-inch thick reinforced concrete masonry units. The end walls of the superstructure will be reinforced concrete full height and will support the roof together with three interior welded steel rigid frames. Insulated porcelain coated steel panel roofing will be supported on steel purlins spanning between steel frames. The structure will be founded on steel bearing piles driven into till overlying bedrock. A 72 inch diameter concrete pipe will conduct interior drainge to the station and will discharge into Shaw Cove through a 78" x 78" gated concrete box conduit during conditions of normal tide. During storm tides above elevation 5.0 NGVD, the gate on the gravity conduit will be closed and the drainage will be discharged over the dike into the cove by three 36-inch pipes.

(2) Stability. Because the structure is located behind the protection line, not subject to tidal flooding, the stability analysis consists of a buoyancy check considering the station empty and maximum groundwater at elevation 6.5. A factor of safety against uplift of 1.24 exists under such conditions. A maximum pile load of 47 tons results from the assumption of maximum loading within the station and minimum groundwater conditions of elevation -4.4 NGVD outside.

(3) Roof Slab and Purlins. The steel roof panels, purlins and their connections are designed for a downward load (snow load) of 40 P.S.F. or upward load (wind suction) of 25 P.S.F. The former loading is specified in the State of Connecticut Building Load for insulated roofs and the latter loading is in accordance with the requirements of EM 1110-2-3104. The same loadings will be specified for the roof hatches and their connections. The roof openings will be approximately 8 feet square, centered over each pump and will allow removal of the pumps by mobile crane located outside the building. The end bays of purlins will be supported at one end by the east and west concrete building walls. The connection holes in the purlins at one wall will be slotted to allow for temperature movements of the roof framing extending between the rigid end walls.

(4) Superstructure Framework. Three steel frames, gabled to follow the slope of the roof will support the roof between the concrete end walls. The frames support the roof purlins which are framed into them and also resist the transverse lateral loads applied to the walls and roof. The base of the frames are assumed to be pinned in the analysis with segments parallel to the roof braced at purlin lines and the vertical segments braced at the bottom and at the eave line. The frames will be fabricated from W12 rolled members. Wind bracing will not be required between frames as longitudinal wind and seismic forces will be resisted by the concrete end walls.

(5) Operating Floor. The operating floor is reinforced concrete slab and beam construction. Beams are located to support equipment and to frame required floor and wall openings. The slab is designed for the heaviest equipment load placed at any location on the floor. Beams are designed for equipment loads in their operating locations in addition to a live load of 100 lbs. per square foot over the entire floor. Slab and beams will be integral with their substructure wall supports.

## G. MECHANICAL DESIGN

25. GENERAL. Plate 6-17 shows the general arrangement of pumps and other mechanical equipment, and Appendix B shows pump computations and curves. Electric service is not considered adequately reliable at the station for electric motor drive.

26. PUMPING EQUIPMENT. The pumps will be driven by diesel engines through right angle gear units. The pumps will be vertical, fixed blade, propeller or mixed-flow type of standard construction using steel columns and discharge elbows: cast iron, cast steel or steel plate bowls and suction bells; cast steel or bronze impellers; stainless steel pump shafts; and bronze bearing. Each pump shall be provided with its own individual electric motor-driven centralized pressure lubrication system. All pumps will be capable of operation against all tidal stages up to the top of the dike.

Trash racks are not required as all inlets to the drains leading to the sump are adequately screened.

Three pumps will be provided with each pump having a capacity of 70 cfs (31,500 gpm), one-third of the required station capacity against the standard project flood with suction sump at high water elevation. Each pump will discharge over the top of the dike. Three sluice gates, one located in front of each pump, will seal off the pump sump except when opened for activation of the station. Gates will be sized for an entrance velocity of approximately 2.5 f.p.s. with all pumps operating. A sluice gate will be provided on the ocean side of the dike to close off the gravity flow conduit. Because of the limited storage of the drainage system and to prevent too frequent cycling of diesels, valved bypass have been provided on two of the pumps.

27. SLUICE GATES. All sluice gates at the pumping station will be seating pressure type of standard cast iron construction with corrosion resistant alloy iron thimbles and monel seals and shafts. Electric motor-operated floorstands will be installed for operation of each gate. Floorstand will also be provided with a hand wheel for manual operation.

28. SUMP PUMP. An electric motor-operated wet pit type sump pump will be provided in the pumping station for dewatering and for handling any leakage into the sump.

29. HEATING. The station will be equipped with an oil-fired warm air furnace thermostatically controlled to maintain inside temperature at 55°F. In addition, a humidistat will override the thermostat to operate the heater as necessary to maintain the relative humidity at not higher than 50%.

30. VENTILATION. A small fan with duct work will be provided for ventilation of the sump. The pump and emergency generator diesel engines will be radiator cooled with each radiator connected to exterior wall louver by duct work to prevent short circuiting of the cooling air. Inlet louvers will be provided for air supply to the radiators.

31. WATER LEVEL INDICATORS. Indicators for both the station pump and the ocean water levels will be provided in the station. The sump water level indicator will also incorporate controls to provide for automatic shutdown of pump diesel engines at a predetermined sump low water level. An alarm will also be sounded at shutdown.

## H. ELECTRICAL DESIGN

32. ELECTRIC AND TELEPHONE SERVICES.

a. Electric service will be obtained from the Hartford Electric Light Company at 208Y/120 Volts, 3 Phase, 60 Hertz. The utility company will install transformers on a pole near pumping station where conduit will be extended underground to the pumping station for secondary service.

b. Telephone service will be obtained from the Southern New England Telephone Company. A conduit and pull wire will be provided for underground service from Bank Street.

33. INTERIOR ELECTRICAL FEATURES.

a. Wiring system. All conductors will have heat and moisture resistant insulation and will be installed in rigid steel conduit.

b. Emergency Lighting. A battery operated emergency lighting unit will be provided.

34. ELECTRICAL LOAD DATA.

| Item | Connected Load-Watts |
|---|---|
| Sluice Gates 4 at 3 HP | 12,000 |
| Pressure Conduit Gate 1 at 3 HP | 3,000 |
| Bypass Valve 2 @ 3/4 | 1,500 |
| Sump Pump | 750 |
| Lighting | 8,800 |
| Receptacles | 1,800 |
| Furnace and Fan 1/6 HP & 1/2 HP | 667 |
| Exhaust Fan 1 @ 1/4 | 250 |
| Incinolet | 2,400 |
| Grease Unit | 333 |
| Total Connected Load | 31,550 Watts |
| Demand Load | 18,500 Watts |

35. ENGINE GENERATOR.

a. 20 KW, 3 Phase, 4 wire 208Y/120 Volt, 60 Hertz Diesel Enginer Generator Set is proposed to handle loads.

## I. CORROSION MITIGATION

36. SHEET PILING. The sheeting used to construct the circular steel cells which support the "L" wall from Station 19+40 to 22+30 at Shaw Cove will be shop coated with coal tar epoxy and cathodically protected using sacrificial zinc anodes.

Interior area of one cell = 11 x diameter x depth = 3.14 x 27 x 36 = 2,204 sq. ft.

Assume 5% holidays.

2204 x .05 = 111.2 sq. ft. to be protected.

.005 amperes/sq. ft. required for protection.

110.2 x .05 = .55 amperes required per cell interior.

$$\frac{.55 \text{ amperes} \times 24 \text{ hours} \times 365 \text{ days}}{335 \text{ amp hr/lb}} = 14.36 \text{ lbs/yr}$$

Approximate lbs. required for 10 years protection.

14.36/yr x 10 years x 1.5 rem. = 215.4 lbs.

For interior, use 4-60 lb. anodes per cell at 1/4 the area, on exterior use 1-60 lb. anode per recess.

Electrical resistivity measurements are as follows:

1 ft. deep, 43.9 ohm-centimeters
4 ft. deep, 36.9 ohm-centimeters
9 ft. deep, 34.5 ohm-centimeters (bottom)

Water PH was measured at 7.7, readings were taken at 11:15 AM on 14 NOV 1977 off existing dock at Shaw Cove.

Coating of the steel sheeting used in construction of the I-type floodwalls is not considered to be necessary.

37. STEEL H-PILES. Steel H-piles used in the project are for the most part driven through undisturbed soil and are not subject to direct tidal action. No protective measures will be specified for this piling.

## J. COST ESTIMATES

38. GENERAL. Estimates of costs include all features for completion of the project and are based on computed quantities and unit prices current as of March 1978. An estimate for each of the project features, contingencies, engineering and design, and supervision and administration is presented in Table 1.

39. COMPARISON OF ESTIMATES. Table 2 compares the current estimated cost of each of the project features with the latest approved project estimate which was contained in Design Memorandum No. 2 (Revised). The current estimate shows a total cost reduction of $450,000 compared to the latest approved estimate. Certain project features have increased in cost while others have decreased. The escalation of costs in the time interval between the two estimates is offset by a reduction in the contingency factor based on the more refined design. All of the cost differentials, therefore, can be explained by either changes in the features or refinement of design and quantities. The cost of relocations has increased due to the cost of sewer relocations in the vicinity of Garabaldi Square in addition to the telephone and electric relocations originally considered. A substantial decrease in the cost for dikes is the result of landfill operations undertaken by the City of New London in the redevelopment area west of Shaw Cove. The landfill, which will extend up to the protection elevation reduces required fill quantities and negates the need for a full dike section along the west shore of the Cove, requiring only stone protection of the embankment. Two substantial changes in the floodwalls have resulted in a net increase in cost to this feature of $70,000. The floodwalls mounted on steel sheet pile cells increased in cost due to an increase in the diameter of the cells with the attendant increase in concere slab width, cell fill and excavation volumes. In addition the unit cost of the sheeting has been increased substantially, reflecting the construction procedures which will be required to minimize excavation in the vicinity of the existing storage tanks at the City Coal Co. Offsetting the increased cost of the cell supported wall is the reduced cost of the floodwalls, which extends between stations 29+70 and 33+00. The savings in this wall resulted from changing to a braced I-type wall from the previously proposed L-type wall. The comparison of estimates indicates a decrease in cost of the pumping station of approximately $100,000. This change is due to more complete information and design data which provided definitive quantities for estimating purposes. An increase in cost of the pressure conduit of $80,000 resulted from having complete contract drawing data available for Phase I of the conduit project from which to derive accurate quantities.

TABLE 1

DETAILED COST ESTIMATE
(March 1978 Price Levels)

| Description | Estimated Quantity | Unit | Unit Cost | Estimated Amount |
|---|---|---|---|---|
| Lands & Damages | | | | $ 970,000 |
| Relocations | | | | |
| Utilities | 1 | Job | L.S. | 65,000 |
| Levees & Floodwalls | | | | |
| Dikes | | | | |
| Site Preparation | 1 | Job | L.S. | 10,000 |
| Removal of Structures | 1 | Job | L.S. | 140,000 |
| General Excavation | 38,500 | C.Y. | $ 4.80 | 184,800 |
| Dredging | 12,000 | C.Y. | 10.00 | 120,000 |
| Class A Stone Protection | 450 | C.Y. | 25.00 | 11,250 |
| Dumped Rock Fill | 9,000 | C.Y. | 18.00 | 162,000 |
| Class B Stone Protection | 7,500 | C.Y. | 20.00 | 150,000 |
| Gravel Bedding | 5,500 | C.Y. | 7.50 | 41,250 |
| Gravel Filter | 1,600 | C.Y. | 6.00 | 9,600 |
| Compacted Gravel | 2,200 | C.Y. | 7.00 | 15,400 |
| Road Gravel Base | 1,000 | C.Y. | 7.00 | 7,000 |
| Compacted Impervious Fill | 17,000 | C.Y. | 6.00 | 102,000 |
| Uncompacted Impervious Fill | 12,500 | C.Y. | 3.00 | 37,500 |
| Dumped Impervious Fill | 7,300 | C.Y. | 3.00 | 21,900 |
| Compacted Sand Fill | 900 | C.Y. | 7.50 | 6,750 |
| Dumped Sand Fill | 7,000 | C.Y. | 5.00 | 35,000 |
| Dumped Random Fill | 40,000 | C.Y. | 1.60 | 64,000 |
| Filter Cloth | 5,700 | S.Y. | 4.00 | 22,800 |
| Bituminous Concrete Base | 2,600 | S.Y. | 7.00 | 18,200 |
| Bituminous Concrete Pavement | 2,600 | S.Y. | 6.00 | 15,600 |
| Bituminous Sidewalk & Crub | 200 | S.Y. | 10.00 | 2,000 |
| Galvanized Steel Guard Rail | 450 | L.F. | 11.00 | 4,950 |
| Fertilizer, Seed and Mulch | 15 | A | 1,800.00 | 27,000 |
| Collector Drain | 1 | Job | L.S. | 35,000 |
| Emergency Pipe Closures | 1 | Job | L.S. | 15,000 |
| Sub-Total Dikes | | | | $1,259,000 |
| | Contingency | | | 181,000 |
| | | TOTAL DIKES | | $1,440,000 |

add 350,000 for land off area

TABLE 1 (CONT'D)

| Description | Estimated Quantity | Unit | Unit Cost | Estimated Amount |
|---|---|---|---|---|
| **Walls** | | | | |
| Excavation Structural | 6,300 | C.Y. | $ 3.50 | $ 22,050 |
| Compacted Gravel Fill | 450 | C.Y. | 6.00 | 2,750 |
| Compacted Impervious Fill | 2,600 | C.Y. | 3.50 | 9,100 |
| Compacted Earth Fill | 550 | C.Y. | 3.50 | 1,925 |
| Cell Fill | 6,200 | C.Y. | 10.50 | 65,100 |
| Dumped Sand Fill | 1,100 | C.Y. | 4.50 | 4,950 |
| Reinforced Concrete Walls | 1,450 | C.Y. | 200.00 | 290,000 |
| Steel Sheet Piling (Cells) | 27,600 | S.F. | 18.50 | 510,600 |
| Steel Sheet Piling (Walls) | 10,700 | S.F. | 14.00 | 149,800 |
| Steel H-Piles (HP 10x42) | 700 | L.F. | 21.00 | 14,700 |
| Cathodic Protection | 1 | Job | L.S. | 67,000 |
| Sub-Total - Walls | | | | $1,137,975 |
| | Contingency | | | 172,025 |
| 350 | Total Walls - | | | $1,310,000 |
| | Total Dikes & Walls - | | | $2,750,000 |
| **Pressure Conduit** | | | | |
| Phase I | 1,850 | L.F. | 487.00 | 900,950 |
| Phase II | 900 | L.F. | 641.00 | 576,900 |
| Sub-Total - Pressure Conduit | | | | $1,477,850 |
| | Contingency | | | 222,150 |
| | Total Pressure Conduit | | | $1,700,000 |
| **Pumping Station** | | | | |
| Pumping Station | 1 | Job | L.S. | 726,000 |
| Gravity Conduit & Gate | 1 | Job | L.S. | 103,000 |
| Sub-Total - Pumping Station | | | | 829,000 |
| | Contingency | | | 121,000 |
| | Total Pumping Station | | | $ 950,000 |
| | Total Construction | | | $6,435,000 |
| | Engineering & Design | | | 615,000 |
| | Supervision & Administration | | | 500,000 |
| | TOTAL PROJECT COST | | | $7,550,000 |

TABLE 2

COMPARISION OF ESTIMATES

| Project Feature | Latest Estimate DM-2 (Revised) May 1977 Price Levels | Current Estimate DM-6 March 1978 Price Levels |
|---|---|---|
| 01. Lands and Damages | $ 970,000 | $ 970,000 |
| 02. Relocations | 45,000 | 65,000 |
| 11. Levee & Floodwalls | 3,200,000 | 2,750,000 |
| 13. Pumping Station | 1,055,000 | 950,000 |
| 19. Pressure Conduit | 1,620,000 | 1,700,000 |
| Engineering & Design | 610,000 | 610,000 |
| Supervision & Administration | 500,000 | 500,000 |
| TOTAL COST | $8,000,000 | $7,550,000 |
| TOTAL FEDERAL COST | $5,600,000 | $5,285,000 |
| NON-FEDERAL COST | $2,400,000 | $2,265,000 |

NOTE: For previous project estimates see Table 8, DM-2 (Revised) July 1977

## K. SCHEDULE FOR DESIGN AND CONSTRUCTION

40. DESIGN. Subsequent to the approval of this memorandum, plans and specifications will be prepared for the barrier, including Phase II of the pressure conduit, and submitted for approval. Plans and specifications for Phase I of the pressure conduit have been issued to prospective bidders. It is anticipated that the Phase I contract will be awarded during late spring of 1978. Plans and specifications for the barrier and Phase II conduit are scheduled for completion during early summer of 1978 with a construction contract to be awarded early in fiscal year 1979.

41. CONSTRUCTION.

a. Pressure Conduit. The contract for construction of Phase I of the conduit requires the contractor to complete the lower reach of the conduit, including work at Shaw Cove, prior to starting the upper reach which connects to the Phase II conduit. This should insure completion of the work in the vicinity of the dikes and pumping station before barrier construction is started. The end of Phase I work will overlap by some 4 months the start of the Phase II construction. Both contracts will require coordination by the contractors engaged on the project both in the construction of the conduits and with other city and utility company contractors working in the area.

b. Barrier. It is estimated that it will require two years to build the protective barrier, including Phase II of the pressure conduit. The first construction season will start with the award of contract in early fiscal year 1979. Actual construction of any consequence is not expected to begin until the spring of 1979.

(1) First Construction Season. The contractor will be required to start construction of the pressure conduit. It is expected that he will also concentrate on the pumping station, gravity conduit, circular steel calls and the I-wall at the access road during the first construction year. At the pumping station the contractor is expected to complete by winter (1979-1980) the excavation, installation of ground water control system, driving of piles, placing of concrete and the superstructure. Simultaneously, in the vicinity of the City Coal Company, the Contractor is expected to initiate work on the steel pile cells. He is expected to remove the unsuitable material in the Spring, take approximately 3 months, (summer) to erect and fill the cells and spend the remaining months of the first construction season forming and placing the concrete "L" wall on top of the cells. Excavation and driving piles for the I-wall in the vicinity of the Access Road (Sta 29+80 to 32+98) requires little disruption of the area and work could be initiated at anytime durying the first season.

(2) Second Construction Season. The major effort during the second season will be spent on completing the walls on top of the cells, completing the pressure conduit, constructing the Access Road, installing equipment in the pumping station and constructing the various segments of dikes thereby completing the protection. The rate of construction is expected to proceed rapidly since the dikes are relatively low and construction can be initiated in several locations simultaneously. As construction of the dikes progresses, the contractor is expected to follow up with the slope protection, final grading, landscaping and cleanup.

CORPS OF ENGINEERS U. S. ARMY

96" PRESSURE CONDUIT

72" STORM DRAIN (BY OTHERS)

96" PRESSURE CONDUIT (PHASE I CONTRACT)

RELOCATED HOWARD ST. (BY OTHERS)

LANDFILL TO EL. 12.0 (BY OTHERS)

ACCESS TO HOWARD ST. (BY OTHERS)

DIKE TOP EL. 12.0

DIKE TOP EL. 14.5

PUMPING STATION

"L" WALL TOP EL. 14.5

CONCRETE DOCK ON SHEET PILE CELLS EL. 5.0

STONE PROTECTION

"I" WALL TOP EL. 14.5

Sta. 54+40

SHAW COVE

NEW LONDON HARBOR

TRUMAN BROOK

GARIBALDI SQUARE

LOCATION MAP
SCALE: 1" = 7.0 MI. approx.

PROJECT SITE

GENERAL PLAN
SCALE: 1" = 100'

NOTE:
ALL ELEVATIONS REFER TO THE NATIONAL GEODETIC VERTICAL DATUM (NGVD), MEAN SEA LEVEL DATUM OF 1929.

GRAPHIC SCALES

SAFETY PAYS

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
GENERAL PLAN

NEW LONDON CONNECTICUT

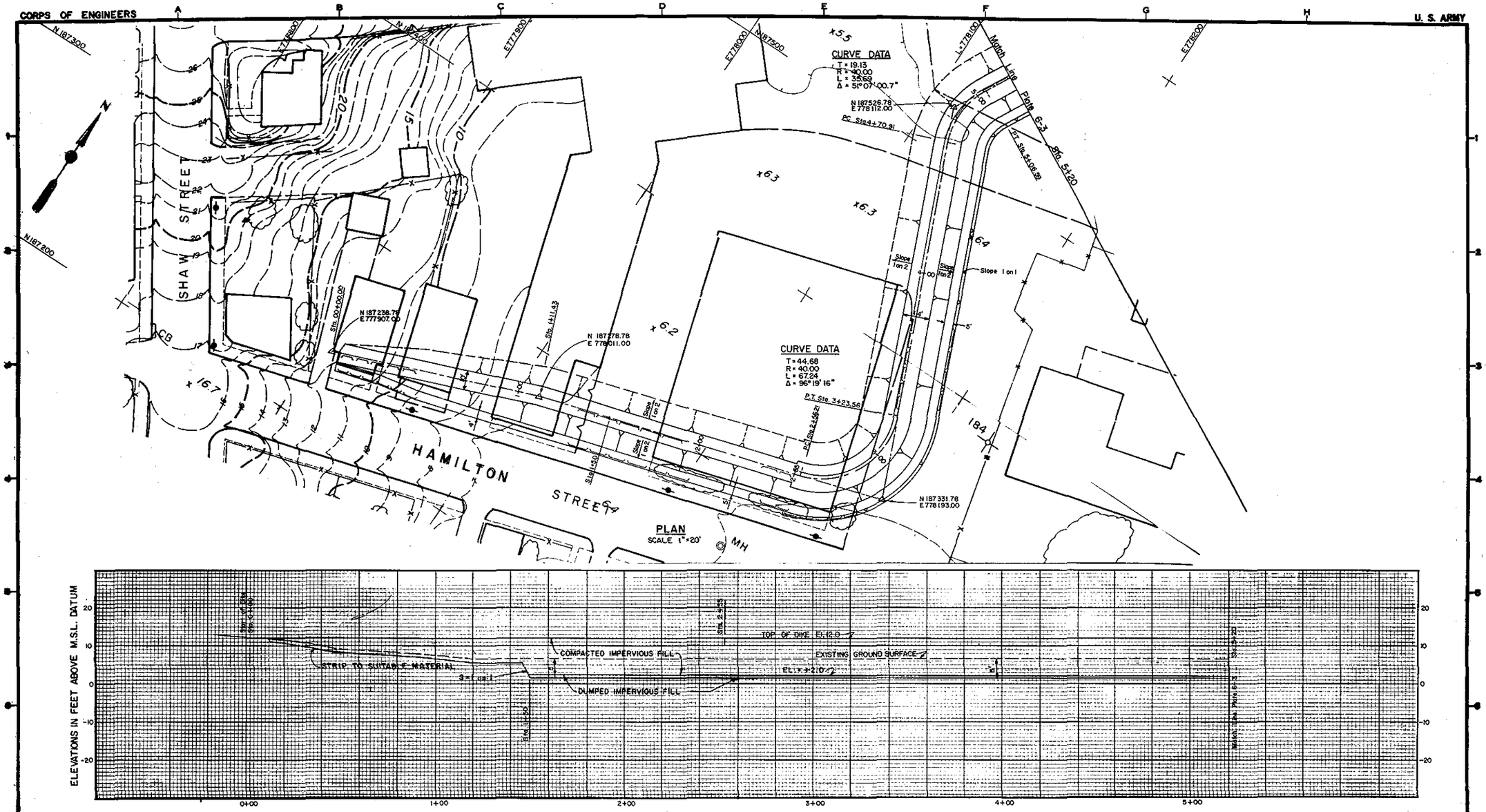
SCALE: AS SHOWN SPEC. NO.

DRAWING NUMBER

SHEET

PLATE 6-1

CORPS OF ENGINEERS U. S. ARMY




| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

# NEW LONDON
# HURRICANE PROTECTION
## SHAW COVE
PLAN AND PROFILE NO. 1

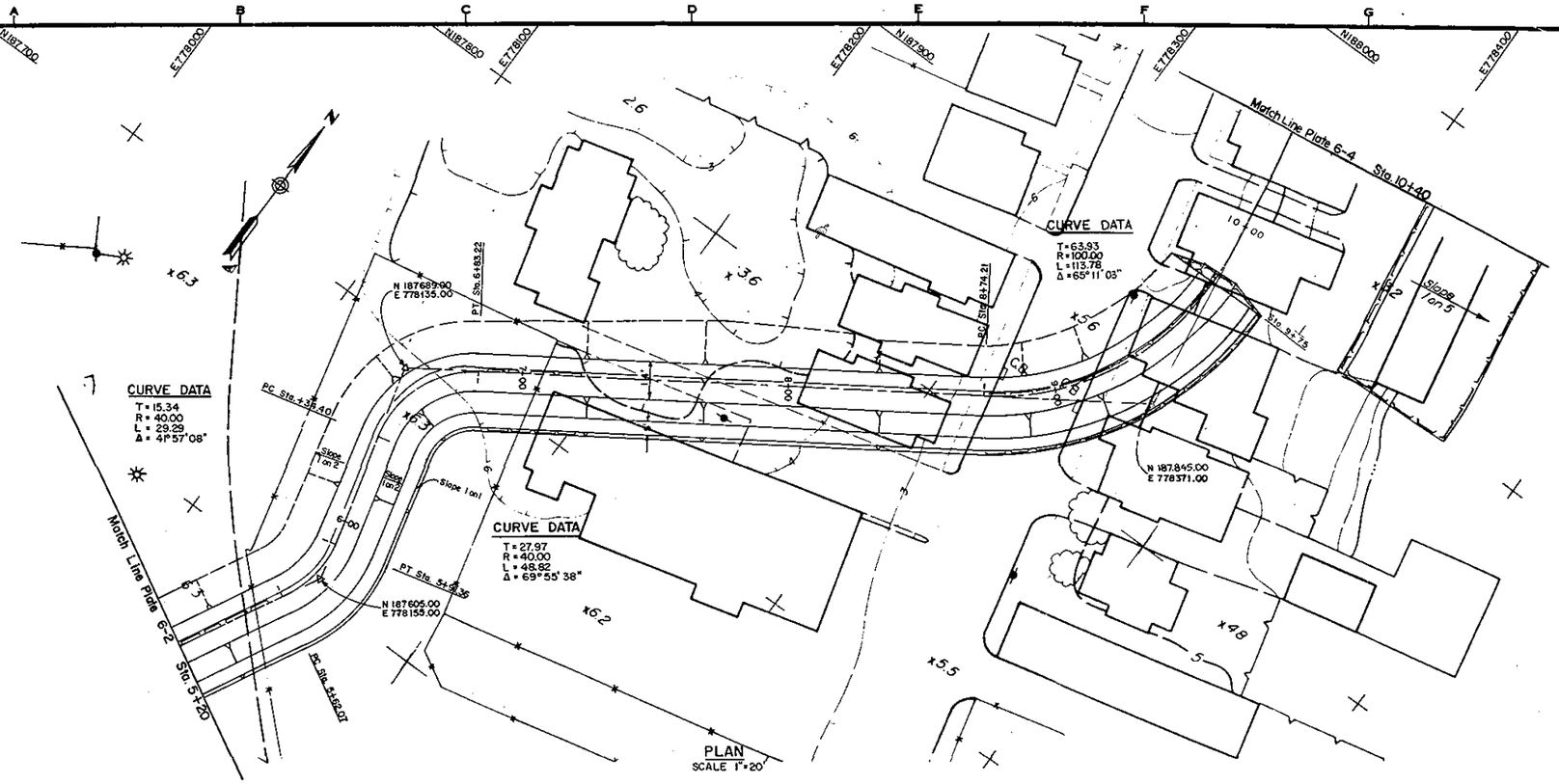
NEW LONDON CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

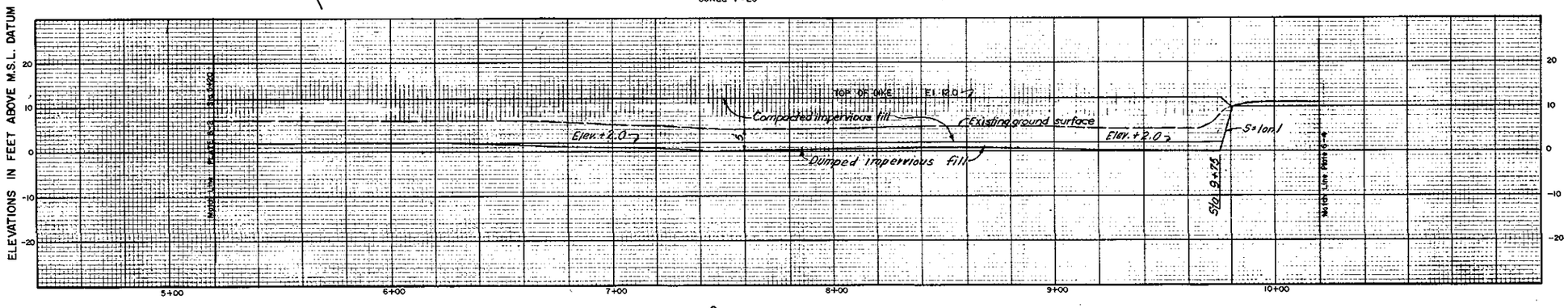
SCALE AS SHOWN SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 6-2

CORPS OF ENGINEERS — U. S. ARMY




PLAN
SCALE 1" = 20'




℄ PROFILE
SCALE HORZ 1" = 20'
VERT 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

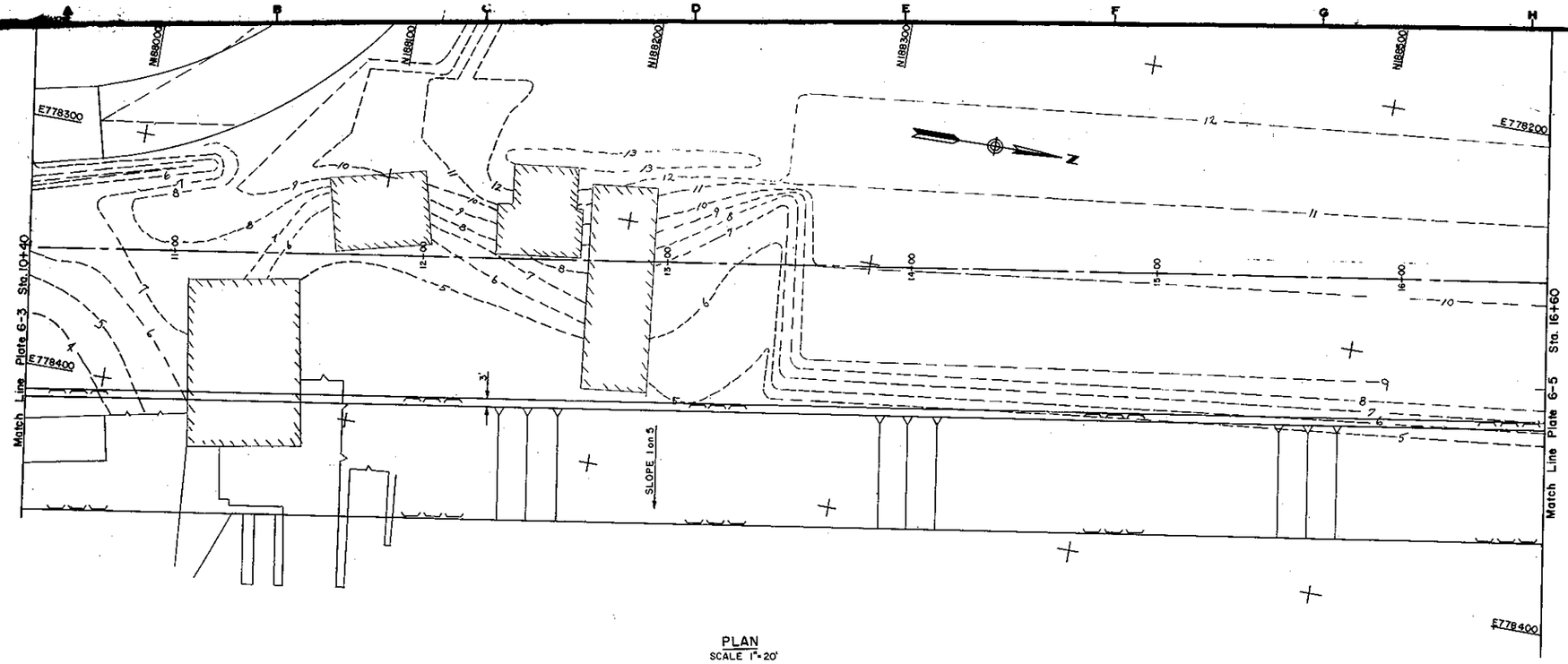
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF, PROJECT BRANCH

# NEW LONDON
# HURRICANE PROTECTION
## SHAW COVE
## PLAN AND PROFILE NO. 2

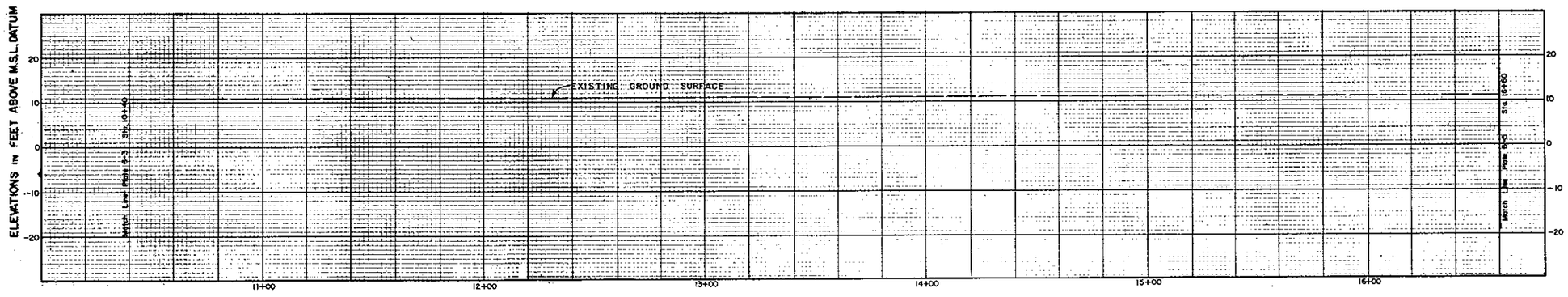
NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE AS SHOWN SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 6-3

U. S. ARMY




PLAN
SCALE 1" = 20'




℄ PROFILE
SCALE HOR 1" = 20'
VERT 1" = 10'

SAFETY PAYS

GRAPHIC SCALES
1" = 20' 20' 0 20' 40
1" = 10' 10' 0 10' 20'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

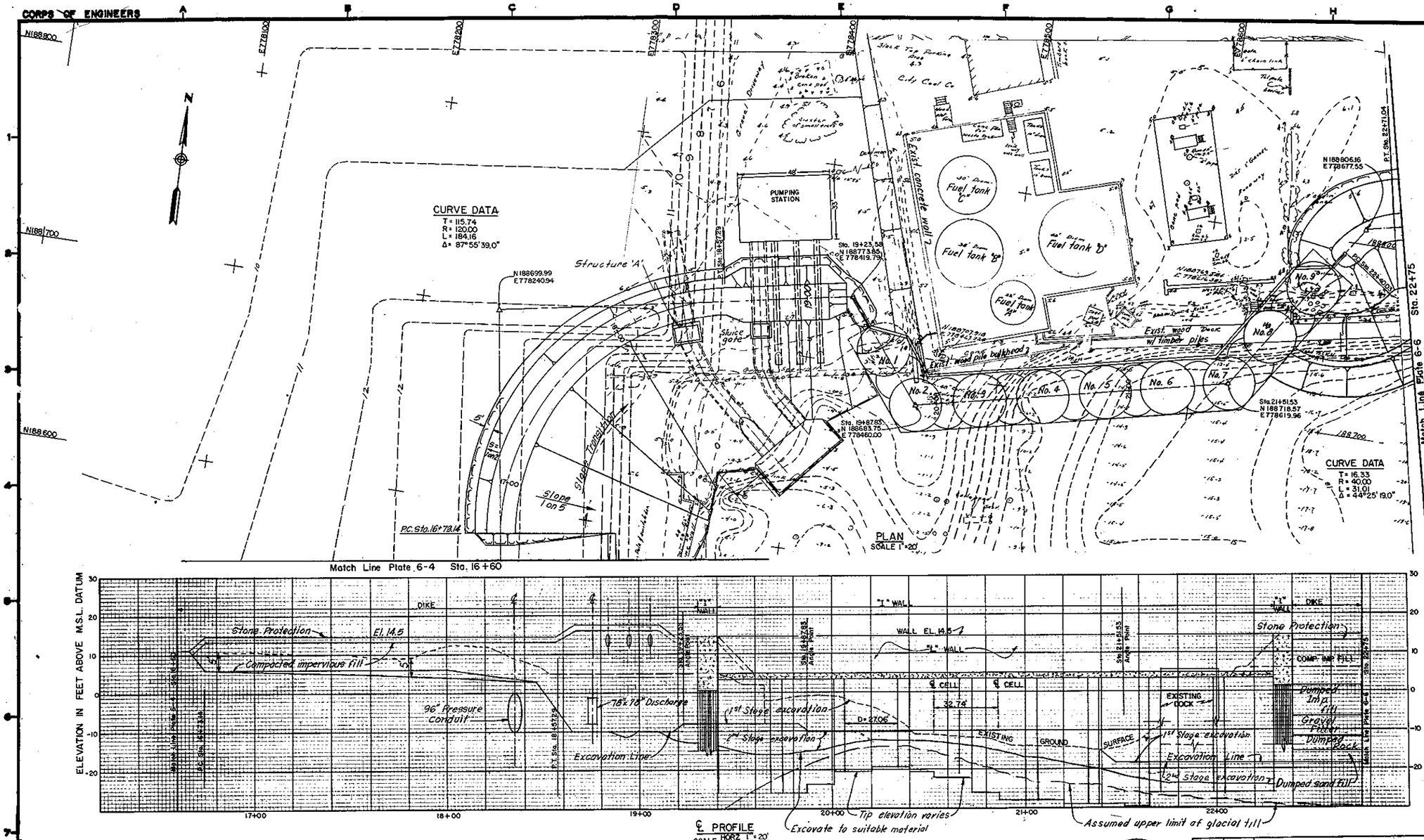
# NEW LONDON
## HURRICANE PROTECTION
SHAW COVE
PLAN AND PROFILE NO. 3

NEW LONDON CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS — U. S. ARMY




GRAPHIC SCALES

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

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

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:

CHIEF, LAYOUT SECTION

APPROVAL RECOMMENDED:

CHIEF, TECH. ENG. BRANCH

REVIEWED:

PROJECT ENGINEER

APPROVAL RECOMMENDED:

CHIEF PROJECT BRANCH

# NEW LONDON HURRICANE PROTECTION

SHAW COVE

PLAN AND PROFILE NO. 4

NEW LONDON CONNECTICUT

APPROVED DATE

CHIEF, ENGINEERING DIVISION

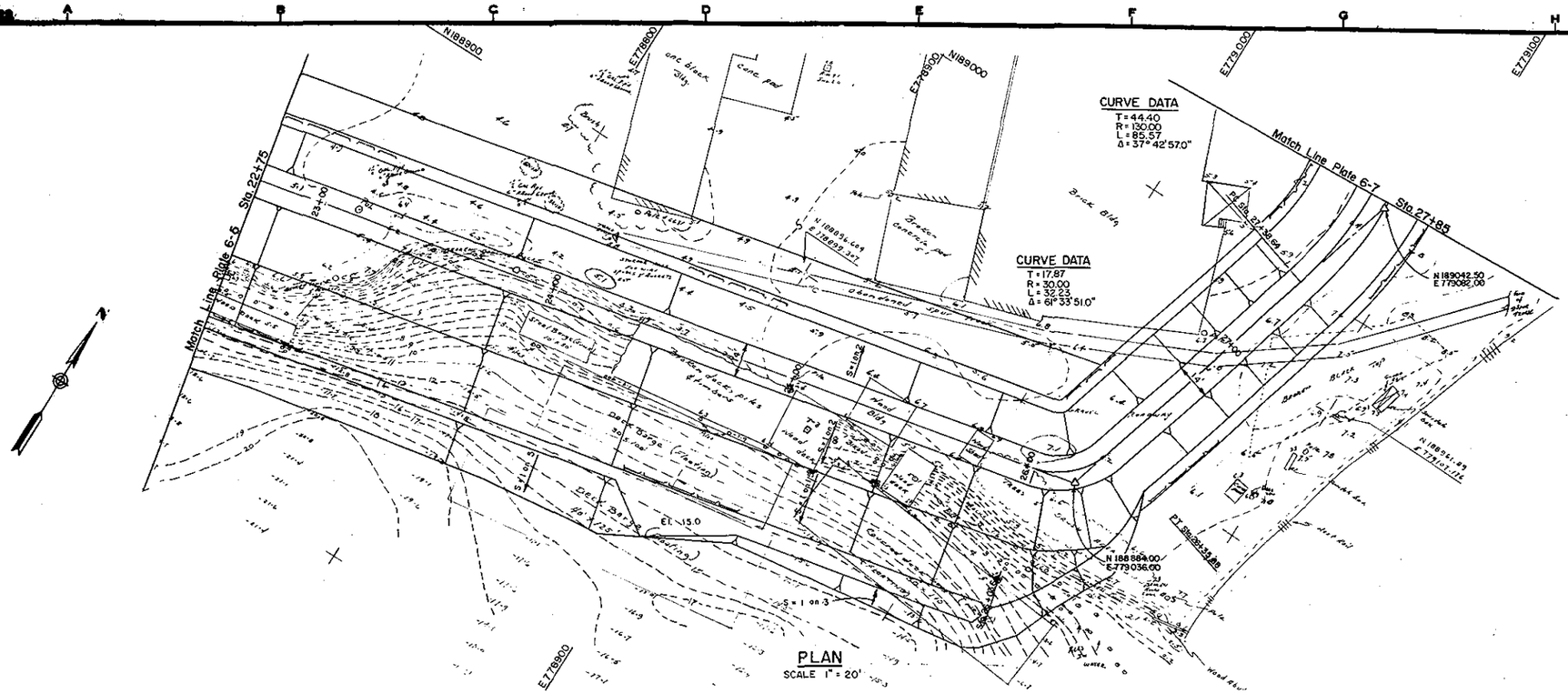
SCALE AS SHOWN | SPEC. NO.

DRAWING NUMBER

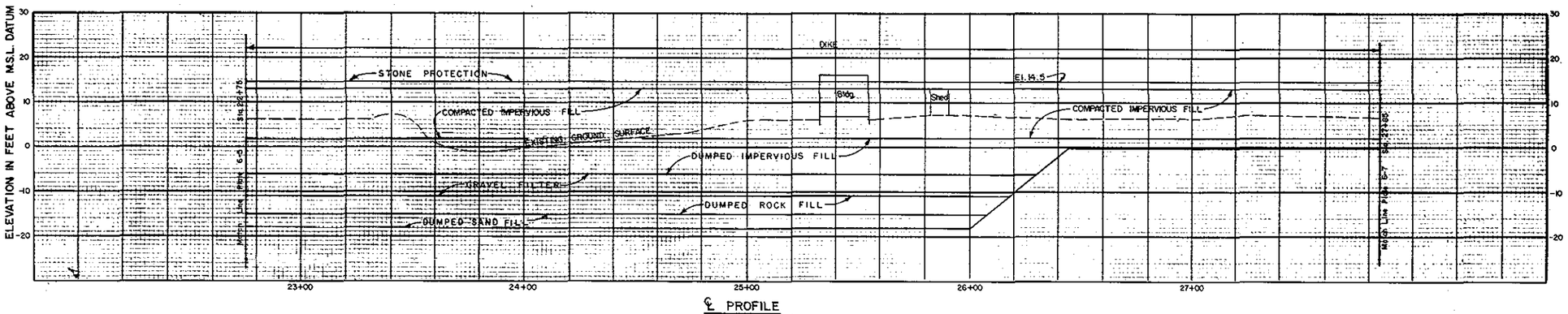
SHEET

PLATE 6-5

U. S. ARMY




PLAN
SCALE 1" = 20'




℄ PROFILE
SCALE HOR 1" = 20'
VERT 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. DES. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF, PROJECT BRANCH

# NEW LONDON
# HURRICANE PROTECTION
## SHAW COVE
### PLAN AND PROFILE NO. 5

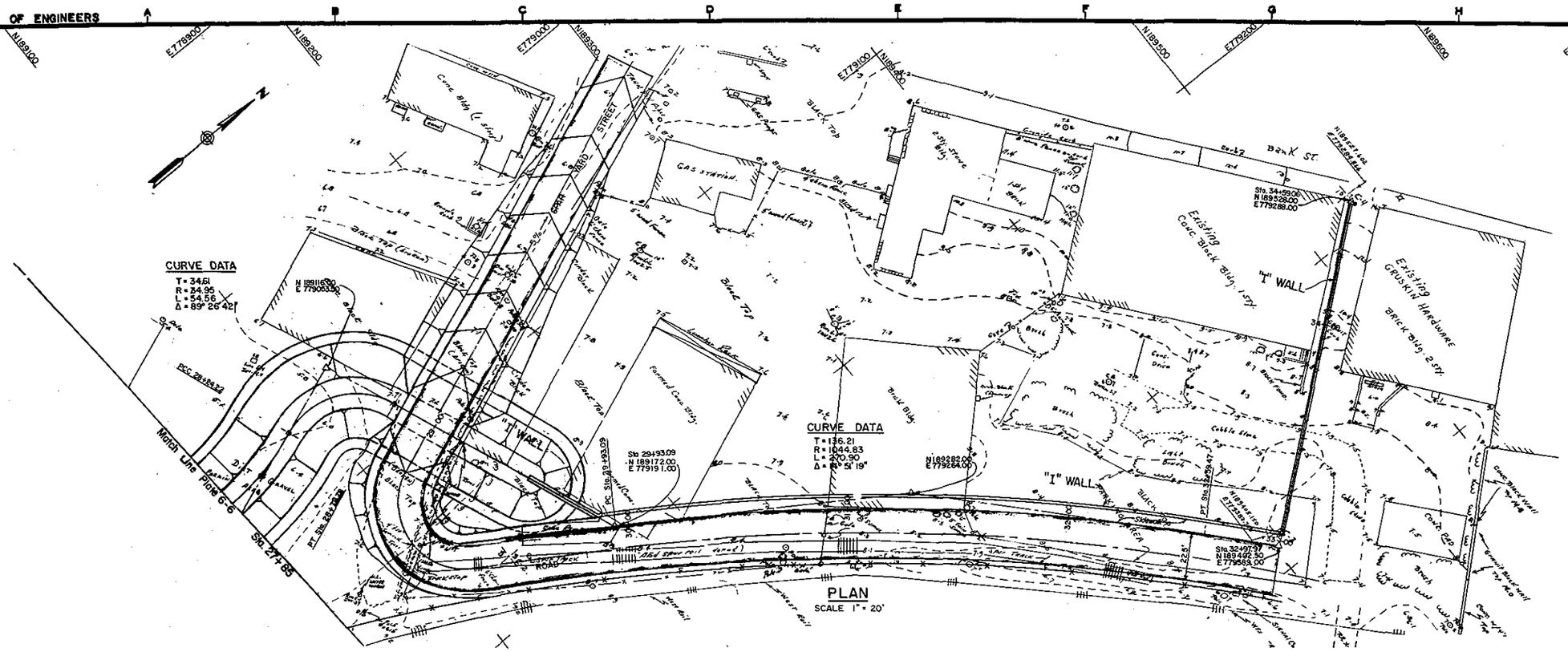
NEW LONDON CONNECTICUT

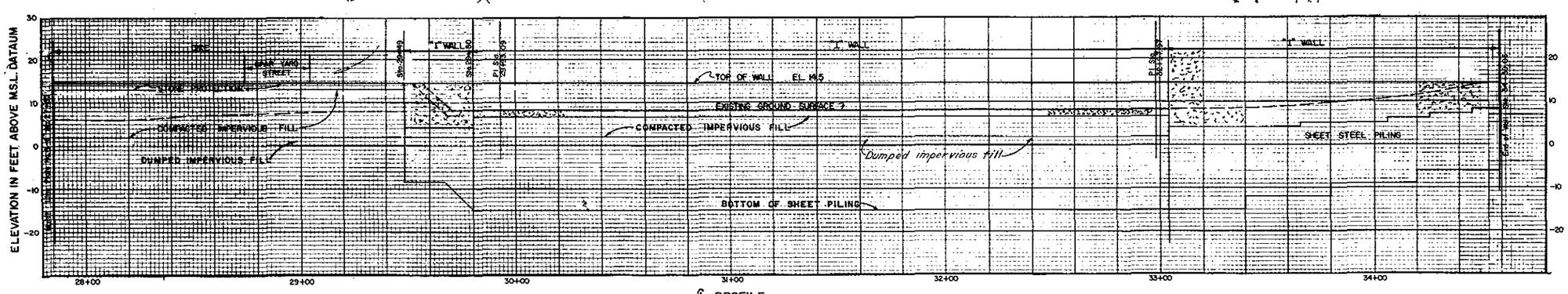
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 6-6

CORPS OF ENGINEERS U. S. ARMY




℄ PROFILE

SCALE HORZ 1" = 20'
VERT 1" = 10'

GRAPHIC SCALES

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

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

SAFETY PAYS

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED: CHIEF, LAYOUT SECTION

APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH

REVIEWED: PROJECT ENGINEER

APPROVAL RECOMMENDED: CHIEF PROJECT BRANCH

# NEW LONDON HURRICANE PROTECTION SHAW COVE

## PLAN AND PROFILE NO. 6

NEW LONDON CONNECTICUT

APPROVED DATE

CHIEF, ENGINEERING DIVISION

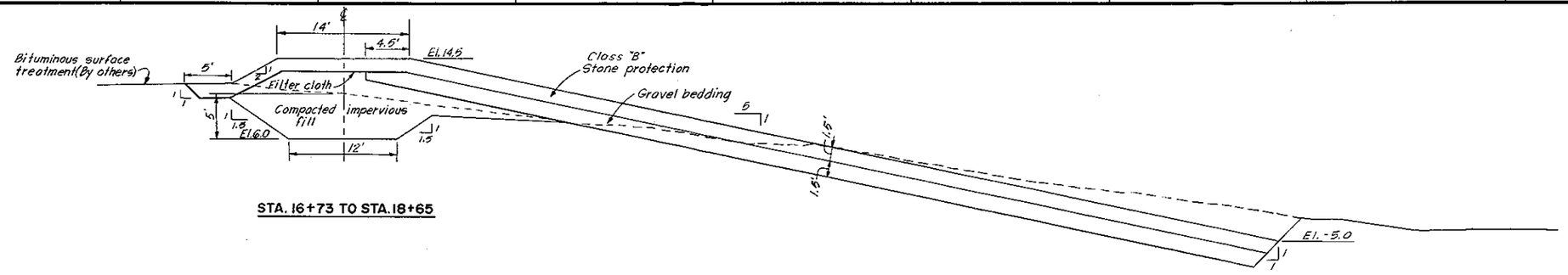
SCALE AS SHOWN | SPEC. NO.

DRAWING NUMBER

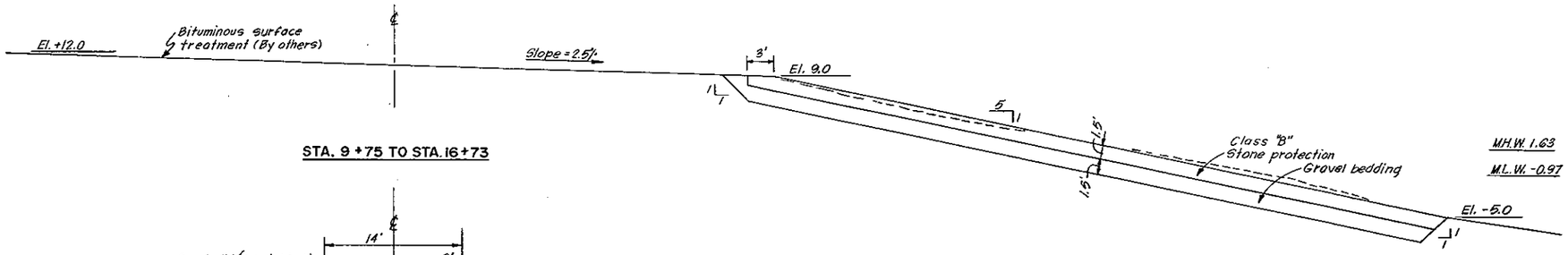
SHEET

PLATE 6-7

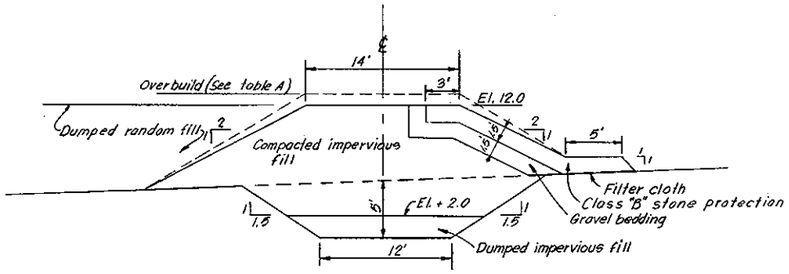
CORPS OF ENGINEERS — U. S. ARMY




STA. 16+73 TO STA. 18+65

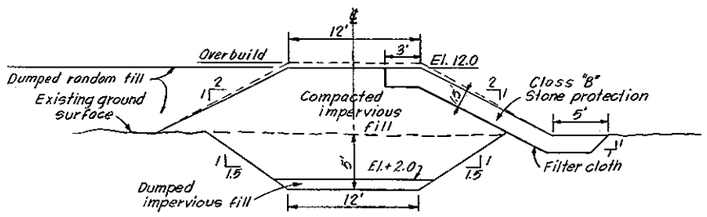



STA. 9+75 TO STA. 16+73

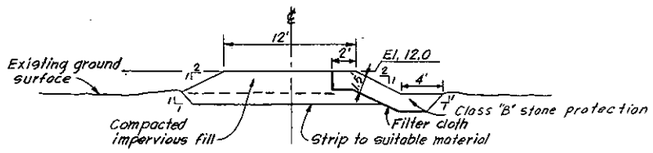



STA. 2+55 TO STA. 9+75

| TABLE A | |
|---|---|
| 0+00 to 1+00 | 0 to 6" |
| 1+00 to 4+00 | 6" |
| 4+00 to 6+00 | 6" to 12" |
| 6+00 to 9+00 | 12" |
| 9+00 to 10+00 | 12" to 6" |
| 10+00 | 6" |




STA. 1+50 TO STA. 2+55




STA. 0+00 TO STA. 1+50

TYPICAL SECTIONS

SCALE 1" = 5'

GRAPHIC SCALES

1" = 5' 5' 0 5' 10'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, DESIGN BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
TYPICAL SECTIONS NO. 1

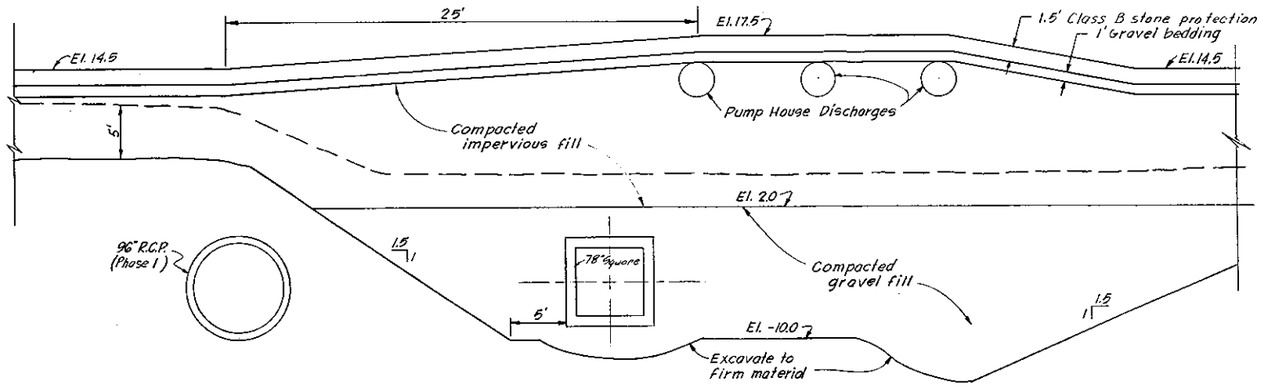
NEW LONDON — CONNECTICUT

APPROVED — DATE
CHIEF, ENGINEERING DIVISION

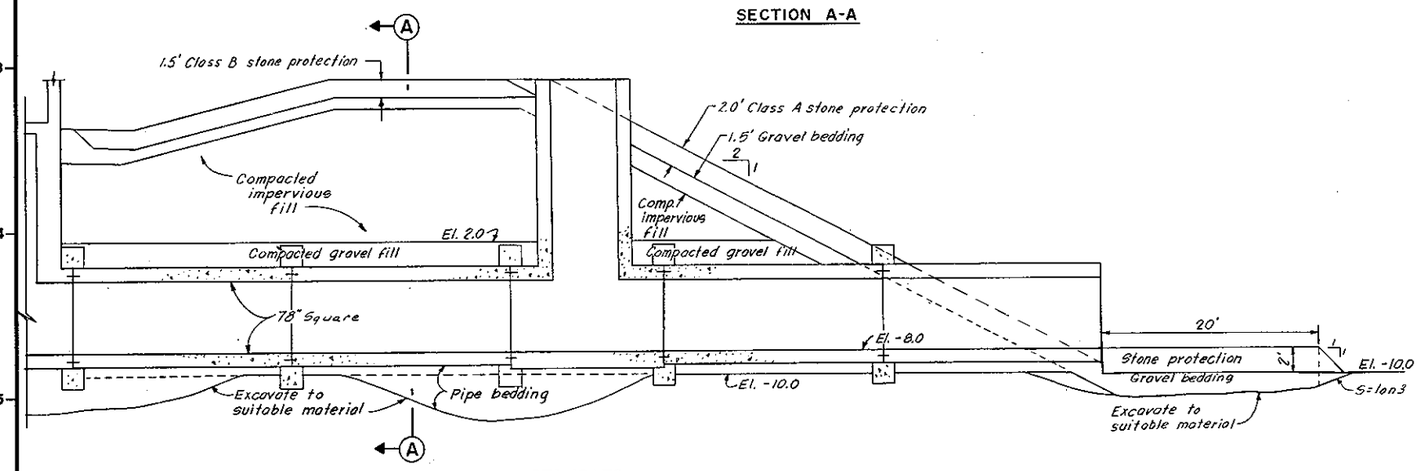
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 6-8

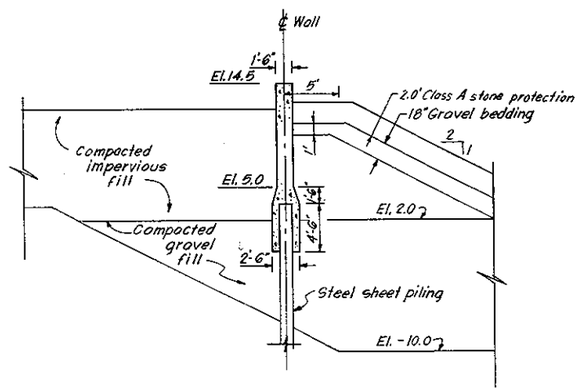
CORPS OF ENGINEERS U. S. ARMY



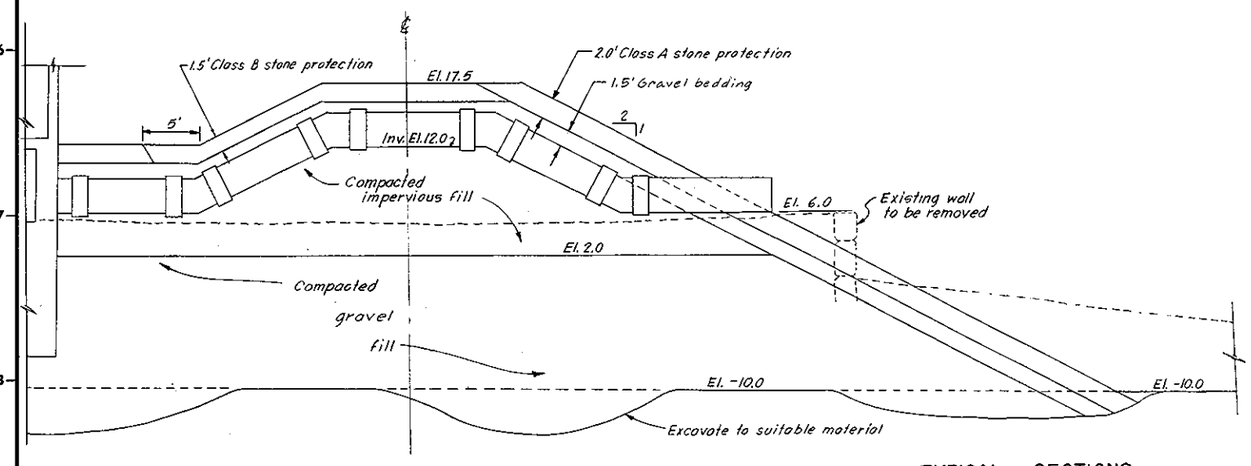

SECTION A-A




STA. 18+76




STA. 19+31 TO STA. 19+41




STA. 18+65 TO STA. 19+31

TYPICAL SECTIONS

SCALE 1" = 5'

GRAPHIC SCALES

1" = 5' 5' 0 5' 10'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

# NEW LONDON
# HURRICANE PROTECTION
## SHAW COVE
## TYPICAL SECTIONS NO. 2

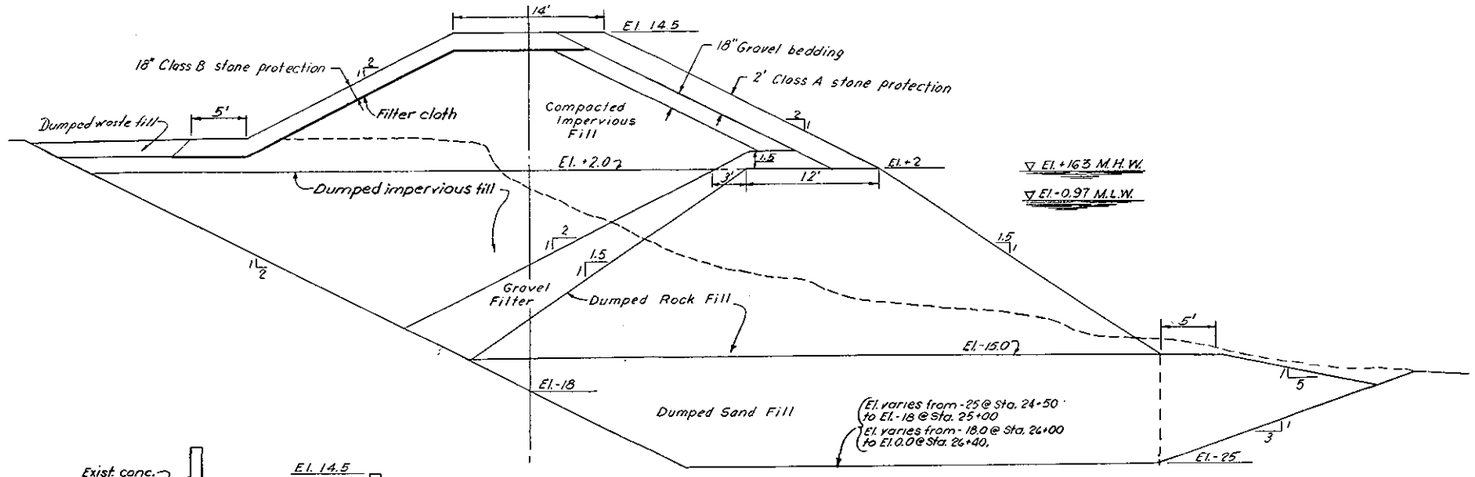
NEW LONDON CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

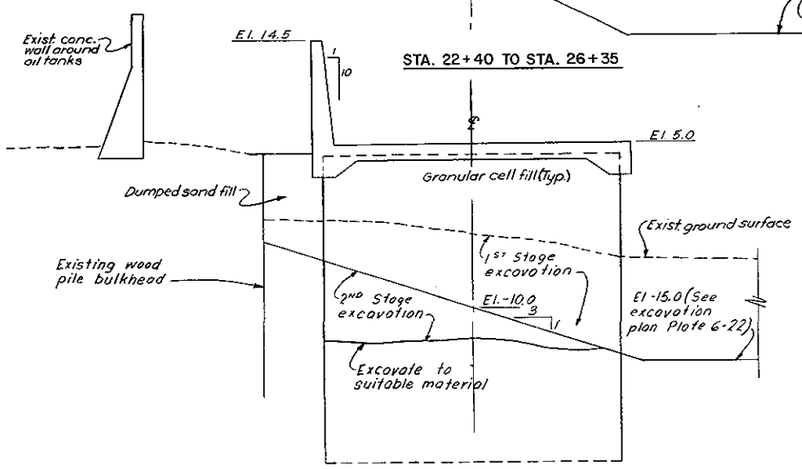
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 6-9

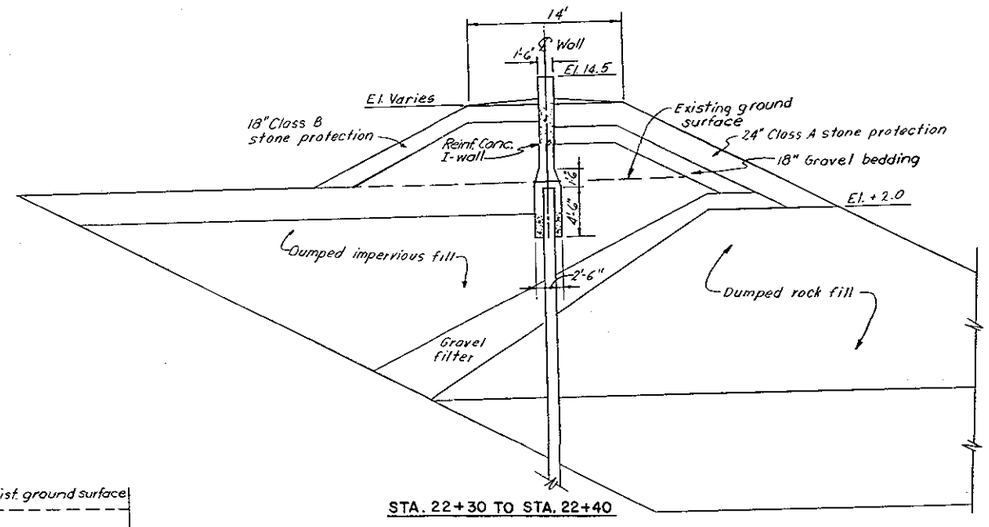
CORPS OF ENGINEERS U. S. ARMY



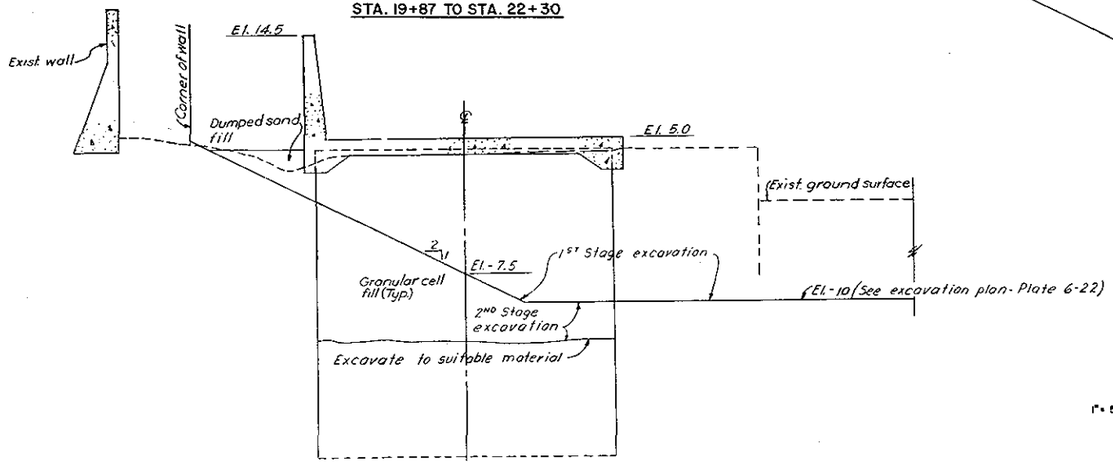

STA. 22+40 TO STA. 26+35




STA. 19+87 TO STA. 22+30




STA. 22+30 TO STA. 22+40




STA. 19+41 TO STA. 19+87

TYPICAL SECTIONS
SCALE 1" = 5'

GRAPHIC SCALES
1" = 5' 5' 0 5' 10'

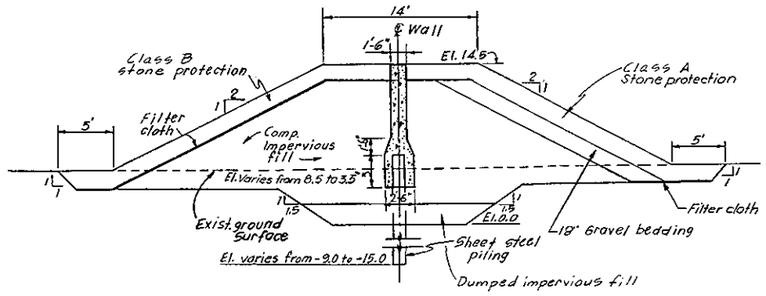
| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

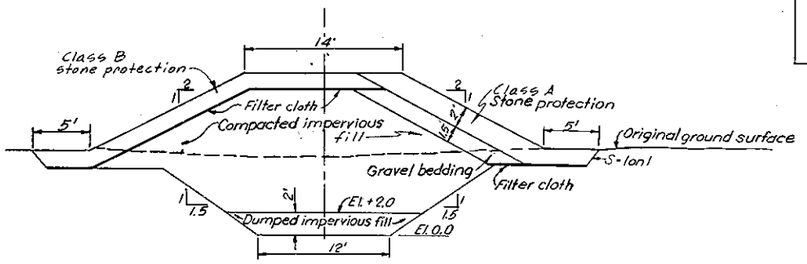
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
TYPICAL SECTIONS NO. 3
NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

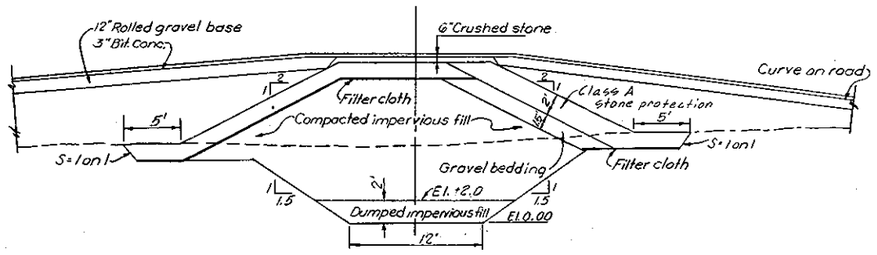
PLATE 6-10



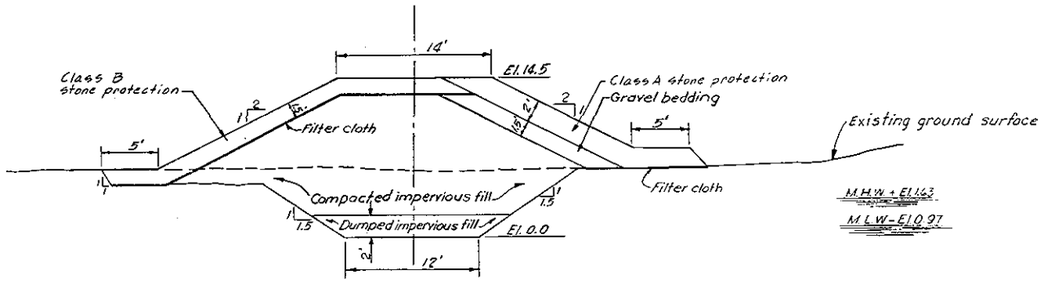

STA. 29+49 TO STA. 29+80



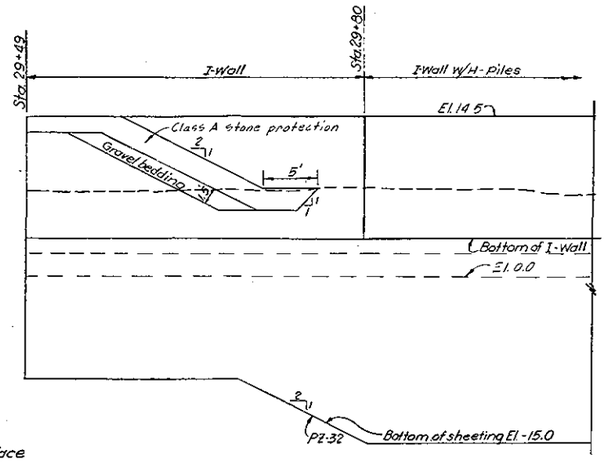

STA. 29+20 TO STA. 29+49



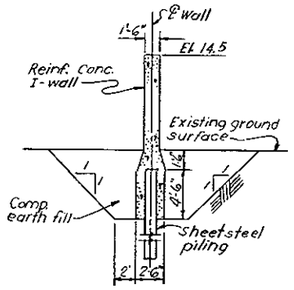

STA. 28+79 TO STA. 29+20



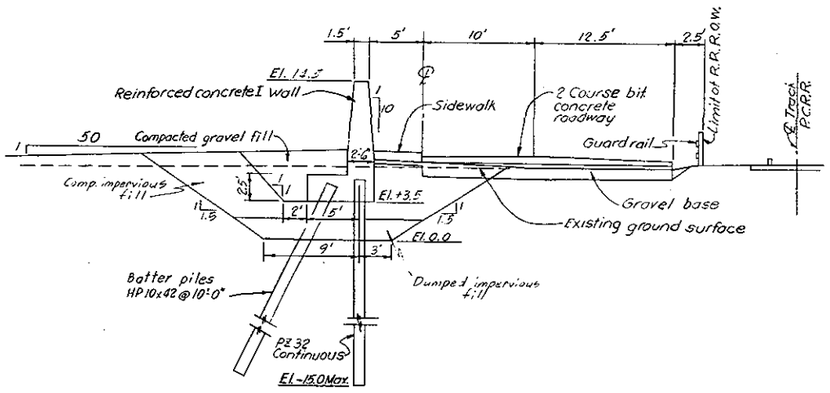

STA. 26+35 TO STA. 28+79




PROFILE




STA. 32+98 TO STA. 34+59




STA. 29+80 TO STA. 32+98

GRAPHIC SCALES

1" = 5'

TYPICAL SECTIONS

SCALE 1" = 5'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

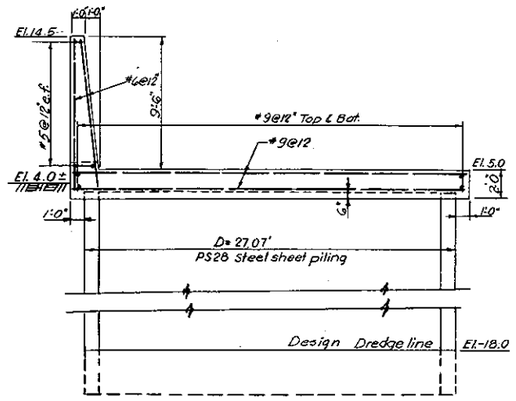
NEW LONDON
HURRICANE PROTECTION
SHAW COVE
TYPICAL SECTIONS NO. 4

NEW LONDON CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO.
DRAWING NUMBER
SHEET

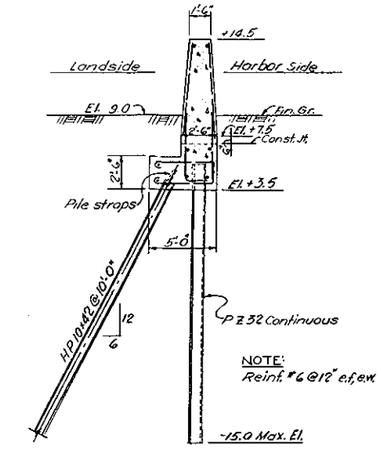
CORPS OF ENGINEERS — U. S. ARMY




STA. 21+00

(APPLIES STA. 19+41 TO STA. 22+30)

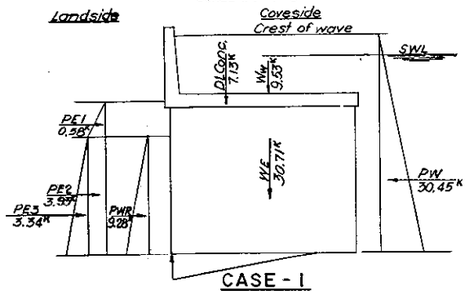
SCALE 1/4"=1'-0"



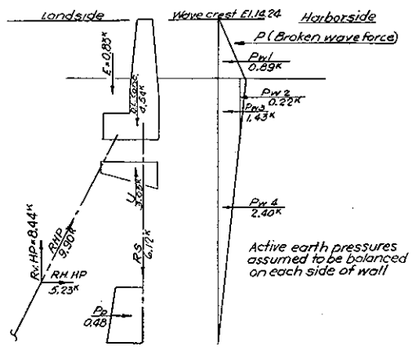

STA. 31+00

(APPLIES STA. 29+70 TO STA. 33+00)

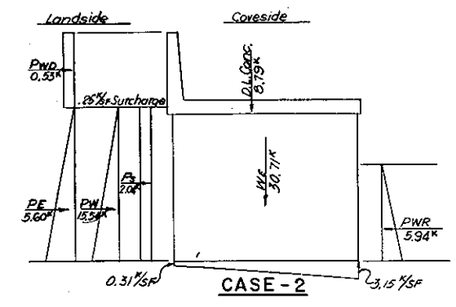
SCALE 1/4"=1'-0"



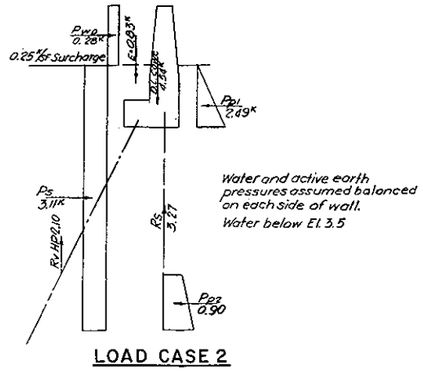

CASE - 1



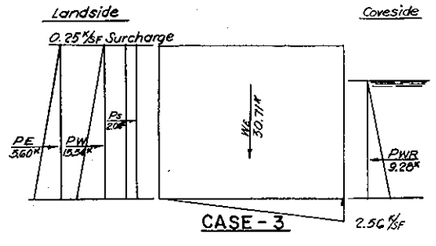

LOAD CASE 1




CASE - 2




LOAD CASE 2




CASE - 3

GRAPHIC SCALES

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

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

# NEW LONDON
# HURRICANE PROTECTION
## SHAW COVE
## WALLS - STRUCTURAL DETAILS

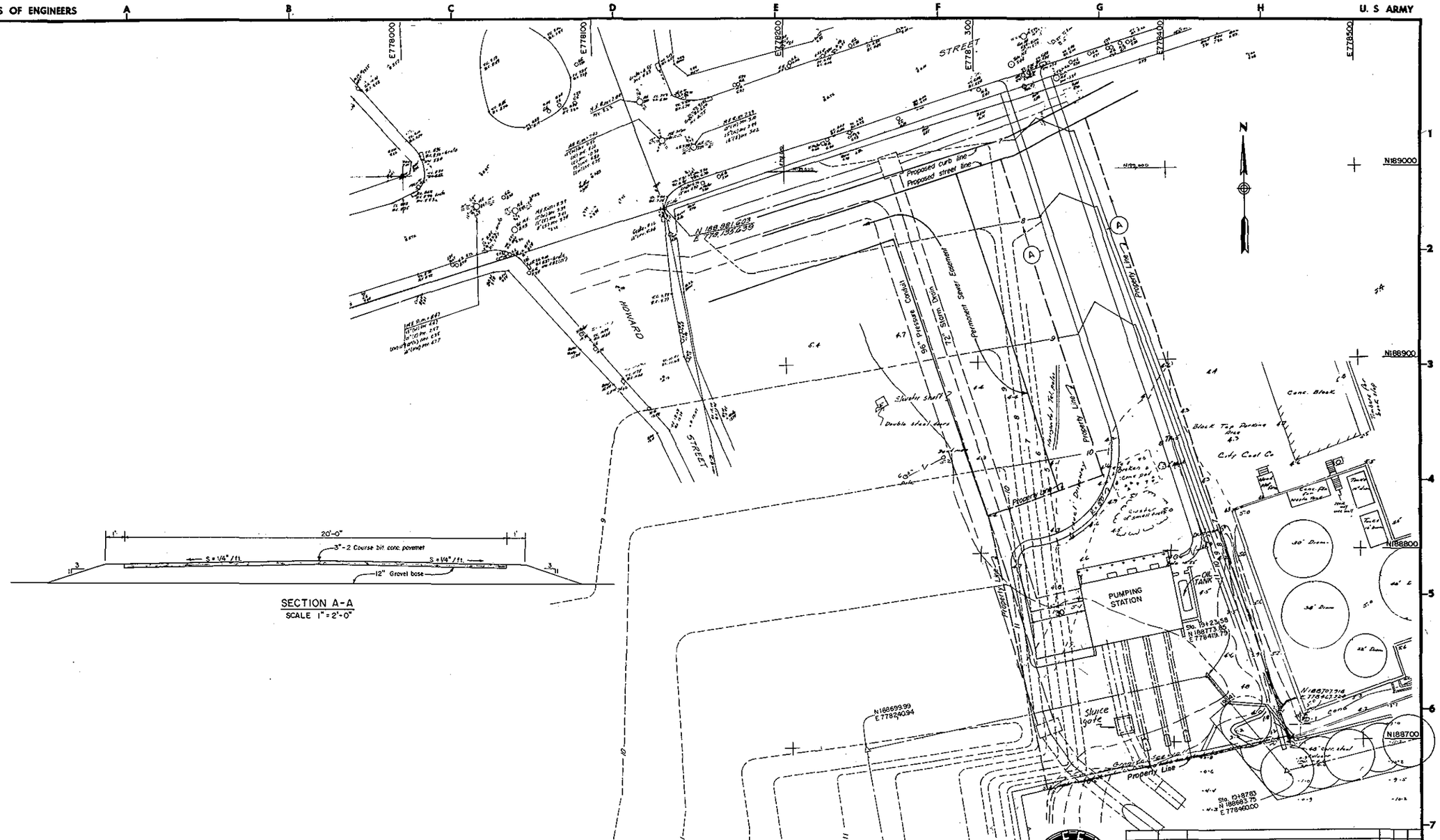
NEW LONDON — CONNECTICUT

APPROVED — DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 6-12

CORPS OF ENGINEERS U. S ARMY







SECTION A-A
SCALE 1" = 2'-0"

PLAN
SCALE 1" = 20'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY | CK. BY

SUBMITTED:
CHIEF LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF TECH. ENG. BRANCH
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

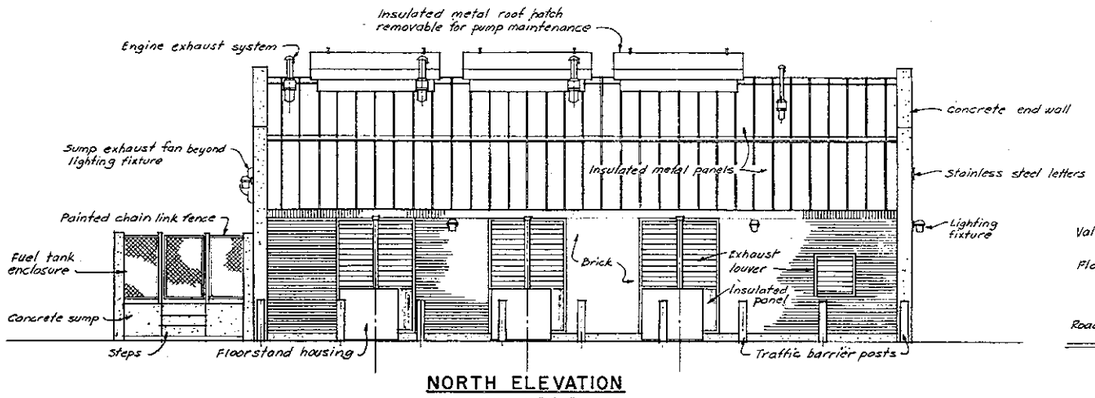
# NEW LONDON
# HURRICANE PROTECTION
## SHAW COVE
## PUMPING STATION - GRADING PLAN & SECTION

NEW LONDON CONNECTICUT

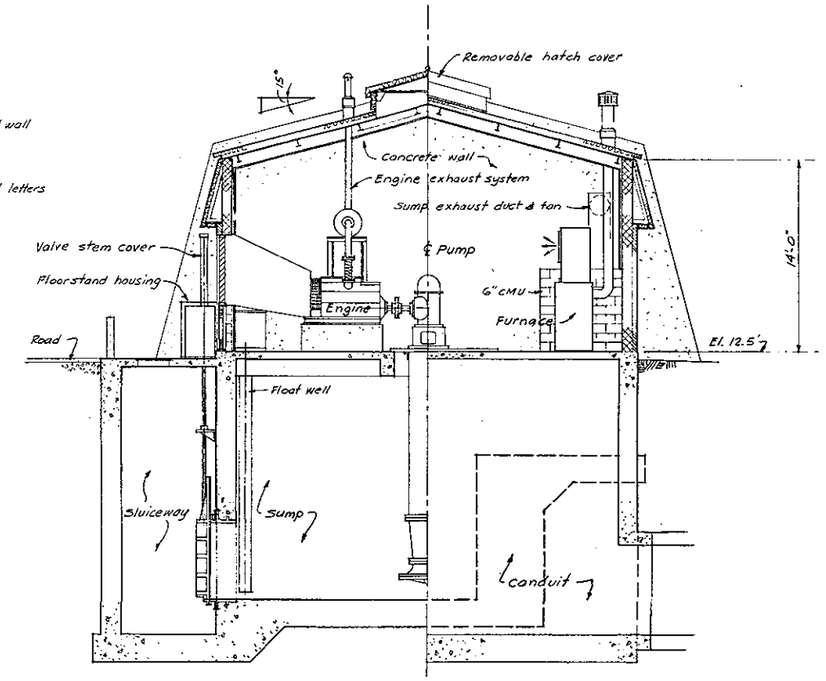
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN
DRAWING NUMBER
SHEET

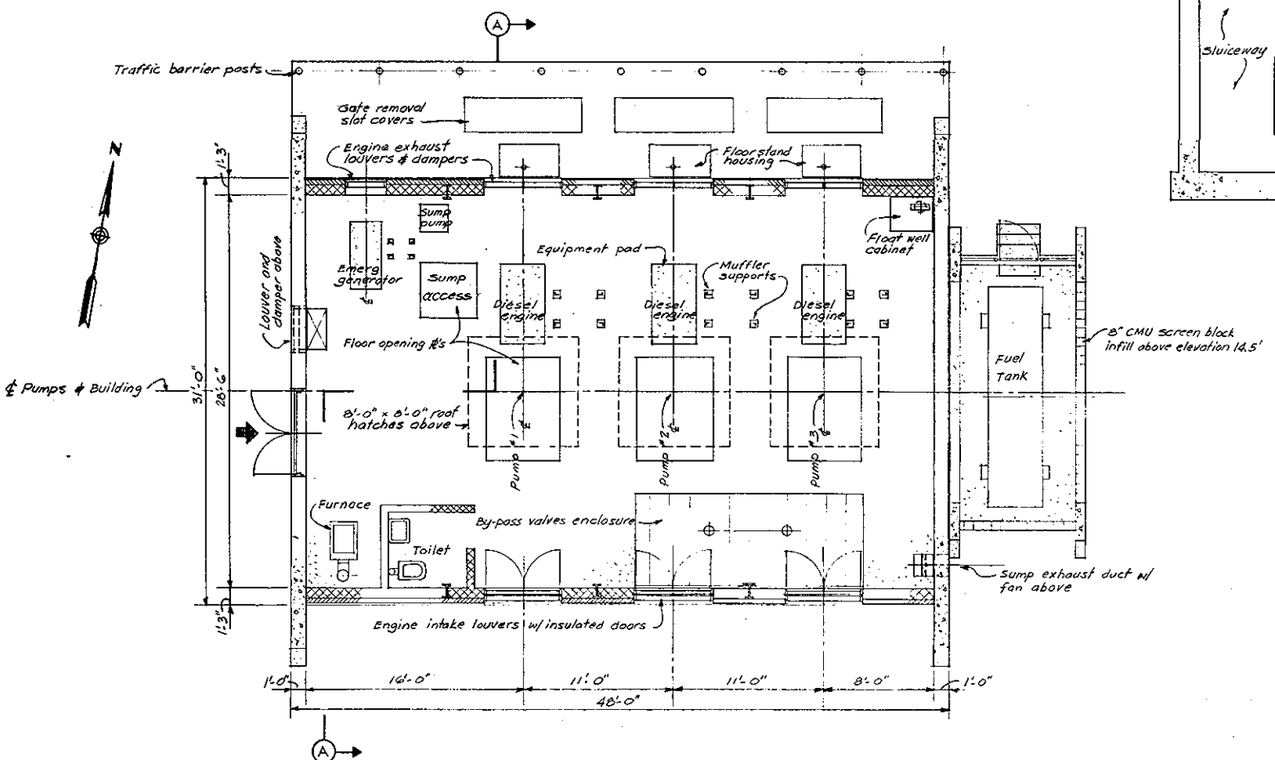
CORPS OF ENGINEERS U. S ARMY




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




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




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

GRAPHIC SCALES
1/4" = 1'-0" 4' 0 4' 8'

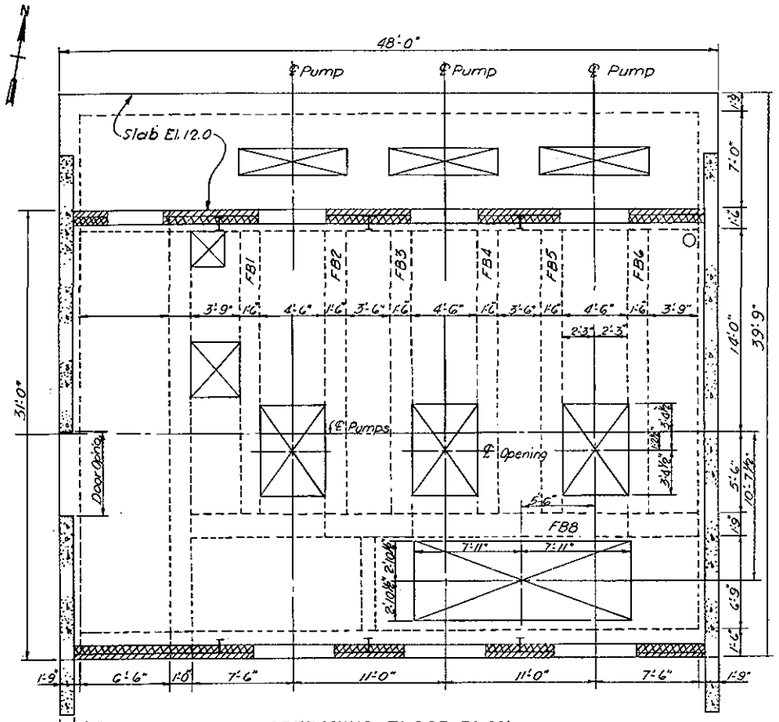
| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

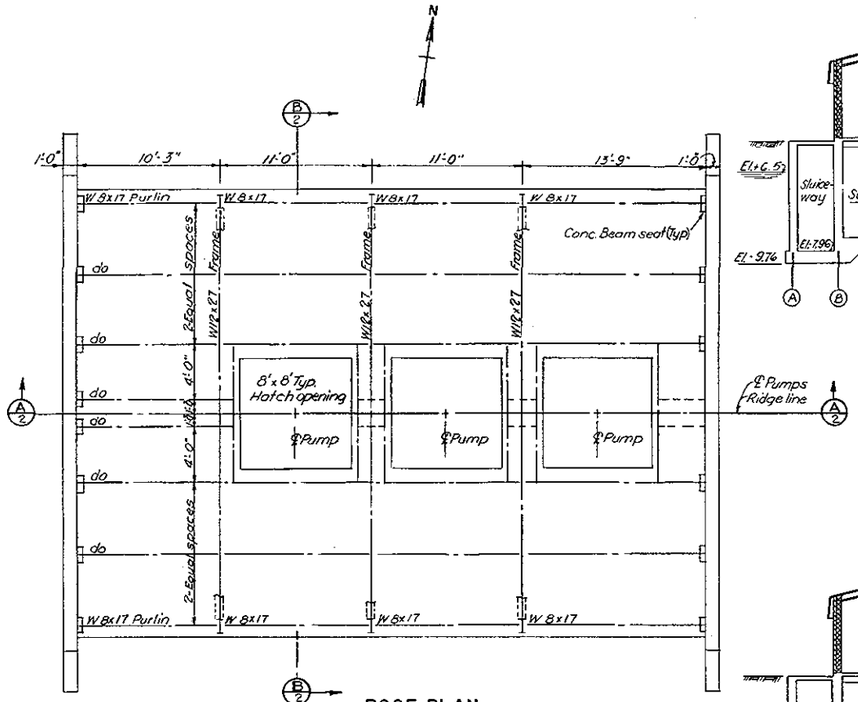
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
PUMPING STATION - ARCHITECTURAL
PLAN, ELEVATION AND SECTION
NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

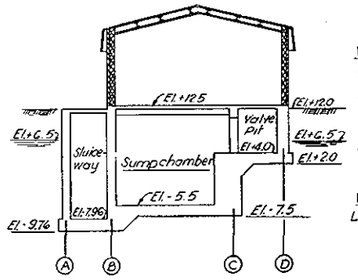
PLATE 6-14




OPERATING FLOOR PLAN
(FINISH SLAB EL. 12.5)
SCALE 1/4"=1'-0"



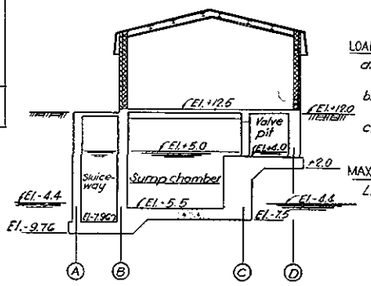

ROOF PLAN
SCALE 1/4"=1'-0"




LOADING ASSUMPTIONS
a. Dead load of structure
b. No equipment
c. No water inside station
d. Water at El. +6.5 outside

MINIMUM PILE REACTIONS
Line A - 10.11 kips
B - 9.97 "
C - 9.44 "
D - 9.22 "

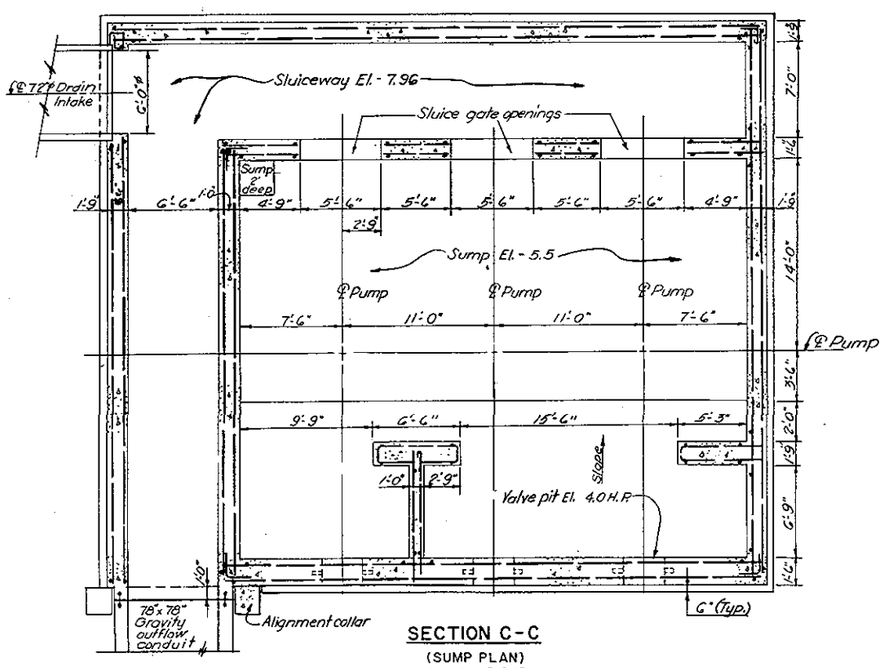
CASE I - STABILITY



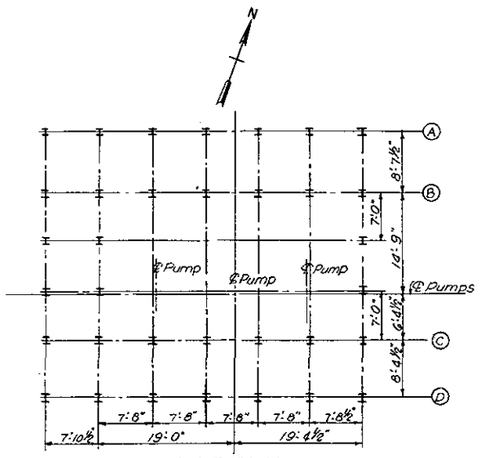

LOADING ASSUMPTIONS
a. Dead load of structure and equipment
b. Water inside station to El. +5.0
c. Water at El. -4.4 outside

MAXIMUM PILE REACTIONS
Line A - 93.33 Kips
B - 88.19 "
C - 75.59 "
D - 70.61 "

CASE 2 - STABILITY




SECTION C-C
(SUMP PLAN)
SCALE 1/4"=1'-0"




PILE PLAN
ALL PILES HP 10 X 42
SCALE 1/8"=1'-0"

GRAPHIC SCALES
1/4" = 1'-0"
1/8" = 1'-0"

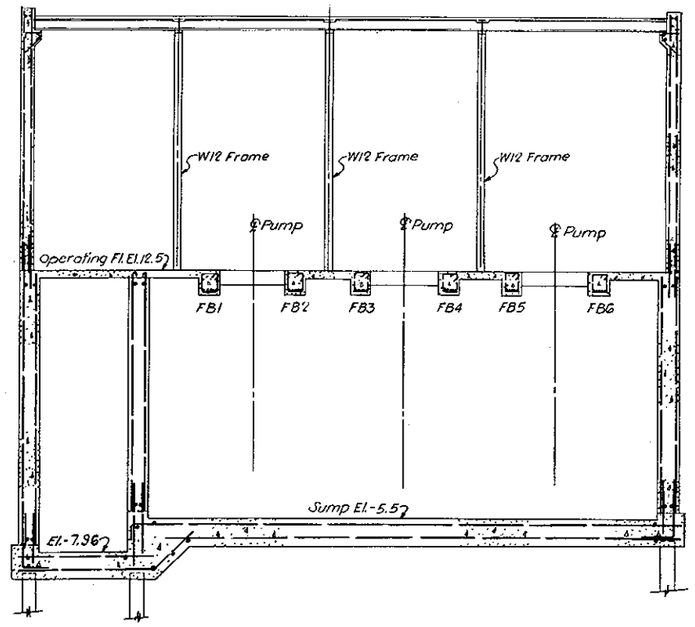
| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

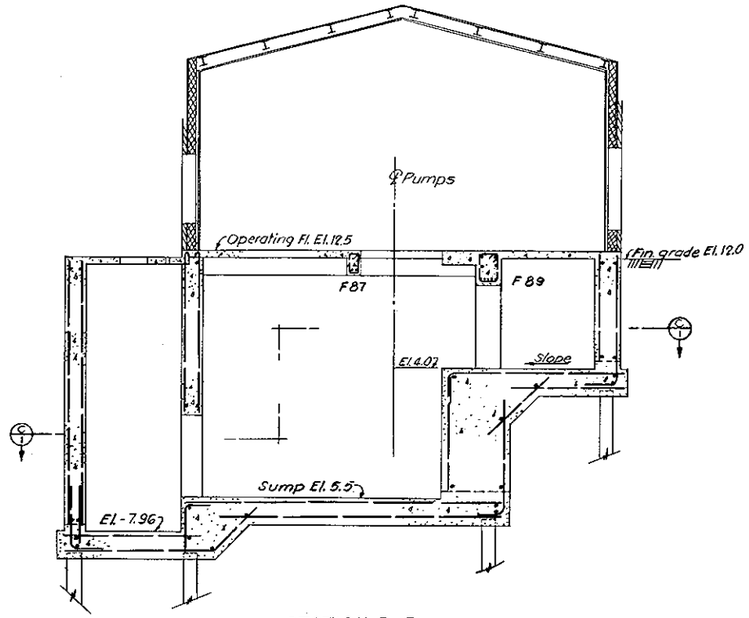
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
PUMPING STATION
STRUCTURAL DETAILS NO. 1
NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS U. S. ARMY




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




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

GRAPHIC SCALES
1/4" = 1'-0" 0 4' 8'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

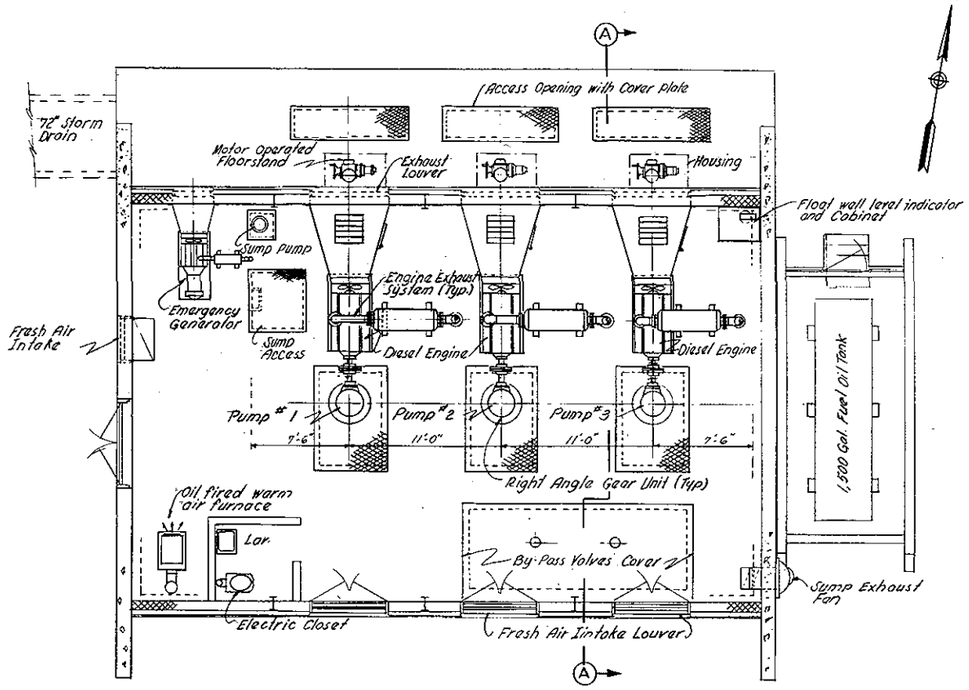
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

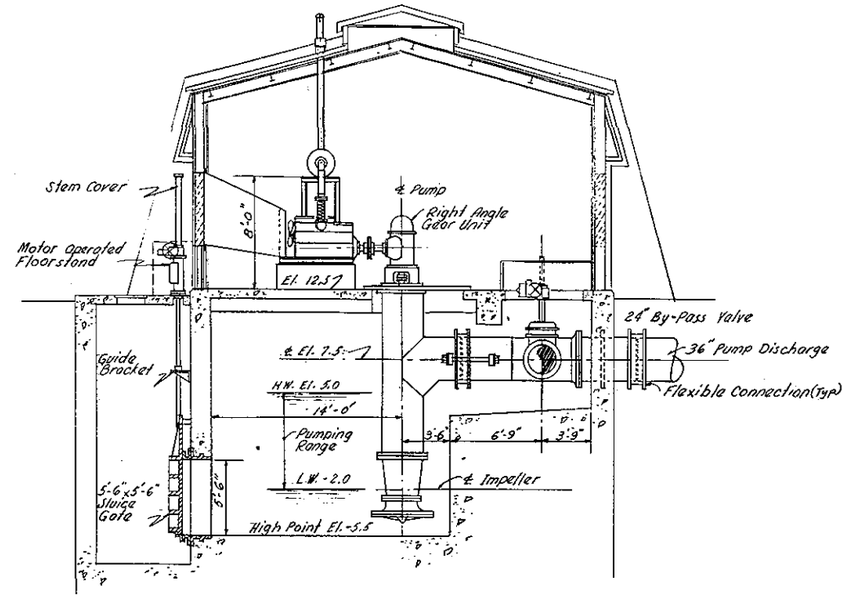
NEW LONDON
HURRICANE PROTECTION
SHAW COVE
PUMPING STATION
STRUCTURAL DETAILS NO. 2
NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

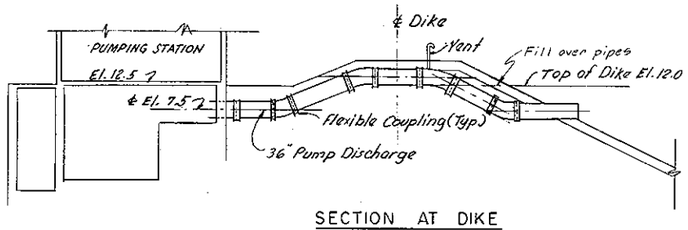
CORPS OF ENGINEERS U. S. ARMY



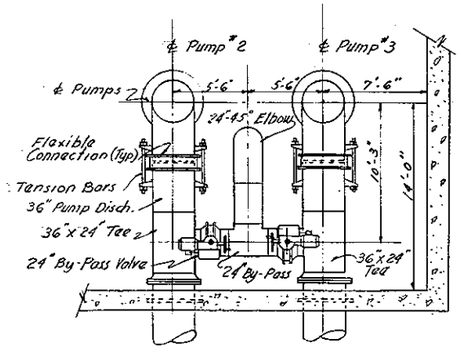

PLAN
SCALE 1/4 = 1'-0"




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




SECTION AT DIKE
SCALE 1" = 10'




PLAN — PUMP BY-PASS
SCALE 1/4" = 1'-0"

GRAPHIC SCALES
1/4" = 1'-0" 4' 0 4' 8'
1" = 10' 10' 0 10' 20'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.T.S. | DR. BY J.P.V. | CK. BY

SUBMITTED: CHIEF, SECTION
APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH
REVIEWED: PROJECT ENGINEER
APPROVAL RECOMMENDED: CHIEF BRANCH

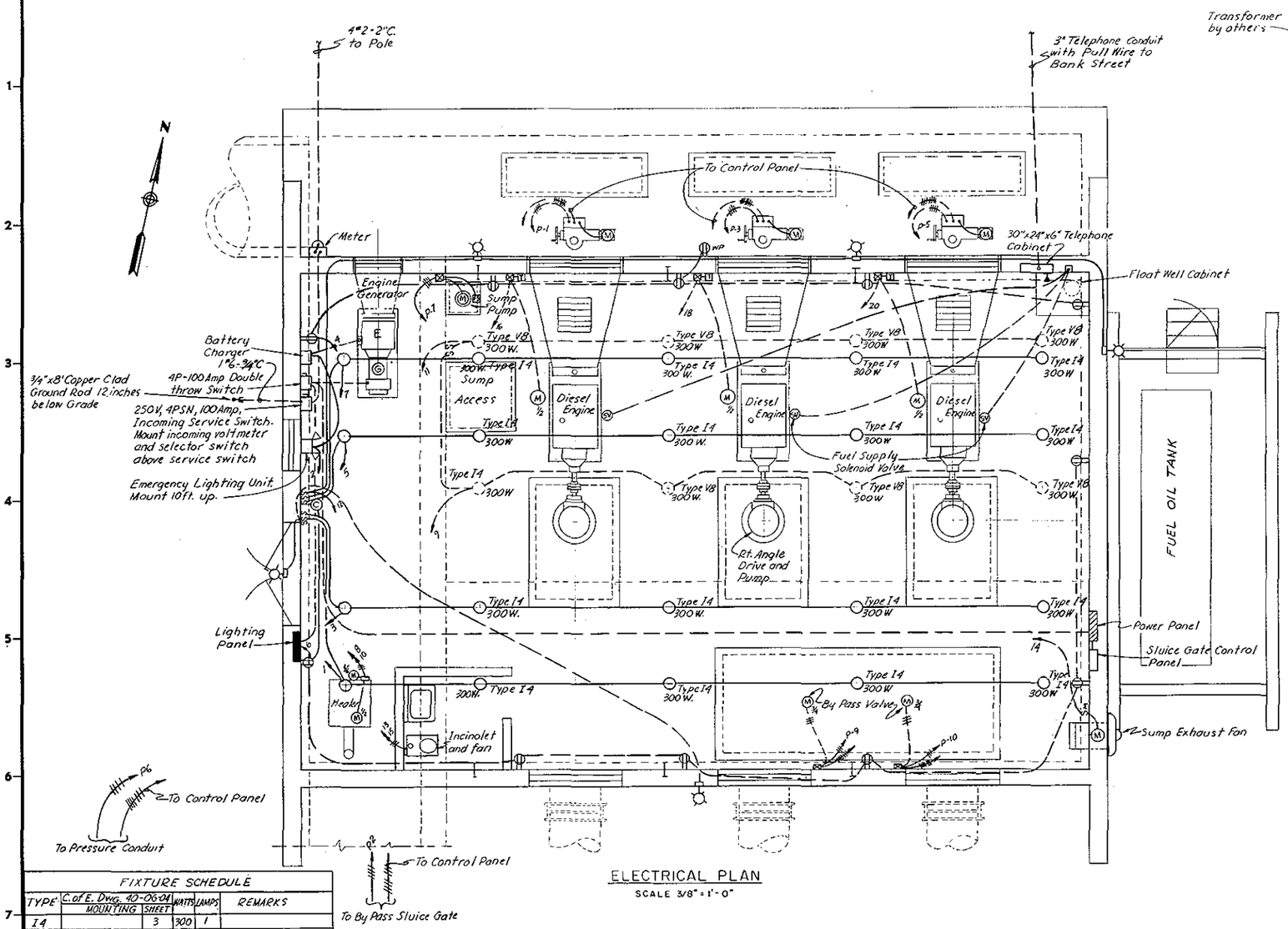
# NEW LONDON HURRICANE PROTECTION
## SHAW COVE
## PUMPING STATION - MECHANICAL
## PLANS AND SECTIONS

NEW LONDON CONNECTICUT

APPROVED CHIEF, ENGINEERING DIVISION DATE

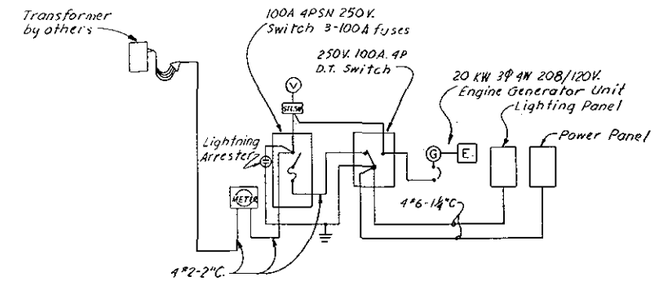
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS — U. S. ARMY




ELECTRICAL PLAN

SCALE 3/8" = 1'-0"




WIRING DIAGRAM

NO SCALE

| LEGEND | |
|---|---|
| SYMBOL | DESCRIPTION |
| | Ceiling Outlet |
| | Wall Outlet |
| | Junction Box |
| | Duplex Receptacle, W.P. indicates weatherproof |
| | Motor HP as indicated |
| | Emergency Lighting Unit |
| | Power Panel |
| | Lighting Panel |
| | Telephone Cabinet |
| | Telephone Outlet, 1'-0" Up |
| | Branch Circuit concealed in ceiling or wall |
| | Branch Circuit in floor |
| | Homerun to panel board. Note: Any circuit without further designation indicates a two wire circuit. For a greater number of wires indicate as follows (3 Wires) (4 Wires) etc. |
| S | Single Pole Switch, 4'-0" up. |
| | Float Switch |
| | Solenoid Valve |
| | Selector Switch |
| | Voltmeter |
| | Clock Outlet |
| | Timer |
| | Engine Generator Unit |

FIXTURE SCHEDULE

| TYPE | C. of E. Dwg. 40-06-04 MOUNTING | SHEET | WATTS | LAMPS | REMARKS |
|---|---|---|---|---|---|
| I4 | | 3 | 300 | 1 | |
| V8 | | 8 | 300 | 1 | |
| WB-1 | | 30A | 100 | 1 | |

POWER PANEL SCHEDULE
3φ, 4 WIRE, 208/120V. 100A. MAINS

| CIR. NO. | POLES | AMP. | DESCRIPTION | WATTS | CIR. NO. | POLES | AMP. | DESCRIPTION | WATTS |
|---|---|---|---|---|---|---|---|---|---|
| P1 | 3 | 30 | Sluice Gate #1 | 3000 | P2 | 3 | 30 | Sluice Gate #4 | 3000 |
| P3 | 3 | 30 | Sluice Gate #2 | 3000 | P4 | 3 | 30 | Spare | — |
| P5 | 3 | 30 | Sluice Gate #3 | 3000 | P6 | 3 | 30 | Pressure Conduit Gate | 3000 |
| P7 | 3 | 15 | Sump Pump | 1500 | P8 | 3 | 15 | Spare | — |
| P9 | 3 | 15 | By Pass Valve #1 | 750 | P10 | 3 | 15 | By Pass Valve #2 | 750 |
| P11 | 3 | 30 | Spare | — | P12 | 3 | 20 | Spare | — |

LIGHTING PANEL SCHEDULE
3φ, 4 Wire 208/120V. 100A. MAINS

| CIR. NO | POLES | AMP | DESCRIPTION | WATTS | CIR. NO | POLES | AMP | DESCRIPTION | WATTS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 20 | Lighting | 1500 | 2 | 1 | 20 | Battery Chrg. | 50 |
| 3 | 1 | 20 | Lighting | 1500 | 4 | 1 | 20 | Receptacles | 900 |
| 5 | 1 | 20 | Lighting | 1500 | 6 | 1 | 20 | Receptacles | 900 |
| 7 | 1 | 20 | Lighting | 1500 | 8 | 1 | 20 | Furnace | 165 |
| 9 | 1 | 20 | Lighting | 1500 | 10 | 1 | 20 | Fan | 500 |
| 11 | 1 | 20 | Lighting | 1200 | 12 | 1 | 20 | Exterior Ltg. | 400 |
| 13 | 2 | 20 | Incinolet | 2400 | 14 | 1 | 20 | Exhaust Fan | 250 |
| 15 | | | | | 16 | 1 | 20 | Grease Unit | 333 |
| 17 | 1 | 20 | Spare | — | 18 | 1 | 20 | " " | " |
| 19 | 1 | 20 | Spare | — | 20 | 1 | 20 | " " | " |

| | SLUICE GATES 1 | 2 | 3 | 4 | CONDUIT BY PASS GATE P.C. | BY PASS VALVES 1 | 2 |
|---|---|---|---|---|---|---|---|
| Green Pilot Lts. | ⊗ | ⊗ | ⊗ | ⊗ | ⊗ | ⊗ | ⊗ |
| Push Button Starting — Open | ⊖ | ⊖ | ○ | ○ | ⊙ | ○ | ○ |
| Push Button Starting — Stop | ○ | ⊖ | ⊖ | ○ | ○ | ○ | ○ |
| Push Button Starting — Close | ⊖ | ⊖ | ○ | ○ | ○ | ○ | ○ |
| Red Pilot Lts. | ⊗ | ⊗ | ⊗ | ⊗ | ⊗ | ⊗ | ⊗ |

SLUICE GATE CONTROL PANEL DETAIL

NOT TO SCALE

GRAPHIC SCALES

3/8" = 1'-0"

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY JGD | CK. BY

SUBMITTED: CHIEF, SECTION

APPROVAL RECOMMENDED: CHIEF, TECH. ENG. BRANCH

REVIEWED: PROJECT ENGINEER

APPROVAL RECOMMENDED: CHIEF BRANCH

APPROVED: CHIEF, ENGINEERING DIVISION — DATE

# NEW LONDON HURRICANE PROTECTION SHAW COVE PUMPING STATION – ELECTRICAL PLAN, SCHEDULES AND WIRING DIAGRAM

NEW LONDON CONNECTICUT

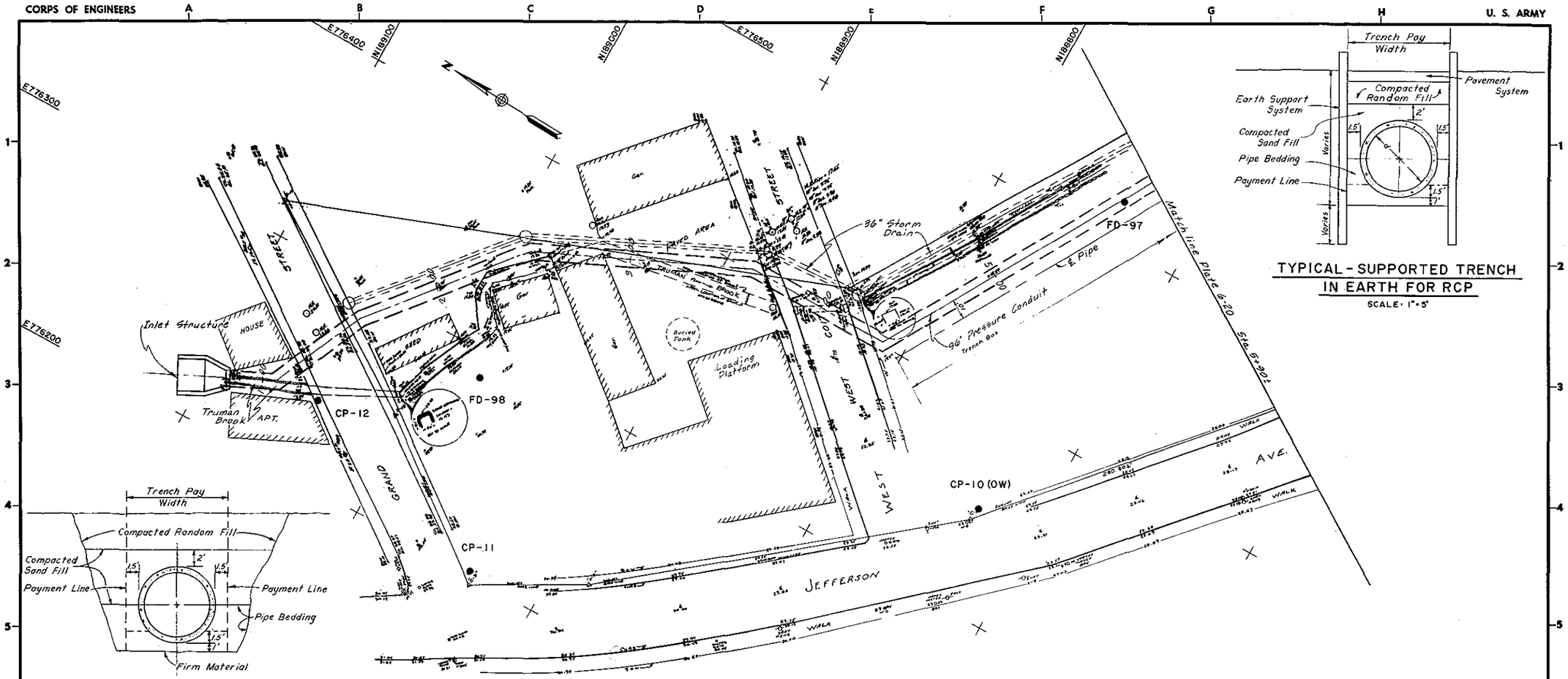
SCALE | SPEC. NO.

DRAWING NUMBER

SHEET

PLATE 6-18

CORPS OF ENGINEERS U. S. ARMY







TYPICAL - SUPPORTED TRENCH IN EARTH FOR RCP

SCALE: 1"=5'

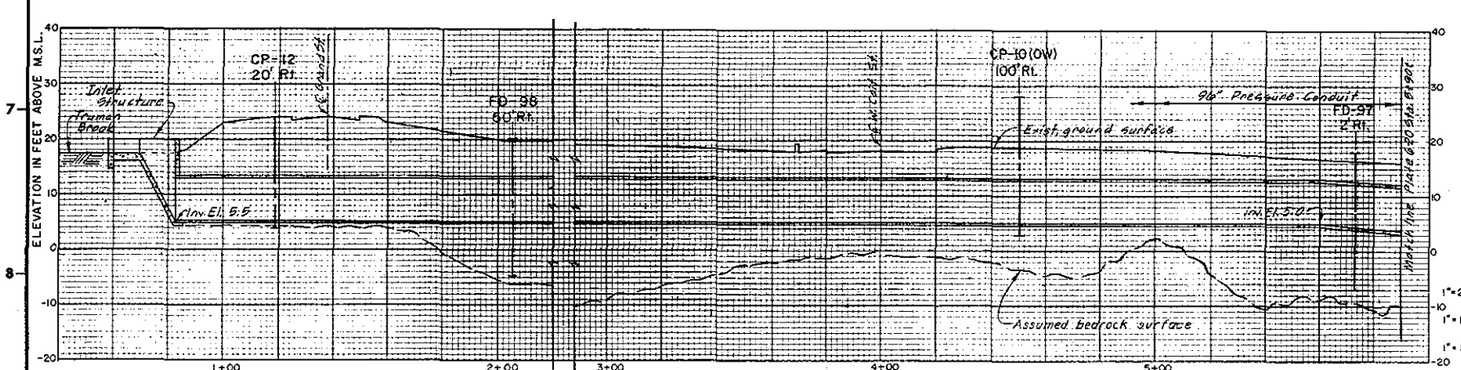



TYPICAL - UNSUPPORTED TRENCH (USING TRENCH BOX) IN EARTH FOR 96' RCP

SCALE: 1"=5'.

PLAN

SCALE: 1"=20'




℄ PROFILE

SCALE: HORIZ. 1"=20'
VERT. 1"=10'

GRAPHIC SCALES

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

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

1"=5' 5' 0 5' 10'

SAFETY PAYS

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

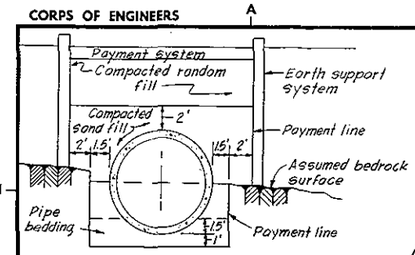
NEW LONDON
HURRICANE PROTECTION
SHAW COVE
96" PRESSURE CONDUIT
PLAN AND PROFILE NO. 1
NEW LONDON CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE: AS SHOWN SPEC. NO.
DRAWING NUMBER
SHEET

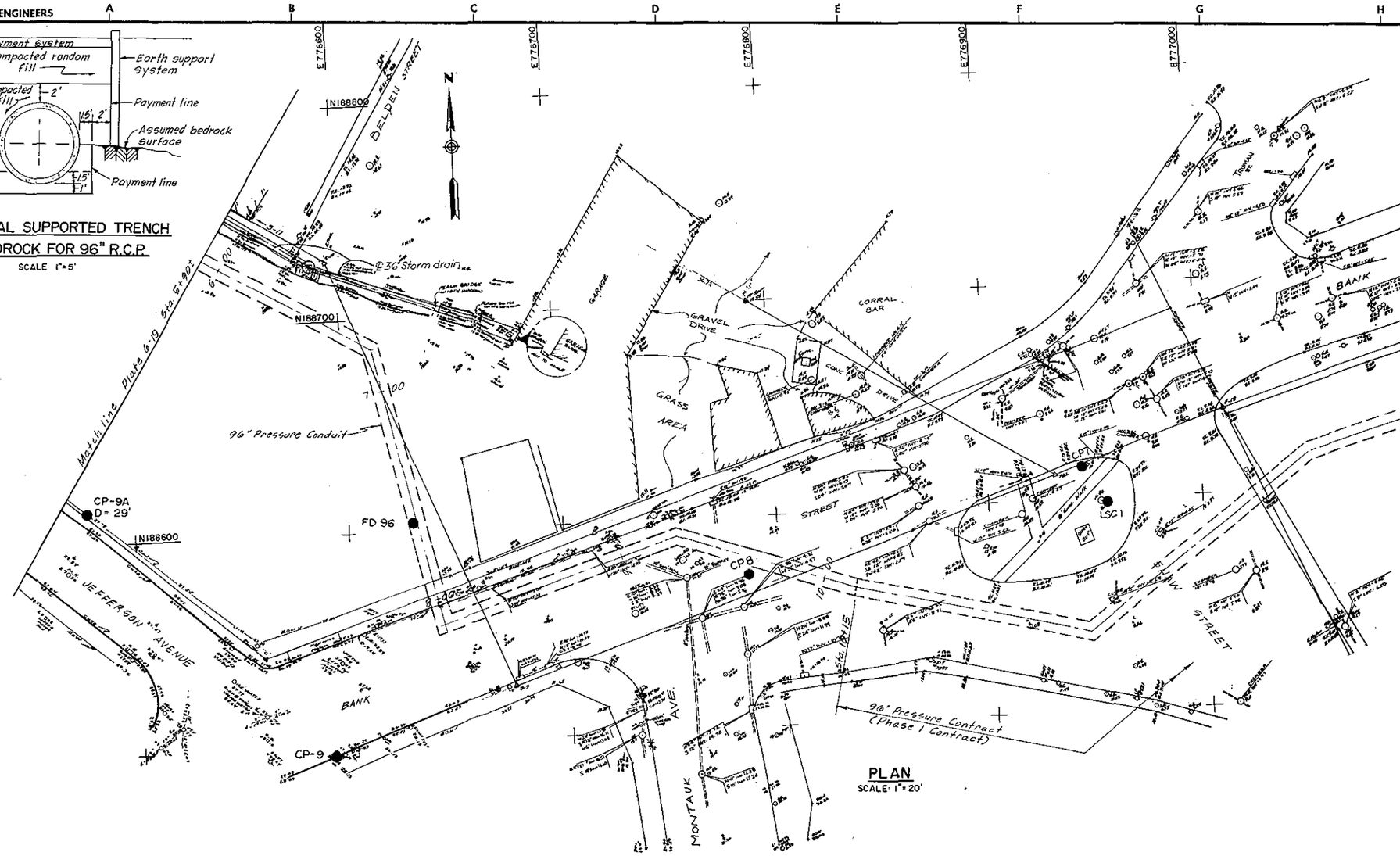
PLATE 6-19

CORPS OF ENGINEERS — U. S. ARMY



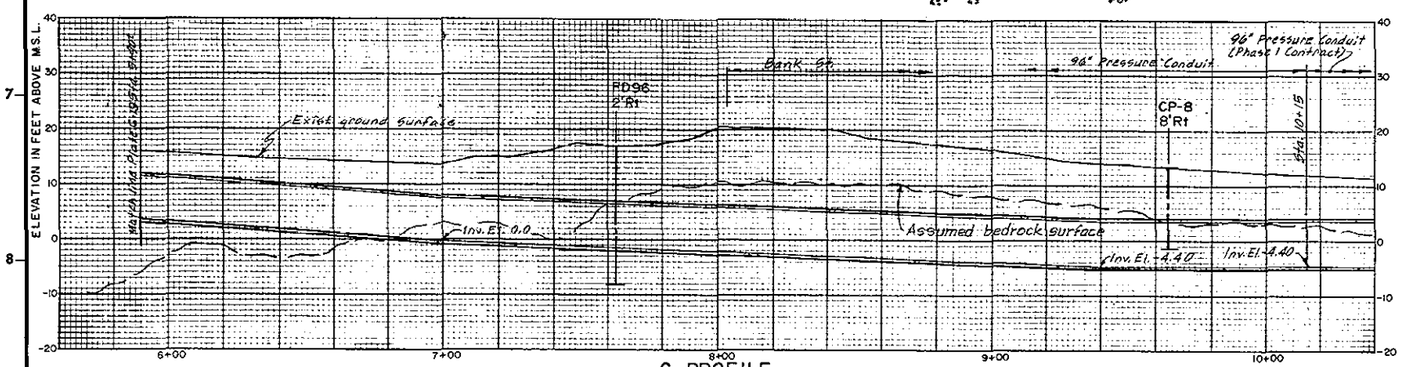

TYPICAL SUPPORTED TRENCH IN BEDROCK FOR 96" R.C.P.

SCALE 1"=5'




PLAN

SCALE: 1"=20'




℄ PROFILE

SCALE: HORIZ. 1"=20' VERT. 1"=10'

GRAPHIC SCALES

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

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

1"=5' 5' 0 5' 10'

SAFETY PAYS

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

# NEW LONDON HURRICANE PROTECTION
## SHAW COVE
## 96" PRESSURE CONDUIT PLAN AND PROFILE NO.2

NEW LONDON CONNECTICUT

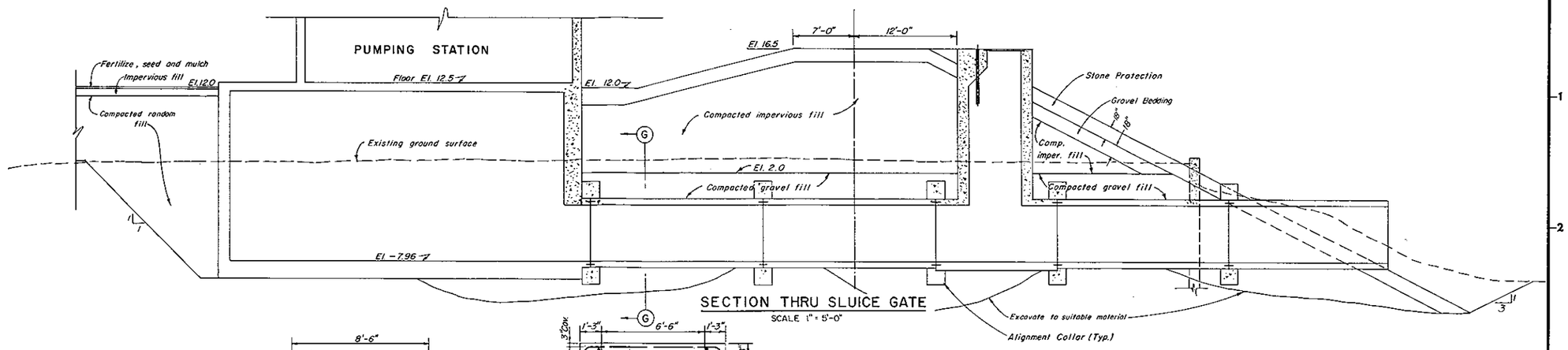
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE: AS SHOWN | SPEC. NO.

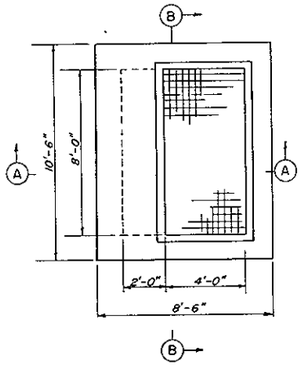
DRAWING NUMBER

SHEET

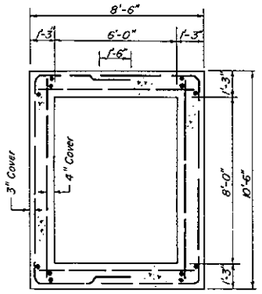
PLATE 6-20



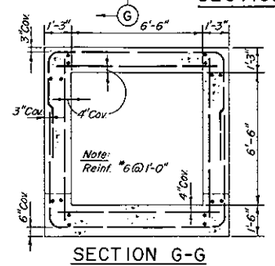

SECTION THRU SLUICE GATE
SCALE 1" = 5'-0"



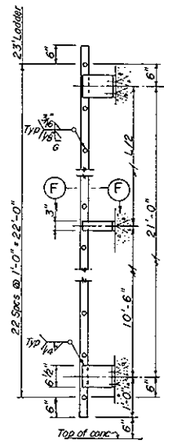

PLAN
SCALE 3/8" = 1'-0"



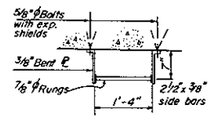

SECTION C-C
SCALE 3/8" = 1'-0"



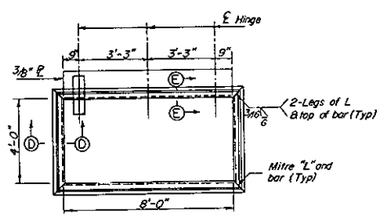

SECTION G-G
SCALE: 3/8" = 1'-0"



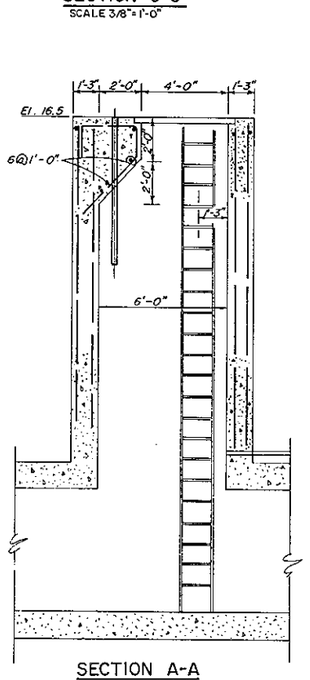

LADDER DETAIL
SCALE: 3/4" = 1'-0"



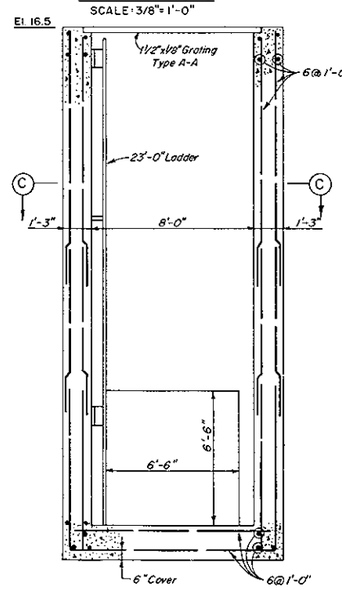

SECTION F-F
SCALE: 3/4" = 1'-0"



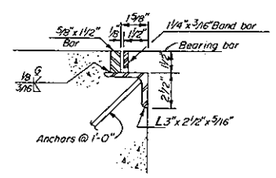

FRAME
NTS



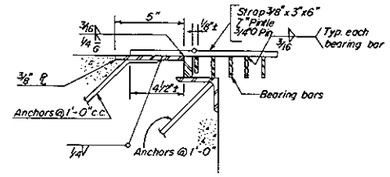

SECTION A-A
SCALE: 3/8" = 1'-0"



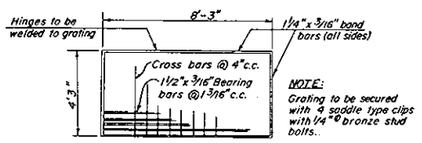

SECTION B-B
SCALE 3/8" = 1'-0"




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

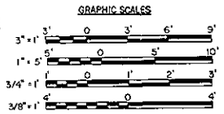



SECTION E-E
SCALE: 3" = 1'-0"




GRATING
NTS

GRAPHIC SCALES




| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

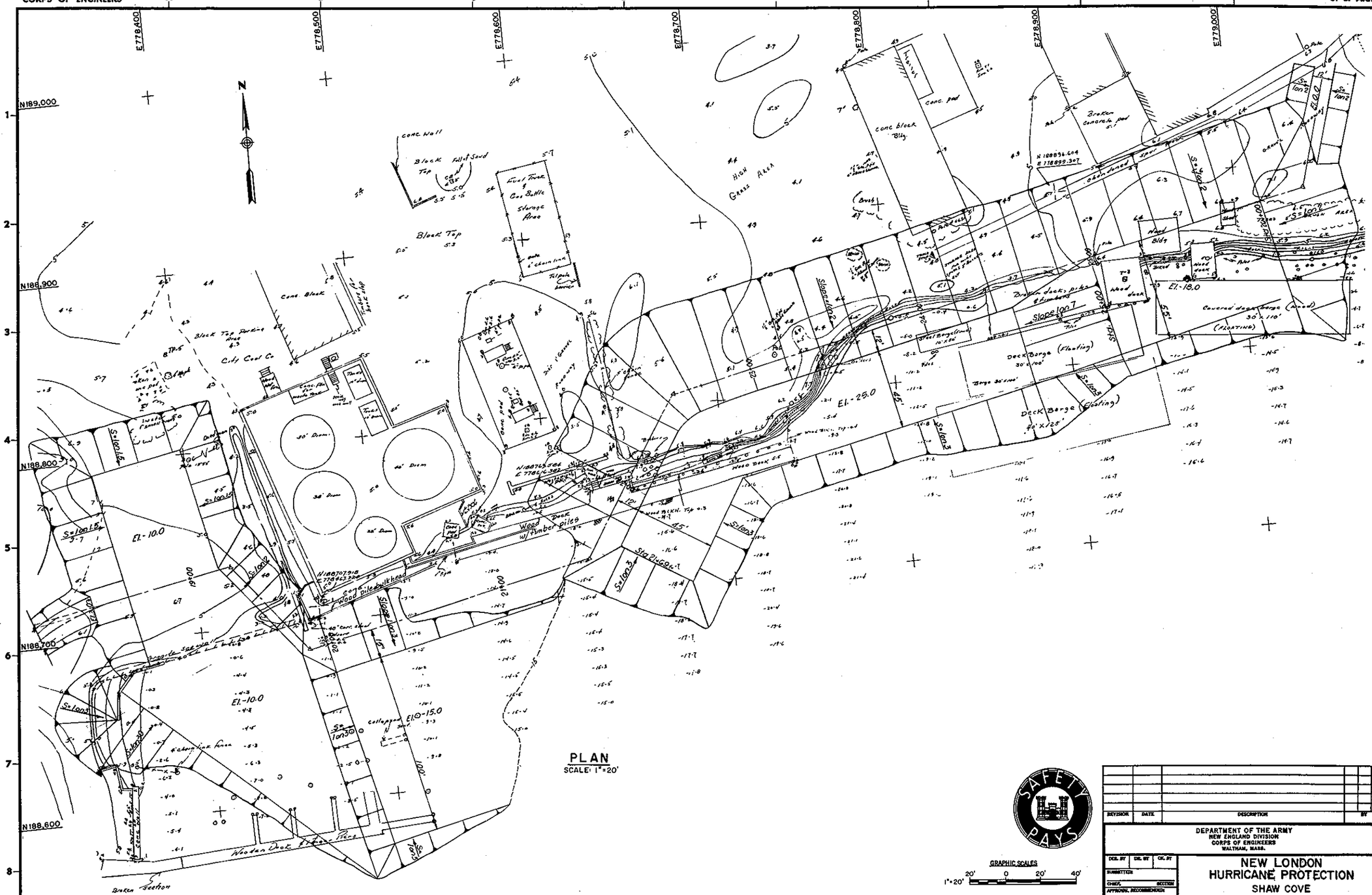
# NEW LONDON HURRICANE PROTECTION
## SHAW COVE
## SLUICE GATE - STRUCTURAL SECTIONS AND DETAILS

NEW LONDON CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO.
DRAWING NUMBER
SHEET

CORPS OF ENGINEERS U. S. ARMY




PLAN
SCALE: 1"=20'

GRAPHIC SCALES
1"=20' 20' 0 20' 40'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

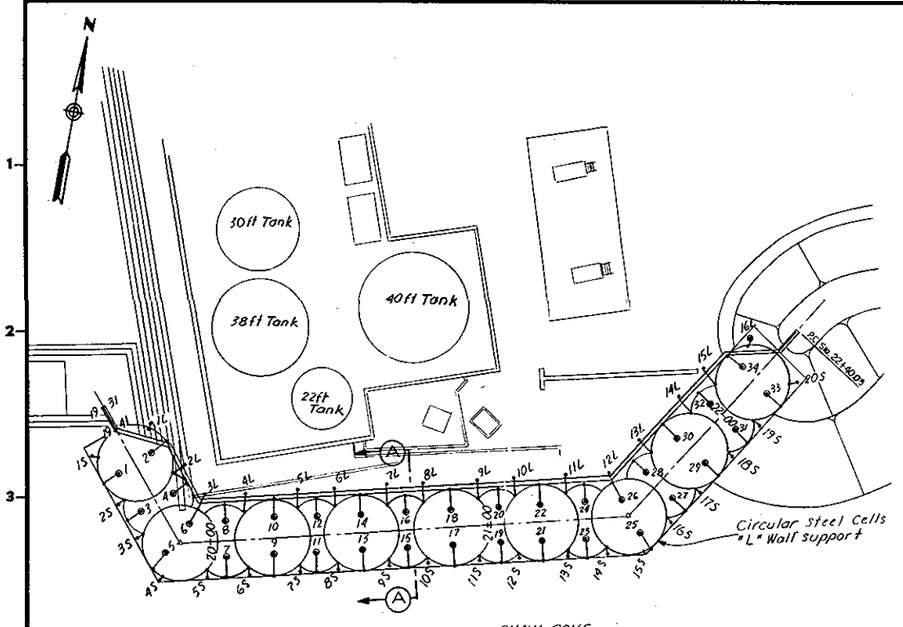
# NEW LONDON HURRICANE PROTECTION
## SHAW COVE
## EXCAVATION PLAN

NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION

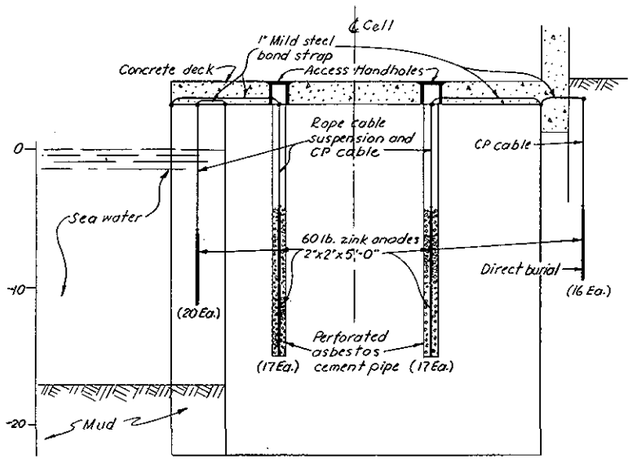
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 6-22

CORPS OF ENGINEERS — U. S. ARMY




PLAN
SCALE 1" = 20'




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

NOTE:
Provide 1" mild steel low resistance bond strap tack welded to each pile with taps for connection to adjacent anodes.
• = 60 lb. Zinc Anode (2"x2"x5')
○ = Access Handhole

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1/4" = 1'-0" 4' 0 4' 8'

SAFETY PAYS

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
CATHODIC PROTECTION
PLAN AND SECTION
NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 6-23

# APPENDIX A

## STRUCTURAL COMPUTATIONS

## INDEX TO SHEETS


| TITLE | PAGE NO. |
|---|---|
| Pumping Station | |
| Design Data | A1 |
| Superstructure | A3 |
| Operating Floor | A9 |
| Substructure | A16 |
| End Wall | A31 |
| Stability - Pile Loads | A36 |
| Flood Walls | |
| I-Wall | A47 |
| Cells | A55 |
| L-Wall | A63 |

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

PAGE A1

SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION
COMPUTED BY R. HARRINGTON CHECKED BY DATE SEPT 1977

DESIGN DATA

CONC. - $f_c' = 3000\ \#/in^2$

$f_c$ operating floor & above $= 1350\ \#/in^2$

$f_c$ below operating floor $= 1050\ \#/in^2$

REINF. Steel $f_s = 20{,}000\ \#/in^2$

CONC. Cover. - INTERIOR SLABS, GIRDERS, BEAMS - 1½"

- CONC. EXPOSED TO WATER - 4"
- BOT. BASE SLABS - 6"
- CONC. EXPOSED TO EARTH - 3"

LOADING

Operating floor beams - 100 #/SF + EQUIP. IN DESIGN LOCATION

operating floor - Heaviest Equip load in any location

Roof - 40 #/SF SNOW.

Wind, Roof - 25 #/SF uplift

Wind, Walls - 20 #/SF

Earthquake - .025 g.

Earth Pressures (walls) - assume at rest coef = 0.5

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27 Sept 49

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SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION
COMPUTED BY R. HARRINGTON CHECKED BY DATE

EQUIPMENT LOADING FROM J. SHAUGHNESSY 11/1/77

| | | |
|---|---|---|
| PUMP | — 6500# | 12,800# |
| UMBRELLA | — 900# | |
| THRUST | — 4000# | |
| GEAR UNIT | — 1400# | — BASE AREA 2'x2' |
| ENGINE | — 3100# | — BASE AREA 5'x3' |

CONC. ENGINE BASE — 3'x6'x1'-9" = 4740#

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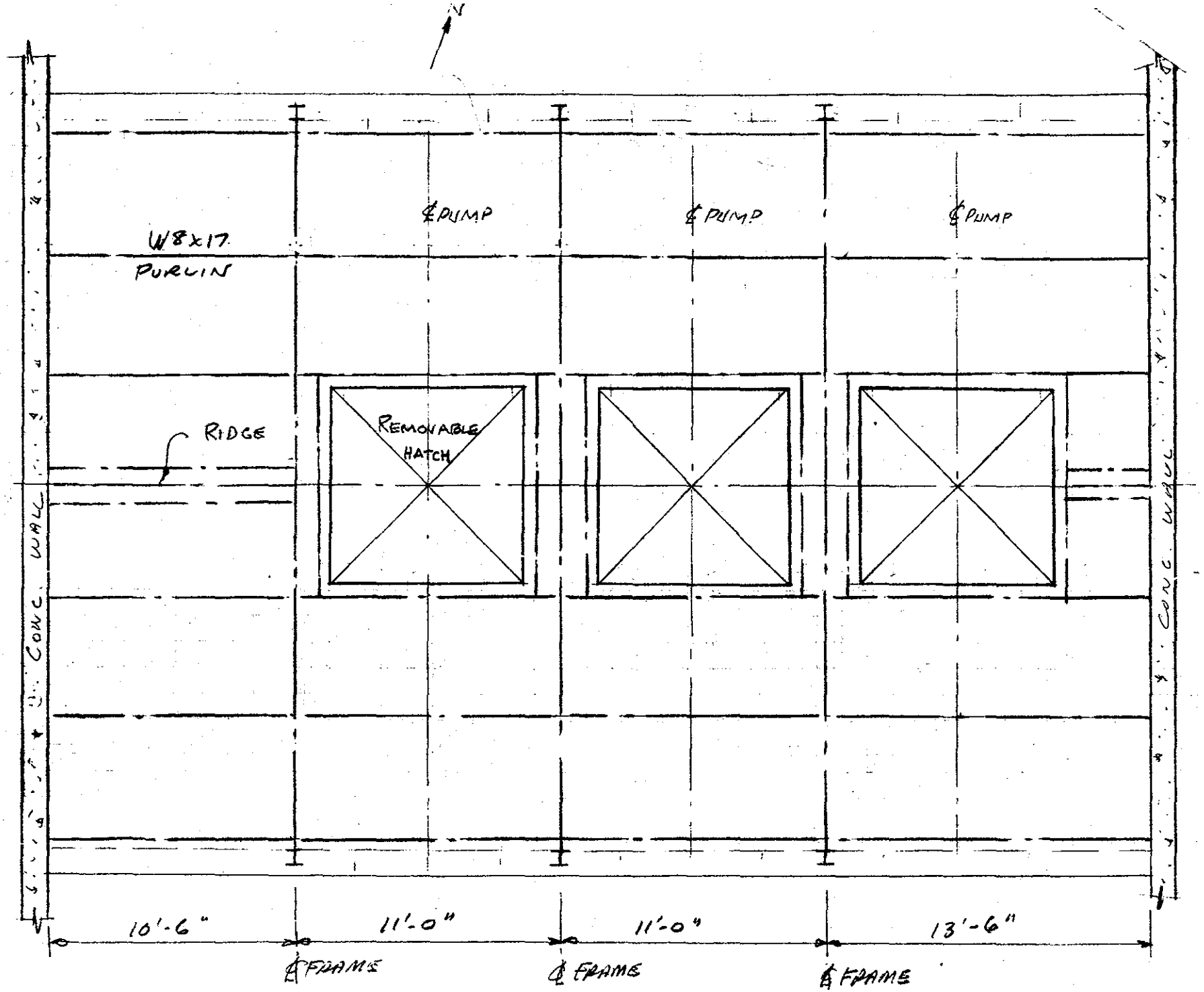
SUBJECT New London Hurricane Barrier
COMPUTATION Pumping Station - Roof Framing
COMPUTED BY Harrington CHECKED BY WHR DATE 20 Oct 77

PAGE A3



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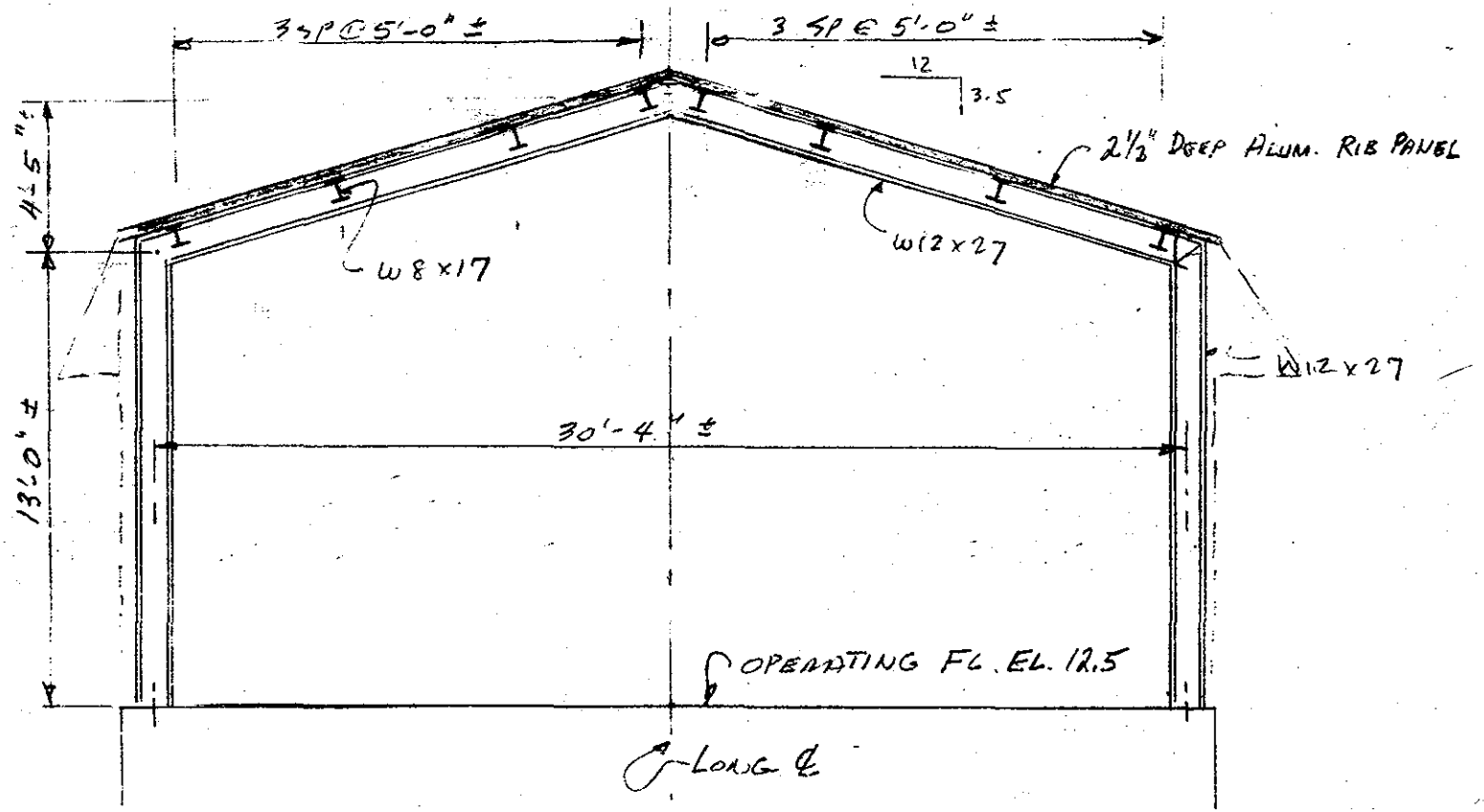
SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION - ROOF FRAMING
COMPUTED BY HARRINGTON CHECKED BY WAC DATE 20 Oct 71



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27 Sept 49

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SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION - ROOF FRAMING
COMPUTED BY HARRINGTON CHECKED BY WHR DATE 20 Oct 77

LOADS ON ROOF

EM 1110-2-3104

WIND - OUTWARD PRESS. NORMAL TO SURFACE $\measuredangle < 30°$

$= 1.25 \times 20 = 25$ PSF UPLIFT. ✓

$81^2 \times .00256 = 17$ PSF $< 20$ ✓

SNOW

MIN = 20 #/SF

CONN. BUILDING CODE.

WIND ON PRIMARY FRAMING

$13/46 = 0.28$

WINDWARD SLOPE $= -0.33 \times 15$ #/SF $= -5.0$ #/SF
LEEWARD SLOPE $= -0.50 \times 15$ $= -7.5$ #/SF

WIND ON PANEL & PURLINS

WINDWARD $= -5.0 \times 1.5 = -7.5$ #/SF
LEEWARD $= -7.5 \times 1.5 = -11.2$ #/SF

INCREASE FOR INSULATED ROOF.

SNOW LOAD = 30 #/SF + 10 #/SF = 40 #/SF

CONCLUSIONS - DESIGN ROOF PANELS AND PURLINS FOR:

Snow — 40 #/SF DOWNWARD LOAD —

Wind — 25 #/SF UPLIFT —

FOR WIND LOADING ALLOW 1/3 INC. —

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY



SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION - ROOF FRAMING
COMPUTED BY HARRINGTON CHECKED BY WHE DATE 20 OCT 77

ROOF PANELS MAX SPAN = 5.0' ALONG SLOPE = 5.21'

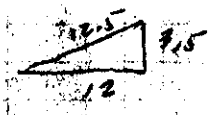
USE - .032 GA. ALUM. INSUL. ZIP RIB PANEL OR EQUAL

WGT PANEL = 1 #/SF

SPECIAL FASTENING DETAILS REQD FOR 25 #/SF UPLIFT

TYP. PURLIN

DL = 1.0 x 5.2 = 5.2 #/LF
LL = 40 x 5 = 200.
PURL = 15# ASSUME = 15.




$\Sigma w$ = 220 #/LF

$w_x = 12/12.5 \times .22 = 0.21$ k/LF  $w_y = 3.5/12.5 \times .22 = .062$ k/LF

$M_x = 0.21 \times 13.5^2/8 = 4.8$ 'k  $M_y = 0.062 \times 13.5^2/8 = 1.42$ 'k

TRY W8x15  $r_T = 1.04$, $d/A_f = 6.44$

$S_{xx} = 11.8$  $S_{yy} = 1.69$

$L/r_T = \frac{12 \times 13.5}{1.04} = 156$  Cb = 1.0

1.5.66 = $F_b = \frac{170,000}{156^2} = 7.0$

1.5.7 = $F_b' = \frac{12000}{12 \times 13.5 \times 6.44} = 11.5$ ← USE

$f_{bx} = \frac{4.8 \times 12}{11.8} = 4.9$, $f_{by} = \frac{1.42 \times 12}{1.69/2} = 20.2$

$\overset{.43}{4.9/11.5} + \overset{.75}{20.2/27} = 1.18 > 1.0$  NO GOOD

TRY W8x17  $r_T = 1.4$  $d/A_f = 4.95$

$S_{xx} = 14.1$  $S_{yy} = 2.83$

SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION - ROOF FRAMING
COMPUTED BY HARRINGTON CHECKED BY DATE 20 Oct 77

PURLIN (CONTD)

$L/r_t = \frac{13.5 \times 12}{1.4} = 115$ ✓

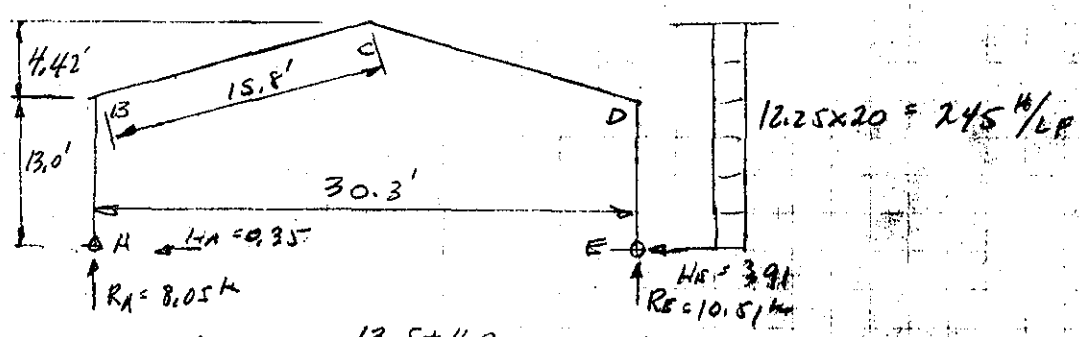
1.5.6b $F_b = \frac{170{,}000}{115^2} = 12.85$ ✓

1.5.7 $F_b = \frac{12{,}000}{12 \times 13.5 \times 4.95} = 15.0$ ←

$f_{bx} = \frac{4.8 \times 12}{14.1} = 4.1$ $f_{by} = \frac{1.42 \times 12}{2.83/2} = 12.1$

$\frac{4.1}{15.0} + \frac{12.1}{27} = 0.72 < 1.0$ ✓ USE W8X17

FRAME $12.25 \times 46 + 50 = 614^{\#}/LF$




SPACING OF FRAME $= \frac{13.5 + 11.0}{2} = 12.25'$

VERTICAL LOAD = SNOW = $40^{\#}/SF$
ROOFING = 1
PURL. $= 17 \times 12.25/5 = 5$
$46^{\#}/SF$ + GIRD. (ASSUME $50^{\#}/LF$

WIND ON VERT SURFACE $= 20^{\#}/SF$

$Q = \frac{4.42}{13} = 0.34$ $\frac{I_2}{I_1} = 1.0$ $k = \frac{13}{15.8} = 0.825$ $C_1 = .06$

$H_E = .06 \times 0.614 \times \frac{30.3^2}{13} = 2.6$ $H_A = 2.60$

$k = 0.41$

$H_E = 0.41 \times .245 \times 13 = 1.31$ $H_A = 17.42(.245) - 1.31 = 2.95$

3.91 4.26 .35

FRAME (CONT'D)

V $R_A$ $\frac{.614 \times 30.3}{2} = 9.28$ $R_E = d_o = 9.28$

H $R_A$ $\frac{.245 \times 17.42^2}{2 \times 30.3} = -1.23$ $R_E = d_o = +1.23$

8.05 10.51

GIRDER @ KNEE (ASSUME 12" COL DEPTH)

MOM. (WITH WIND) = $3.9 \times 13 = -51^{'k}$

MOM. (WITHOUT WIND) = $2.6 \times 13 = -34^{'k}$

MOM @ RIDGE = $\frac{.614 \times 30.3^2}{8} - 2.6 \times 17.42 = 25^{'k}$

AXIAL FORCE = $3.91 \times \frac{15.15}{15.8} + 10.51 \times \frac{4.42}{15.8} = 3.74 + 2.94 = 6.68^k$

GIRDER BRACED @ 9'-0" @ ℄ (ridge), @ 5'-0" @ (eave to hatch opng)

TRY W12x27 $r_{yy} = 1.52$ $A = 7.95$ $S_{xx} = 34.2$ $r_T = 1.74$ $d/A_f = 4.6$

$KL/r = 9 \times 12 / 1.52 = 71$ $F_a = 16.33$ $f_a = 6.68/7.95 = 0.84$

$F_b = 22$ $f_b = \frac{51 \times 12}{34.2} = 17.9$

$0.84/16.33 + 17.9/22 = 0.87$

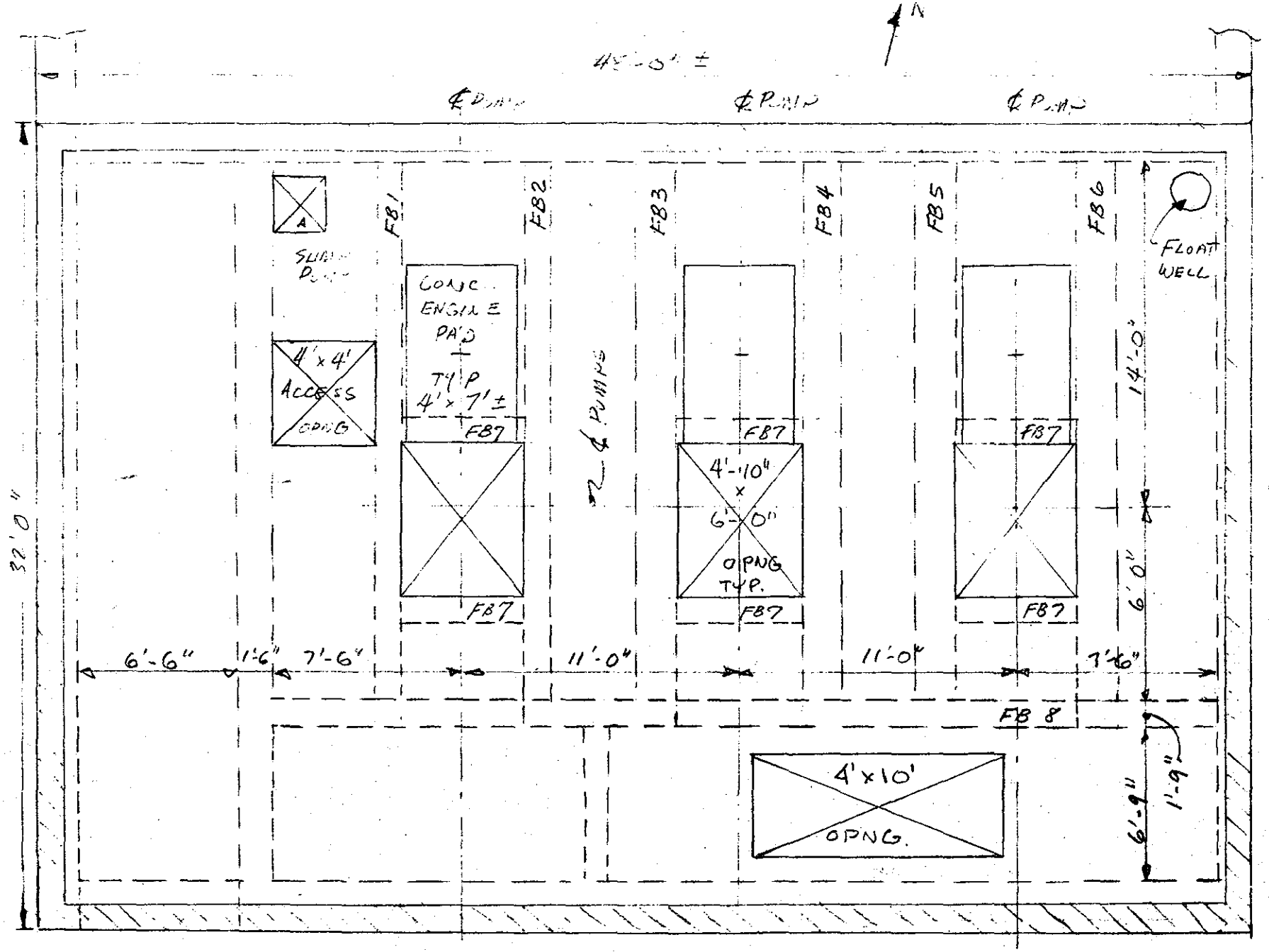
COLUMN SECTION, $M = 51^{'k}$ AXIAL LD @ TOP = $10.51^k$

$KL/r = 13 \times 12 / 1.52 = 103$

$F_a = 12.59$ $f_a = 10.51/7.95 = 1.33$

$F_b = \frac{12000 \times 1.75}{13 \times 12 \times 4.60} = 29.2 > 22$

$1.33/12.59 + 17.9/22 = 0.93$




PLAN - OPERATING FLOOR

3/16" = 1'-0"

CORPS OF ENGINEERS, U.S. ARMY

SUBJECT NEW LONDON HURRICANE BARRIER

COMPUTATION PUMPING STATION

COMPUTED BY R. HARRINGTON CHECKED BY DATE SEPT 1977

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27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

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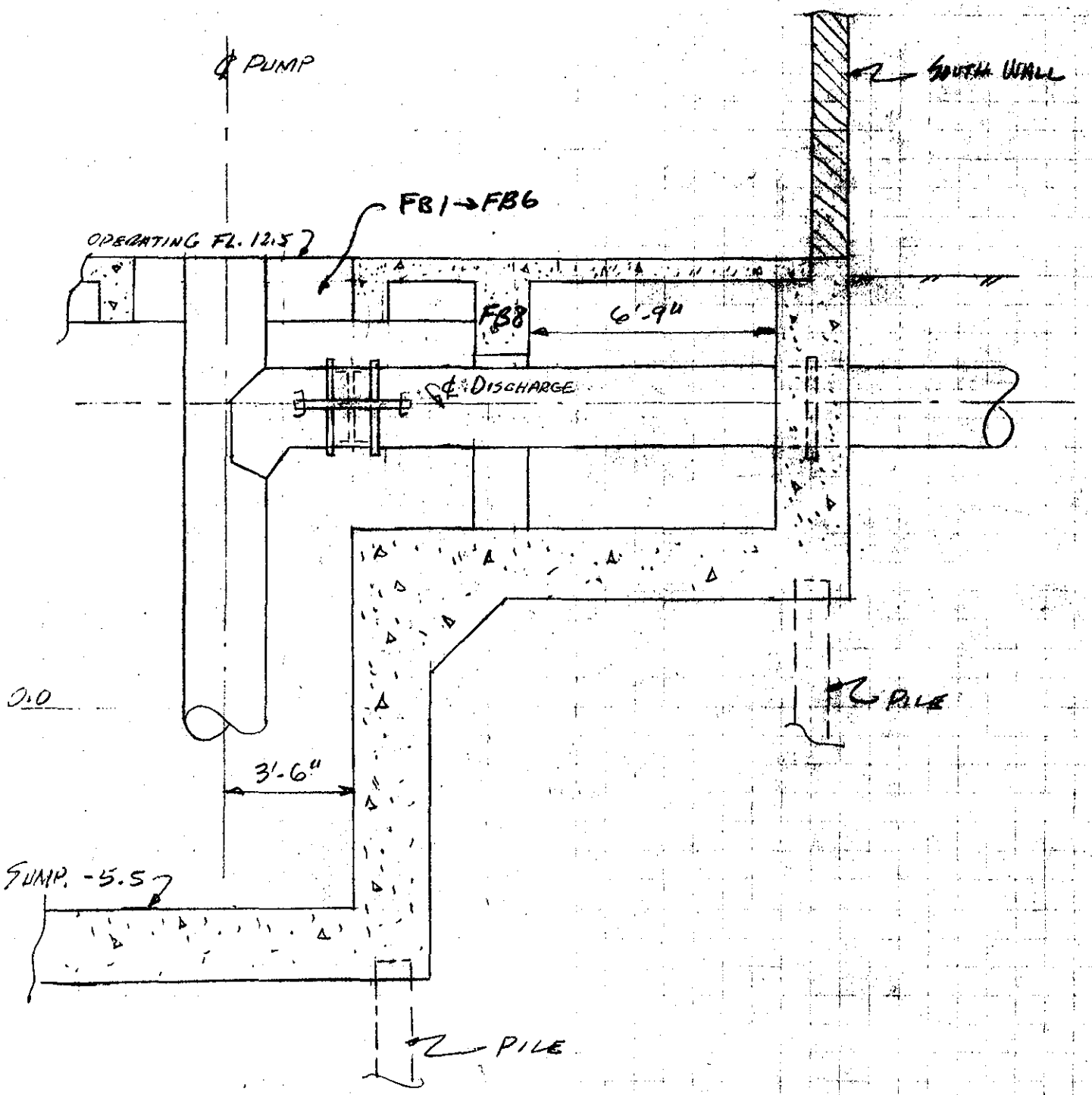
SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION - PRELIMINARY
COMPUTED BY P. HARRINGTON CHECKED BY DATE SEPT. 1977




SECTION @ SOUTH WALL

1/4" = 1'-0"

SUBJECT New London Hurricane Barrier
COMPUTATION Pumping Station
COMPUTED BY R. Harrington CHECKED BY DATE Oct. 1977

## Operating Floor Slab

Max clear slab span over sump area = 3'-6"

Max clear slab span over sluiceway & valve pit = 6'-6"

Design for heaviest equipment weight anywhere on floor

Engine wgt = 3100# / 5'x3' = 207 #/SF or 3100/5 = 620 #/LF

Gear unit = 1400 / 2'x2' = 350 #/SF or 1400/2 = 700 #/LF

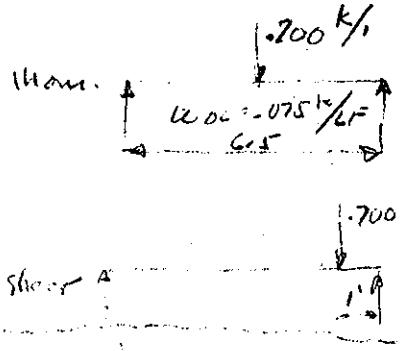
### 3'-6" span

$w_{LL}$ = 350 #/SF
$w_{DL}$ = 075 #/SF
$w_{TOT}$ = 425 #/SF

$M_{TOT} = \frac{.425 \times 3.5^2}{8} = 0.65$ 'k/'

$V = .425 \times 3.5 \times \frac{1}{2} = 0.74$ k/'

### 6'-6" span




$M_{LL} = .70 \times 6.5 \times \frac{1}{4} = 1.14$ 'k/' or $\frac{.207 \times 6.5^2}{8} = 1.09$

$M_{DL} = .075 \times 6.5^2/8 = .40$

$M_{TOT} = 1.54$ 'k/' ←

$V_{LL} = 0.70 \times 5.5/6.5 = 0.59$

$V_{DL} = .075 \times 3.25 = 0.24$

$V_{TOT} = 0.83$ ←

$d_{reqd} = \sqrt{\frac{1.54}{.236}} = 2.55''$  $t_{REQD} = 2.55 + 1.5 + 0.5 = 4.55''$

Assume 6" slab d = 4"

$N_{max} = \frac{830}{12 \times 4} = 17.3$ #/"²

$A_{s_{MAX}} = \frac{1.54}{1.44 \times 4} = 0.27$  #5@12"

NED FORM 223
27 Sept 49

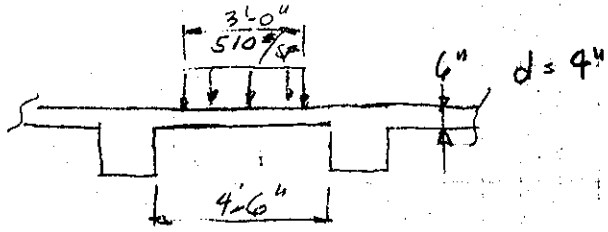
**NEW ENGLAND DIVISION**
**CORPS OF ENGINEERS, U. S. ARMY**



SUBJECT
COMPUTATION
COMPUTED BY CHECKED BY DATE

PERMANENT FLOOR SLAB (CONT'D)

CHECK SLAB IN ENGINE AREA:




ENGINE WGT = 3100#
PAD = 3×6×1.75×150 = 4740
7840/18 = 435# SF

DL SLAB = 75
Σ = 510 #/SF

$M = \frac{.510 \times 4.5^2}{8} = 1.3^{'k}$ $d_{req} = \sqrt{\frac{1.3}{.236}} = 2.35 < 4.0$

$V = .510 \times 4.5 \times \frac{1}{2} = 1.15^{k/'}$ $v = \frac{1150}{12 \times 4} = 24\ \#/in^2$ ok

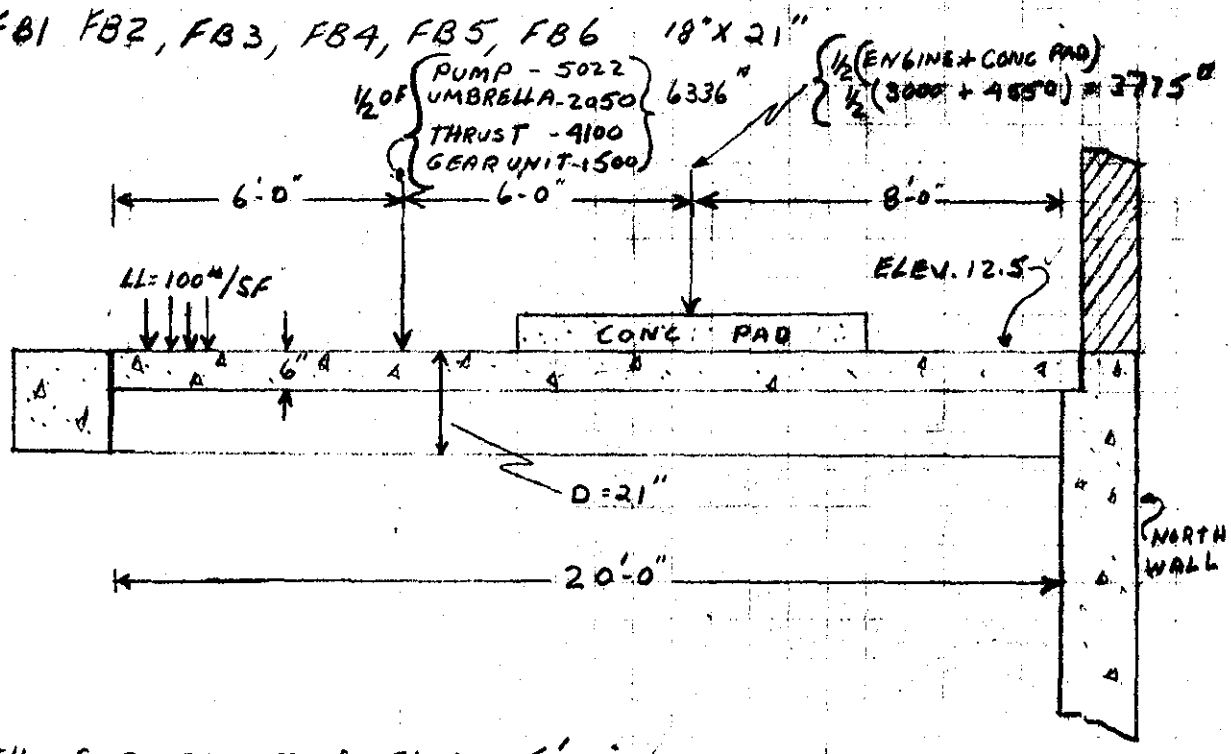
SUBJECT NEW LONDON HURRICANE BARRIER

COMPUTATION PUMPING STATION - OPERATING FLOOR BEAMS

COMPUTED BY E.E. CHECKED BY RLH DATE SEPT 1977

REVISE EXISTING CALC'S BY R. HARRINGTON TO REFLECT LATEST LAYOUT DIMENSIONS & CONFIGURATION

BEAMS FB1 FB2, FB3, FB4, FB5, FB6 18"X 21"




WIDTH OF CONTRIBUTING SLAB = 6'-0"

$W_{DL} + W_{LL} = (6.0 \times 75) + (6.0 \times 100) = 450 + 600 = 1050$ #/LF

$W_{Bm\ wgt}$ = use 18X15 for 18X21 = $1.5 \times 1.25 \times 150 = 282$ # LF

1332 #/LF

$R_R = (1332 \times 20 \times 1/2) + (3775 \times 12/20) + (6336 \times 6/20) = 17{,}486$ #

$R_L = 13{,}320 + 1510 + 4435 = 19265$ #

Pt 0 Shear = $(17486 - 3775)/1332 = 10.6$ ft from $R_R$

$M_{max}$ @ 10.6' from $R_R$ = $(17.49^{185} \times 10.6) - (3.77^{9.8} \times 2.6) - 1.33^{75} \times \frac{10.6^2}{2} = 100^{1k}$

SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION - OPERATING FLOOR BEAMS
COMPUTED BY E.E. CHECKED BY RLH DATE SEPT 1977

$$d_{req} = \sqrt{\frac{100 \times 12}{18 \times .236}} = 16.8'' + 1.5 + .5 = 18.9$$

USE $D = 21''$ $d = 21 - 2 = 19''$ ✓

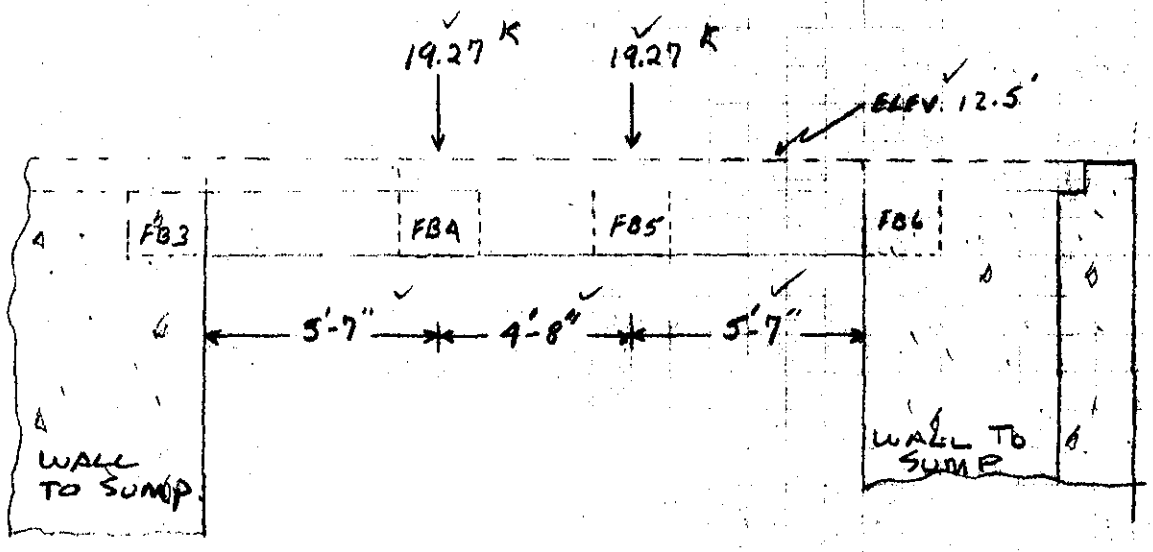
$$v = \frac{19265}{18 \times 19} = 56 \text{ psi min. stirr. reqd.}$$

$$A_s = \frac{100}{1.44 \times 19} = 3.65 \text{ in}^2 \quad 5\#8 \quad A_s = 3.95 \text{ in}^2$$ ✓

$$\text{Min } A_s = .005 \times 18 \times 19 = 1.72 \text{ in}^2 < 3.95 \text{ in}^2$$ ✓

O.K.

BEAM - FB8




ELEVATION

SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION PUMPING STATION - OPERATING FLOOR BEAMS
COMPUTED BY RLH CHECKED BY E.E. DATE SEPT 1977

F13.8 (CONT'D)

WIDTH OF CONTRIBUTING SLAB OVER VALVE PIT = 4'

ASSUME BM = 21" x 30" d = 28"

$w_{DL} + w_{LL} = (4 \times 0.075) + (4 \times 0.100) = 0.70$ k/'

$w_{BM} = 1.75 \times 2.5 \times 0.15 = 0.66$ k/'

$w_{TOT} = 1.36$ k/'

$R_L = R_R = 1.36 \times 15.83/2 + 19.27 = 30.3^k$

$M_{max} @ \mathcal{E} = (30.3 \times 7.92) - (1.36 \times 7.92^2/2) - (19.27 \times 2.33) = 156^{'k}$

$d_{reqd} = \sqrt{\frac{156 \times 12}{18 \times .236}} = 21 < 28$ ok

$v = \frac{30,300}{21 \times 28} = 51.53$ psi + Torsion.

$A_s = \frac{156}{1.44 \times 28} = 3.87''^2$ 5-#8 $A_s = 3.95''^2$

$Min\ A_s = .005 \times 21 \times 28 = 2.94''^2 < 3.95$

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT New London Hurricane Barrier
COMPUTATION Pumping Station
COMPUTED BY UF
CHECKED BY
DATE April '78
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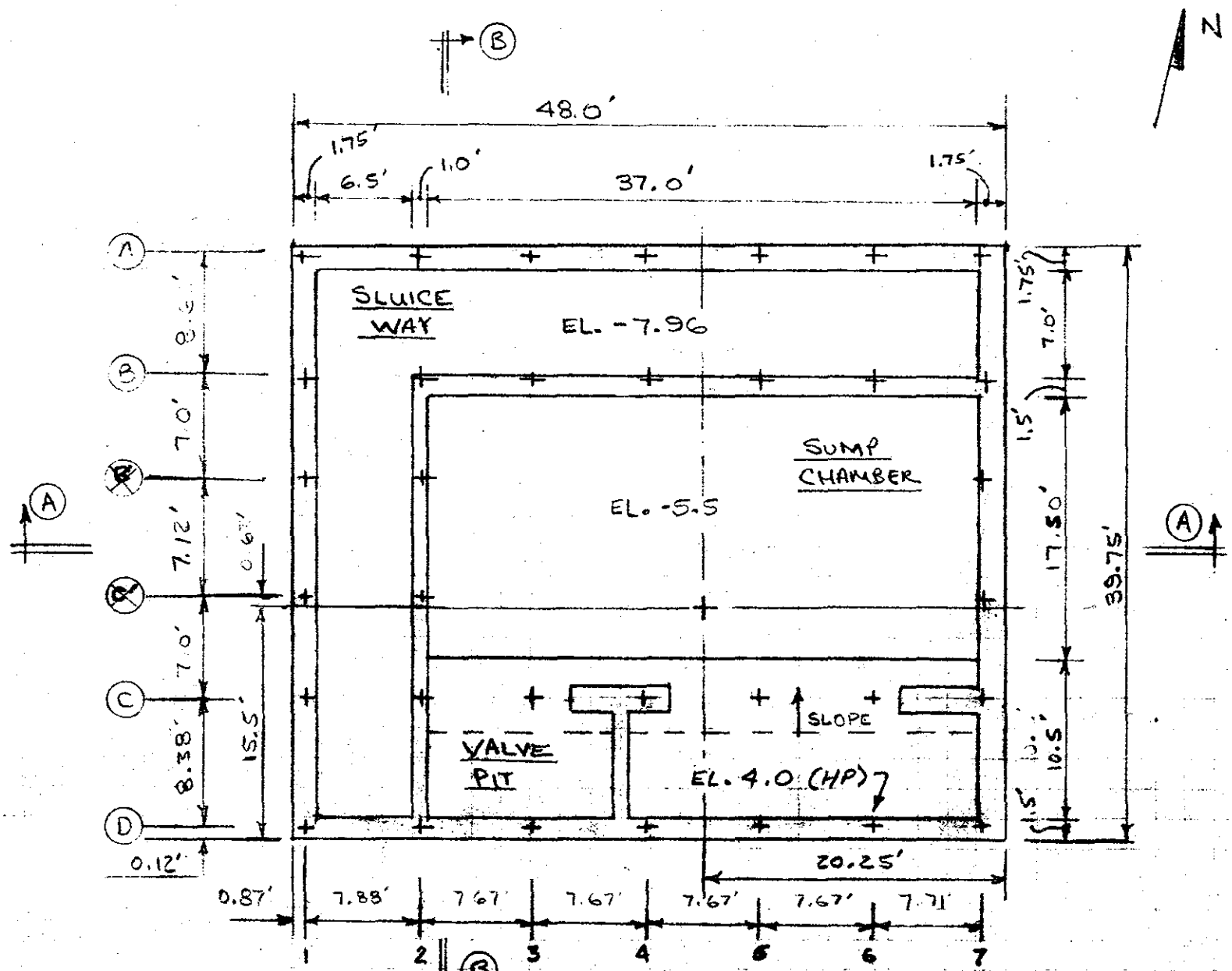
Base Slab Design




PLAN - BASE SLAB
SCALE: 1" = 10.0'

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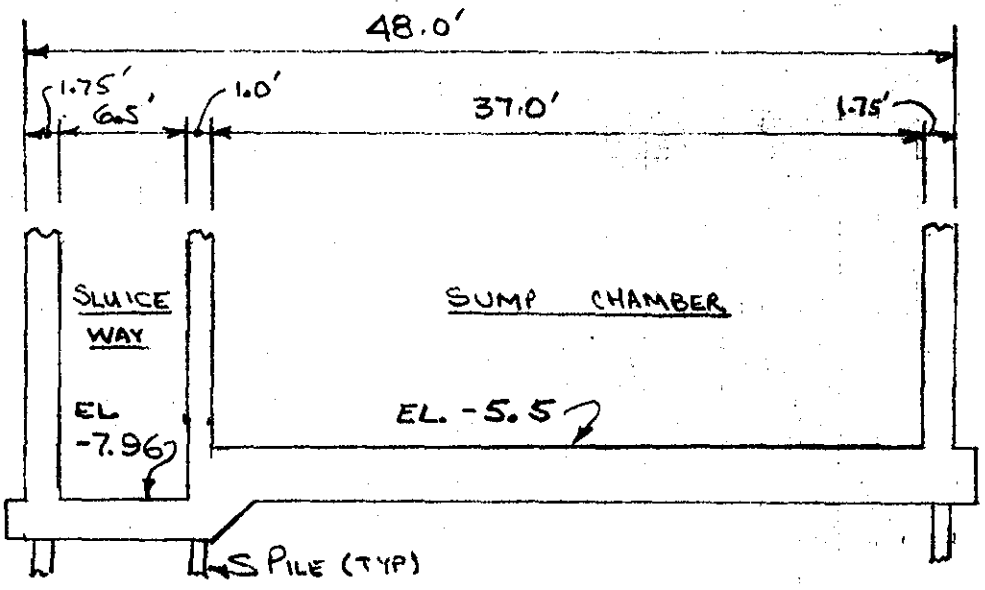
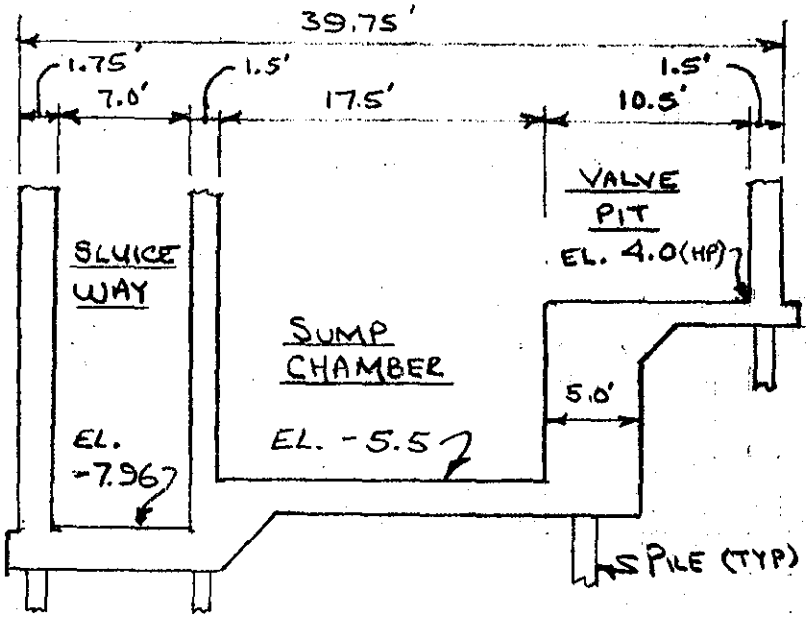
SUBJECT New London
COMPUTATION Pumping Station B2
COMPUTED BY JF CHECKED BY DATE April '78




SECTION (A)(A)
SCALE: 1" = 10.0'




SECTION (B)(B)
SCALE: 1" = 10.0'

## LOADING CASES

### CASE No. 1

a. DEAD LOAD
b. NO EQUIPMENT
c. NO WATER INSIDE
d. WATER OUTSIDE TO EL. 6.5'

### CASE No. 2

a. STRUCTURE DEAD LOAD
b. EQUIPMENT
c. WATER INSIDE TO EL. +5.0
d. WATER OUTSIDE TO EL. -4.4

## DESIGN CONSTANTS

$f'_c = 3000$ PSI
$f_c = 1050$ PSI
$f_s = 20000$ PSI

$\therefore \begin{cases} K = 152 \text{ psi} \\ a = 1.44 \\ j = 0.891 \end{cases}$ $v_c = 60$ psi

CONC. COVER:

BOT. OF BASE SLAB - 6"
CONC. EXPOSED TO WATER - 4"
" " " EARTH - 3"
} see below

EARTH PRESS. ($K_o$) = 0.5

* MIN. SLAB &/OR WALL THICKNESS:

BASE SLAB: $t_{MIN} = 6 + 4 + 2 \times 1.0 + 2 = 14''$

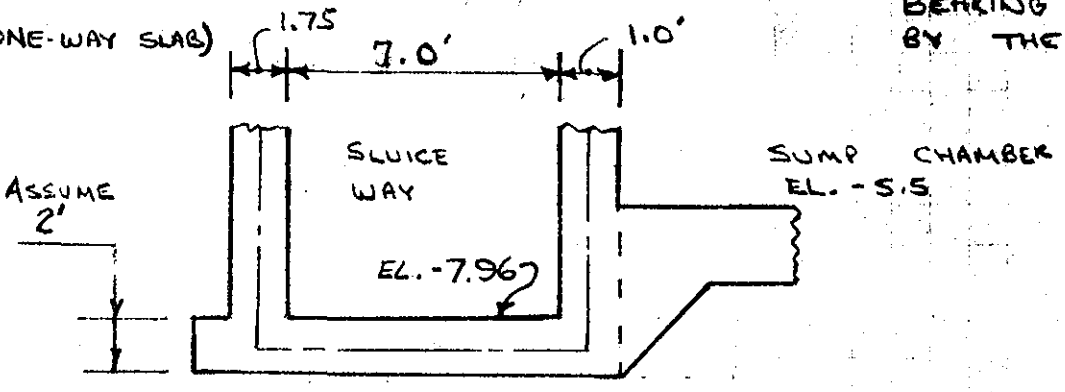
WALL EXPOSED TO WATER: $t_{MIN} = 4 + 4 + 2 \times 1.0 + 2 = 12''$

$A_{SMIN} = 0.002\,bt$

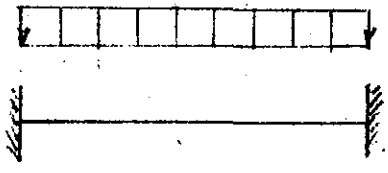
## SLUICE WAY

NOTE: ASSUME ALL BEARING IS TAKEN BY THE PILES.

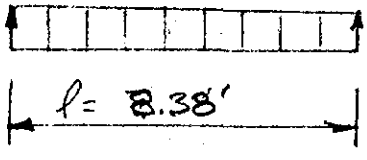
(ONE-WAY SLAB)




CASE 1:



$w_c = 0.15 \times 2 = 0.30$ KSF




$w_u = 0.0625 \times (6.5 - (-9.96)) = 1.03$ KSF

NET $w = 1.03 - 0.30 = 0.73$ KSF ↑

$M_N = \frac{wl^2}{12} = 0.73 \times \frac{8.38^2}{12} = 4.27$ K'

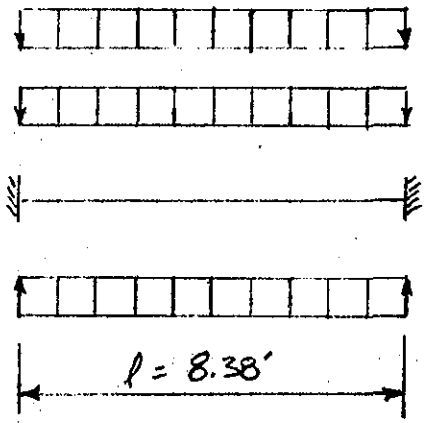
$M_P = \frac{wl^2}{24} = 0.73 \times \frac{8.38^2}{24} = 2.14$ K'

$d_{REQ} = \sqrt{\frac{4.27}{0.152}} = 5.30 \quad \therefore \quad t = 5.5 + 6.5 = 12.0''$

$A_{SN} = \frac{4.27}{1.44 \times 5.5} = 0.54$ IN$^2$ (BOT) $\qquad V = \frac{0.73 \times 7.0}{2} = 2.56^k$

$A_{SP} = \frac{2.14}{1.44 \times 7.5} = 0.20$ IN$^2$ (TOP) $\qquad v = \frac{2560}{12 \times 5.5} = 38.7$ psi $< 60$ psi

CASE 2:




$w_c = 0.15 \times 2.00 = 0.30 \downarrow$ KSF

$w_w = 12.96 \times 0.0625 = 0.81 \downarrow$ KSF

$w_u = 5.56 \times 0.0625 = 0.35 \uparrow$ KSF

$w_{NET} = \quad = 0.76 \downarrow$ KSF

$M_N = \frac{wl^2}{12} = \frac{0.76 \times 8.38^2}{12} = 4.45$ 'K $\qquad d_{REQ} = \sqrt{\frac{4.45}{0.152}}$

$M_P = \frac{M_N}{2} = \frac{4.45}{2} = 2.22$ 'K $\qquad d_{REQ} = 5.41$ in

$A_{SN} = \frac{4.45}{1.44 \times 7.5} = 0.41$ in$^2$ (TOP) $\qquad V = \frac{0.76 \times 7.0}{2} = 2.66$ K

$A_{SP} = \frac{2.22}{1.44 \times 5.5} = 0.28$ in$^2$ (BOT) $\qquad v = \frac{2660}{12 \times 7.5} = 30$ psi

SUMP CHAMBER

LONG SPAN = 38.38'
SHORT SPAN = 19.00'
$\frac{LS}{SS} = \frac{38.38}{19.00} \approx 2.0$ ∴ ASSUME TWO-WAY ACTION

CASE 1:

$w_c = 0.30$ KSF ↓
$w_u = 0.0625 \times (6.5 - (-7.5)) = 0.88$ KSF ↑

$w = 0.88 \uparrow - 0.30 \downarrow = 0.58 \uparrow$ KSF

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USE METHOD 2 ACI-63 A2002

CASE 5 - FOUR DISCONTINUOUS EDGES

$$m = \frac{SS}{LS} = \frac{19.00}{38.38} = 0.5$$

COEFFICIENTS (C) $M = CwS^2$

| MOMENTS | SHORT SPAN | LONG SPAN | |
|---|---|---|---|
| M (-) | 0.055 | 0.033 | @ EDGE |
| M (+) | 0.083 | 0.050 | @ MID-SPAN |

$M(-)S = 0.055 \times 0.58 \times 19.0^2 = 11.52'^K$ (B)

$M(+)S = 0.083 \times 0.58 \times 19.0^2 = 17.38'^K$ (T)

$M(-)L = 0.033 \times 0.58 \times 19.0^2 = 6.91'^K$ (B)

$M(+)L = 0.050 \times 0.58 \times 19.0^2 = 10.47'^K$ (T)

$d_{req} = \sqrt{\frac{17.38}{0.152}} = 10.7$ in

$t \approx 10.5 + 4.5 = 16$ in
[$d(-) = 9.5$ in., $d(+) = 11.5$ in.]

$A_{s(-)S} = \frac{11.52}{1.44 \times 9.5} = 0.84$ in$^2$ (BOT)

$A_{s(+)S} = \frac{17.38}{1.44 \times 11.5} = 1.05$ in$^2$ (TOP)

$A_{s(-)L} = \frac{6.91}{11.52} \times 0.84 = 0.50$ in$^2$ (BOT)

$A_{s(+)L} = \frac{10.47}{17.38} \times 1.05 = 0.63$ in$^2$ (TOP)

SHEAR

| | LS | SS |
|---|---|---|
| EQUIVALENT UNIFORM LOAD = | $wS \div 3$ | $wS(3-m^2) \div 6$ |
| $w'$ = | $0.58 \times 19 \div 3 = 3.67$ | $0.58 \times 19(3-0.5^2) \div 6 = 5.05$ |
| $v$ = | $\frac{3.67 \times 1000}{12 \times 9.5}$ | $= 5.05 \times 1000 \div (11.5 \times 12)$ |
| $v$ = | 32 psi < 60 psi | = 36 psi < 60 psi |

$v = \frac{w' \times 1000}{bd}$

CASE 2:

$w_c = 0.30$ KSF ↓
$w_w = 0.0625 \times (5.0 - (-5.5)) = 0.66$ KSF ↓
$w_u = 0.0625 \times (7.5 - 4.4) = 0.19$ ↑

$w = 0.77$ KSF ↓

$M_{(-)S} = 0.055 \times 0.77 \times 19.0^2 = 15.29'^k$ (T)

$M_{(+)S} = 0.083 \times 0.77 \times 19.0^2 = 23.07'^k$ (B)

$M_{(-)L} = 0.033 \times 0.77 \times 19.0^2 = 9.17'^k$ (T)

$M_{(+)L} = 0.050 \times 0.77 \times 19.0^2 = 13.90'^k$ (B)

$d_{REQ} = \sqrt{\frac{23.07}{0.152}} = 12.3$ in (-) ∴ $t = 12.5 + 6.5 = 19$ in
[$d(-) = 12.5$, $d(+) = 14.5$]

$A_{s(-)S} = \frac{15.29}{1.44 \times 12.5} = 0.85$ in² (TOP)

$A_{s(+)S} = \frac{23.07}{1.44 \times 14.5} = 1.10$ in² (BOT.)

$A_{s(-)L} = \frac{9.17}{1.44 \times 12.5} = 0.51$ in² (TOP)

$A_{s(+)L} = \frac{13.90}{1.44 \times 14.5} = 0.67$ in² (BOT.)

SHEAR

| | LS | SS |
|---|---|---|
| $w'$ | $= 0.77 \times 19.0 \div 3$<br>$= 4.88$ KSF | $= 0.77 \times 19.0 (3 - 0.5^2) \div 6$<br>$= 6.71$ KSF |
| $v$ | $= \frac{4880}{12 \times 12.5}$ | $= \frac{6710}{12 \times 12.5}$ |
| | $= 32.5$ psi $< 60$ psi OK | $= 44.7$ psi $< 60$ OK |

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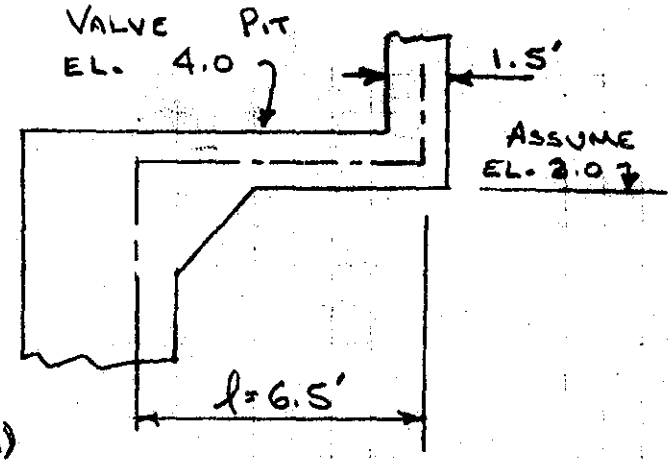
VALVE PIT




(ONE WAY SLAB)

$l = 6.5'$

CASE 1:

$w_c = 0.15$ KSF ↓
$w_w = 0.0625 \times 4.5 = 0.28$ ↑ KSF

$w = 0.13$ KSF ↑ (NOT MUCH)

$M(-) = \frac{wl^2}{12} = \frac{0.13 \times 6.5^2}{12} = 0.46$ 'K

$d_{REQ} = \sqrt{\frac{.46}{0.152}}$

$M(+) = 0.23$ 'K (= ½ M(-))

$d_{REQ} = 1.74$

$V = \frac{wl}{2} = \frac{0.13 \times 6.5}{2} = 0.42^K$

$t_{MIN} = 14$ in
$d_t = 9.5''$ $d_{(-)} = 7.5''$

USE MIN REINF i.e. $A_s = 0.001 \times 12 \times 14$
$A_s = 0.17$ in² use #5 @18"

SHEAR OK BY INSPECTION

CASE 2:

$w_c = 0.15$ KSF ↓
$w_w = 0.06$ KSF ↓

$w = 0.21$ KSF ↓ CASE NOT CRITICAL BY INSPECTION.

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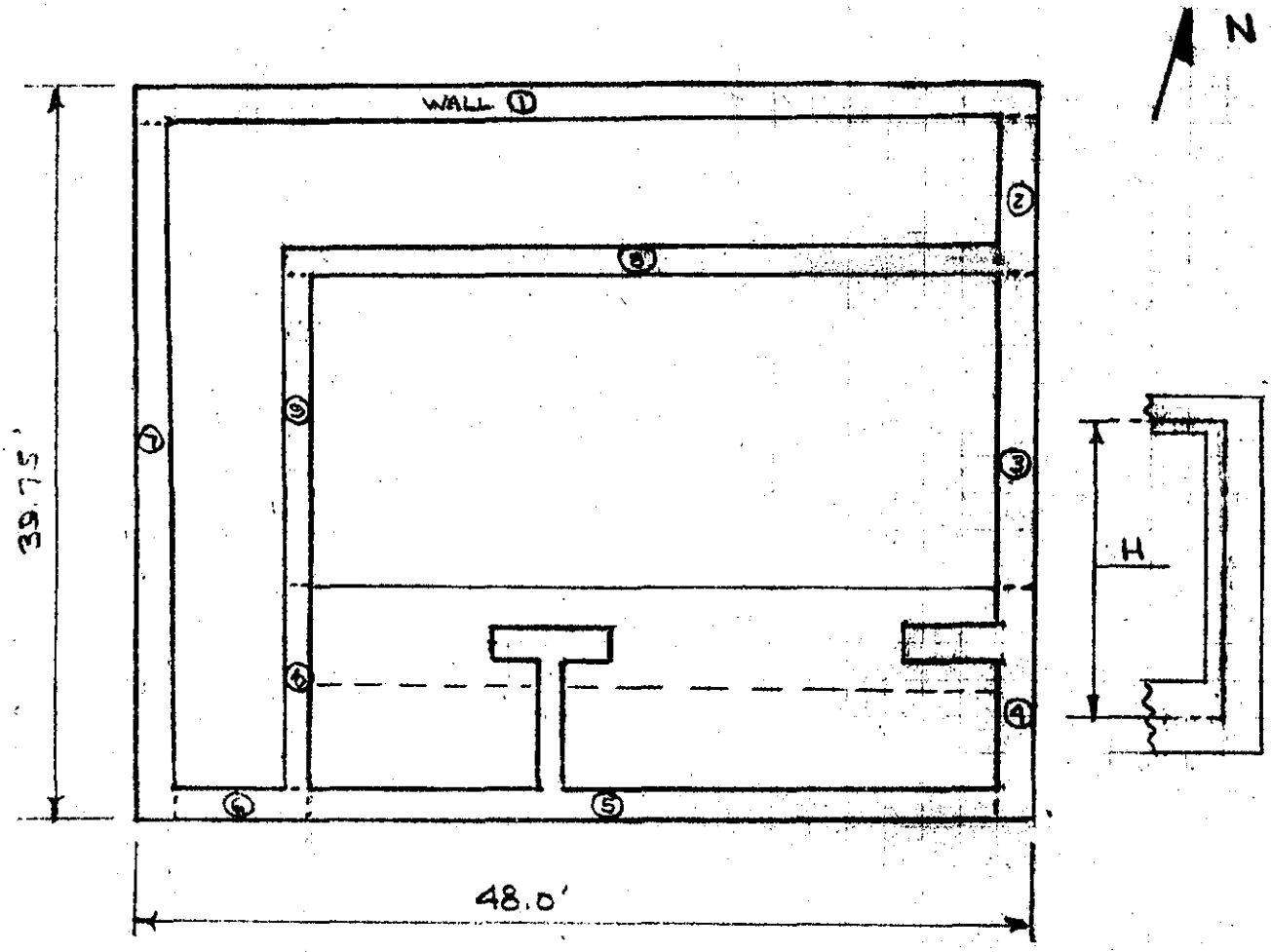
SUBJECT NEW LONDON
COMPUTATION PUMPING STATION F1
COMPUTED BY JF CHECKED BY DATE APR '78




PLAN
1" = 10.0'

| WALL | HT. - H (FT) | LENGTH (FT) | 1/mv LB/SS | SPAN H OR V | ONE-WAY OR TWO WAY | |
|---|---|---|---|---|---|---|
| 1 | 21.21 | 46.25 | 2.18 | V | ONE | |
| 2 | 21.21 | 8.50 | 2.50 | H | ONE | |
| 3 | 18.75 | 19.00 | 1.01 | V | TWO | |
| 4 | 9.25 | 11.25 | 1.22 | V | TWO | |
| 5 | 9.25 | 35.50 | 3.84 | V | ONE | |
| 6 | 21.21 | 8.00 | 2.65 | H | ONE | |
| 7 | 21.21 | 38.00 | 1.79 | V | TWO | |
| 8 | 18.75 | 35.50 | 1.89 | V | TWO | |
| 9 | 18.75 | 19.00 | 1.01 | V | TWO | |
| 10 | 9.25 | 11.25 | 1.22 | V | TWO | |

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COMPUTATION Pumping Station F2
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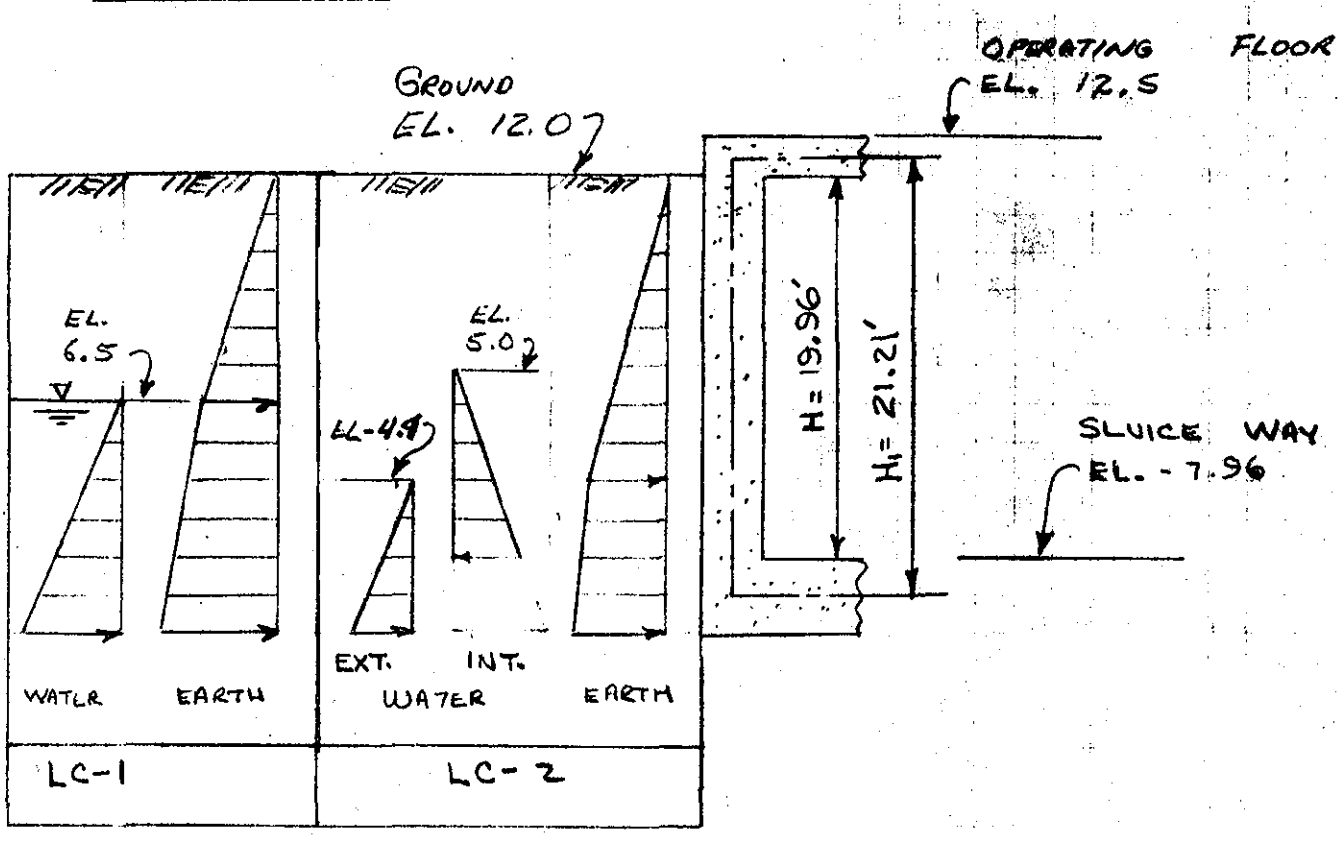
ASSUME WALLS SPAN VERTICALLY W/ ONE WAY ACTION

## 21.21 FT. WALL DESIGN

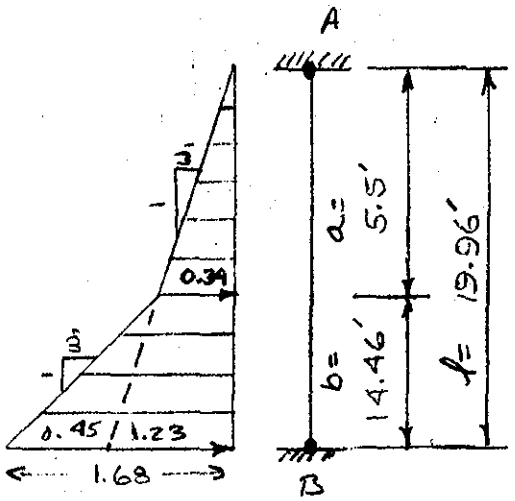



SOIL PROPERTIES:

$\gamma_{SUB.} = 61$ PCF $K_o = 0.5$
$\gamma_{SAT.} = 125$ PCF
$\gamma_{WAT.} = 64$ PCF

SUBJECT New London
COMPUTATION Pumping Station F3
COMPUTED BY JF CHECKED BY DATE Apr. '78

## LC-1 OUTSIDE WATER TO EL. 6.5




$d = a + \frac{2}{3}b = 15.14'$

$e = b/3 = 4.82'$

$\omega_1 = \frac{1.23}{19.96} = 0.062$

$\omega_2 = \frac{0.45}{14.46} = 0.031$

$$M_A = -\frac{\omega_1 l^3}{30} + \frac{\omega_2 b^2}{540 L^2}\left[b^2(30L - 45a - 28b) - 270 d e^2\right]$$

$$M_A = -\frac{0.062 \times 19.96^3}{30} + \frac{0.031 \times 14.46^2}{540 \times 19.96^2}\left[14.46^2(30 \times 19.96 - 45 \times 5.5 - 28 \times 14.46) - 270 \times 15.14 \times 4.82^2\right]$$

$M_A = -19.62$ 'k

$$M_B = -\frac{\omega_1 l^3}{20} + 7.23$$

$$M_B = -\frac{0.062 \times 19.96^3}{20} - 7.23$$ ← SEE REF. CASE 5

$M_B = -31.88$ 'k

$R_A = 4.29^k$
$R_B = 11.24^k$
} SEE REF. COMBINE CASES 5 & 6

REF. DESIGN MANUAL FOR HIGH STRENGTH STEELS
by H. M. PRIEST pp. 129-130

SUBJECT NEW LONDON
COMPUTATION P.S. - FDN WALL F3A
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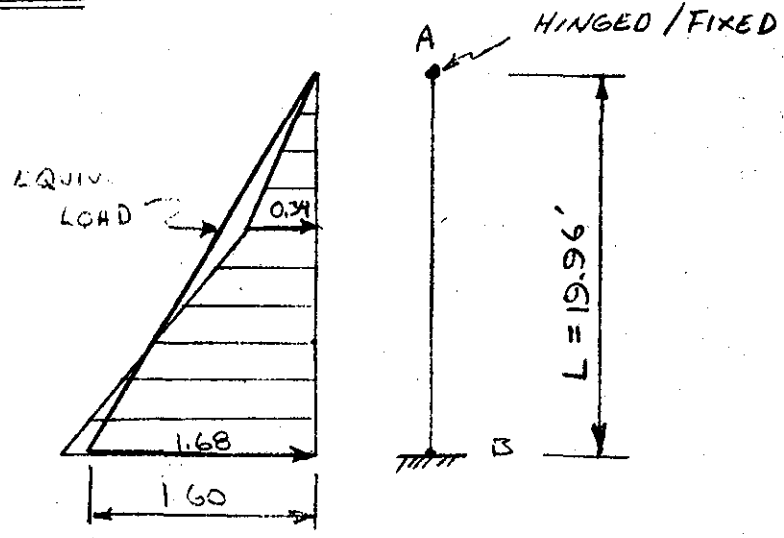
LC-1




HINGED

$M_B = -\frac{wL^2}{15}$

$M_B = -\frac{1.60 \times 19.96^2}{15}$

$M_B = -42.50'^k$

$M_{(+)} = 0.02981\ wL^2$
$M_{(+)} = 0.02981 \times 1.60 \times 19.96^2$
$M_{(+)} = 19.0'^k$ (8.93 FT. FROM A)

$M_A = 0.0'^k$

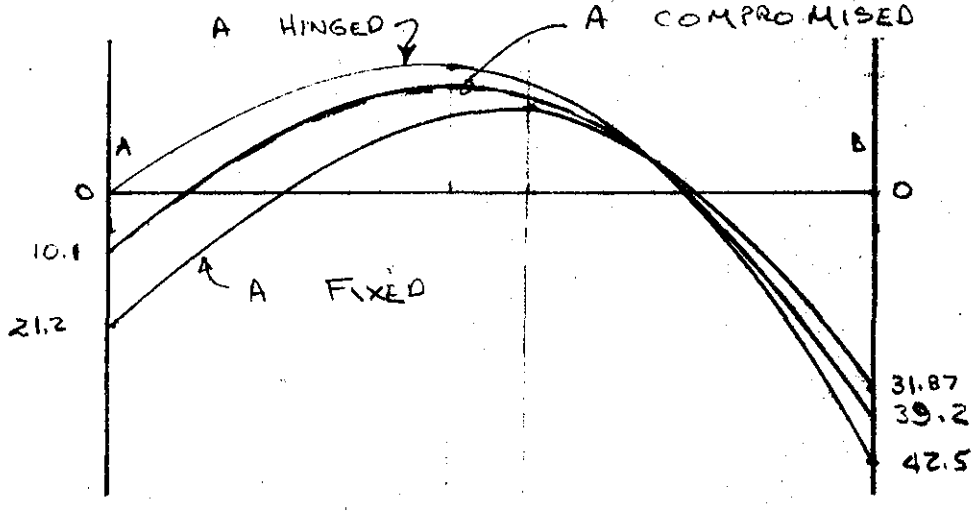
FIXED

$M_A = -\frac{wL^2}{30} = \frac{1.60 \times 19.96^2}{30} = -21.25'^k$

$M_B = \frac{-wL^2}{20} = \frac{1.60 \times 19.96^2}{20} = 31.87'^k$

$M_{(+)} = 0.02144\ wL^2$

$M_{(+)} = 13.67'^k$
(10.93 FT FROM A)



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COMPUTATION Pumping Station F4
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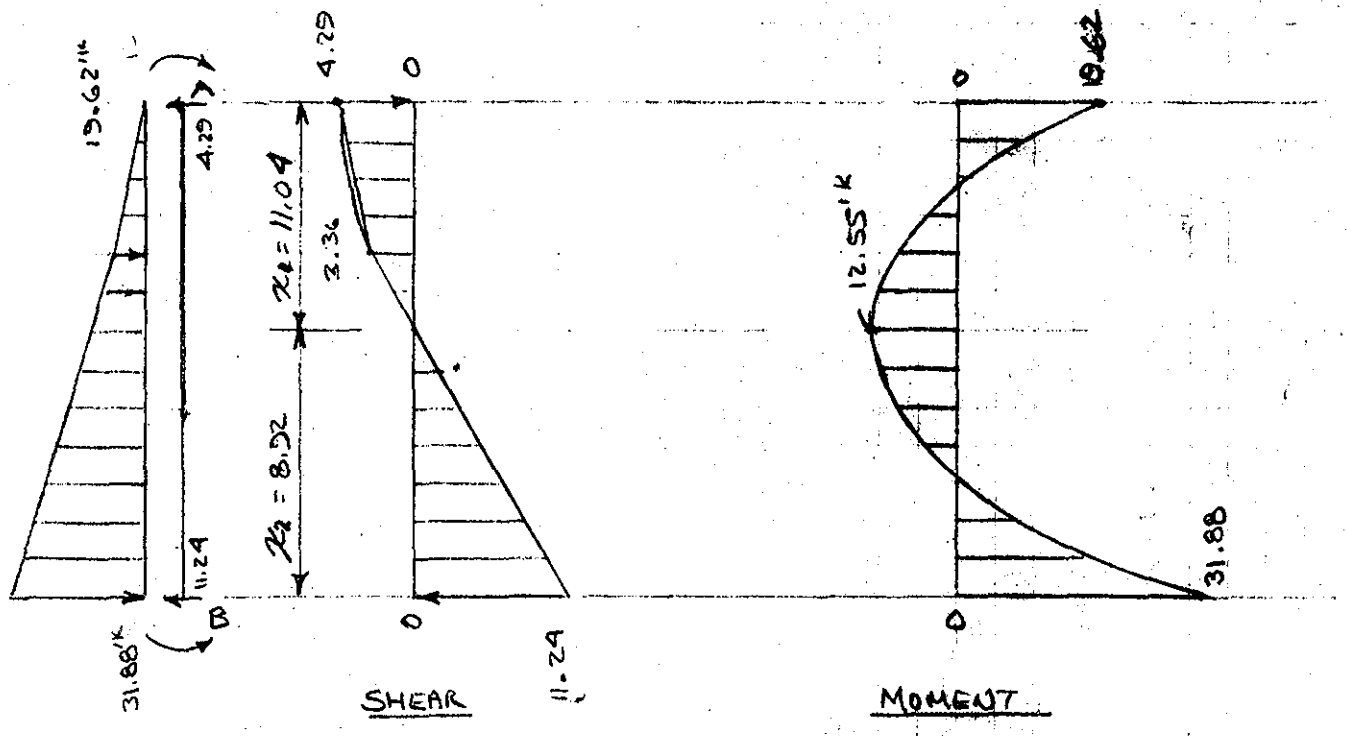
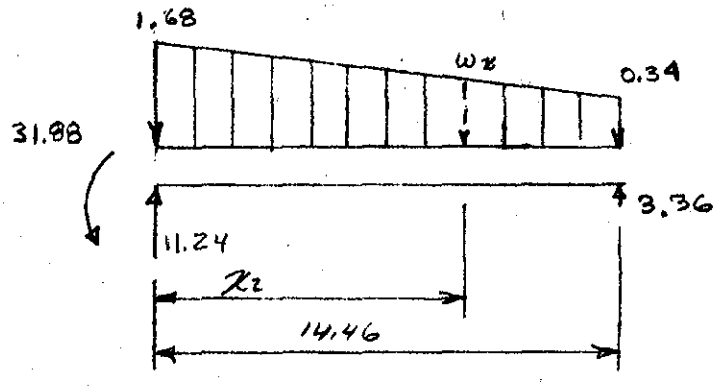



PT OF ZERO SHEAR




$$w_x = 1.68 - \frac{1.34}{14.46} x_2$$

$$w_x = 1.68 - 0.093 x_2$$

$$11.24 = (1.68 + 1.68 - 0.093 x_2)\frac{x_2}{2}$$

$$11.24 = 1.68 x_2 - 0.047 x_2^2$$

$$0.047 x_2^2 - 1.68 x_2 + 11.24 = 0$$

$$x_2^2 - 35.74 x_2 + 239.15 = 0$$

$$x_2 = 8.92'$$

$$M_{x2} = 31.88 + \frac{8.92^2}{6}(2 \times 1.68 + 0.85) - 11.24 \times 8.92$$

$$M_{x2} = 31.88 + 55.83 - 100.26$$

$$M_{x2} = -12.55'^k$$

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COMPUTATION PUMPING STATION F5
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DESIGN:

$d_{req} = \sqrt{\frac{31.88}{0.152}} = 14.5 \text{ in}$ $t = 19''$

$A_{s(-)} = \frac{31.88}{1.44 \times 14.5} = 1.53 \text{ in}^2$ (BOTTOM OF WALL, OUTSIDE)

$A_{s(+)} = \frac{12.55}{1.44 \times 14.5} = 0.60 \text{ in}^2$ (INSIDE FACE)

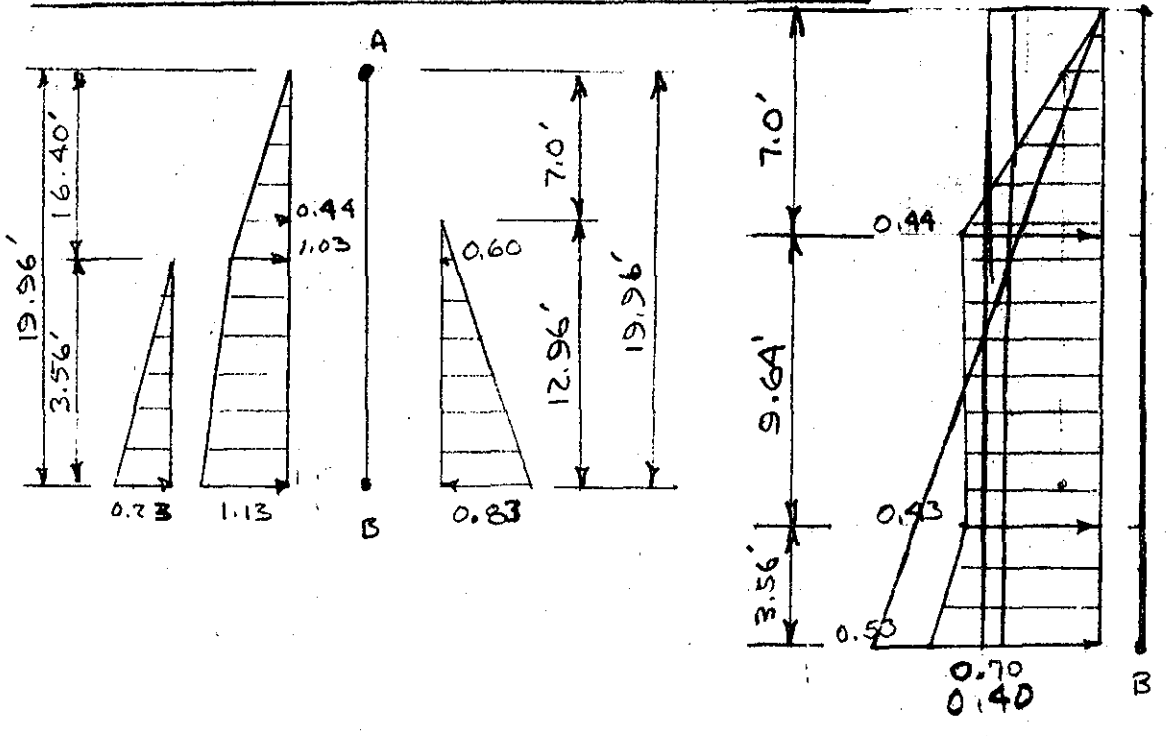
$A_{s(-)} = \frac{13.62}{1.44 \times 14.5} = 0.94 \text{ in}^2$ (TOP OUTSIDE FACE)

$v = \frac{11240}{12 \times 14.5} = 64.60$ psi ∴ Check @ d from face of support

$V = 11.24 - \left(\frac{1.60 + 1.50}{2}\right)\frac{14.5}{12} = 9.37^k$

$v = \frac{9370}{12 \times 14.5} = 53.8$ psi < 60 psi ∴ OK

LC-2-INSIDE WATER EL 5.0 / OUTSIDE EL -4.4



SUBJECT NEW LONDON
COMPUTATION PUMPING STATION - F6
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ASSUME UNIFORM LOAD OF 0.40 KLF

$$M_{(-)} = -\frac{wL^2}{12} = \frac{0.40 \times 19.96^2}{12}$$

$M_{(-)} = 13.28'^K$

$M_{(+)} = 6.64'^K$

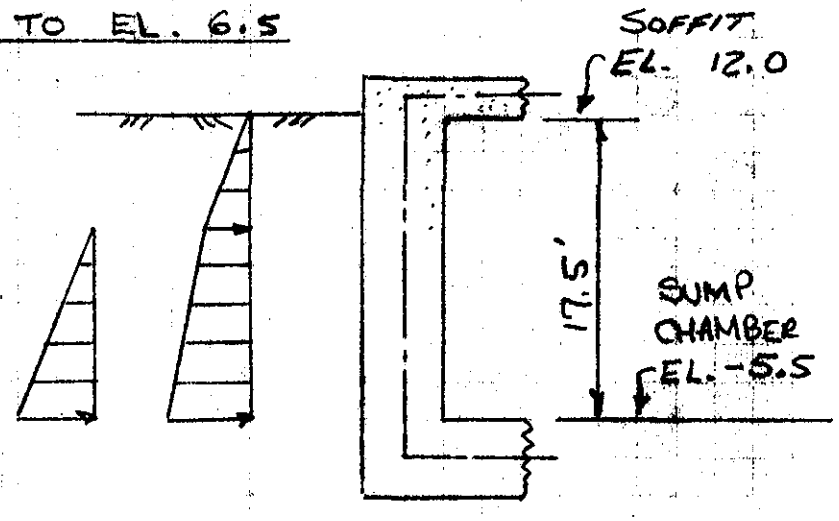
$V_{MAX} = 3.99^K$

NOT CRITICAL - USE LC-1 DESIGN

TRY ANOTHER WALL

18.75 FT. WALL DESIGN

LC-1 OUTSIDE WATER TO EL. 6.5



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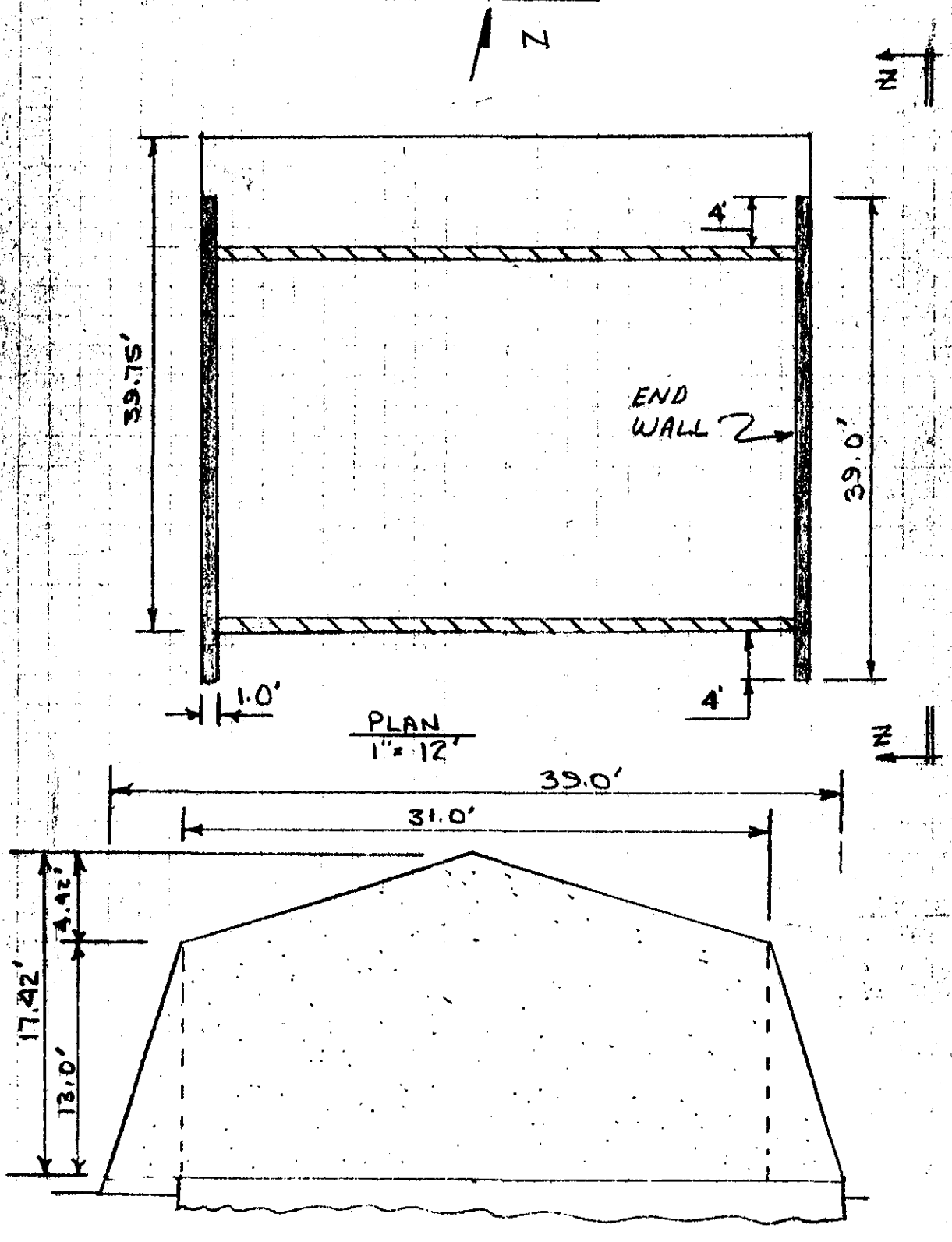
## Superstructure End Wall

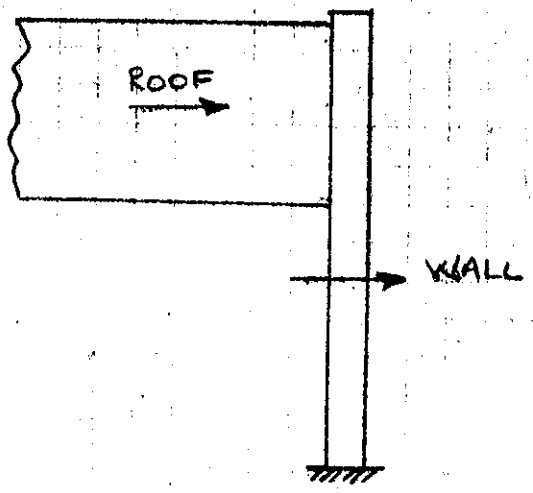


## LOADS -

1. EARTHQUAKE 0.025 g (INCLUDE WT. OF ROOF)
2. WIND 20 PSF

## LOAD 1 - EARTHQUAKE

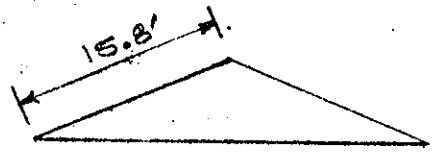
(WALL ACTS LIKE A CANTILEVER BEAM)



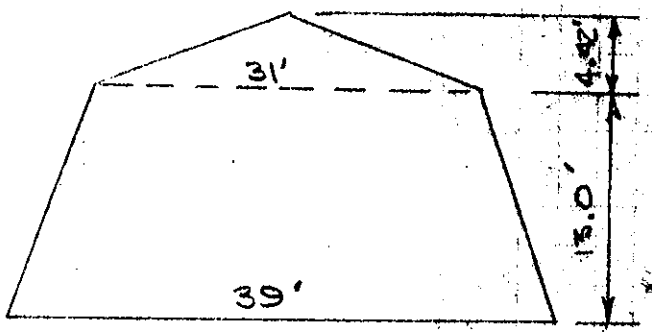

**DESIGN CONST.**

$f'_c$ = 3000 psi
$f_c$ = 1350 psi
$f_s$ = 20 000 psi
$n$ = 1.44
$K$ = 226 psi
$j$ = 0.872

END WALL TO RESIST EARTHQUAKE ACCELERATION FORCES FOR THE WEIGHT OF THE ROOF & ITS OWN WEIGHT IN THE EAST-WEST DIRECTION.




ROOF SECTION




END-WALL ELEV.

SUBJECT New London
COMPUTATION Pumping Station SE3
COMPUTED BY JF CHECKED BY DATE Apr 78

## ROOF WT.

ASSUME ROOF & ALL OTHER PARAPHERNALIA WEIGHS 10 PSF.

ROOF AREA = 46 × 2×15.8 = 1453.6 SF

ROOF WT = 1453.6 × 10 = 14.5$^k$

PURLINS = 17 PLF × 46 = 782 lb/ROW (8 ROWS)
= 6.3$^k$

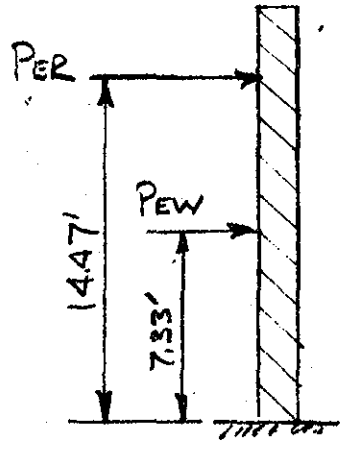
## END WALL WT.

WALL AREA = ½(31 × 4.42 + (31+39) × 13) = 523.5 SF

WALL WT. = 523.5 × 0.150 = 78.5$^k$

C. OF G. IS 7.33' above OPERATING FLOOR LEVEL.

$P_E = \alpha W$




$P_{ER}$ = 0.025 × (14.5 + 6.3) = 0.52$^k$

$P_{EW}$ = 0.025 × 78.5 = 1.96$^k$

$M_{MAX} = P_{ERX} \times 14.47 + P_{EW} \times 7.33$

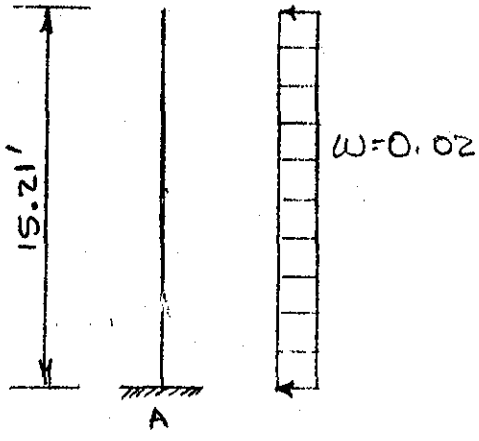
$M_{MAX} = 0.52 \times 14.47 + 1.96 \times 7.33$

$M_{MAX} = 21.93$ '^K

$M$ /FT $= \frac{21.93}{35.00} = 0.63$ '^K /1FT STRIP

LC-2 WIND LOAD

USE 1 FT. STRIP TO MID HT. OF PITCHED ROOF.




$M_A = \frac{wl^2}{2} = \frac{0.02 \times 15.21^2}{2}$

$M_A = 2.31$ '^K /FT ← CONTROLLING CASE

$V_A = 0.02 \times 15.21$
$V_A = 0.30$ K

SUBJECT New London

COMPUTATION PUMPING STATION SES

COMPUTED BY JF CHECKED BY DATE APR. '78

$d_{REQ} = \sqrt{\frac{2.31}{0.226}}$

$d_{REQ} = 3.2$ IN.

$d_{PROV} = 10$ IN

$A_{SMIN} = 0.001\ bt$

$A_{SMIN} = 0.001 \times 12 \times 12$

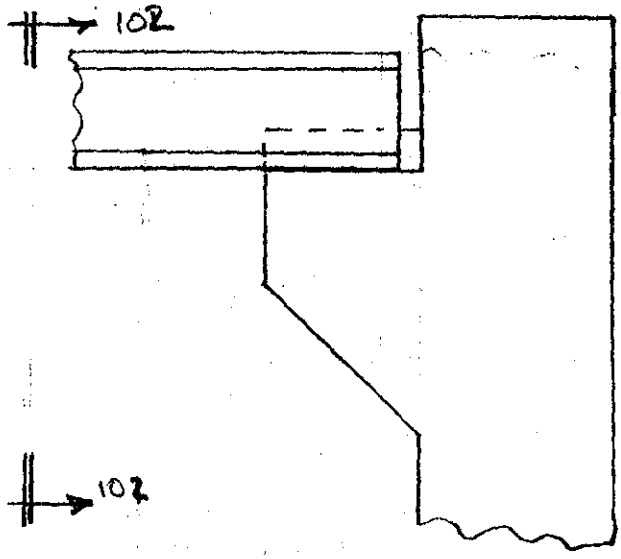
$A_{SMIN} = 0.14\ in^2$

$A_S = \frac{2.31}{1.44 \times 10}$

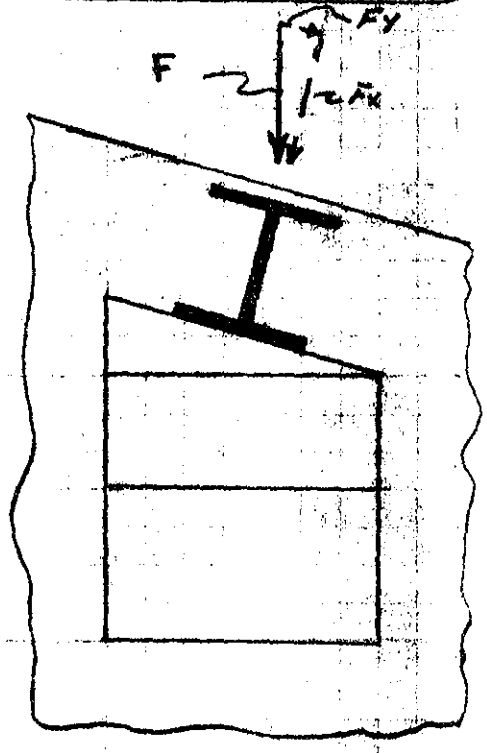
$A_S = 0.16\ in^2$

$v = \frac{300}{12 \times 10} = 2.50$ PSI $< 60$ PSI NO SHEAR PROB.

PURLIN BRACKET




SECTION 101-101
N.T.S.




SECTION 102-102
N.T.S.

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

PAGE A36

SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station Pile Loads Stability
COMPUTED BY TKW CHECKED BY DATE Nov 1977

~~Loads~~
Live
Operating floor beams - 100 #/sf + Equipment in Design Location
Operating floor - Heaviest Equipment load any Location
Roof (snow) - 40 #/sf
Roof (wind) - 25 #/sf uplift
Walls (wind) - 20 #/sf
Earthquake - .025 g
Earth Pressures (walls) - at rest coef = 0.5
Dead
Equipment
Pump - 6500 #
Umbrella - 900 #
Thrust - 4000 #
Gear Unit - 1400 # Base area 2x2
Engine - 3100 # Base area 5x3

Conc Engine Base 3'x6'x1'-9" = 4740 #

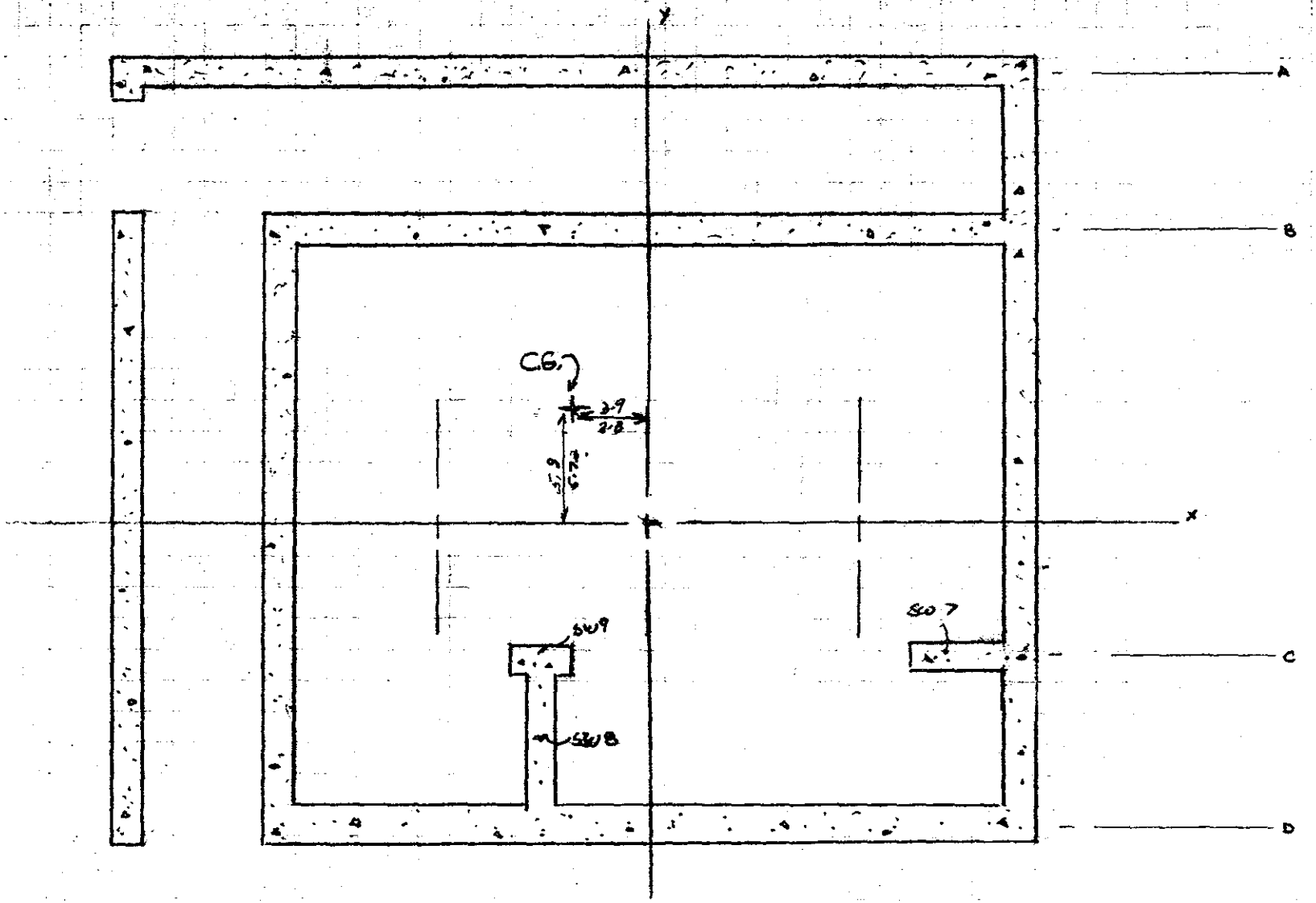
Roof (roofing + Purlins) - 8 #/sf

weight concrete 150 #/cf
weight water 62.5 #/cf
weight masonry wall 140 #/sf

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT New London Hurricane Barrier
COMPUTATION Pumping Station - Pile Loads
COMPUTED BY TKH
CHECKED BY
DATE Nov 1972
PAGE A87



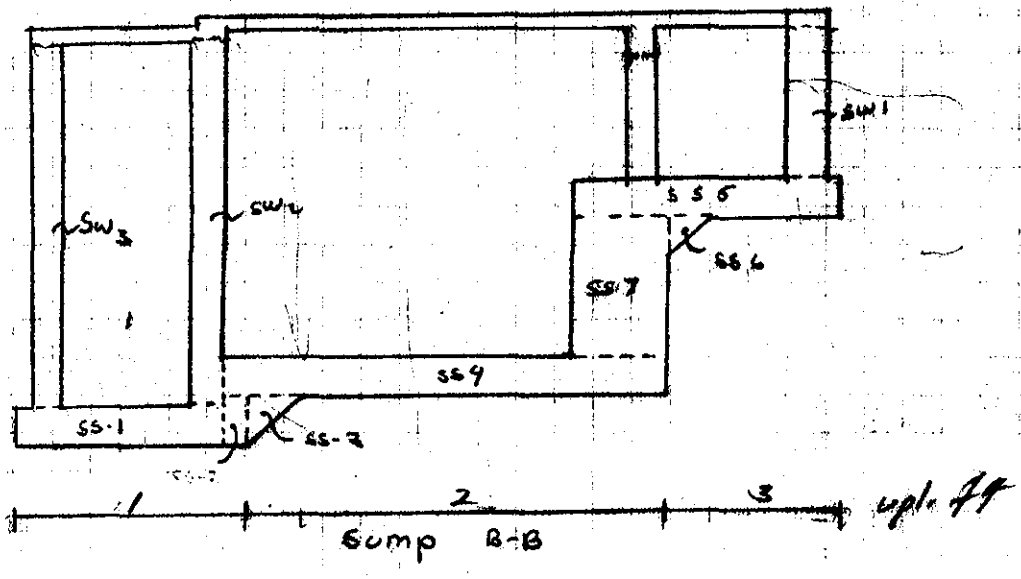

Sump plan

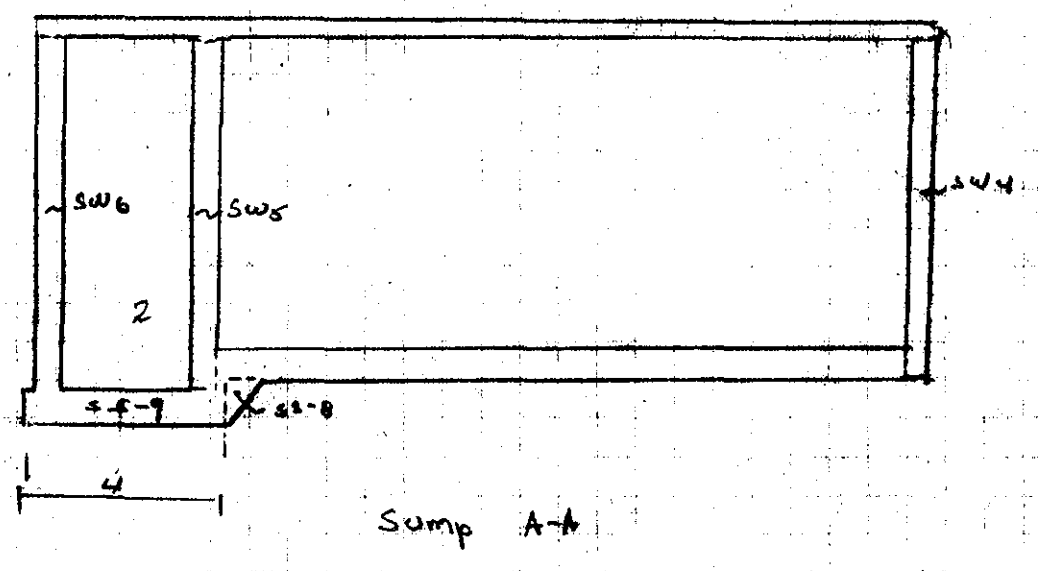
NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY



SUBJECT New London Hurricane Barrier
COMPUTATION Pumping Station - Pile Loads
COMPUTED BY PAH CHECKED BY DATE Nov 1972



NED FORM 223
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NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

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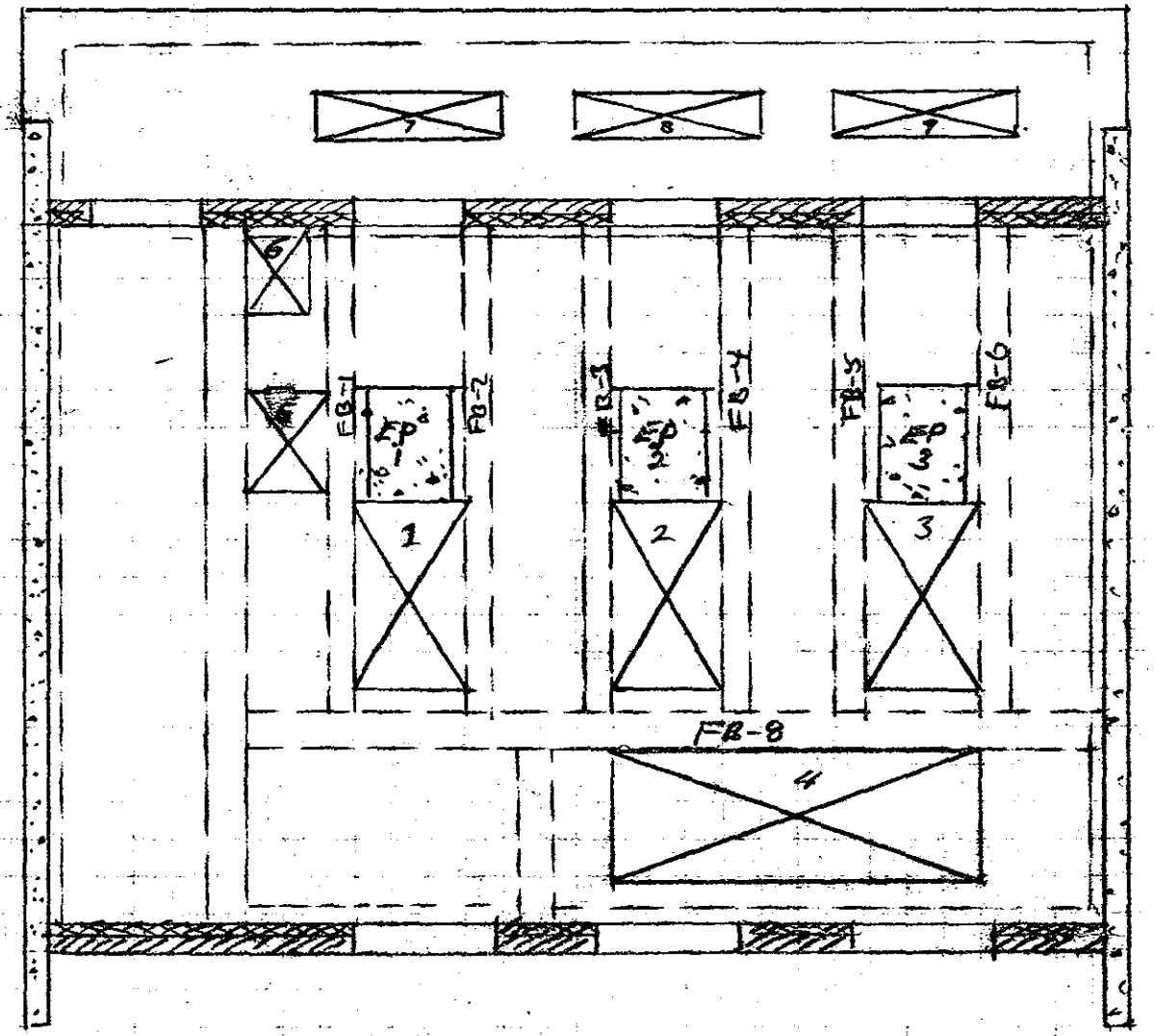
SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station - Pile Loads
COMPUTED BY TKH CHECKED BY DATE Nov 1972




Operating floor plan

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

PAGE A-40

SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station - Pile Loads
COMPUTED BY FAH CHECKED BY DATE Nov 1977

| ITEM | FORCE COMPUTATION | P (K) | X (Ft) | Y (Ft) | P(X) (Ft-K) | P(Y) (Ft-K) |
|---|---|---|---|---|---|---|
| Dead loads | Concrete | | | | | |
| Sump Slab | | | | | | |
| SS-1 | 2 x 10.75 x 49 x .15 | 158 | -3.75 | 19.375 | -592.5 | 3061.3 |
| SS-2 | 2.45 x .75 x 39.25 x .15 | 10.8 | 0 | 13.625 | 0 | 147.2 |
| SS-3 | 2.45 x 2.45/2 x 39.25 x .15 | 17.7 | 0 | 12.433 | 0 | 220.1 |
| SS-4 | 2 x 22.5 x 37 x .15 | 249.8 | 0 | 2.75 | 0 | 687.0 |
| SS-5 | 2 x 12.5 x 37 x .15 | 138.8 | 0 | -9.75 | 0 | -1353.3 |
| SS-6 | 2 x 7/2 x 37 x .15 | 11.1 | 0 | -7.167 | 0 | -101.8 |
| SS-7 | 5 x 7.5 x 37 x .15 | 83.2 | 0 | -6.000 | 0 | -499.2 |
| SS-8 | 2.45 x 2.45/2 x 29.5 x .15 | 13.3 | -17.683 | -0.75 | -235.2 | -10.0 |
| SS-9 | 2 x 9.75 x 29.5 x .15 | 86.3 | -23.375 | -0.75 | -2017.3 | -64.7 |
| Sump Walls | | | | | | |
| SW-1 | 1.5 x 8 x 39.75 x .15 | 71.5 | 0.375 | -19.75 | 26.8 | -1054.6 |
| SW-2 | 1.5 x 19.96 x 37 x .15 | 166.2 | 0 | 14.75 | 0 | 2451.5 |
| SW-3 | 1.75 x 19.96 x 44.5 x .15 | 227.3 | -3.75 | 23.375 | -852.4 | 5313.1 |
| SW-4 | 1.75 x 19.5 x 24 x .15 | 122.8 | 19.375 | 12.25 | 2379.3 | 1504.3 |
| SW-4' | 1.75 x 14 x 7 x .15 | 25.7 | 19.375 | -12.00 | 497.9 | -308.4 |
| SW-5 | 1.0 x 19.96 x 31 x .15 | 92.8 | -18.00 | 0 | -1670.4 | 0 |
| SW-6 | 1.75 x 19.96 x 31 x .15 | 162.4 | -26.875 | 0 | -4364.5 | 0 |
| SW-7 | 1.75 x 5.25 x 8 x .15 | 11.0 | 15.875 | -6.375 | 174.6 | -70.1 |
| SW-8 | 1 x 6.75 x 8 x .15 | 8.1 | -5.5 | -10.625 | -44.6 | -86.1 |
| SW-9 | 1.75 x 6.5 x 8 x .15 | 12.7 | -5.5 | -6.375 | -75.4 | -81.3 |
| Operating Room | | | | | | |
| Slab | .15 x 29 x 46 x .15 | 100.1 | -3.75 | 0 | -375.4 | 0 |
| FB-1 | 1.25 x 1.5 x 4.25 x .15 | 5.5 | -14 | 4.25 | -77.0 | 23.4 |
| FB-2 | " | 5.5 | -8 | 4.25 | -44.0 | 23.4 |
| FB-3 | " | 5.5 | -3 | 4.25 | -16.5 | 23.4 |
| FB-4 | " | 5.5 | 3 | 4.25 | 16.5 | 23.4 |
| FB-5 | " | 5.5 | 8 | 4.25 | 44.0 | 23.4 |
| FB-6 | " | 5.5 | 14 | 4.25 | 77.0 | 23.4 |
| FB-B | 1.75 x 1.833 x 37 x .15 | 17.8 | 0 | -6.375 | 0 | -113.5 |
| Opening -1 | -.5 x 4.5 x 6.75 x .15 | -2.3 | -11.0 | -1.208 | 25.3 | 2.8 |
| Opening - 2 | -.5 x 4.5 x 6.75 x .15 | -2.3 | 0 | -1.208 | 0 | 2.8 |
| Opening - 3 | -.5 x 4.5 x 6.75 x .15 | -2.3 | 11.0 | -1.208 | -25.3 | 2.8 |
| Opening - 4 | -.5 x 5.75 x 15.833 x .15 | -6.8 | 5.5 | -16.625 | -37.4 | 112.3 |
| Opening - 5 | -.5 x 3.75 x 4.0 x .15 | -1.1 | -16.625 | 4.167 | 18.3 | -4.6 |
| Opening - 6 | -.5 x 2.5 x 2.5 x .15 | -0.5 | -17.25 | 12.75 | 8.6 | -6.4 |

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY



SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station - Pile Loads
COMPUTED BY TKH CHECKED BY DATE Nov 1977

| ITEM | FORCE COMPUTATION | P (K) | X (ft) | Y (ft) | P(X) (ft-K) | P(Y) (ft-K) |
|---|---|---|---|---|---|---|
| EP-1 | Concrete Engine Pad | 4.74 | -11.0 | 5.167 | -52.1 | 24.5 |
| EP-2 | " | 4.74 | 0 | 5.167 | 0 | 24.5 |
| EP-3 | " | 4.74 | 11.0 | 5.167 | 52.1 | 24.5 |
| Outside slab | | | | | | |
| Slab | .5 x 8.75 x 48 x .15 | 31.5 | -3.75 | 19.9 | -118.1 | 626.9 |
| Opening 1 | -.5 x 2 x 8 x .15 | -1.2 | -11.0 | 20.0 | 13.2 | -24.0 |
| Opening 2 | -.5 x 2 x 8 x .15 | -1.2 | 0 | 20.0 | 0 | -24.0 |
| Opening 3 | -.5 x 2 x 8 x .15 | -1.2 | 11.0 | 20.0 | -13.2 | -24.0 |
| End Walls | | | | | | |
| East wall | 1.0 x (40 + 21.5 x 15.5 + 31.5 x 4/2) x .15 | 92.6 | 19.75 | 0 | 1828.9 | 0 |
| West wall | 1.0 x (40 + 31.5 x 15.5 + 21.5 x 4/2) x .15 | 92.6 | -27.25 | 0 | -2523.4 | 0 |
| | Masonry walls (.11 K/SF) | | | | | |
| North wall | 46 x 14 x .11 K/SF | 70.8 | -3.75 | 15.0 | -265.5 | 1062.0 |
| South wall | 46 x 14 x .11 K/SF | 70.8 | -3.75 | 15.0 | -265.5 | 1062.0 |
| | Roof (roofing + purlins 8#/SF) | | | | | |
| Main roof | 46 x 16 x 2 x .008 | 11.8 | -3.75 | 0 | -44.3 | 0 |
| Overhang N | 46 x 5 x .008 | 1.8 | -3.75 | 16.0 | -6.8 | -28.8 |
| Overhang E | 46 x 5 x .008 | 1.8 | -3.75 | -6.0 | -6.8 | 28.8 |
| | Equipment | | | | | |
| Pump Unit 1 | 6.5 + .9 + 1.4 | 8.8 | -11.0 | 1.0 | -96.8 | 0 |
| Pump Unit 2 | " | 8.8 | 0 | 0 | 0 | 0 |
| Pump Unit 3 | " | 8.8 | 11.0 | 0 | 96.8 | 0 |
| Engine 1 | 3.1 | 3.1 | -11.0 | 5.167 | -34.1 | 16.0 |
| Engine 2 | 3.1 | 3.1 | 0 | 5.167 | 0 | 16.0 |
| Engine 3 | 3.1 | 3.1 | 11.0 | 5.167 | 34.1 | 16.0 |
| | DEAD LOAD No Equipment | 2190.4 | -3.9 | 5.8 | -8561.1 | 12598 |
| | DEAD LOAD with Equipment | 2226.1 | -3.8 | 5.7 | -8561.1 | 12646 |

NOTE DEAD LOAD DOES NOT INCLUDE WEIGHT OF W12x27 FRAME MEMBERS APPROX 2.6 KIP will not effect C.G.

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY



SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station - Pile Loads
COMPUTED BY TKH CHECKED BY DATE Nov 1977

Case 1 { a. dead load structure
b. no equipment
c. no water inside
d. water outside to el 6.5'

Min Pile Reactions

| ITEM | Force Computation | P | X | Y | P(x) | P(y) |
|---|---|---|---|---|---|---|
| Dead Load | (from pg 6) | 2190 | -3.9 | 5.8 | -8561.1 | 12,598 |
| Uplift | | | | | | |
| 1 | 49 x 10.75 x 16.46 x .0625 | -541.9 | -3.75 | 19.375 | 2032.1 | -10499.3 |
| 2 | 39.25 x 22.5 x 14 x .0625 | -772.7 | 1.125 | 2.75 | -869.3 | -2124.9 |
| 3 | 39.25 x 7.5 x 8.5 x .0625 | -156.4 | 1.125 | -12.25 | -175.9 | 1915.9 |
| 4 | 9.75 x 29 x 16.46 x .0625 | -290.9 | -23.375 | -.5 | 6799.8 | 145.5 |
| | TOTAL<br>Safety = 2190/1764.9 = 1.24 | 428.1 | -1.81 | 4.76 | -774.4 | 2035.2 |

Case 2 { a. dead load structure plus equipment
b. Water inside station to el +5.0
c. water outside to el -4.4

Max Pile Reactions

| ITEM | Force Computations | P | X | Y | P(x) | P(y) |
|---|---|---|---|---|---|---|
| Dead Load | (from pg 6) | 2226 | -3.8 | 5.7 | -8561.1 | 12646 |
| Uplift | | | | | | |
| 1 | 49 x 10.75 x 5.56 x .0625 | -183.0 | -3.75 | 19.375 | 686.2 | -3545.6 |
| 2 | 39.25 x 22.5 x 3.1 x .0625 | -171.1 | 1.125 | 2.75 | -192.5 | -470.5 |
| 4 | 9.75 x 29 x 5.56 x .0625 | -98.2 | -23.375 | -.5 | 2295.4 | 49.1 |
| Water | | | | | | |
| Sluiceway 1 | 7 x 44.5 x 12.96 x .0625 | 252.3 | -3.75 | 19.0 | -946.12 | 4793.7 |
| Sluiceway 2 | 6.5 x 31 x 12.96 x .0625 | 163.2 | -22.75 | 0 | -3712.8 | 0 |
| Sump | 17.5 x 37 x 10.5 x .0625 | 424.9 | 0 | 5.25 | 0 | 2230.7 |
| Valve Pit | 10.5 x 37 x 1 x .0625 | 24.3 | 0 | -8.75 | 0 | -212.6 |
| | TOTAL | 2638.4 | -3.95 | 5.87 | -10430.92 | 15490.8 |

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NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

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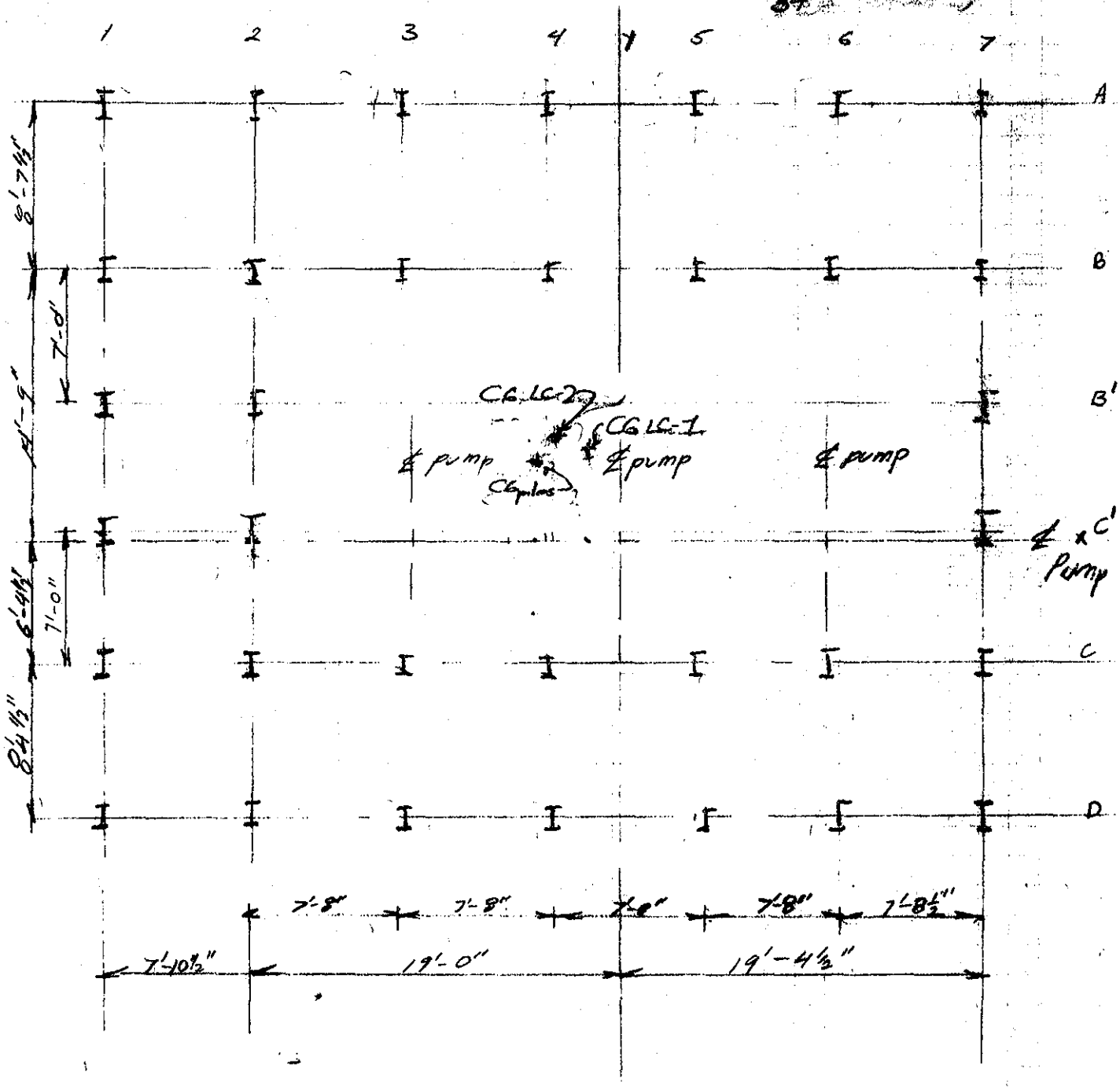
SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station - Pile Loads
COMPUTED BY TKV CHECKED BY DATE Nov 1977

Piles 50T cap (100 K) number req. $\frac{2638.4}{100}$ = 27 min

Avg pile reaction $\frac{2638.4}{84}$ = 77.6



NED FORM 223
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NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

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SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station - Pile Loads
COMPUTED BY JKH CHECKED BY DATE Nov 1977

C.G piles

about x axis

$7 \times 23.375 = 167.29$
$7 \times 14.75 = 103.25$
$7 \times -6.375 = -44.62$
$7 \times -14.75 = -103.25$
$3 \times 16.25 = 1.88$
$3 \times 7.750 = 23.25$
$147.80$

$\frac{147.80}{34} = 4.35$

about y axis

$6 \times -26.875 = -161.25$
$6 \times -19.00 = -114.00$
$4 \times -11.33 = -45.20$
$4 \times -3.667 = -14.67$
$4 \times 4.000 = 16.00$
$4 \times 11.667 = 46.67$
$6 \times 19.375 = 116.25$
$-156.20$

$\frac{-156.20}{34} = -4.59$

Case 1

$e_x = 4.75 - 4.35 = .40$
$e_y = -1.81 - (-4.59) = 2.78$

$M_x = .40\ (428.1) = 171.28$
$M_y = 2.78\ (428.1) = 1190.12$

$P_Q = Q/N = 428.1/34 = 12.59$

Case 2

$e_x = 5.87 - 4.35 = 1.52$
$e_y = -3.95 - (-4.59) = 0.64$

$M_x = 1.52\ (2638.4) = 4010.37$
$M_y = 0.64\ (2638.4) = 1688.58$

$P_Q = Q/N = 2638.4/34 = 77.60$

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

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SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station - Pile Loads
COMPUTED BY ITK CHECKED BY DATE Nov 1977

Case 1

| Pile | y | $y^2$ | $\frac{M_x y}{\Sigma y^2}$ | x | $x^2$ | $\frac{M_y x}{\Sigma x^2}$ | $Q/N$ | P min |
|---|---|---|---|---|---|---|---|---|
| A-1 | 19.03 | 362.14 | .40 | -22.29 | 496.84 | -2.88 | 12.59 | 10.11 |
| A-2 | | | | -14.41 | 207.64 | -1.86 | | 11.13 |
| A-3 | | | | -6.74 | 45.43 | -0.87 | | 12.12 |
| A-4 | | | | 0.92 | .82 | 0.12 | | 13.11 |
| A-5 | | | | 8.59 | 73.79 | 1.11 | | 14.10 |
| A-6 | | | | 16.26 | 264.39 | 2.10 | | 15.09 |
| A-7 | | | | 23.97 | 574.56 | 3.10 | | 16.09 |
| B-1 | 10.40 | 108.16 | .26 | | | | | 9.97 |
| B-2 | 10.40 | 108.16 | .26 | | | | | 10.99 |
| B-3 | | | | | | | | 11.98 |
| B-4 | | | | | | | | 12.97 |
| B-5 | | | | | | | | 13.96 |
| B-6 | | | | | | | | 14.95 |
| B-7 | | | | | | | | 15.95 |
| B'-1 | -3.49 | 11.56 | .09 | -22.29 | | -2.88 | | 9.80 |
| B'-2 | | | | -14.41 | | -1.86 | | 10.82 |
| B'-7 | | | | 23.97 | | 3.10 | | 15.78 |
| C'-1 | -3.73 | 13.91 | -.09 | -22.29 | | -2.88 | | 9.62 |
| C'-2 | | | | -14.41 | | -1.86 | | 10.64 |
| C'-7 | | | | 22.97 | | 3.10 | | 15.60 |
| C-1 | -10.23 | 115.13 | -.27 | -22.29 | | -2.88 | | 9.44 |
| C-2 | | | | -14.41 | | -1.86 | | 10.46 |
| C-3 | | | | -6.74 | | -0.87 | | 11.45 |
| C-4 | | | | 0.92 | | 0.12 | | 12.44 |
| C-5 | | | | 8.59 | | 1.11 | | 13.43 |
| C-6 | | | | 16.23 | | 2.10 | | 14.42 |
| C-7 | | | | 23.97 | | 3.10 | | 15.42 |
| D-1 | -19.10 | 364.81 | -.49 | | | | | 9.22 |
| D-2 | | | | | | | | 10.24 |
| D-3 | | | | | | | | 11.23 |
| D-4 | | | | | | | | 12.22 |
| D-5 | | | | | | | | 13.21 |
| D-6 | | | | | | | | 14.20 |
| D-7 | | | | | | | | 15.20 |

$\Sigma y^2 = 672809$ $\Sigma x^2 = 9211.96$

NED FORM 225
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY



SUBJECT New London Hurricane Barrier
COMPUTATION Pump Station - Pile Loads
COMPUTED BY TKM CHECKED BY DATE Nov 77

| Pile | $y$ | $y^2$ | $\frac{M_x y}{\Sigma y^2}$ | $x$ | $x^2$ | $\frac{M_y x}{\Sigma x^2}$ | $Q/N$ | P |
|---|---|---|---|---|---|---|---|---|
| A-1 | | | 11.34 | | | -4.09 | 77.60 | 84.85 |
| A-2 | | | | | | -2.64 | | 86.30 |
| A-3 | | | | | | -1.24 | | 87.70 |
| A-4 | | | | | | .17 | | 89.11 |
| A-5 | | | | | | 1.57 | | 90.51 |
| A-6 | | | | | | 2.98 | | 91.92 |
| A-7 | | | | | | 4.39 | | 93.33 |
| B-1 | | | 6.20 | | | [illegible] | | 79.71 |
| B-2 | | | | | | | | 81.16 |
| B-3 | | | | | | | | 82.56 |
| B-4 | | | | | | | | 83.97 |
| B-5 | SEE | SEE | | SEE | SEE | | | 85.37 |
| B-6 | | | | | | | | 86.78 |
| B-7 | | | | | | | | 88.19 |
| B'-1 | | | 2.03 | | | -4.09 | | 75.54 |
| B'-2 | | | | | | -2.69 | | 76.94 |
| B'-3 | CASE | CASE | | CASE | CASE | 4.39 | | 84.02 |
| C'-1 | | | -2.22 | | | -4.09 | | 71.29 |
| C'-2 | | | | | | -2.69 | | 72.69 |
| C'-3 | 1 | 1 | | 1 | 1 | 4.39 | | 79.77 |
| C-1 | | | -6.40 | | | -4.09 | | 67.11 |
| C-2 | | | | | | -2.69 | | 68.51 |
| C-3 | | | | | | -1.24 | | 69.96 |
| C-4 | | | | | | .17 | | 71.37 |
| C-5 | | | | | | 1.57 | | 72.77 |
| C-6 | | | | | | 2.98 | | 74.18 |
| C-7 | | | | | | 4.39 | | 75.59 |
| D-1 | | | -11.38 | | | | | 62.13 |
| D-2 | | | | | | | | 63.58 |
| D-3 | | | | | | | | 64.98 |
| D-4 | | | | | | | | 66.39 |
| D-5 | | | | | | | | 67.79 |
| D-6 | | | | | | | | 69.20 |
| D-7 | | | | | | | | 70.61 |

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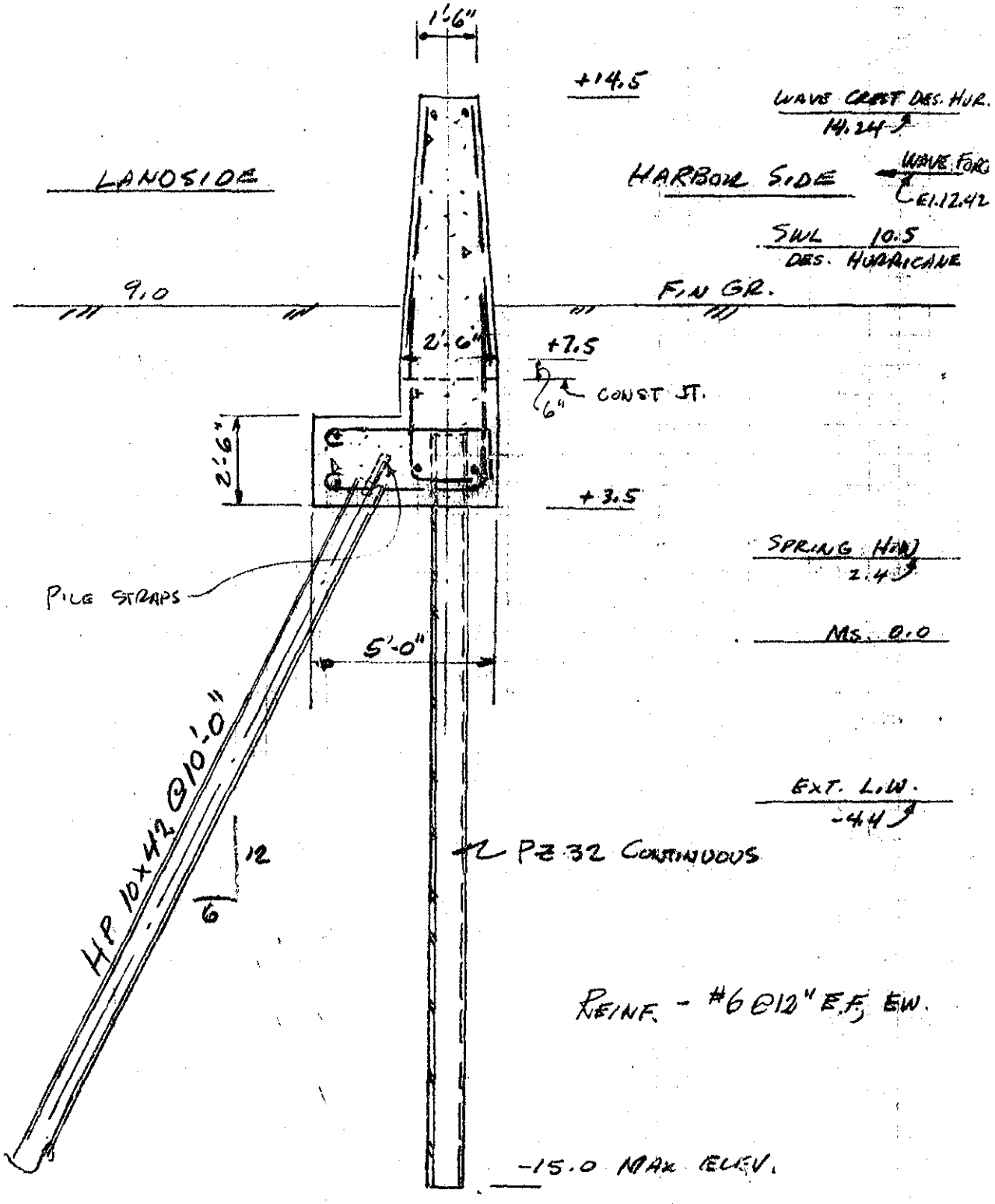
SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION FLOODWALL STA. 29+70± TO STA 33+0±
COMPUTED BY R. HARRINGTON CHECKED BY DATE NOV. 1977




SECTION AT WALL
1/4" = 1'-0"

LOADING CONDITIONS

CASE 1 - DESIGN HURRICANE CONDITION

5.2' BROKEN WAVE FORCE APPLIED TO WALL
WATER HARBORSIDE @ WAVE CREST ELEV. 14.24
WATER LANDSIDE @ ELEV. 9.0
FULL UPLIFT ON BASE.

CASE 2 - AT REST CONDITION

250 #/SF SURCHARGE LANDSIDE
50 #/SF WIND LOAD FROM LANDSIDE
WATER BELOW ELEV. 3.5

SELECTION OF WALL TYPE

BECAUSE IT IS IMPRACTICAL TO REMOVE STRATA OF ORGANIC SILT OF VARYING THICKNESS DUE TO PROXIMITY OF BOSTON-NEW YORK MAINLINE, AN I-TYPE FLOODWALL, STIFFENED WITH BATTER PILES TO RESTRICT DEFLECTION, WAS SELECTED.

DESIGN ASSUMPTIONS FOR LOAD CASE 1

THE I WALL SHEET PILING WILL BE CONSIDERED TO RESIST HYDROSTATIC LOADS SPANNING FROM THE TOP OF THE BEARING PILES TO A POINT OF ADEQUATE PASSIVE RESISTANCE IN THE SANDY-SILT BELOW ELEV. -10.

A COUPLE CONSISTING OF SHEET PILES AND H-PILE LINES WILL RESIST THE OVER TURNING MOMENTS ABOVE THE BOT. OF CONCRETE AND RESISTANCE TO LATERAL LOADS WILL BE BY THE HORIZONTAL COMPONENT OF LOADS ON THE H PILES. THE MOMENTS WILL RESULT IN COMPRESSION ON THE BATTERED H-PILES AND A NET UPLIFT ON THE SHEET PILING WHICH WILL DEPEND ON FRICTION BETWEEN THE SOIL AND PILING FOR STABILITY.

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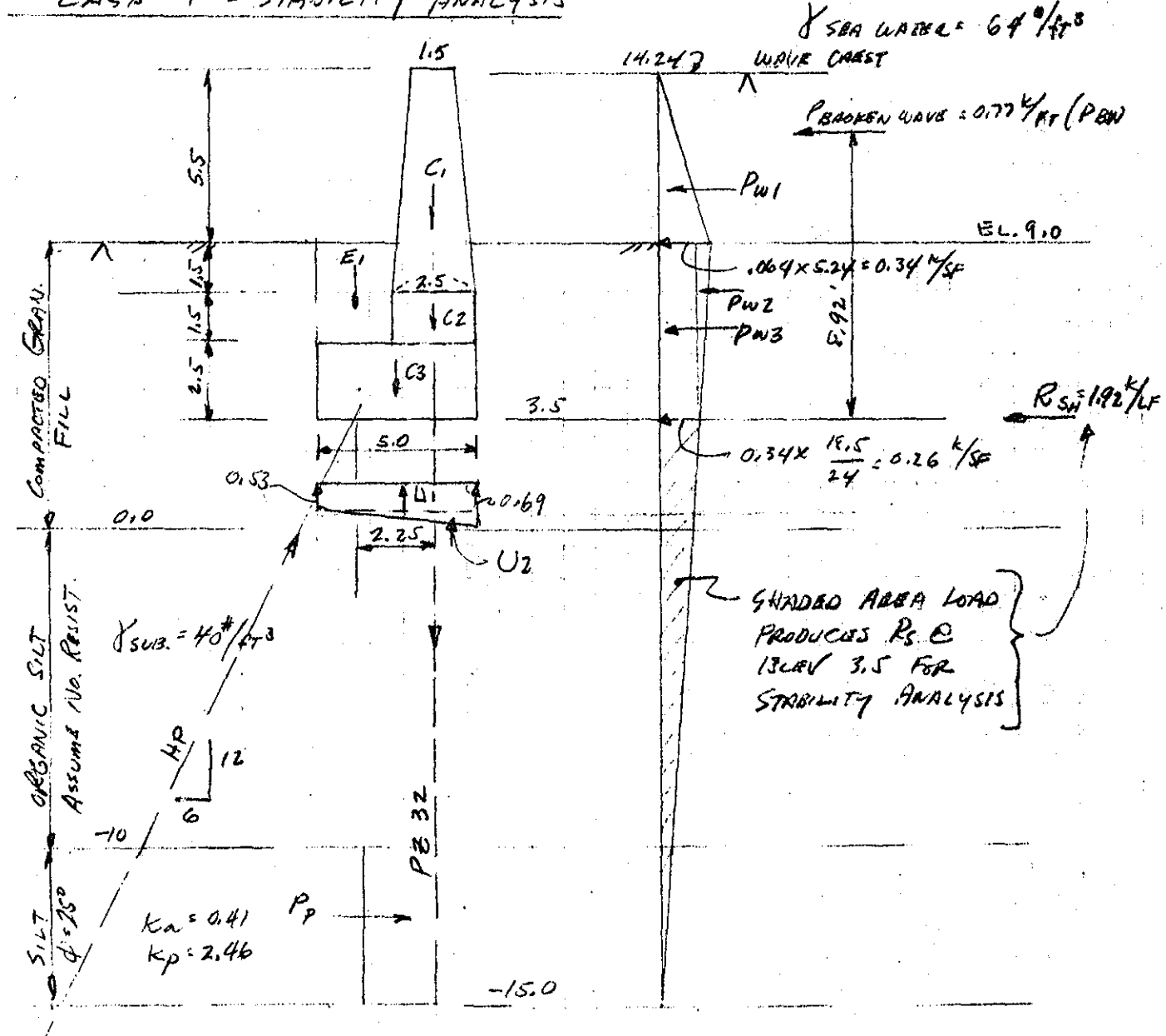
CASE 1 - STABILITY ANALYSIS




LOADING DIAGRAM

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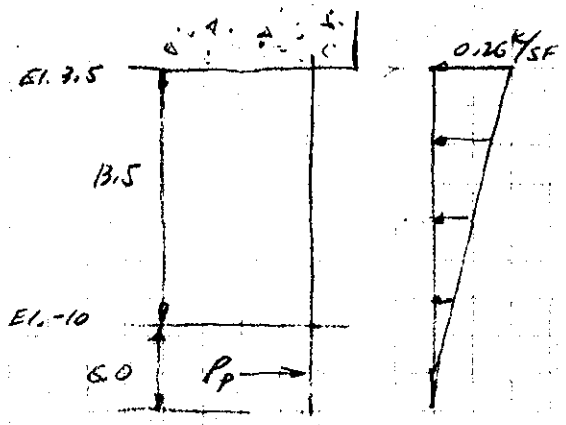
STABILITY ANALYSIS (CONT'D)
CONSIDER LOADING ON SHEET PILE.




$K_p - K_a = 2.46 - 0.41 = 2.05$

FOR DETERMINATION OF REQD PASSIVE PRESSURE, ASSUME PILE PINNED AT TOP & FREE EARTH SUPPORT @ BOT.

$$\text{APPROX } P_p \text{ REQD} = \frac{0.26 \times 18.5^2/6}{16} = 0.92 \text{ K/LF}$$

$$\text{AVG } P_p \text{ reqd (F.S.=2)} = \frac{0.92 \times 2}{5} = 0.37 \text{ K/SF}$$

$$P_p \text{ avail @ } -10 = 0.04 \times 13.5 \times 2.05 = 1.1 > 0.37 \text{ ok}$$

FOR DETERMINING MAX REACTION OF PILING @ TOP CONSIDER PILING FIXED @ TOP & PINNED @ BOT.

$$R_{S_H} \text{ @ EL. } 3.5 = .80 \times .26 \times 18.5 \times \tfrac{1}{2} = 1.92 \text{ K/LF.}$$

$$\text{MAX. MOMENT IN SHEETING} = 0.26 \times 18.5^2 \times \tfrac{1}{2} \times .128 = 5.69 \text{ 'K}$$

LIGHTEST PILE OK
PZ 32 SELECTED DUE TO CABLES ETC
BY F&M BRANCH.

| FACTOR | FORCE ↓ | FORCE ↑ | FORCE ← | FORCE → | ARM | MOMENT @ HP ↷ | MOMENT @ HP ↶ |
|---|---|---|---|---|---|---|---|
| C1 $-(1.5+2.5)\times\frac{1}{2}\times 7.0\times .150$ | 2.10 | | | | 2.25 | 4.73 | |
| C2 $-2.5\times 1.5\times 0.15$ | 0.56 | | | | 2.25 | 1.26 | |
| C3 $-2.5\times 5.0\times .150$ | 1.88 | | | | 1.00 | 1.88 | |
| E1 $-2.5\times 3.0\times .110$ | 0.83 | | | | 0.25 | | 0.21 |
| U1 $-0.53\times 5.0$ | | 2.65 | | | 1.00 | | 2.65 |
| U2 $-0.16\times 5.0\times\frac{1}{2}$ | | 0.40 | | | 1.83 | | 0.73 |
| P.BW. 0.77 | | | .77 | | 8.92 | | 6.87 |
| PW1 $-0.34\times 5.24\times\frac{1}{2}$ | | | .89 | | 7.25 | | 6.45 |
| PW2 $-0.08\times 5.5\times\frac{1}{2}$ | | | .22 | | 3.67 | | 0.81 |
| PW3 $-0.26\times 5.5$ | | | 1.43 | | 2.75 | | 3.93 |
| $R_{S_H}$ 1.92 | | | 1.92 | | 0 | | — |
| Σ | 5.37 | 3.05 | 5.23 | | | 7.87 | 26.65 |
| NET | 2.32 | | | | | | 13.28 |

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STABILITY ANALYSIS (CONTD)

LOC. R = $\frac{13.78}{2.32}$ = 5.94' Lt. of HP.

R SHEETING = $\frac{2.32 \times 5.94}{2.25}$ = 6.12 k/ft. ↓

R HP PILE = 2.32 + 6.12 = 8.44 k/ft. ↑

WGT. SHEET PILE = 18.5 × .032 = .590 k/ft.

NET UPLIFT @ SHTG TO BE RESIST BY FRICTION = 6.12 − 0.59 = 5.53

SURFACE AREA / LF SHTG = (2 × 21 + 2 × 11.5) × 12/21 × 12 × 1/144 = 3.09 ft²/LF

REQD FRICTION SILT to SHTG = $\frac{5530}{3.09 \times 18.5}$ = 97 #/SF OK.

ALSO - PROVIDE POSITIVE CONN BETWEEN CONC. & SHEET PILE.

HP
ASSUME 10 BP 42 ALLOW LD = 50T

REQD SPCG. = $\frac{50 \times 2000}{8440}$ = 11.8' - USE 10'-0" SPC. (R = 42T)

REQD BATTER = $\frac{5.23}{8.44}$ = 0.62 - USE 6/12 BATTER

STEM REINFORCEMENT

ΣM @ ELEV. +6.0

$0.34 \times \overset{4.23}{5.24} \times \frac{1}{2} \times 4.75 + 0.34 \times \overset{1.53}{3^2} \times \frac{1}{2} + 0.77 \times \overset{4.94}{6.42} = 10.7^{'k}$

d = 30" − 7 = 23" AS REQD = $\frac{10.7}{1.44 \times 23}$ = 0.32"² USE #6 @ 12 MIN AS = 0.44

MIN AS = .001 × 30 × 12 = 0.36"²

V = 0.89 + 1.00 + 0.77 = 2.66 k

USE #6 @ 12" EW, EF.

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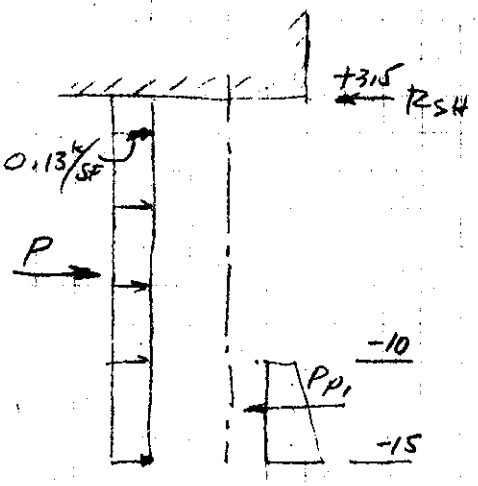
LOAD CASE 2 - STABILITY ANALYSIS

CONSIDER SHEET PILING FIXED @ TOP AND PINNED @ BOTTOM

ASSUME NO TENSION IN H.P WITH LATERAL RESISTANCE PROVIDED BY COMPACTED FILL ON HARBOR SIDE

FIND REACTION OF SHEETING @ TOP




ORGANIC SILT ASSUME $\phi = 20°$

$K_a = 0.5$

$\gamma = 0.5 \times 0.25 = 0.13$ k/SF

$P = 0.13 \times 18.5 = 2.4^k$

$R_{SH} = 2.4 \times 5/8 = 1.5^k$

$P_{P2} = 2.4 \times 3/8 = 0.9^k$

$M_{MAX} = 2.4 \times 18.5 \times 1/8 = 5.6'^k$

| FACTOR | FORCE ↓ | FORCE ↑ | FORCE ← | FORCE → | ARM | MOMENT @ H.P. ↻ | MOMENT @ H.P. ↺ |
|---|---|---|---|---|---|---|---|
| D.L. CONC. | 4.54 | | | | 1.73 | 7.87 | |
| E - 2.5 × 3.0 × 0.11 | 0.83 | | | | 0.25 | | 0.21 |
| $P_S$ (EL. +3.5 to +9.0) = .13 × 5.5 | | | | 0.71 | 2.75 | 1.97 | |
| $P_{WD}$ - 0.05 × 5.5 | | | | 0.28 | 8.25 | 2.27 | |
| $R_{SH}$ - | | | | 1.50 | — | | |
| $P_{P1}$ | | | 2.49 | | 1.83 | | 4.55 |
| Σ | 5.37 | — | 2.49 | 2.49 | | 12.11 | 4.76 |
| NET | | | | | | 7.35 | |

$\text{LOC. } R = \frac{7.35}{5.37} = 1.37'$ RT OF H.P.

$R_S = \frac{7.35}{2.25} = 3.27$

$R_V \text{ HP} = 5.37 - 3.27 = 2.10^k$

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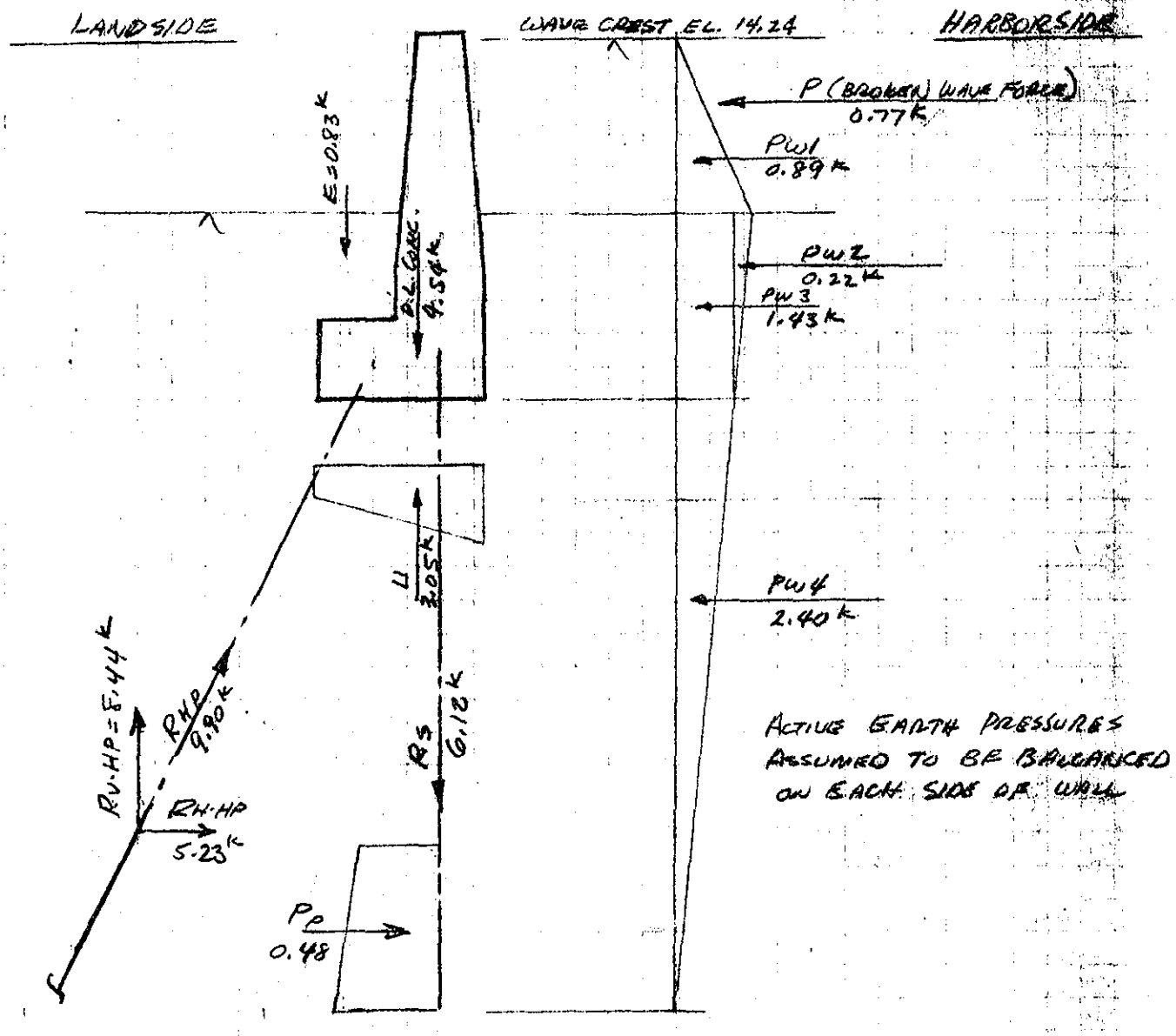
SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION FLOODWALL STA 29+70± TO STA 33+00±
COMPUTED BY R.HARRINGTON CHECKED BY DATE NOV. 1977




LOAD CASE 1

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SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION FLOODWALL STA 29+70± TO STA 33+00±
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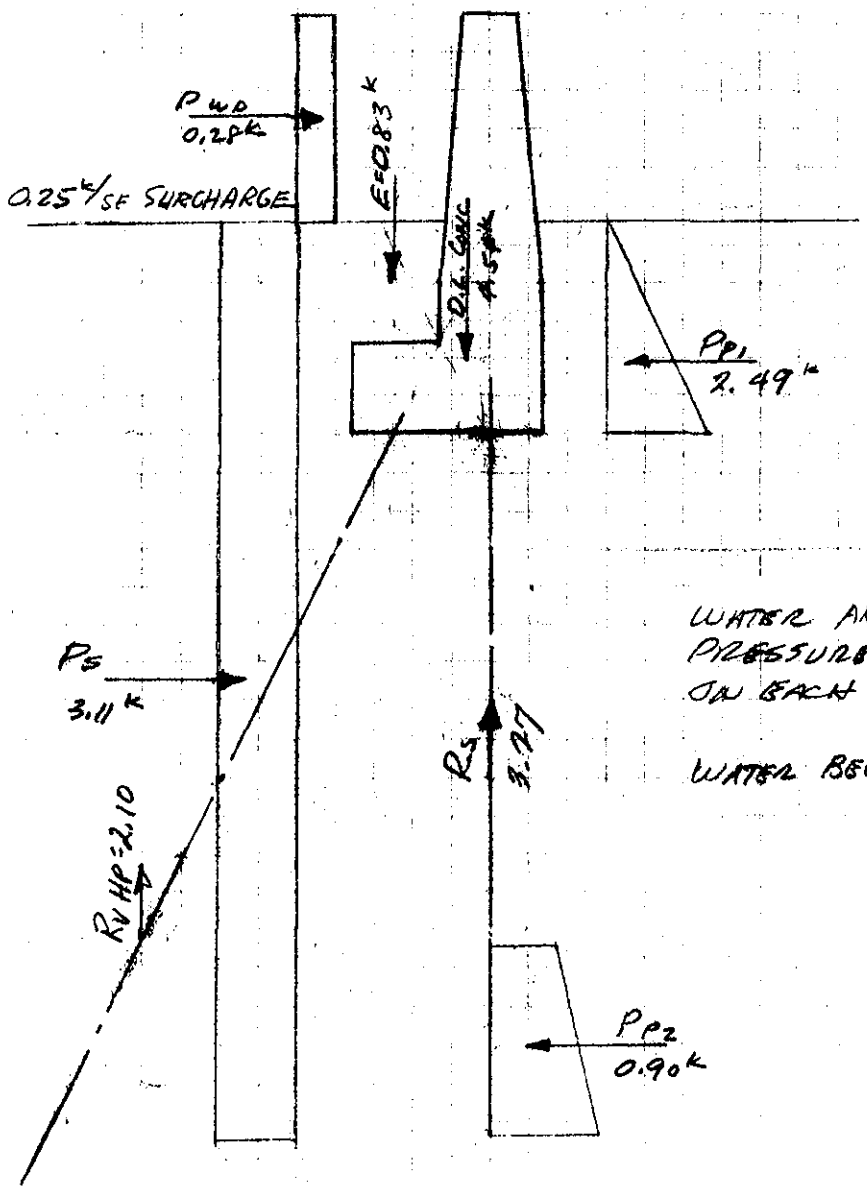


WATER AND ACTIVE EARTH PRESSURES ASSUMED BALANCED ON EACH SIDE OF WALL

WATER BELOW EL. 3.5

LOAD CASE 2

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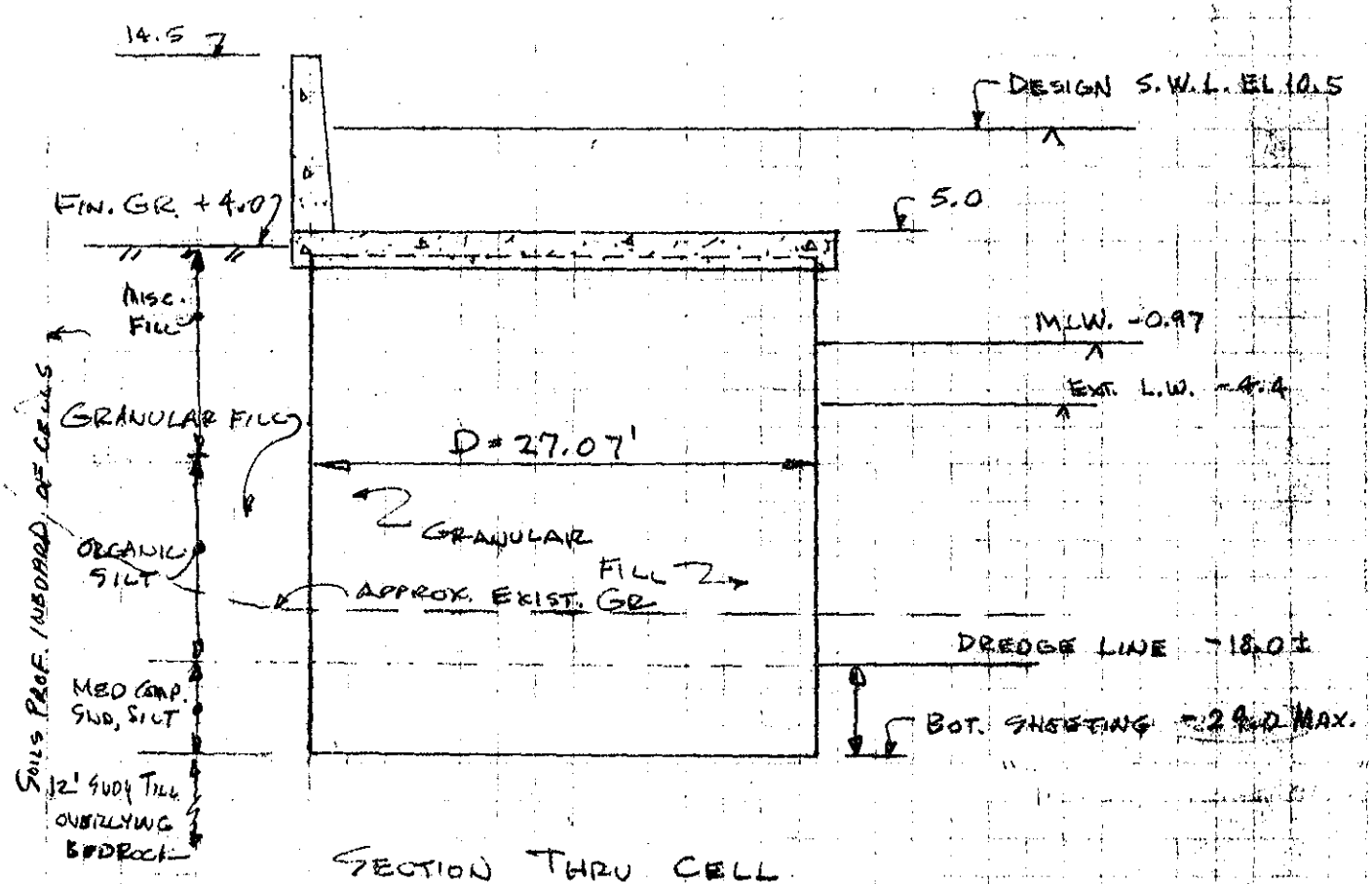
SUBJECT: NEW LONDON HURRICANE BARRIER
COMPUTATION: "L" WALL AND CELLS @ CITY COAL
COMPUTED BY: HARRINGTON CHECKED BY: WHC DATE: SEPT 1977




SECTION THRU CELL
STA. 21+0 ±

LOADING CONDITIONS.

CASE 1 - DESIGN HURRICANE
SWL @ ELEV. 10.5
MAX WAVE HGT = 2.4'
WATER LANDSIDE @ MLW (-.97)

CASE 2 - MAX. LOADING AS RETAINING WALL
FIN. GR. LANDSIDE @ ELEV. +4.0
SURCH. LOADING LANDSIDE = 250 #/SF
WATER LANDSIDE @ ELEV. +4.0
SWL TIDE SIDE @ ELEV. -4.4
WIND FROM LAND = 50 #/SF

CASE 3 - CONSTRUCTION CONDITION
CELL FILLED IN PLACE
FIN GRADE LANDSIDE +4.0
WATER LANDSIDE = +4.0
SWL TIDE SIDE = -1.0
SURCHARGE LANDSIDE = 250 #/SF

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SUBJECT
COMPUTATION
COMPUTED BY WHR
CORPS OF ENGINEERS, U.S. ARMY
CHECKED BY
DATE 14 Oct 1997
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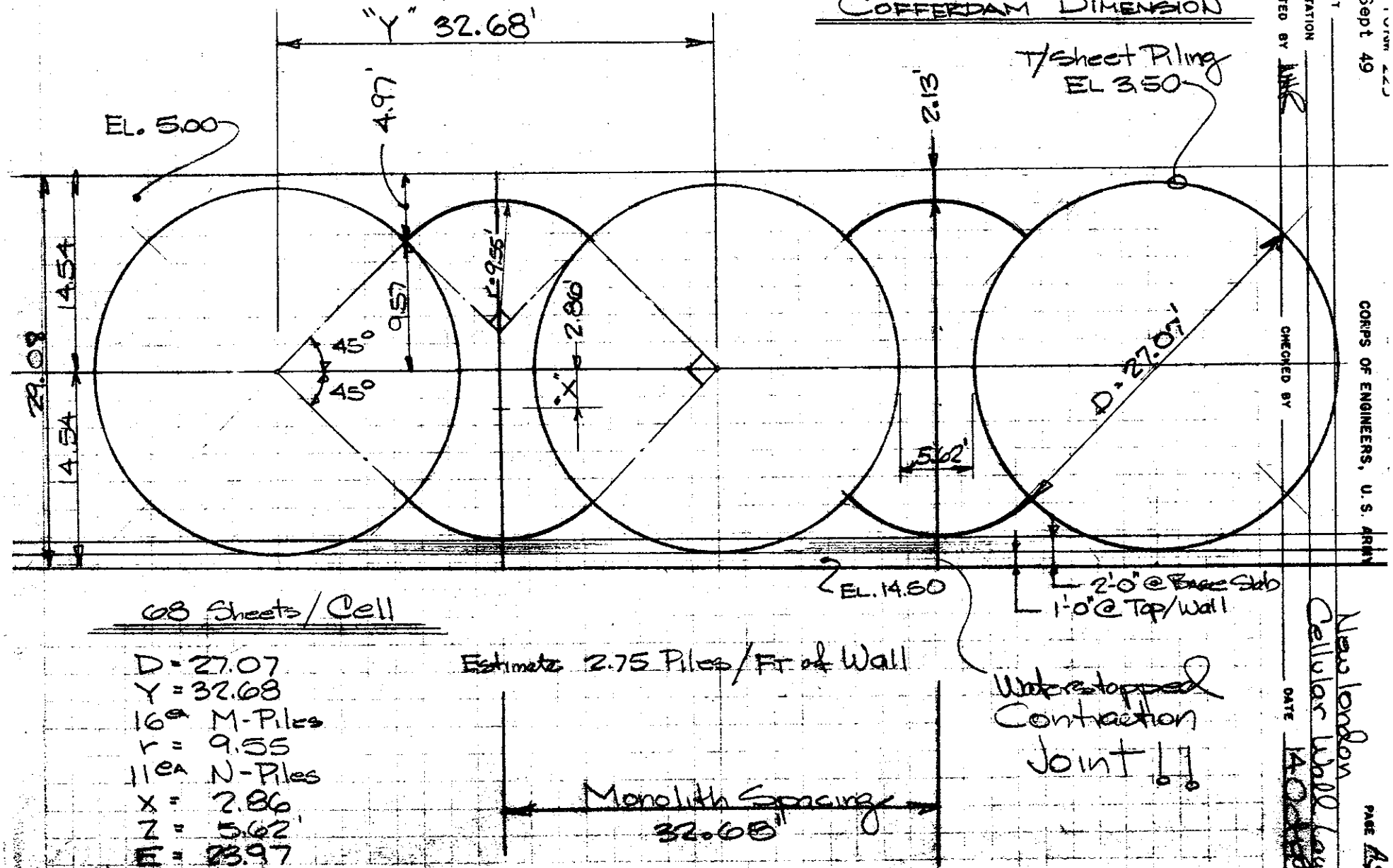
New London
Cellular Wall Layout

# TYPICAL CELLULAR COFFERDAM DIMENSION




68 Sheets/Cell

D = 27.07
Y = 32.68
16 ea M-Piles
r = 9.55
11 ea N-Piles
X = 2.86
Z = 5.62'
E = 23.97
$A_{air}$ = 575 SF
$A_{sec}$ = 208 SF

Estimate 2.75 Piles/Ft of Wall

SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION "L" WALL AND CELLS @ CITY COAL
COMPUTED BY HARRINGTON CHECKED BY WMC DATE SEPT 1977

DATA FROM F&M. BRANCH

CELL FILL - ASSUME $\phi = 30°$ $K_a = 0.33$

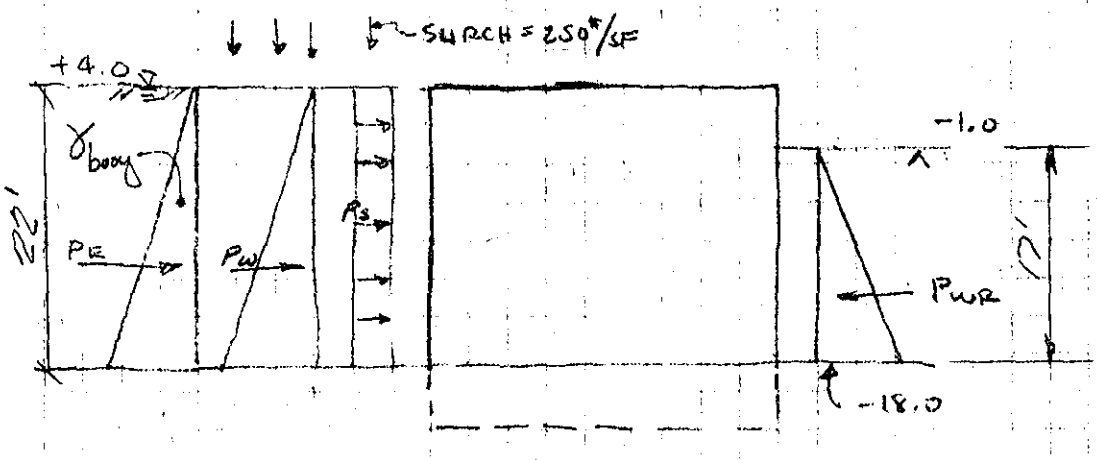
FILL BEHIND CELLS - ASSUME $\phi = 28°$ $K_a = 0.37$

WGT FILLS = 125#/FT³

WGT SEAWATER = 64.2#/FT³

APPLIED FORCES AND OVERTURNING MOMENTS

LOADING CASE #3




| OVERTURNING MOMENT | F | × | A | = | M. |
|---|---|---|---|---|---|
| PE = .0625* × 0.37 × 22² × ½ | = 5.60' | | 22/3' | = | 41.0' |
| PW = .0642 × 22² × ½ | = 15.54' | | 22/3' | = | 113.9' |
| Ps = .250 × 0.37 × 22 | = 2.04' | | 22/2 | = | 22.4' |
| | ΣF = 23.18 | | | ΣMo = | 177.3 ft-k/1' |

RESISTING MOMENT

| | | | | |
|---|---|---|---|---|
| PWR = .0642 × 17² × ½ | = 9.28' | | 17/3 | 52.6 ft-k/1' |

SUBJECT (NEW LONDON) HURRICANE BARRIER

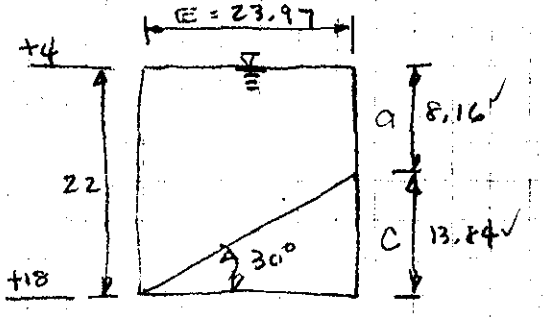
COMPUTATION "L" WALL AND CELLS @ CITY COAL

COMPUTED BY HARRINGTON CHECKED BY WHC DATE SEPT 1977

CASE 3 CONTD.

$M_R$, HORIZONTAL SHEAR RESIST. (ASSUME WATER TO TOP OF CELL)

ASSUME D = 27.07' E = 23.97'




$$M_R = .0625\left(\frac{8.16 \times 13.84^2}{2} + \frac{13.84^3}{3}\right) = 104.1^{k}$$

$M_f$, INTERLOCK FRICTION RESISTANCE

$M_f = PfE$

$f = 0.3$, $E = 23.97$

$p_e = .0625 \times 0.33 = .021$

$p_w = .064 = .064$

$.085$

$$P = .085 \times \overset{20.57}{22^2} \times \tfrac{1}{2} - .0642 \times \overset{9.28}{12^2} \times \tfrac{1}{2} = 11.29^{k}$$

$$M_f = 11.29 \times 0.3 \times 23.97 = 81.2^{k}$$

FACTOR OF SAFETY VS. TILTING. $N_t$

$$N_t = \frac{104.1 + 81.2 + 52.6}{177.3} = 1.34 > 1.25 \text{ (CONST COND)}$$

OK.

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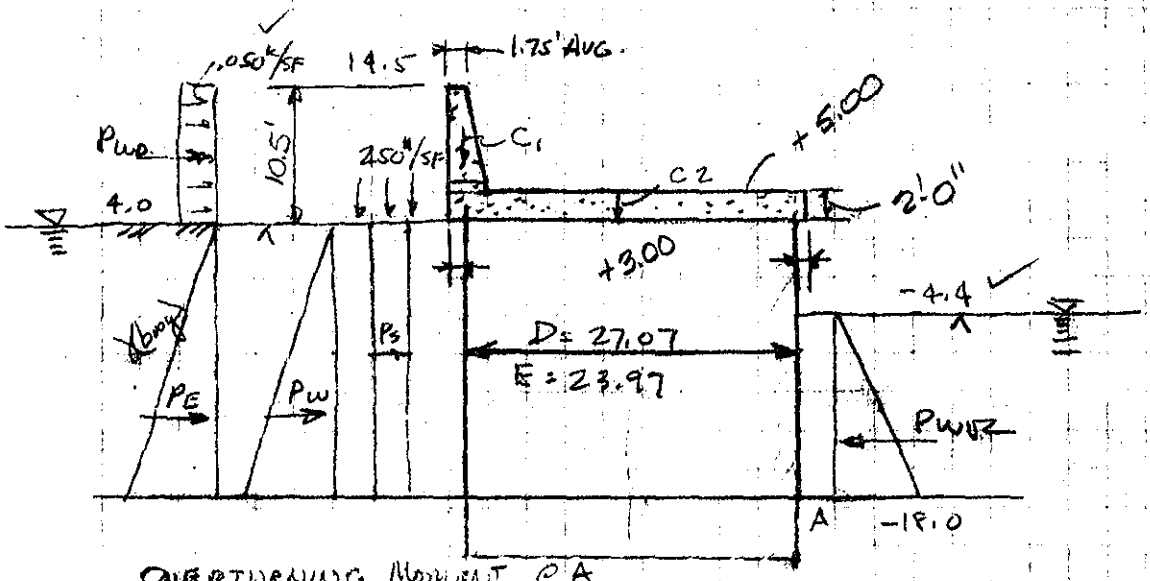
SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION "L" WALL AND CELLS @ CITY COAL
COMPUTED BY HARRINGTON CHECKED BY WHC DATE SEPT 1977

## APPLIED FORCES AND OVERTURNING MOMENTS

### LOADING CASE #2




### OVERTURNING MOMENT @ A

| | F | × | A | = | M |
|---|---|---|---|---|---|
| $P_E$ = | 5.60 | | 22/3 | = | 41.0 |
| $P_W$ = | 15.54 | | 22/3 | = | 113.9 |
| $P_S$ = | 2.04 | | 22/2 | = | 22.4 |
| $P_{WO}$ = 10.5 × .050 | = 0.53 | | 27.25 | = | 14.4 |
| | | | $\Sigma M_o$ | = | 191.7 ik |

### RESISTING MOMENT

| | FH | FV | | | |
|---|---|---|---|---|---|
| $P_{WR}$ = .0642 × 13.6² × ½ = | 5.94 | | 13.6/3 | = | 26.9 |
| C1 = 9.5 × 1.75 × 0.150 = | | 2.49 | 23.1 | = | 57.6 |
| C2 = 29 × 2.0 × 0.15 = | | 8.70 | 23.97/2 | = | 104.3 |
| | | | $\Sigma M$ | = | 188.8 ik |

$M_R$ = 104.1 ik

$P = .085 \times 22^2 \times \frac{1}{2} - .0642 \times 13.6^2 \times \frac{1}{2} = 14.63$

$M_f = 14.63 \times 0.3 \times 23.97 = 105.2$ ik

FACTOR OF SAFETY VS. TILTING.

$$N_t = \frac{104.1 + 105.2 + 188.8}{191.7} = \frac{398.1}{191.7} = 2.08 > 1.5$$

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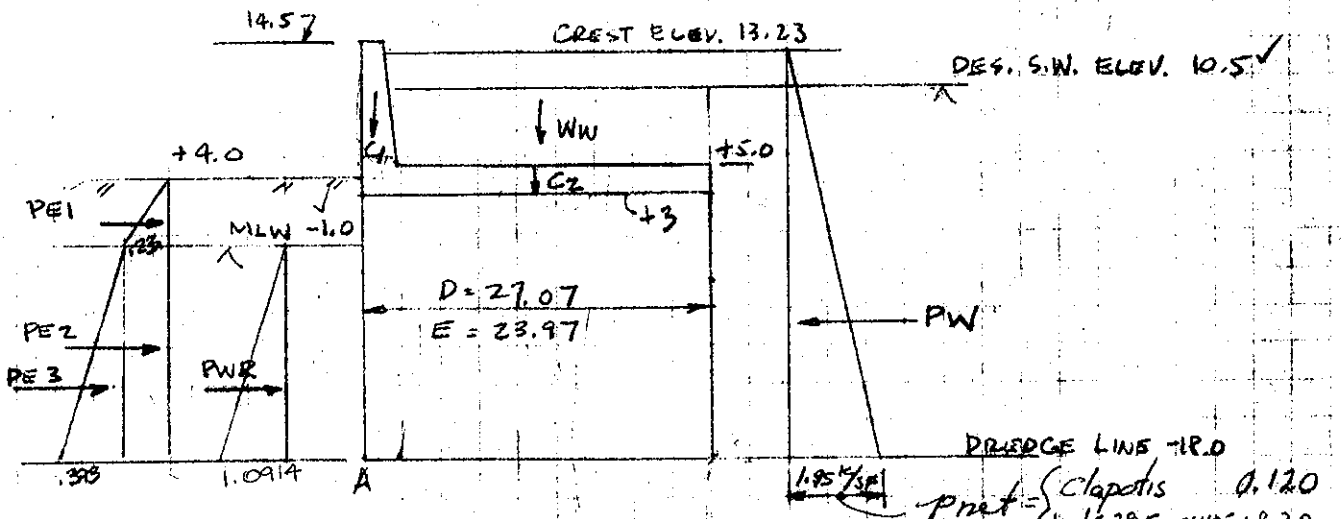
SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION "L" WALL AND CELLS @ CITY COAL
COMPUTED BY R. HARRINGTON CHECKED BY WAR DATE

## APPLIED FORCES AND OVERTURNING MOMENTS

### LOADING CASE 1




$p_{net} = \begin{cases} \text{Clapotis} & 0.120 \\ 40d = 28.5 \times .0642 = & 1.830 \end{cases}$
$1.950$

OVERTURNING MOMENT @ A

| | | F | × | A | = | M |
|---|---|---|---|---|---|---|
| ← $P_W = 1.95 \times 31.23 \times \frac{1}{2}$ | = | 30.45 | × | 31.23/3 | = | 317.0 |
| ↓ $C_1 = 9.5 \times 1.75 \times 0.15$ | = | 2.49 | × | (13.53 − 1.99)/1.54 | = | 3.8 |
| | | | | $\Sigma M_O$ | = | 320.8 ft |

RESISTING MOMENT

| | | | | | | |
|---|---|---|---|---|---|---|
| → $P_{WR} = .0642 \times 17^2 \times \frac{1}{2}$ | = | 9.28 | × | 17/3 | = | 52.6 |
| → $P_{E1} = 0.125 \times 0.37 \times 5^2 \times \frac{1}{2}$ | = | 0.58 | × | 17 + 5/3 | = | 10.8 |
| → $P_{E2} = 0.125 \times 5.0 \times 0.37 \times 17$ | = | 3.93 | × | 17/2 | = | 33.4 |
| → $P_{E3} = 0.0625 \times 0.37 \times 17^2 \times \frac{1}{2}$ | = | 3.34 | × | 17/3 | = | 18.9 |
| ↓ $W_W = 27 \times .0642 \times 5.5$ | = | 9.53 | × | 23.97/2 | = | 114.3 |
| ↓ $C_2 = .086 \times 27 \times 2$ | = | 4.64 | × | 23.97/2 | = | 55.6 |
| | | | | $\Sigma M$ | = | 285.6 ft |

$M_R = 104.1$

$M_f = P f E \qquad P = .085 \times \overset{20.57}{22^2} \times \frac{1}{2} - (\overset{17.13}{9.28 + 0.58 + 3.93 + 3.34}) = 3.44$

$M_f = 3.44 \times 0.3 \times 23.97 = 24.7$ ft

$$N_T = \frac{104.1 + 24.7 + 285.6}{320.8} = 1.29 > 1.25$$

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SUBJECT: NEW LONDON HURRICANE BARRIER
COMPUTATION: "L" WALL AND CELLS @ CITY COAL
COMPUTED BY: R. HARRINGTON  CHECKED BY:  DATE:

## BEARING PRESSURES

### CASE 3

$$BP = \frac{W}{E}\left(1 \pm \frac{6e}{E}\right)$$

$W = \gamma_{sew} H E$

$W = .061 \times 21 \times 23.97 = 30.71^k$

$M_{O\mathbb{C}} = 177.3 - 52.6 = 124.70^{'k}$ ; $e = \frac{M}{W} = \frac{124.7}{30.71} = 4.05$

$BP = \frac{W}{E}\left(1 \pm \frac{6e}{E}\right) = \frac{30.71}{23.97}\left(1 \pm \frac{6 \times 4.05}{23.97}\right) = +2.56\ ^k/_{SF}\ ,\ -0.00\ ^k/_{SF}$

### CASE 2

$M_{O\mathbb{C}} = 191.7 - 26.9 - 9.5 \times 1.5 \times \overset{7.5.12}{0.150} \times 13.53 = 135.88^{'k}$

$W = .061 \times 21 \times \overset{30.71}{23.97} + 8.7 + 9.5 \times 1.5 \times \overset{2.14}{.150} = 41.55$

$e = \frac{135.88}{41.55} = 3.27$

$BP = \frac{41.55}{23.97}\left(1 + \frac{6 \times 3.27}{23.97}\right) = +3.15\ ^k/_{SF}\ ,\ +0.31\ ^k/_{SF}$

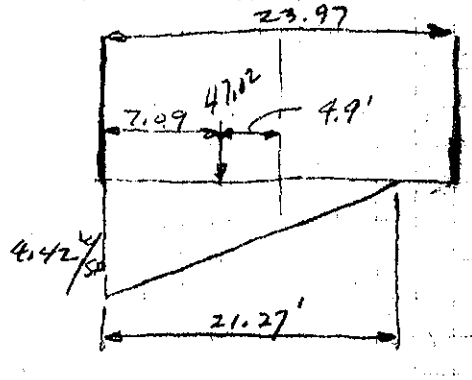
### CASE 1

$M_{O\mathbb{C}} = 317.0 + 9.5 \times 1.5 \times 0.150 \times \overset{28.92}{13.53} - (52.6 + 10.8 + \overset{115.7}{33.4} + 18.9) = 230.2^{'k}$

$W = 0.61 \times \overset{30.71}{21} \times 23.97 + 4.64 + 9.53 + 2.14 = 47.02^k$

$e = \frac{230.2}{47.02} = 4.90$

$BP_{max} = \frac{2 \times 47.02}{3 \times 7.09} = 4.42\ ^k/_{SF}$



SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION "L" WALL AND CELLS @ CITY COAL
COMPUTED BY R. HARRINGTON CHECKED BY DATE

STABILITY AGAINST BEARING CAPACITY FAILURE @ TOE

ULTIMATE BEARING CAPACITY $= \gamma D N_q + \gamma \frac{E}{2} N_\gamma$ , $\phi = 30°$

ASSUME $D = 6'$

$UBC = 0.061 \times 6 \times 20 + 0.061 \times \frac{23.97}{2} (E) = 7.32 + 5.85 = 13.17$

$$\left.\begin{array}{l} F_S \text{ CASE } 1 = 13.17/4.42 = 2.98 \\ F_S \text{ CASE } 2 = 13.17/3.15 = 4.18 \\ F_S \text{ CASE } 3 = 13.17/2.64 = 4.99 \end{array}\right\} > 2.0$$

PULL OUT RESISTANCE, SHEET PILING

$F.S. = \frac{Q_{TU}}{Q_P} \geq 1.5$

$Q_{TU} = \frac{1}{2} K_H \gamma D^2 \tan\delta \times \text{Perimeter}$

OUTBOARD SHEET

$K_{H\gamma} = 0.5 \times .061 = 0.031$ $D = 6'$ $\tan\delta = 0.5$ perim $= 2$

$Q_{TU} = \frac{1}{2} \times .031 \times 6^2 \times 0.5 \times 2 = 0.56$

$Q_P = \frac{M_O}{3E(1 + \frac{E}{4L})} = \frac{230.2}{3 \times 23.97 \left(1 + \frac{23.97}{4 \times 16.34}\right)} = 2.34$

1.37

TRY $D = 15'$

$Q_{TU} = 0.5 \times .031 \times 15^2 \times 0.5 \times 2 = 3.49$

$\frac{Q_{TU}}{Q_P} = \frac{3.49}{2.34} = 1.50$

FOR $M_O = 124.7$ (CASE 3)

$Q_P = \frac{124.7}{96.52} = 1.26$

REQD $Q_{TU} = 1.26 \times 1.5 = 1.89$ $D_{REQD} = \sqrt{\frac{1.89}{0.5 \times .031}} = 11' > 6'$ AVAIL

CHECK STABILITY @ TOP OF TILL WITH BERM.

SUBJECT NEW LONDON HURRICANE BARRIER
COMPUTATION "L" WALL AND COLS @ CITY COAL
COMPUTED BY R. HARRINGTON CHECKED BY WNK DATE

## WALL STEM

### REINF. COVE SIDE FACE

LOAD CASE 1.

MOM @ BASE WALL = .0642 x 9.5³ x 1/6 = 9.17 ¹ᵏ

$d_{reqd} = \sqrt{\frac{9.17}{.169}} = 7.37$  $d_{AVAIL} = 24 - 5 - .19''$

$A_s$ REQD. = $\frac{9.17}{1.44 \times 19} = 0.34^{in^2}$

$A_s$ MIN = .005 x 19 x 12 = 1.14 or 1.3 x .34 = 0.442

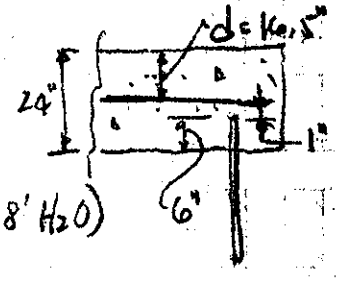
USE #6 @ 12" $A_s = 0.44$

### REINF. LANDSIDE FACE

LOAD CASE 2

M @ BASE OF WALL = .050 x 9.5² x 1/2 = 2.26 ¹ᵏ

USE #6 @ 12" MIN.




### BASE SLAB.

ASSUME LIVE LOAD = 500 #/SF (EQUIV. 7.8' $H_2O$)
DEAD LOAD = 300 #/SF

$\Sigma w$ = 800 #/SF

$M_{TOT}$ = .800 x 13.53³/3 = 660.48 (SEELY - SMITH Pg. 224)

AVG. M/FT = 660.48/27.07 = 24.40 ¹ᵏ/ᴸᴾ

$M_{max}$/FT = 24.4 (3/8) (3 + .25) = 29.74 ¹ᵏ/ᴸᴾ  (Poisson's Ratio)

AVG = 27.07 ¹ᵏ/ᴸᴾ

$d_{reqd} = \sqrt{\frac{27.07}{.169}} = 12.66 < 16.5$

$A_s$ REQD = $\frac{27.07}{1.44 \times 16.5} = 1.14^{in^2}$  SAY #9 @ 12

27 Sept 49

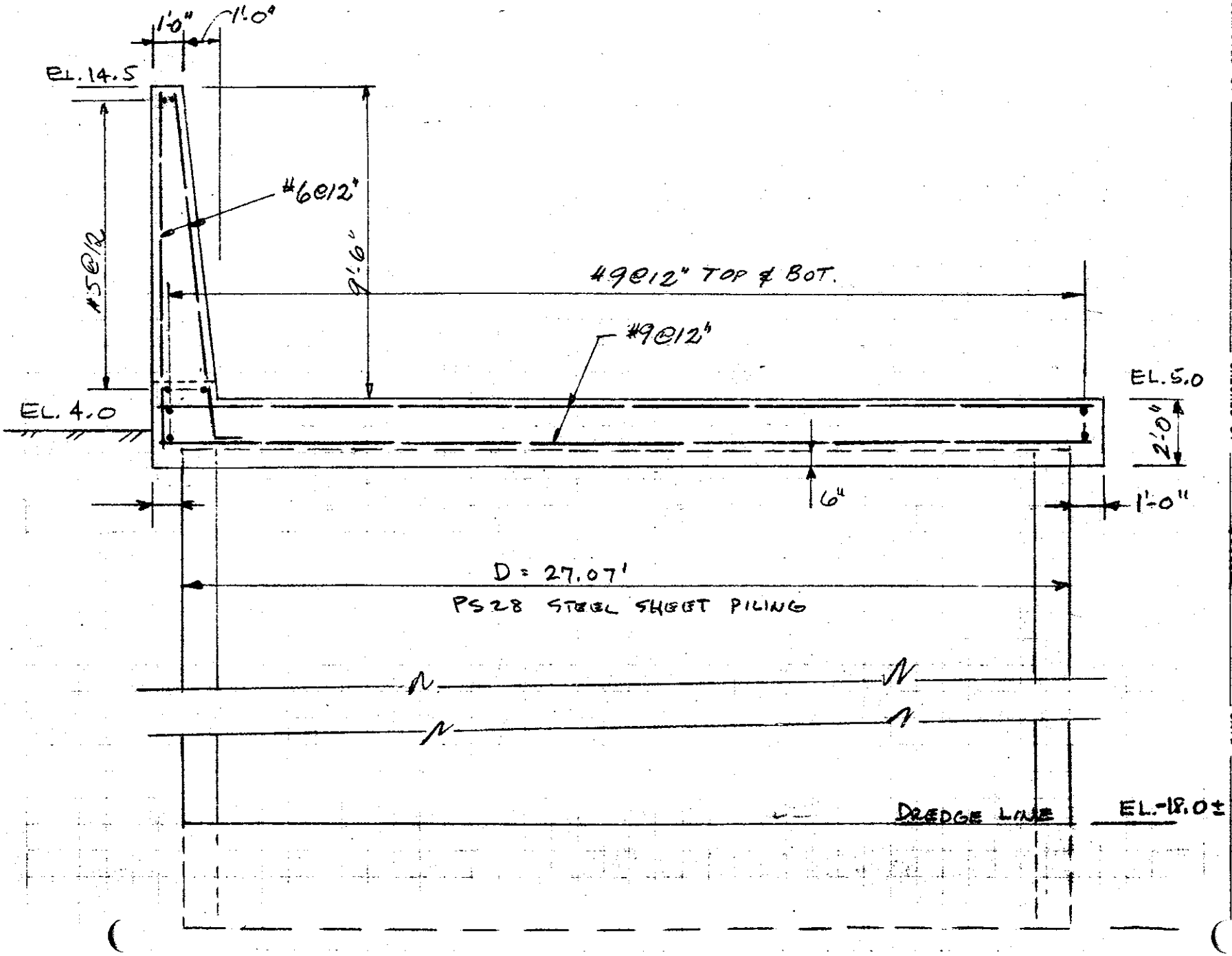
SUBJECT (NEW) LONDON HURRICANE BARRIER

COMPUTATION "L" WALL AND CELLS @ CITY COAL

COMPUTED BY R. HARRINGTON CHECKED BY WWK DATE

CORPS OF ENGINEERS, U.S. ARMY

PAGE A64



# APPENDIX B

# MECHANICAL COMPUTATIONS

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY



SUBJECT: NEW LONDON, CONN. LOCAL PROTECTION
COMPUTATION: SHAW COVE PUMPING STATION
COMPUTED BY: J.T.S CHECKED BY: DATE: Oct. 1977

## STATION DESIGN CAPACITY

210 cfs
Top of Dike
Suction Chamber: High Water
" " Low "
Three Pumps (each to handle 1/3 of total)

## PUMP DESIGN CONDITION POINT

210/3 = 70 cfs = 31,500 gpm

Diam. of disch. = $\sqrt{\frac{4 \times 70}{12\pi}}$ = 2.72 ft = 32.70 in

Try 30" & 36" discharge pipe

Head @ Q = 31,500 gpm

| | | | 30" | 36" |
|---|---|---|---|---|
| H.W. Suction top disch. pipe | 14.5 - (+5) | | 9.50 | |
| " " " " " | 15.0 - (+5) | | | 10.00 |
| L.W " " " " | 14.5 - (-2) | | 16.50 | |
| " " " " " | 15.0 - (-2) | | | 17.00 |
| Velocity Head | | | 3.66 | 1.54 |
| Discharge pipe loss | | | 4.98 | 1.92 |
| | Total Head | (H.W) | 18.14 | 13.46 |
| | | (L.W) | 25.14 | 20.46 |

## SYSTEM LOSSES

30" Discharge Pipe (280 ft. equiv $L_e$)

| | Vel. | hv | Pipe Hf | Total Hd. |
|---|---|---|---|---|
| 20,000 | 9.71 | 1.47 | 2.05 | 3.52 |
| 25,000 | 12.10 | 2.29 | 3.16 | 5.45 |
| 30,000 | 14.60 | 3.30 | 4.51 | 7.81 |
| 31,500 | 15.32 | 3.66 | 4.98 | 8.64 |
| 35,000 | 17.00 | 4.49 | 6.08 | 10.57 |
| 40,000 | 19.40 | 5.87 | 7.92 | 13.79 |

36" Discharge Pipe (320 ft. equiv. $L_e$)

| | | | | |
|---|---|---|---|---|
| 20,000 | 6.30 | 0.62 | 0.79 | 1.41 |
| 25,000 | 7.88 | 0.97 | 1.21 | 2.18 |
| 30,000 | 9.46 | 1.39 | 1.73 | 3.12 |
| 31,500 | 9.92 | 1.54 | 1.92 | 3.46 |
| 35,000 | 11.00 | 1.89 | 2.32 | 4.21 |
| 40,000 | 12.60 | 2.47 | 3.01 | 5.48 |

## PUMP OPERATING CYCLE

Pipe Storage = 149,610 gals
Sump " = 47,470

Total 197,080 gals

Pump capacity = 31,500 gals/min

Operating time (no inflow) $\frac{197,080}{31,500}$ = 6.26 mins

Min. Pump operating cycle (operating at full speed)
Inflow = 50% of pump capacity

Time to empty = $\frac{197,080}{15,750}$ = 12.51 mins

Time to refill = $\frac{197,080}{15,750}$ = 12.51 "

Time between engine starts = 24.51 mins.

Due to the absence of pooling areas and the small storage within the drainage system, by-passes have been provided on two of the pumps to prevent too frequent cycling of the diesel engines.

## SUMMARY

Computations and curves, pages M-15 thru M-20 show that a mixed flow pump operating at 714 RPM, using a 36" discharge pipe satisfactorily meet requirement and is best selection.

Computations and curves on pages M-15 thru M-20 also include head capacities and horsepower requirements for pump with 30" discharge pipe over dike.

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY



SUBJECT NEW LONDON CONN. LOCAL PROTECTION
COMPUTATION SHAW COVE PUMPING STATION
COMPUTED BY JAS CHECKED BY DATE OCT. 1977

## VALUES FROM CURVE - PLATE 18

| | Qm | Hm | Pm |
|---|---|---|---|
| Max. Eff. | 11,250 | 31.0 | 109 |
| | 13,000 | 25.5 | 98 |
| | 14,250 | 20.0 | 88 |
| | 15,200 | 15.0 | 78 |
| | 16,050 | 10.0 | 68 |
| | 16,800 | 5.0 | 57 |
| Values at cond. pt 30" | 14,650 | 18.1 | 84 |
| " " " " 36" | 15,500 | 13.5 | 74 |

## ACTUAL MODEL RATIOS

30" Pump Discharge $\overline{MR}^2 = \frac{31,500}{14,650} = 2.150$ ; MR = 1.466

36" " " $\overline{MR}^2 = \frac{31,500}{15,500} = 2.032$ ; MR = 1.426

## PROTOTYPE VALUES

| | Qp | Hp | Pp |
|---|---|---|---|
| **30" Pump Disch.** | | | |
| Max. Eff | 24,190 | 31.0 | 234 |
| | 27,950 | 25.5 | 211 |
| | 30,640 | 20.0 | 189 |
| Cond. Pt. | 31,500 | 18.1 | 181 |
| | 32,680 | 15.0 | 168 |
| | 34,510 | 10.0 | 146 |
| | 36,120 | 5.0 | 123 |
| **36" Pump Disch.** | | | |
| Max. Eff. | 22,860 | 31.0 | 222 |
| | 26,420 | 25.5 | 199 |
| | 28,960 | 20.0 | 179 |
| | 30,890 | 15.0 | 158 |
| Cond. Pt. | 31,500 | 13.5 | 150 |
| | 32,620 | 10.0 | 138 |
| | 34,140 | 5.0 | 116 |

## 30" DISCHARGE PIPE

$N = \frac{974}{1.466} = 664$ rpm

Impeller diam. = 17.96 x 1.466 = 26.34 in

From plotted curve

Q = 31,500 gpm
P @ rated Q = 181

| | | |
|---|---|---|
| BHP required by pump | = | 181 |
| +10% | = | 199 |
| Loss in reduct gear +4% | = | 8 |
| BHP at engine coupling | = | 207 (Continuous Rating) |
| $P_{max}$ | = | 204 |
| +10% | = | 224 |
| Loss in reduct. gear +4% | = | 9 |
| BHP at engine coupling | = | 233 (Intermittent Rating) |

## 36" DISCHARGE PIPE

$N = \frac{974}{1.426} = 683$ rpm

Impeller diam. = 17.96 x 1.426 = 25.60 in

From plotted curve

Q = 31,500
P @ rated Q = 150

| | | |
|---|---|---|
| BHP required by pump | = | 150 |
| +10% | = | 165 |
| Loss in reduct. gear +4% | = | 7 |
| BHP at engine coupling | = | 172 (Continuous Rating) |
| $P_{max}$ | = | 180 |
| +10% | = | 198 |
| Loss in reduct. gear +4% | = | 8 |
| BHP at engine coupling | = | 206 (Intermittent Rating) |

## SPECIFIC SPEED

### 30" DISCHARGE PIPE

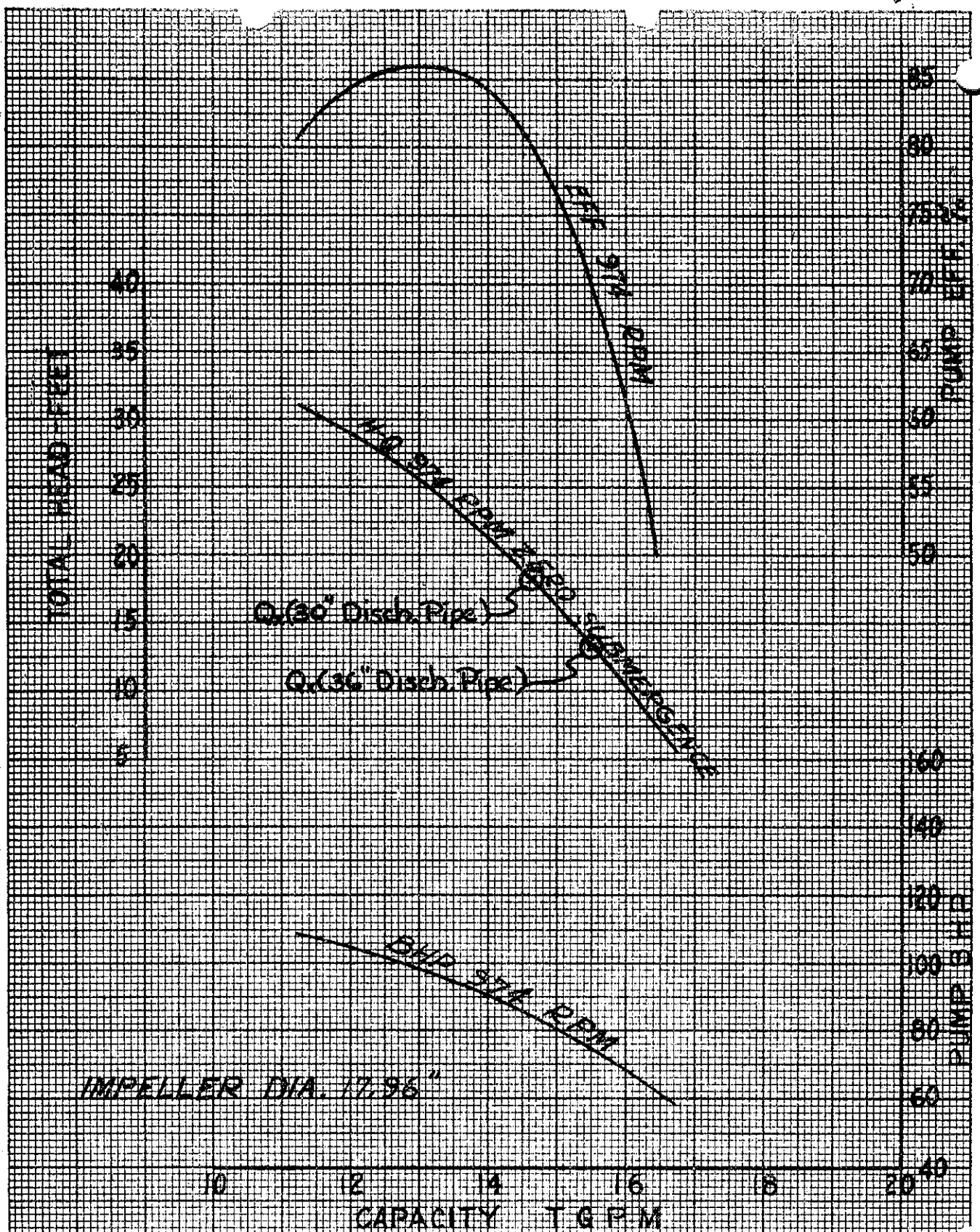
$$N_s = \frac{664\sqrt{27{,}950}}{25.5^{3/4}} = 9782 \text{ rpm}$$

Suction Hd = 0

### 36" DISCHARGE PIPE

$$N_s = \frac{683\sqrt{26{,}420}}{25.5^{3/4}} = 9783 \text{ rpm}$$

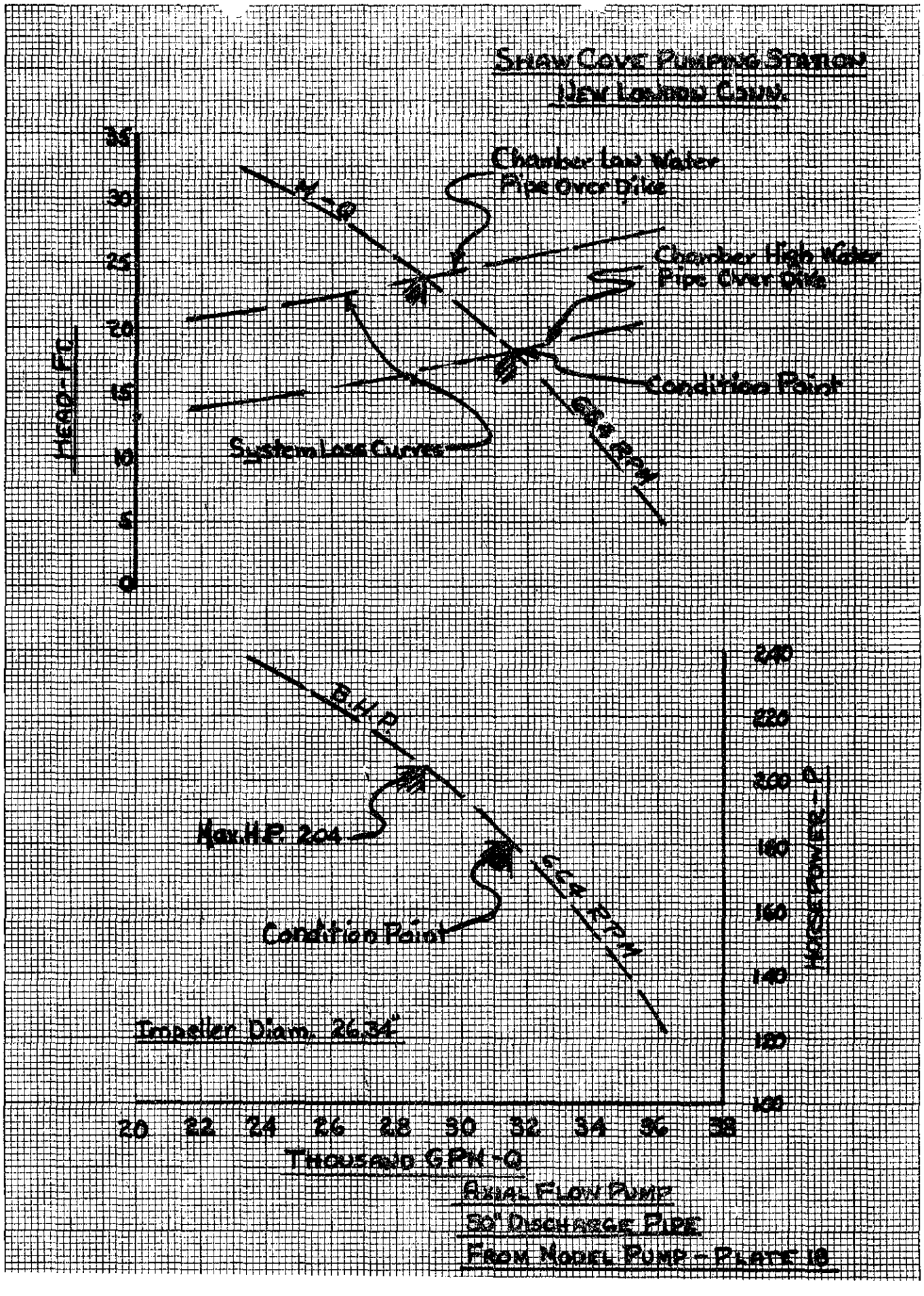
Suction Hd. = 0



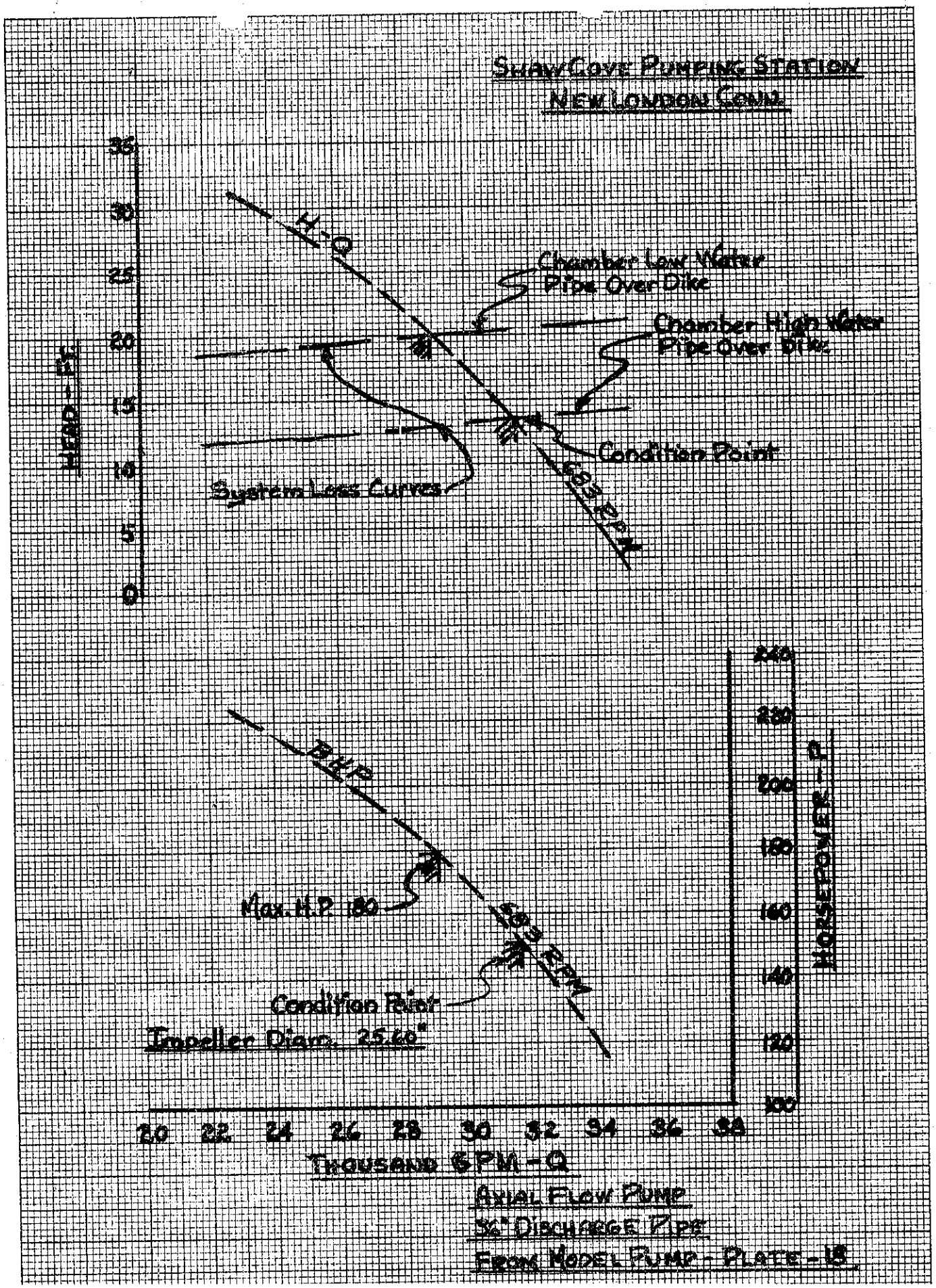

20" AXIAL-FLOW MODEL PUMP PERFORMANCE CURVES

PLATE NO. 18
FM 110-2-3105

KEUFFEL & ESSER CO.




46 1323
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.


SHAW COVE PUMPING STATION
NEW LONDON CONN.
HEAD - FT.
35
30
25
20
15
10
5
0
H-Q
Chamber Low Water Pipe Over Dike
Chamber High Water Pipe Over Dike
Condition Point
System Loss Curves
683 RPM
BHP
Max. H.P. 180
683 RPM
Condition Point
Impeller Diam. 25.60"
HORSEPOWER - P
240
220
200
180
160
140
120
100
20
22
24
26
28
30
32
34
36
38
THOUSAND GPM - Q
AXIAL FLOW PUMP
36" DISCHARGE PIPE
FROM MODEL PUMP - PLATE - 18

SUBJECT NEW LONDON, CONN. LOCAL PROTECTION
COMPUTATION SHAW COVE PUMPING STATION
COMPUTED BY JTS CHECKED BY DATE Oct. 1977

## VALUES FROM CURVE - PLATE 19

| | Qm | Hm | Pm |
|---|---|---|---|
| Max. Eff. | 9,600 | 32.5 | 98 |
| | 10,350 | 30.0 | 95 |
| | 11,700 | 25.0 | 85 |
| | 12,750 | 20.0 | 77 |
| | 13,550 | 15.0 | 69 |
| | 14,250 | 10.0 | 59 |
| | 14,800 | 5.0 | 48 |
| Values at cond. Pt. 30" | 13,050 | 18.1 | 74 |
| " " " " 36" | 13,750 | 13.5 | 66 |

## ACTUAL MODEL RATIOS

30" Pump Discharge $\overline{MR}^2 = \frac{31,500}{13,050} = 2.414$ ; MR = 1.554

36" " " $\overline{MR}^2 = \frac{31,500}{13,750} = 2.291$ ; MR = 1.514

## PROTOTYPE VALUES

| | Qp | Hp | Pp |
|---|---|---|---|
| **30" Pump Disch.** | | | |
| | 23,170 | 32.5 | 236 |
| | 24,980 | 30.0 | 229 |
| Max. Eff | 28,240 | 25.0 | 205 |
| | 30,780 | 20.0 | 186 |
| Cond. Pt. | 31,500 | 18.1 | 179 |
| | 32,710 | 15.0 | 166 |
| | 34,400 | 10.0 | 142 |
| | 35,720 | 5.0 | 116 |
| **36" Pump Disch.** | | | |
| | 21,990 | 32.5 | 224 |
| | 23,710 | 30.0 | 218 |
| Max. Eff | 26,800 | 25.0 | 195 |
| | 29,210 | 20.0 | 176 |
| | 31,040 | 15.0 | 158 |
| Cond. Pt. | 31,500 | 13.5 | 151 |
| | 32,640 | 10.0 | 135 |
| | 33,900 | 5.0 | 110 |

## 30" DISCHARGE PIPE

$N = \frac{1037}{1.554} = 667$ rpm

Impeller diam. = 17.96 × 1.554 = 27.90 in

From plotted curve

Q = 31,500 gpm

P @ rated Q = 179

| | | |
|---|---|---|
| BHP required by pump | = | 179 |
| +10% | = | 197 |
| Loss in reduct gear +4% | = | 8 |
| BHP at engine coupling | = | 205 (Continuous Rating) |
| $P_{max}$ | = | 202 |
| +10% | = | 222 |
| Loss in reduct. gear +4% | = | 9 |
| BHP at engine coupling | = | 231 (Intermittent Rating) |

## 36" DISCHARGE PIPE

$N = \frac{1037}{1.514} = 685$ rpm

Impeller diam. = 17.97 × 1.514 = 27.20 in

From plotted curve

Q = 31,500 gpm

P @ rated Q = 151

| | | |
|---|---|---|
| BHP required by pump | = | 151 |
| +10% | = | 166 |
| Loss in reduct. gear +4% | = | 7 |
| BHP at engine coupling | = | 173 (Continuous Rating) |
| $P_{max}$ | = | 175 |
| +10% | = | 192 |
| Loss in reduct. gear +4% | = | 8 |
| BHP at engine coupling | = | 200 (Intermittent Rating) |

## SPECIFIC SPEED

### 30" DISCHARGE PIPE

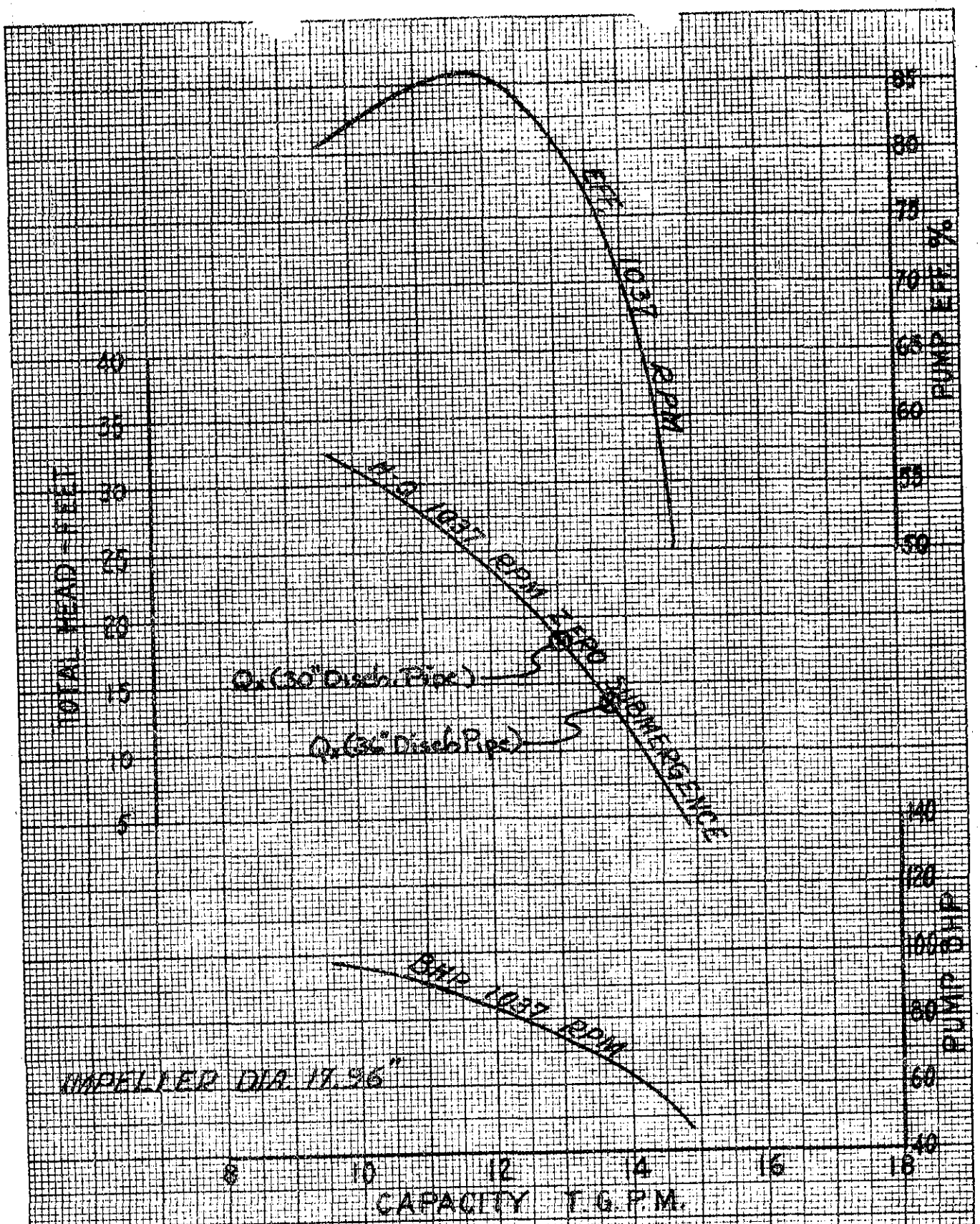
$$N_S = \frac{667\sqrt{28,240}}{25.0^{3/4}} = 10,025 \text{ rpm}$$

Suction Hd = 0

### 36" DISCHARGE PIPE

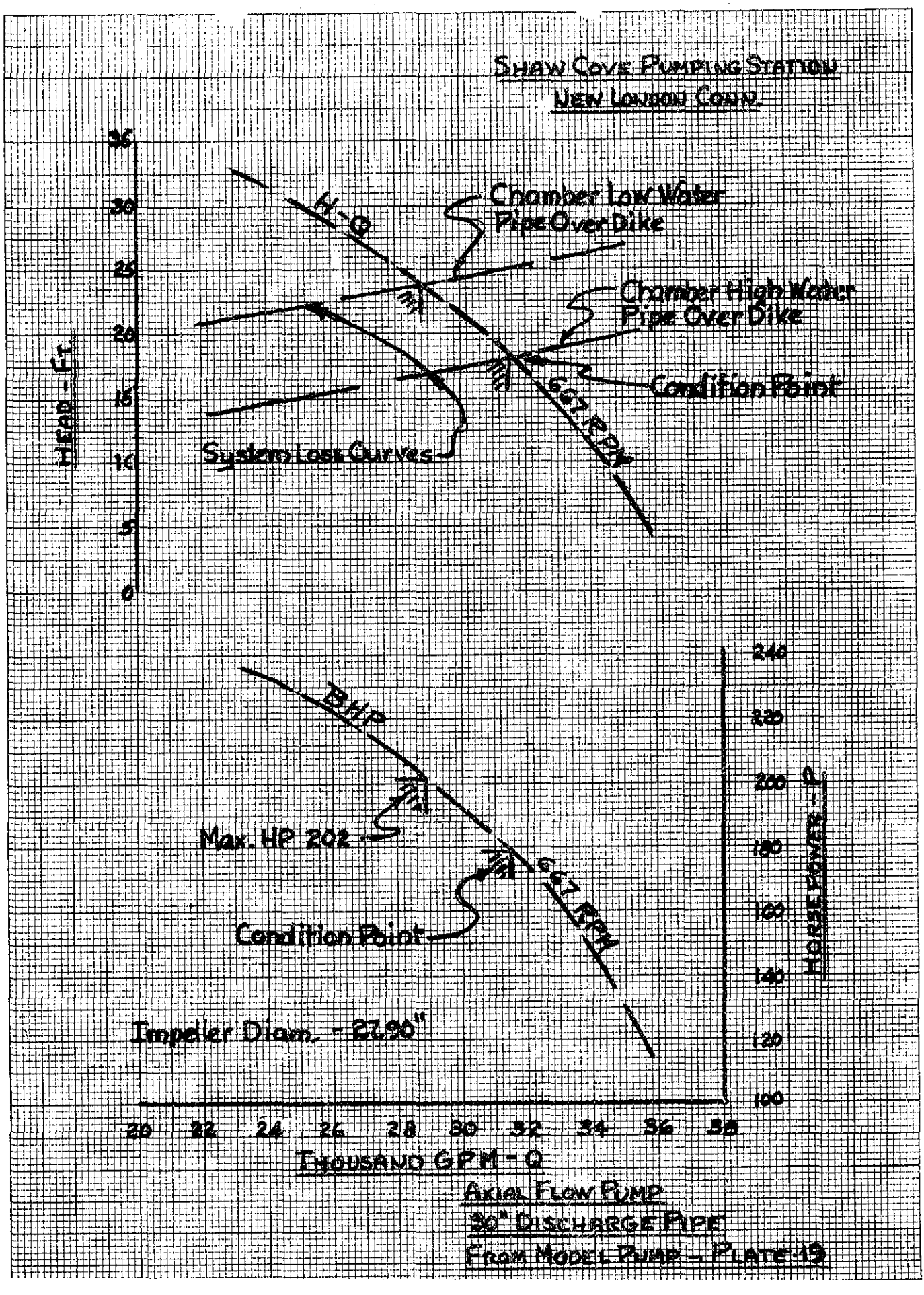
$$N_S = \frac{685\sqrt{26,800}}{25.0^{3/4}} = 10,030 \text{ rpm}$$

Suction Hd = 0

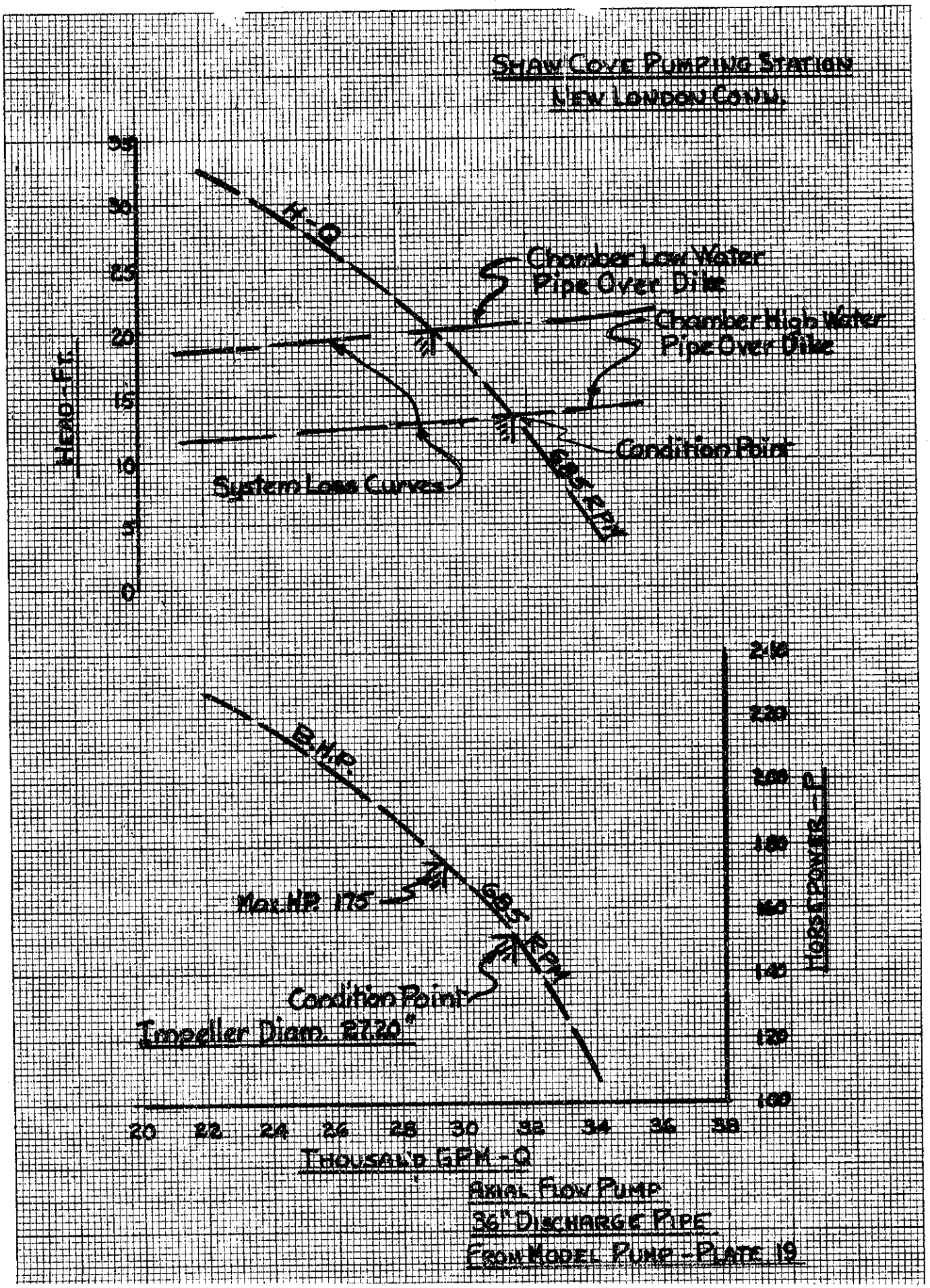



20" AXIAL-FLOW MODEL PUMP PERFORMANCE CURVES

PLATE NO. 19
EM 1110-2-3105




46 1323
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.


SHAW COVE PUMPING STATION
NEW LONDON CONN.
HEAD - FT.
35
30
25
20
15
10
5
0
H-Q
Chamber Low Water Pipe Over Dike
Chamber High Water Pipe Over Dike
Condition Point
System Loss Curves
685 RPM
B.H.P.
Max. H.P. 175
685 RPM
Condition Point
Impeller Diam. 27.20"
HORSEPOWER - P
240
220
200
180
160
140
120
100
20
22
24
26
28
30
32
34
36
38
THOUSAL'D GPM - Q
AXIAL FLOW PUMP
36" DISCHARGE PIPE
FROM MODEL PUMP - PLATE 19

SUBJECT New London, Conn. Local Protection
COMPUTATION Shaw Cove Pumping Station
COMPUTED BY JTS CHECKED BY DATE Oct. 1977

## Values From Curve - Plate 20

| | Qm | Hm | Pm |
|---|---|---|---|
| | 10,000 | 29.0 | 106 |
| | 12,100 | 27.5 | 107 |
| Max. Eff. | 14,600 | 23.5 | 105 |
| | 15,900 | 20.0 | 100 |
| | 17,500 | 15.0 | 87 |
| | 18,500 | 10.0 | 75 |
| | 19,000 | 7.5 | 65 |
| Values at cond. Pt. 30" | 16,580 | 18.1 | 95 |
| " " " " 36" | 17,800 | 13.5 | 84 |

## Actual Model Ratios

30" Pump Discharge $\overline{MR}^2 = \frac{31,500}{16,580} = 1.900$ ; MR = 1.378

36" " " $\overline{MR}^2 = \frac{31,500}{17,800} = 1.770$ ; MR = 1.330

## Prototype Values

| | Qm | Hm | Pm |
|---|---|---|---|
| 30" Pump Disch. | | | |
| | 19,000 | 29.0 | 201 |
| | 22,990 | 27.5 | 203 |
| Max. Eff. | 27,740 | 23.5 | 199 |
| | 30,210 | 20.0 | 190 |
| Cond. Pt. | 31,500 | 18.1 | 180 |
| | 33,250 | 15.0 | 165 |
| | 35,150 | 10.0 | 142 |
| | 36,100 | 7.5 | 123 |
| 36" Pump Disch | | | |
| | 17,700 | 29.0 | 188 |
| | 21,410 | 27.5 | 189 |
| Max. Eff | 25,840 | 23.5 | 186 |
| | 28,140 | 20.0 | 177 |
| | 30,970 | 15.0 | 154 |
| Cond. Pt. | 31,500 | 13.5 | 149 |
| | 32,740 | 10.0 | 133 |
| | 33,620 | 7.5 | 115 |

## 30" DISCHARGE PIPE

$N = \frac{950}{1.378} = 689$ rpm

Impeller diam. = 21 x 1.378 = 28.94 in

From plotted curve

Q = 31,500 gpm
P @ rated Q = 180
BHP required by pump = 180
+10% = 198
Loss in reduct gear +4% = 8
BHP at engine coupling = 206 (Continuous Rating)

$P_{max}$ = 199
+10% = 219
Loss in reduct. gear +4% = 9
BHP at engine coupling = 228 (Intermittent Rating)

## 36" DISCHARGE PIPE

$N = \frac{950}{1.330} = 714$ rpm

Impeller diam. = 21 x 1.330 = 27.94 in.

From plotted curve

Q = 31,500 gpm
P @ rated Q = 149
BHP required by pump = 149
+10% = 164
Loss in reduct. gear +4% = 6
BHP at engine coupling = 170 (Continuous Rating)

$P_{max}$ = 175
+10% = 192
Loss in reduct. gear +4% = 8
BHP at engine coupling = 200 (Intermittent Rating)

SPECIFIC SPEED

30" DISCHARGE PIPE

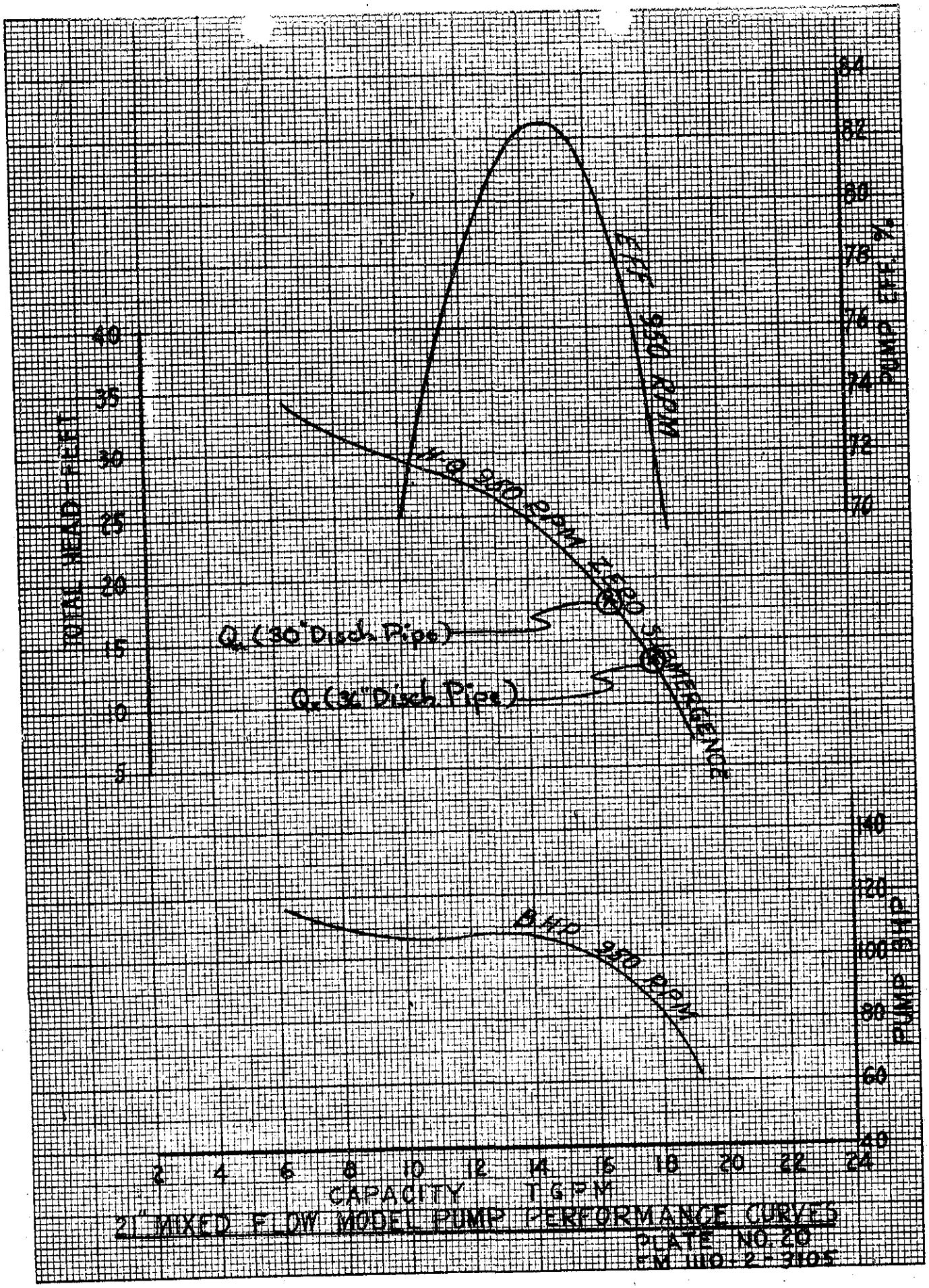
$$N_S = \frac{689\sqrt{27,740}}{23.5^{3/4}} = 10,751 \text{ rpm}$$

Suction Hd. = 0

36" DISCHARGE PIPE

$$N_S = \frac{714\sqrt{25,840}}{23.5^{3/4}} = 10,753 \text{ rpm}$$

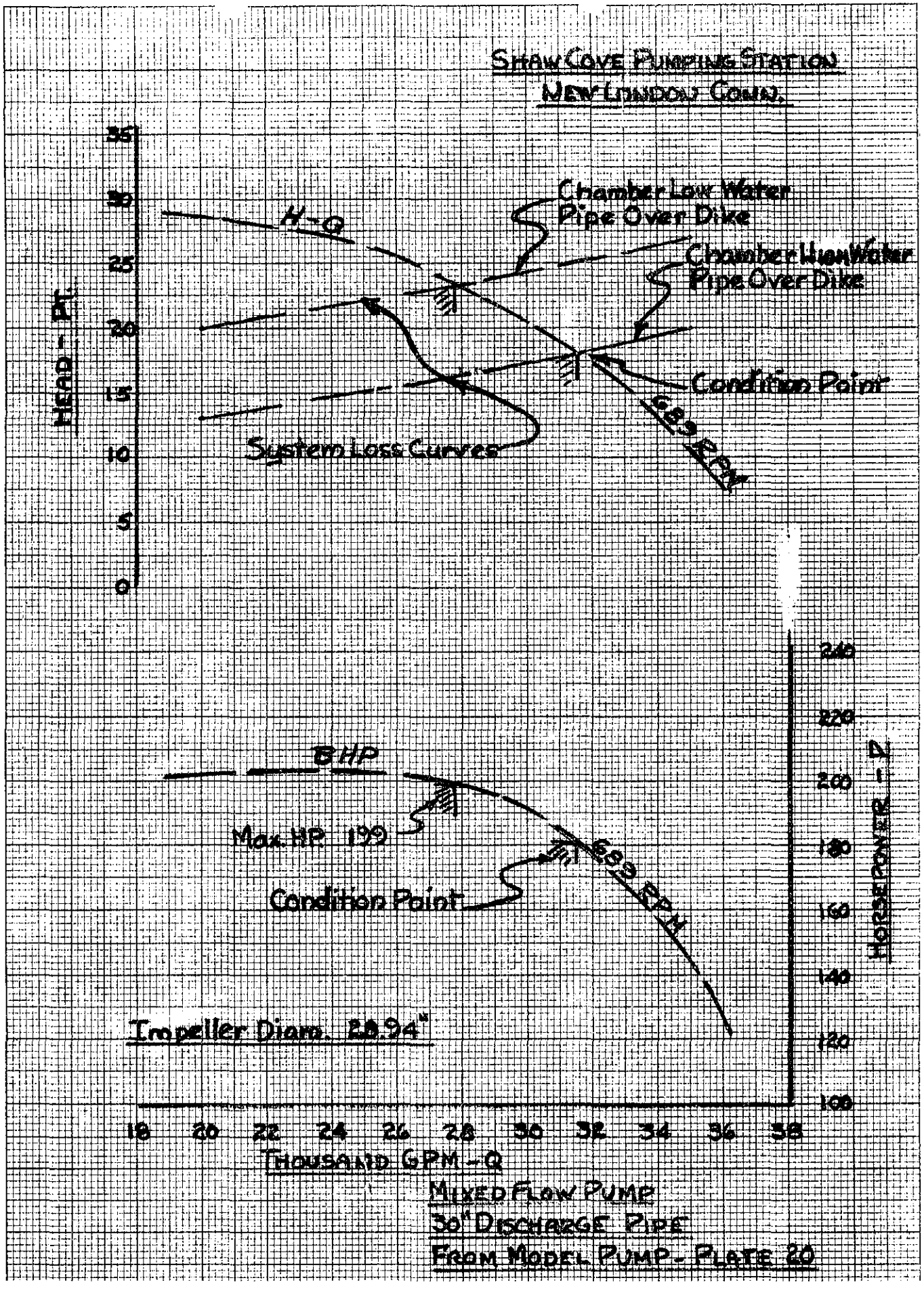
Suction Hd = 0



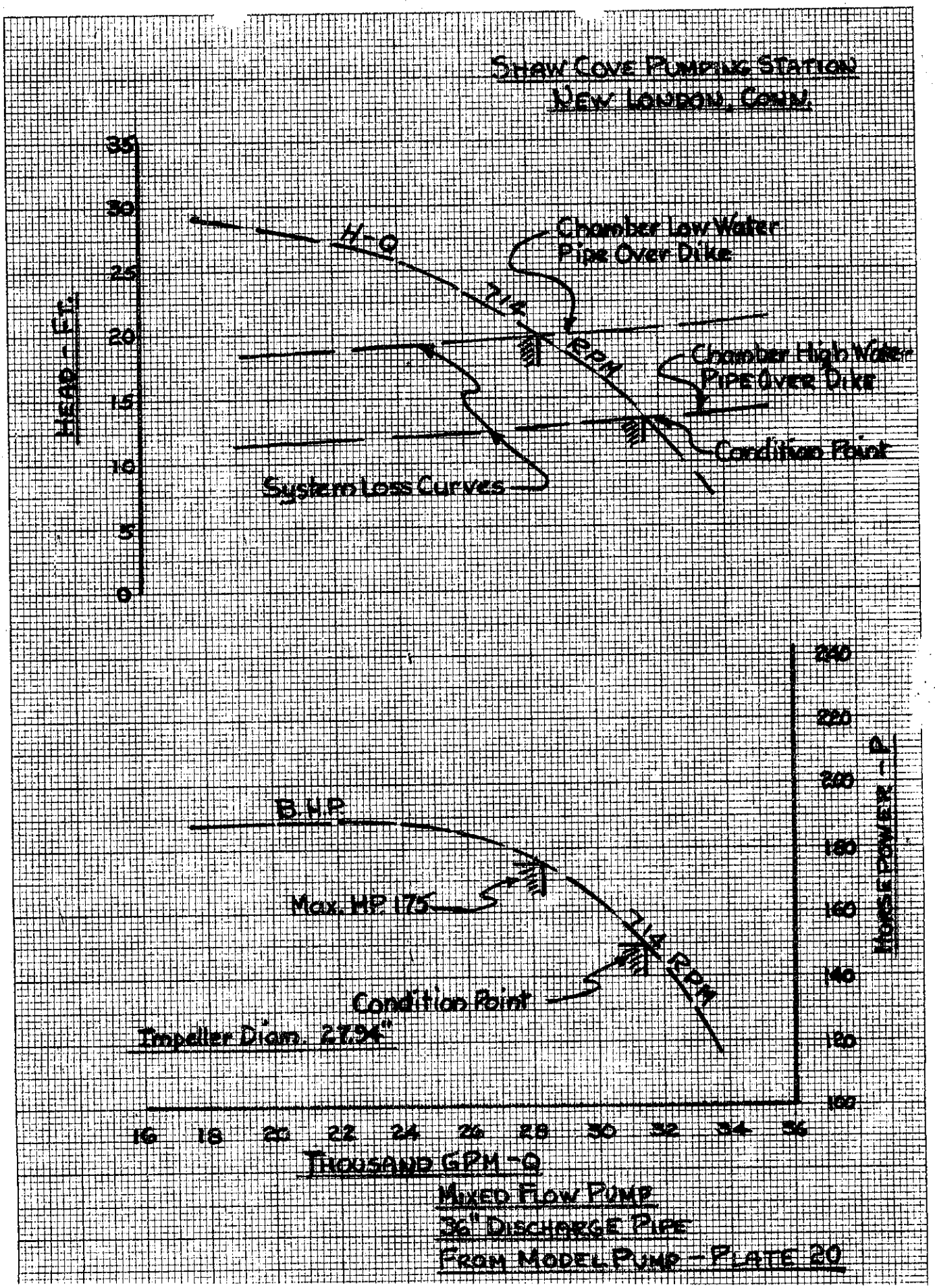

21" MIXED FLOW MODEL PUMP PERFORMANCE CURVES

PLATE NO. 20

EM 1110-2-3105




46 1323
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.


Shaw Cove Pumping Station
New London, Conn.
Head - Ft.
35
30
25
20
15
10
5
0
H-Q
Chamber Low Water Pipe Over Dike
Chamber High Water Pipe Over Dike
Condition Point
System Loss Curves
B.H.P.
Max. HP. 175
Condition Point
Impeller Diam. 27.94"
Horse Power - P
240
220
200
180
160
140
120
100
16
18
20
22
24
26
28
30
32
34
36
Thousand GPM - Q
Mixed Flow Pump
36" Discharge Pipe
From Model Pump - Plate 20

SUBJECT New London, Conn. Local Protection
COMPUTATION Shaw Cove Pumping Station
COMPUTED BY JRS CHECKED BY DATE Oct. 1977

## Values From Curve – Plate 21A

| | Qm | Hm | Pm |
|---|---|---|---|
| Max. Eff. | 7,500 | 36.5 | 82.5 |
| | 8,450 | 30.0 | 81.0 |
| | 9,000 | 25.0 | 78.5 |
| | 9,250 | 21.5 | 76.0 |
| | 9,500 | 17.5 | 72.5 |
| | 9700 | 13.0 | 68.0 |
| | 9800 | 10.0 | 64.5 |
| Values at. cond. pt. 30" | 9450 | 18.1 | 73.5 |
| " " " " 36" | 9680 | 13.5 | 68.5 |

## Actual Model Ratios

30" Pump Discharge $\overline{MR}^2 = \frac{31,500}{9450} = 3.333$ ; MR = 1.826

36" " " $\overline{MR}^2 = \frac{31,500}{9680} = 3.254$ ; MR = 1.804

## Prototype Values

| | Qp | Hp | Pp |
|---|---|---|---|
| 30" Pump Disch. Max. Eff | 25,000 | 36.5 | 275 |
| | 28,170 | 30.0 | 270 |
| | 30,000 | 25.0 | 262 |
| | 30,830 | 21.5 | 253 |
| Cond. Pt. | 31,500 | 18.1 | 245 |
| | 31,670 | 17.5 | 242 |
| | 32,330 | 13.0 | 227 |
| | 32,670 | 10.0 | 215 |
| 36" Pump Disch. Max. Eff | 24,400 | 36.5 | 268 |
| | 27,500 | 30.0 | 263 |
| | 29,290 | 25.0 | 255 |
| | 30,100 | 21.5 | 247 |
| | 30,910 | 17.5 | 236 |
| Cond. Pt. | 31,500 | 13.5 | 223 |
| | 31,560 | 13.0 | 221 |
| | 31,890 | 10.0 | 210 |

SUBJECT: NEW LONDON, CONN. LOCAL PROTECTION
SHAW COVE PUMPING STATION

COMPUTATION

COMPUTED BY: JTS CHECKED BY: DATE: Oct. 1977

## 30" DISCHARGE PIPE

$N = \frac{1288}{1.826} = 705$ rpm

Impeller diam. = 13.438 x 1.826 = 24.53 in

From plotted curve

Q = 31,500 gpm
P @ rated Q = 245

| | | |
|---|---|---|
| BHP required by pump | = | 245 |
| +10% | = | 270 |
| Loss in reduct gear +4% | = | 11 |
| BHP at engine coupling | = | 281 (Continuous Rating) |

| | | |
|---|---|---|
| $P_{max}$ | = | 261 |
| +10% | = | 287 |
| Loss in reduct. gear +4% | = | 11 |
| BHP at engine coupling | = | 298 (Intermittent Rating) |

## 36" DISCHARGE PIPE

$N = \frac{1288}{1.804} = 714$ rpm

Impeller diam. = 13.438 x 1.804 = 24.24 in

From plotted curve

Q = 31,500
P @ rated Q = 223

| | | |
|---|---|---|
| BHP required by pump | = | 223 |
| +10% | = | 245 |
| Loss in reduct. gear +4% | = | 10 |
| BHP at engine coupling | = | 255 (Continuous Rating) |

| | | |
|---|---|---|
| $P_{max}$ | = | 243 |
| +10% | = | 267 |
| Loss in reduct. gear +4% | = | 11 |
| BHP at engine coupling | = | 278 (Intermittent Rating) |

SUBJECT NEW LONDON CONN. LOCAL PROTECTION
COMPUTATION SHAW COVE PUMPING STATION
COMPUTED BY JTS CHECKED BY DATE Oct. 1977

## SPECIFIC SPEED

### 30" DISCHARGE PIPE

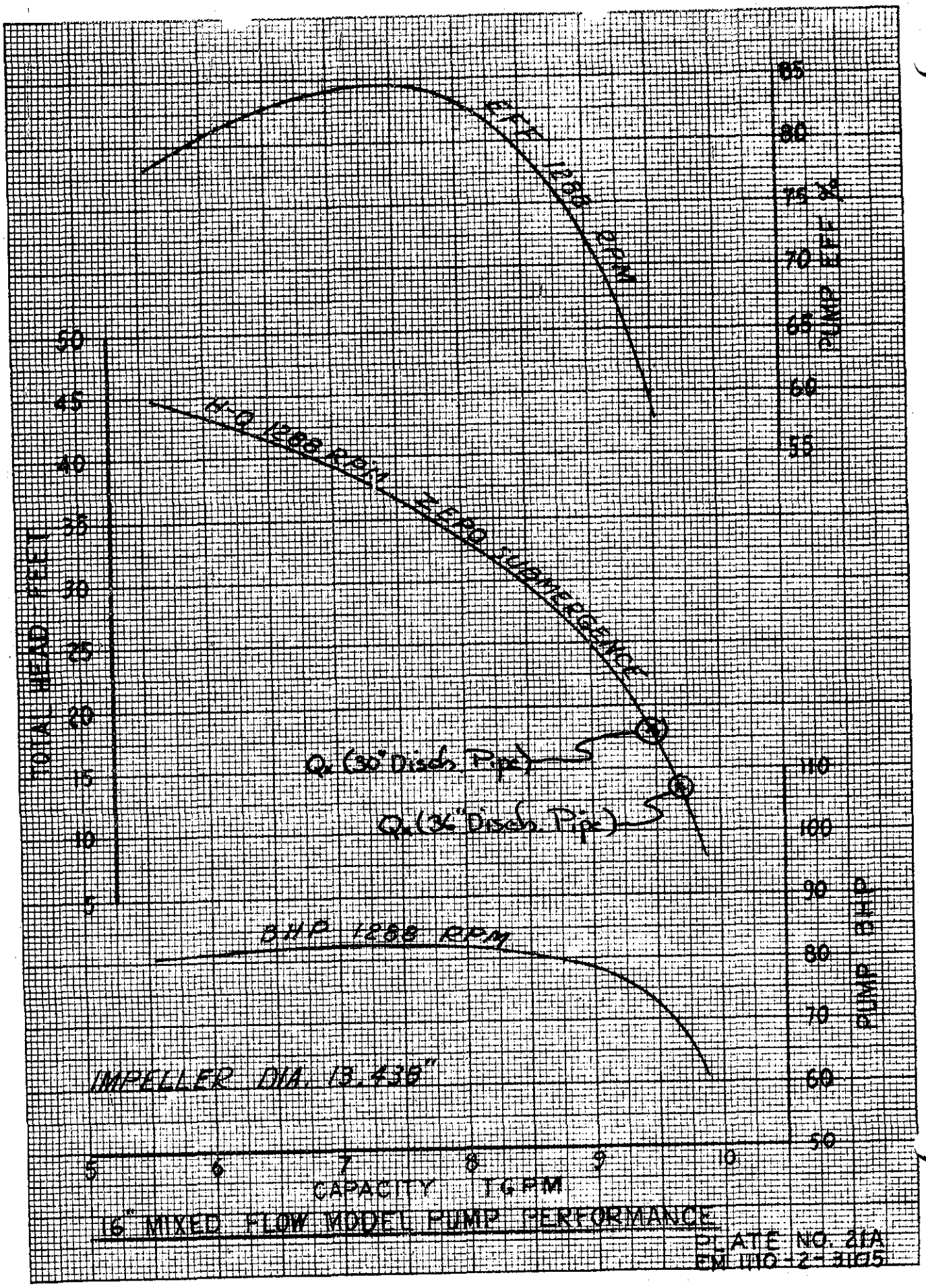
$$N_S = \frac{705\sqrt{25,000}}{36.5^{3/4}} = 7506 \text{ rpm}$$

Suction Hd. = 0

### 36" DISCHARGE PIPE

$$N_S = \frac{714\sqrt{24,400}}{36.5^{3/4}} = 7510 \text{ rpm}$$

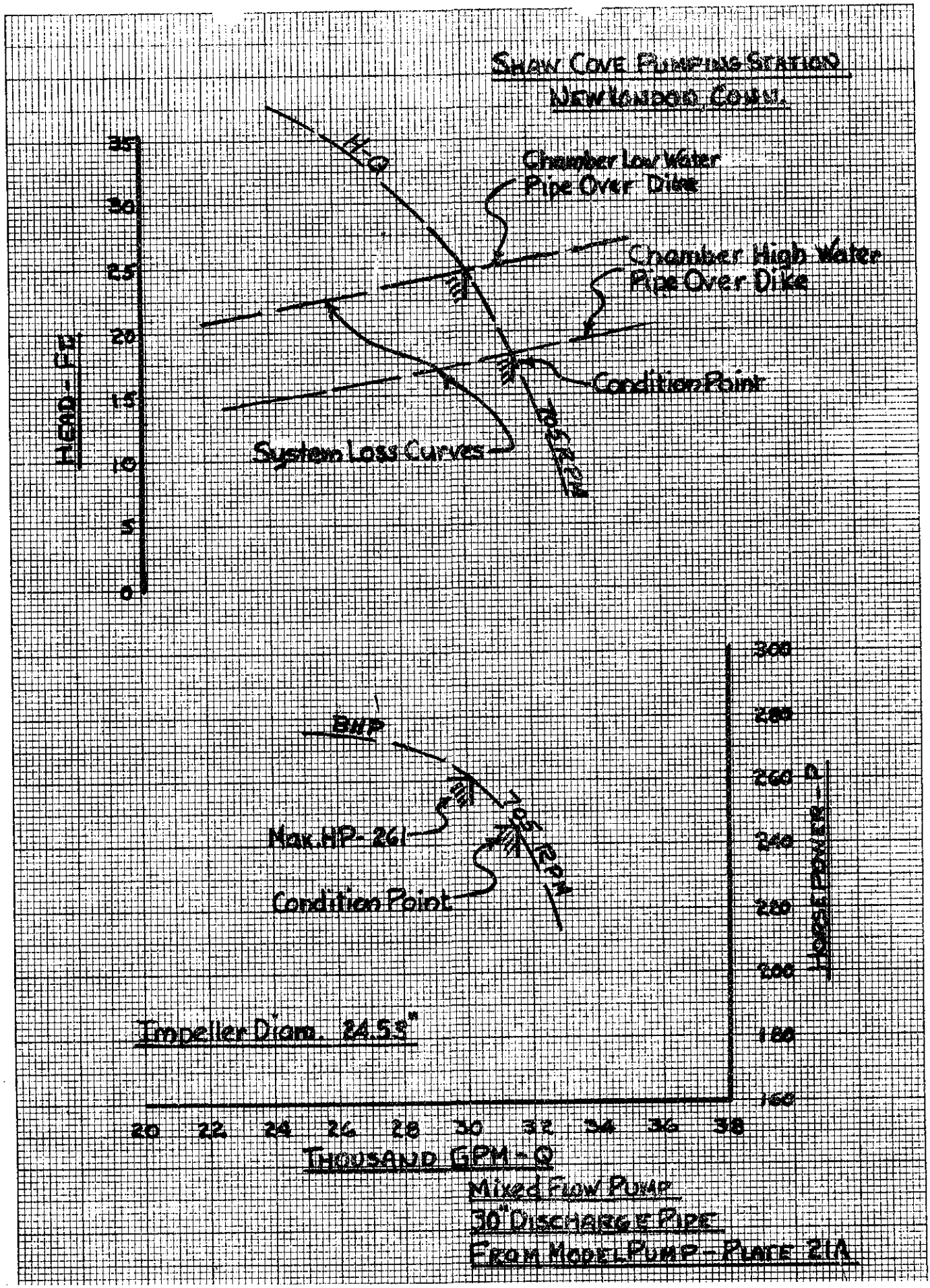
Suction Hd = 0



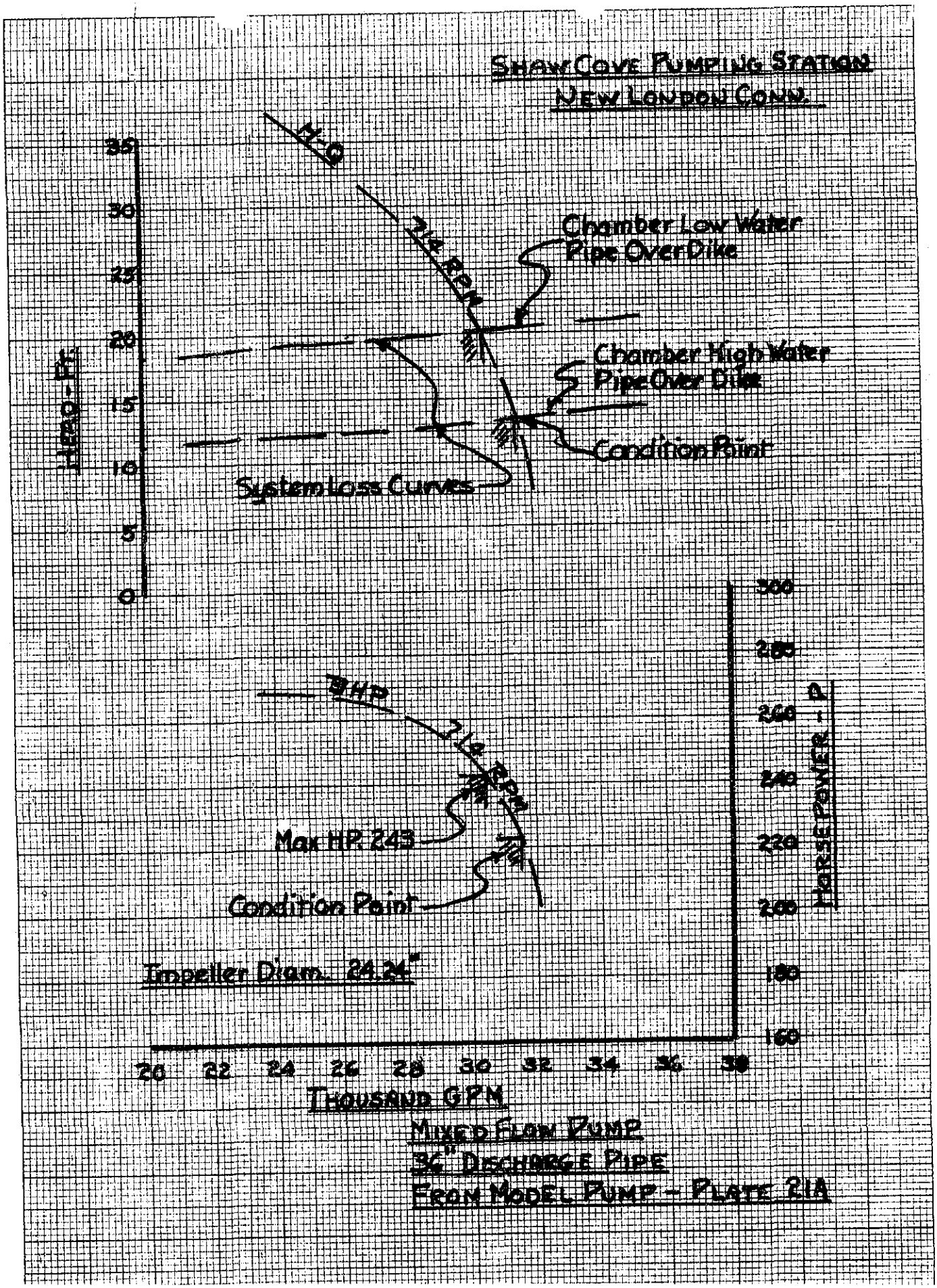

16" MIXED FLOW MODEL PUMP PERFORMANCE

PLATE NO. 21A
EM 1110-2-3105

KEUFFEL & ESSER CO.




46 1323
K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.




MIXED FLOW PUMP
36" DISCHARGE PIPE
FROM MODEL PUMP - PLATE 21A

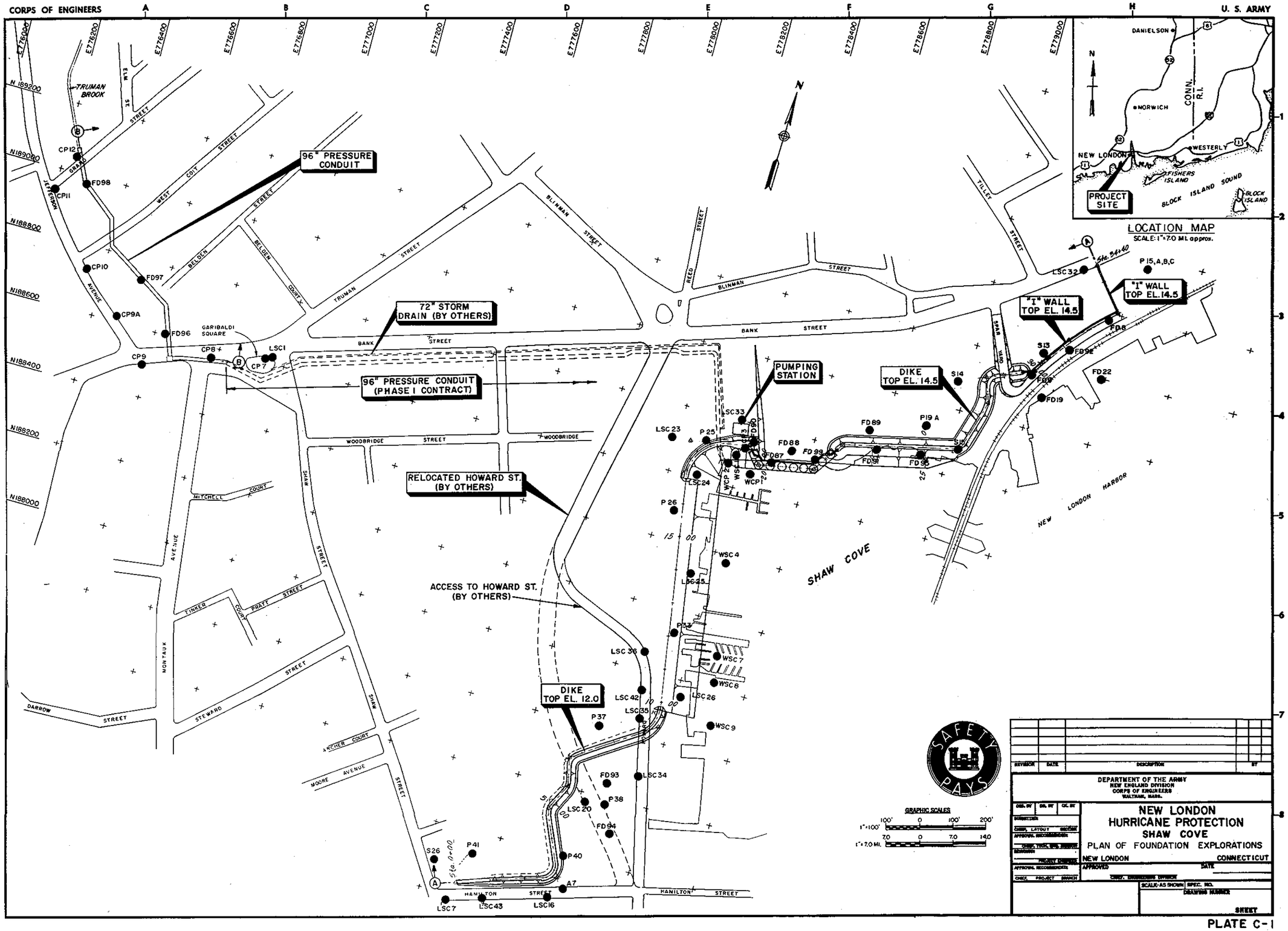
## APPENDIX C

## EMBANKMENTS AND FOUNDATIONS

## INDEX TO PLATES


| TITLE | PLATE NO. |
|---|---|
| Plan of Foundation Explorations | C-1 |
| Engineering Log Profile A-A | C-2 thru C-7 |
| Engineering Log Profile B-B | C-8 and C-9 |
| Plan of Borrow Explorations | C-10 |
| Selected Test Data - Impervious Embankments Materials | C-11 |
| Gradation Specifications - Gravel Filter and Gravel Bedding | C-12 |
| Gradation Specifications - Gravel Fill and Sand Fill | C-13 |
| Summary of Laboratory Test Results | C-14 thru C-17 |

CORPS OF ENGINEERS — U. S. ARMY




DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

# NEW LONDON HURRICANE PROTECTION SHAW COVE

## PLAN OF FOUNDATION EXPLORATIONS

NEW LONDON — CONNECTICUT

APPROVED — DATE

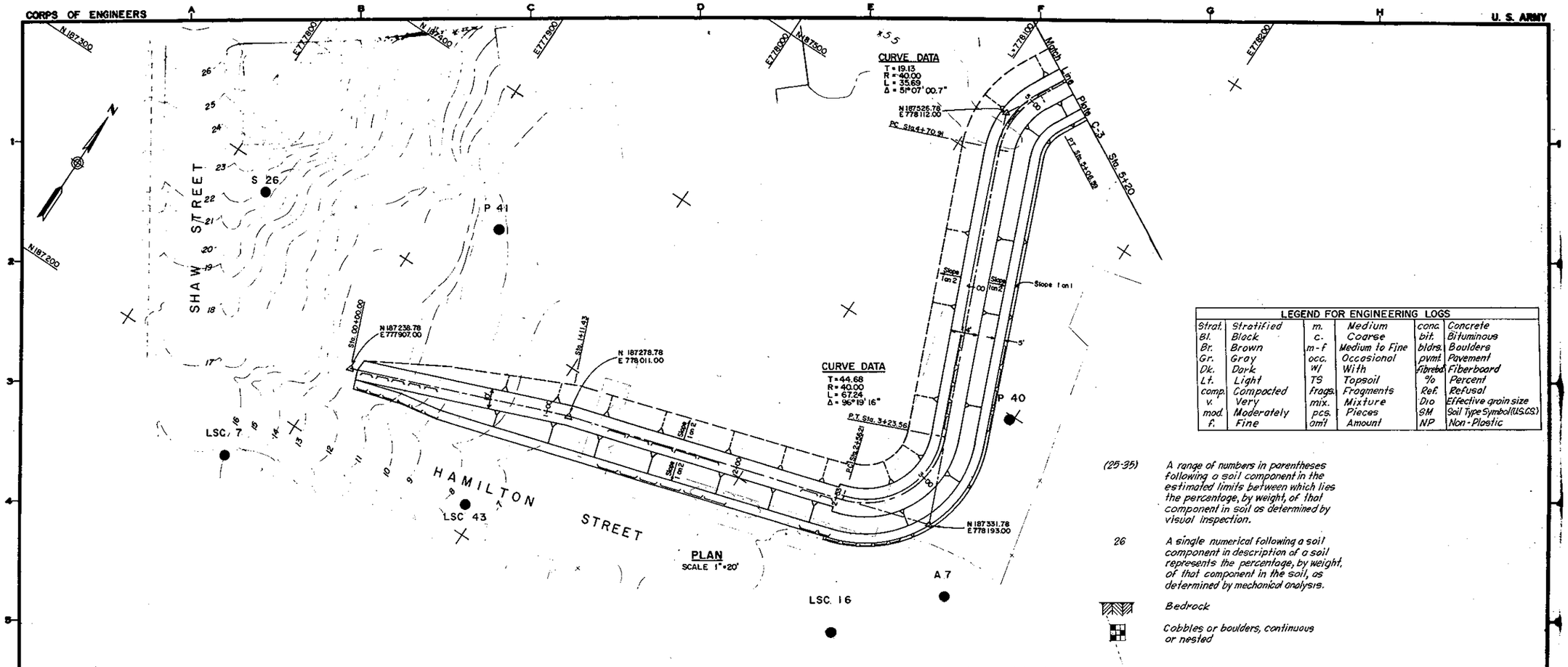
SCALE: AS SHOWN — SPEC. NO.

DRAWING NUMBER

SHEET

PLATE C-1

CORPS OF ENGINEERS U. S. ARMY



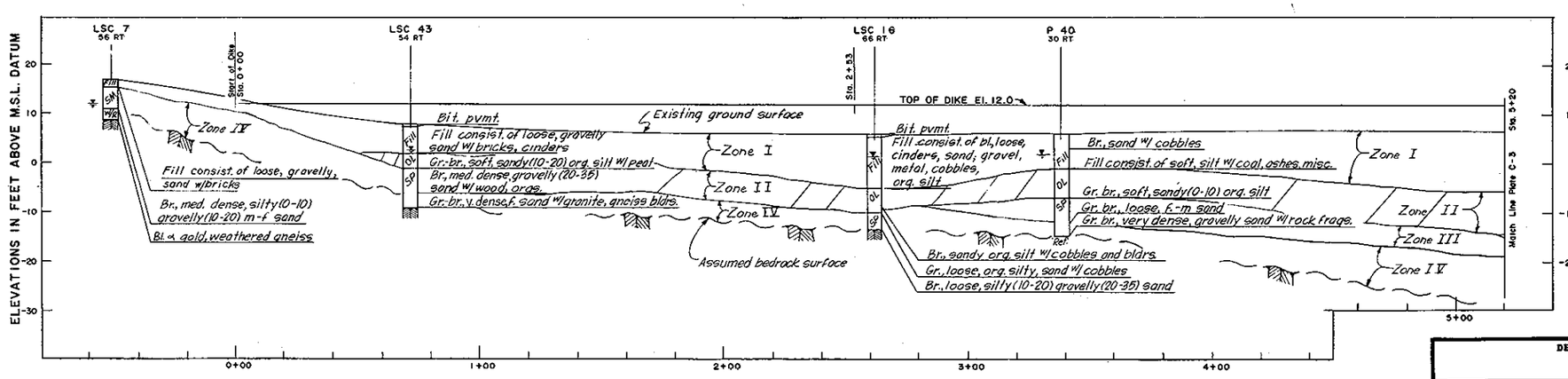

| LEGEND FOR ENGINEERING LOGS | | | | | |
|---|---|---|---|---|---|
| Strat. | Stratified | m. | Medium | conc. | Concrete |
| Bl. | Black | c. | Coarse | bit. | Bituminous |
| Br. | Brown | m-f | Medium to Fine | bldrs. | Boulders |
| Gr. | Gray | occ. | Occasional | pvmt. | Pavement |
| Dk. | Dark | w/ | With | fibrebd. | Fiberboard |
| Lt. | Light | TS | Topsoil | % | Percent |
| comp. | Compacted | frags. | Fragments | Ref. | Refusal |
| v. | Very | mix. | Mixture | Dio | Effective grain size |
| mod. | Moderately | pcs. | Pieces | SM | Soil Type Symbol (U.S.C.S.) |
| f. | Fine | amt | Amount | NP | Non-Plastic |

(25-35) A range of numbers in parentheses following a soil component in the estimated limits between which lies the percentage, by weight, of that component in soil as determined by visual inspection.

26 A single numerical following a soil component in description of a soil represents the percentage, by weight, of that component in the soil, as determined by mechanical analysis.

Bedrock

Cobbles or boulders, continuous or nested




ENGINEERING LOG PROFILE A-A ALONG ℄ OF STRUCTURES

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

GRAPHIC SCALES

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

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

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

DRAWING

CHIEF, LAYOUT SECTION

APPROVAL RECOMMENDED

CHIEF, TOPO. ENG. SURVEY SECTION

PROJECT ENGINEER

APPROVAL RECOMMENDED

CHIEF, PROJECT SEARCH

# NEW LONDON HURRICANE PROTECTION SHAW COVE

ENGINEERING LOG PROFILE A - A

NEW LONDON CONNECTICUT

APPROVED DATE

CHIEF, ENGINEERING DIVISION

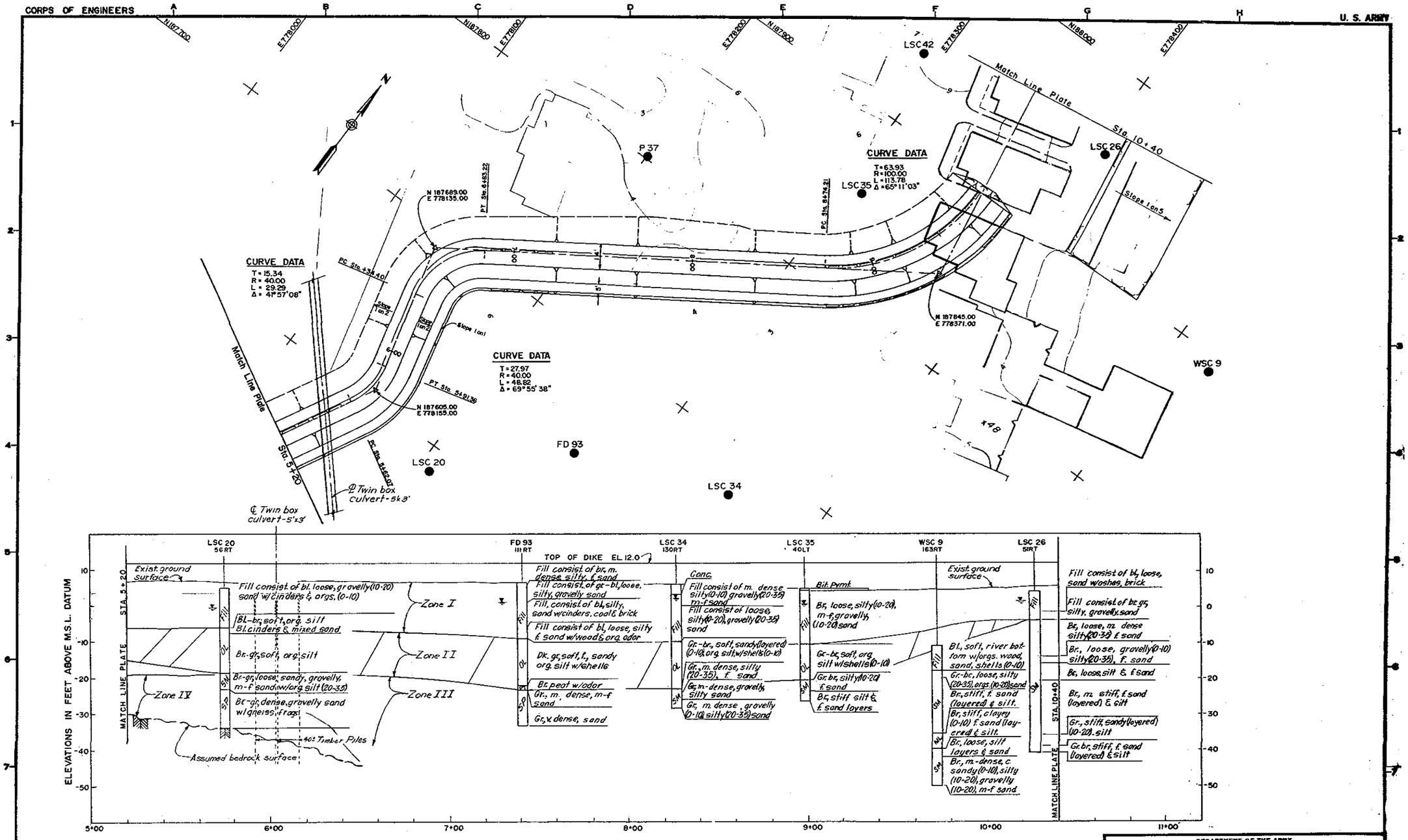
SCALE AS SHOWN SPEC. NO.

DRAWING NUMBER

SHEET

PLATE C-2

CORPS OF ENGINEERS U. S. ARMY







ENGINEERING LOG PROFILE A-A ALONG ℄ OF STRUCTURES

SCALE: HOR. 1" = 20'
VERT. 1" = 10'

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
ENGINEERING LOG PROFILE A-A

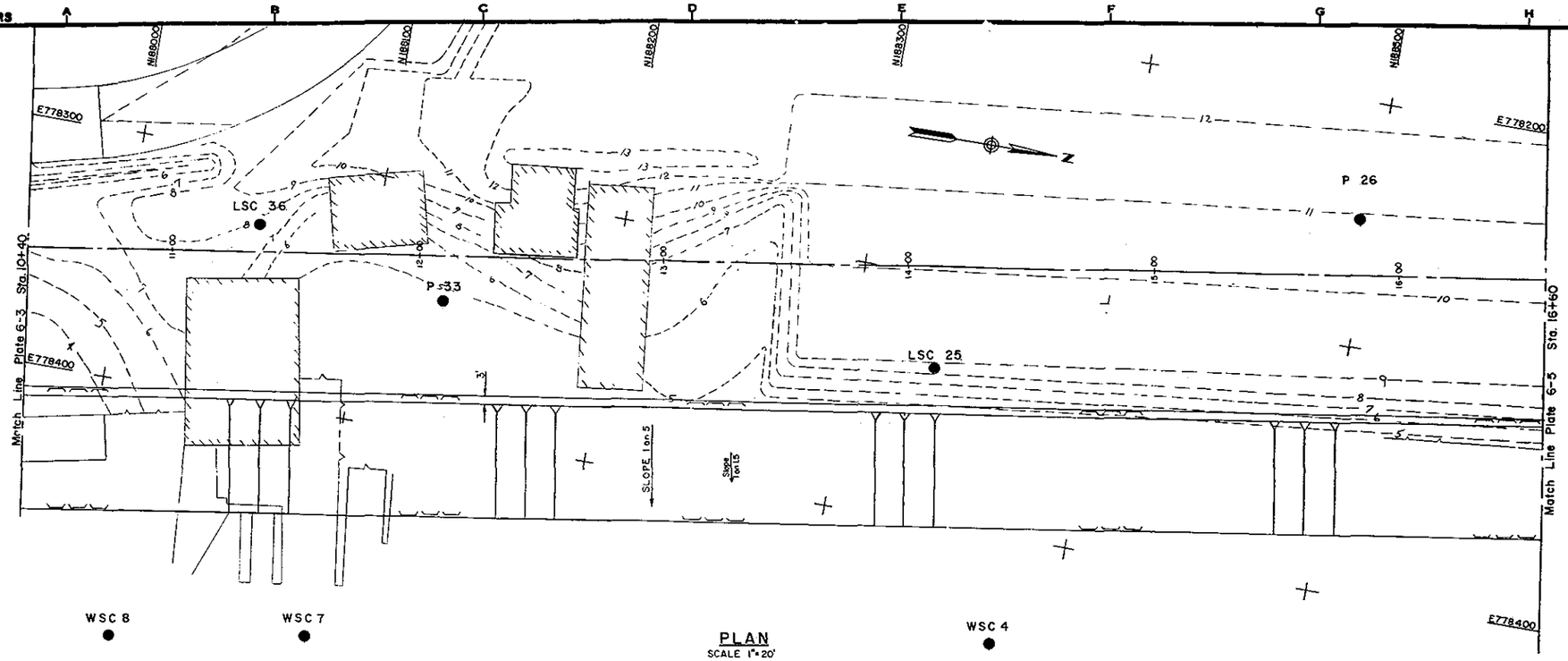
NEW LONDON CONNECTICUT

SCALE AS SHOWN SPEC. NO.

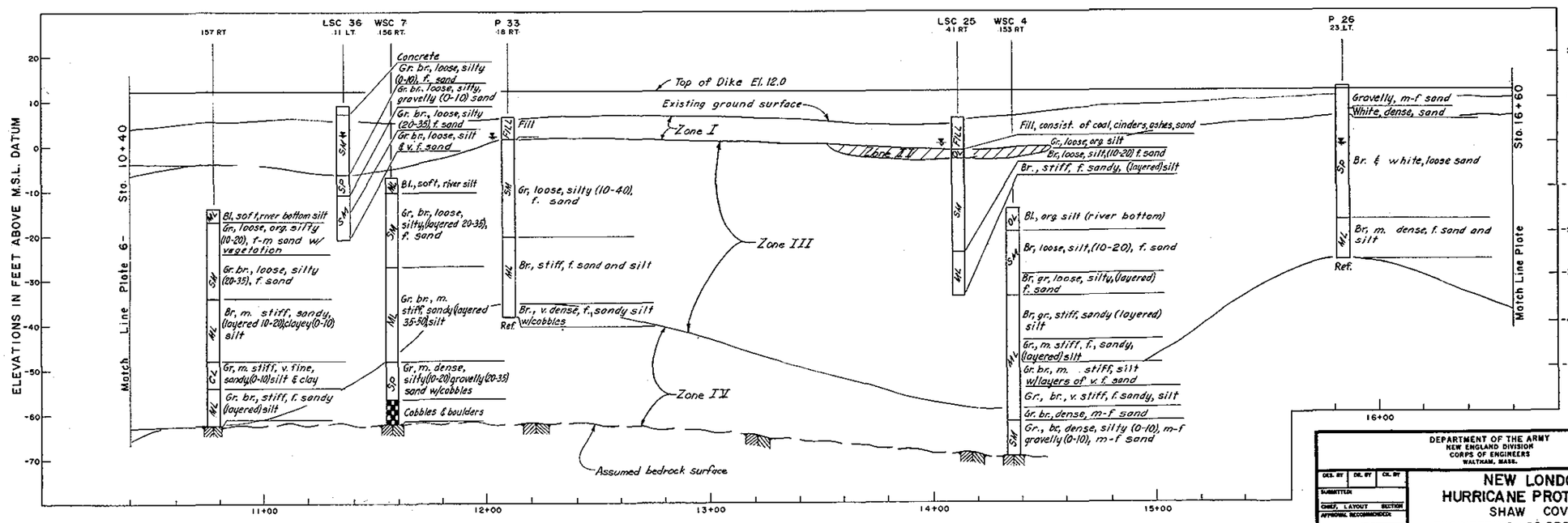
SHEET

PLATE C-3

CORPS OF ENGINEERS — U. S. ARMY




PLAN
SCALE 1" = 20'




ENGINEERING LOG PROFILE A-A ALONG ℄ OF STRUCTURES
SCALE: HOR: 1" = 20'
VERT: 1" = 10'

1" = 10'-0" 10' 0 10' 20'
1" = 20'-0" 20' 0 20' 40'

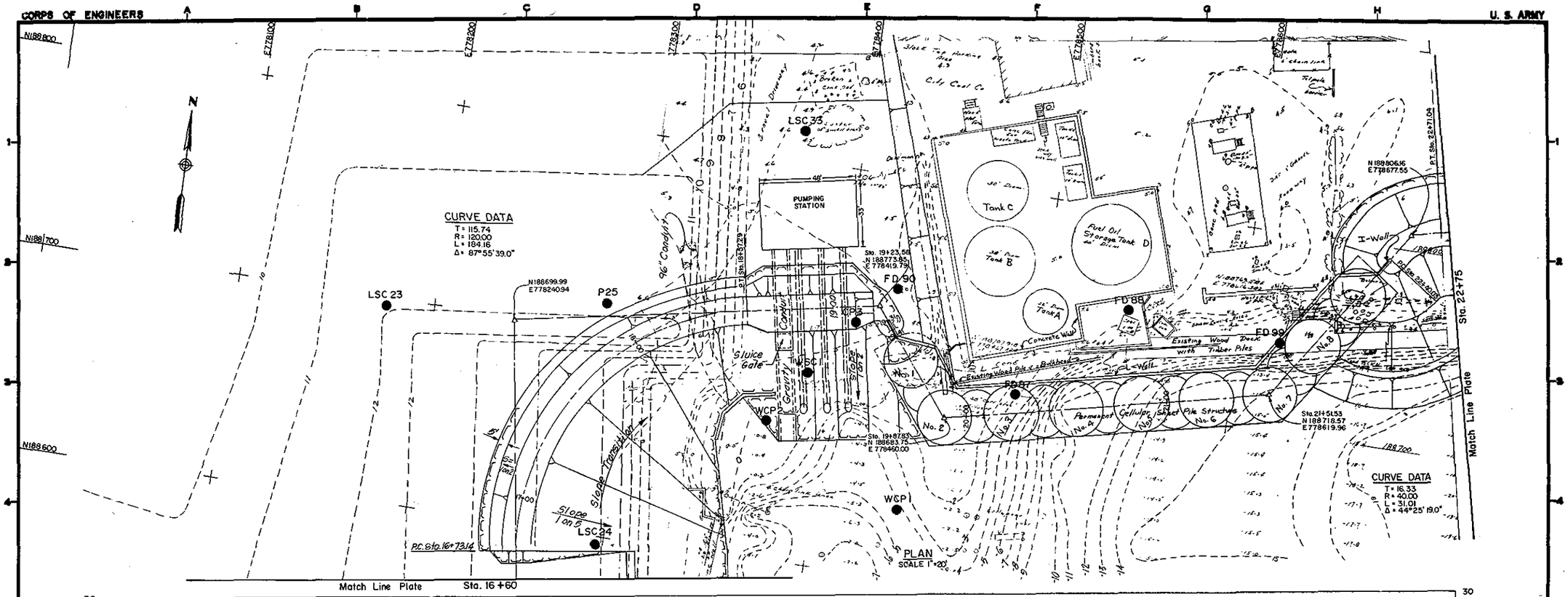
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

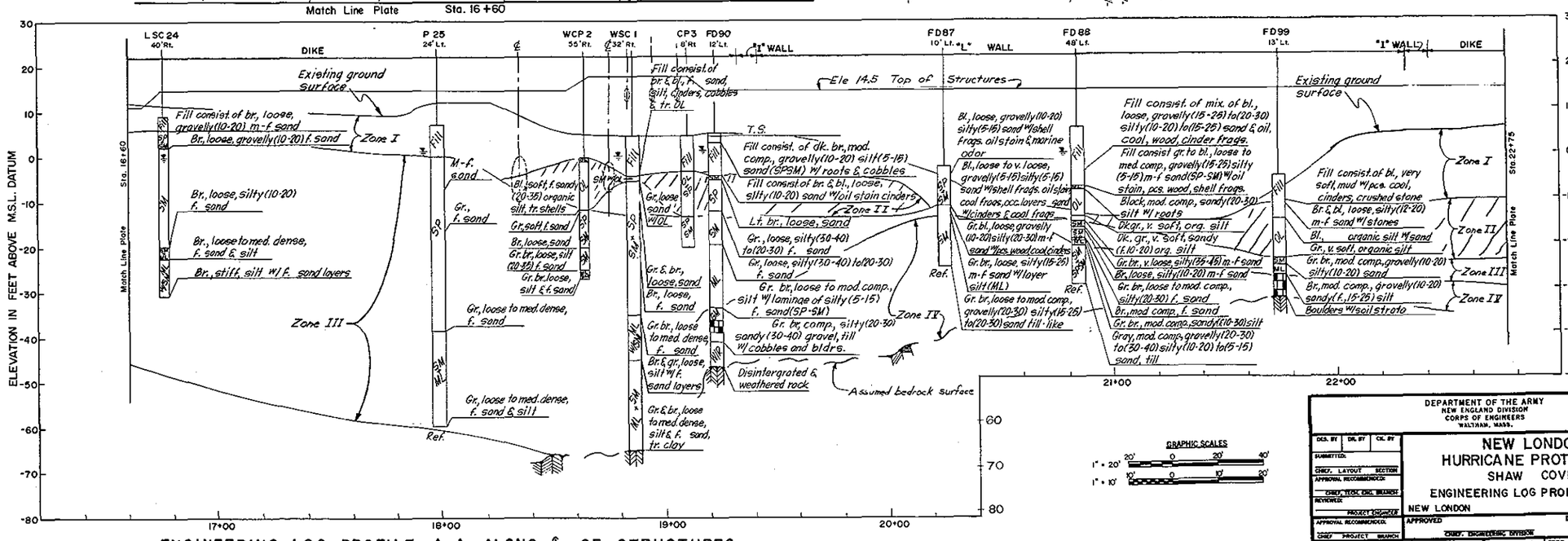
DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED
CHIEF, TECH. DES. BRANCH
REVIEWED
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF PROJECT BRANCH

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
ENGINEERING LOG PROFILE A-A
NEW LONDON CONNECTICUT
DATE
APPROVED
CHIEF, ENGINEERING DIVISION
SCALE AS SHOWN | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE C-4

CORPS OF ENGINEERS — U. S. ARMY




ENGINEERING LOG PROFILE A-A ALONG ℄ OF STRUCTURES

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

GRAPHIC SCALES
1" = 20' 20' 0 20' 40'
1" = 10' 10' 0 10' 20'

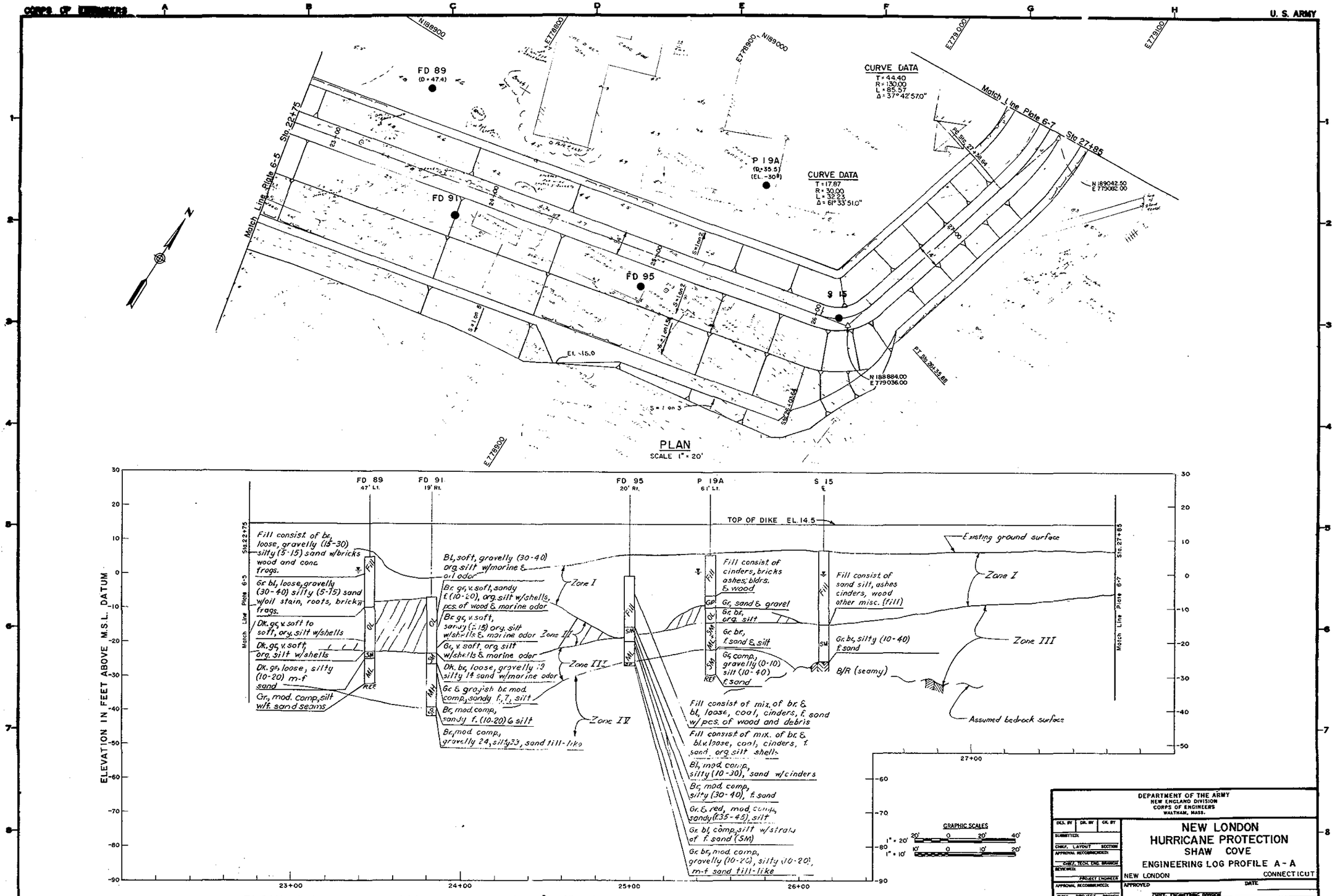
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

NEW LONDON
HURRICANE PROTECTION
SHAW COVE
ENGINEERING LOG PROFILE A - A
NEW LONDON CONNECTICUT

APPROVED
CHIEF, ENGINEERING DIVISION
DATE
SCALE AS SHOWN
SPEC. NO.
DRAWING NUMBER
SHEET

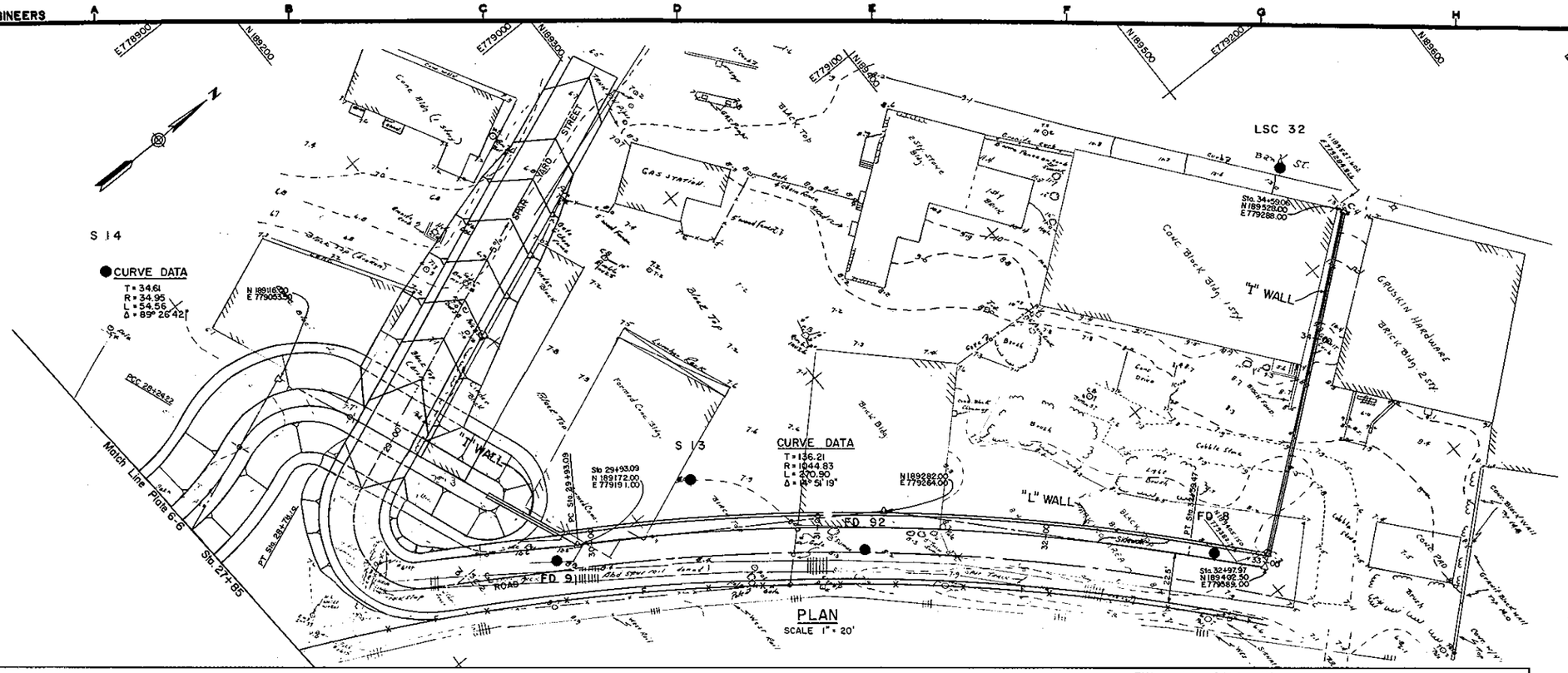
PLATE C-5

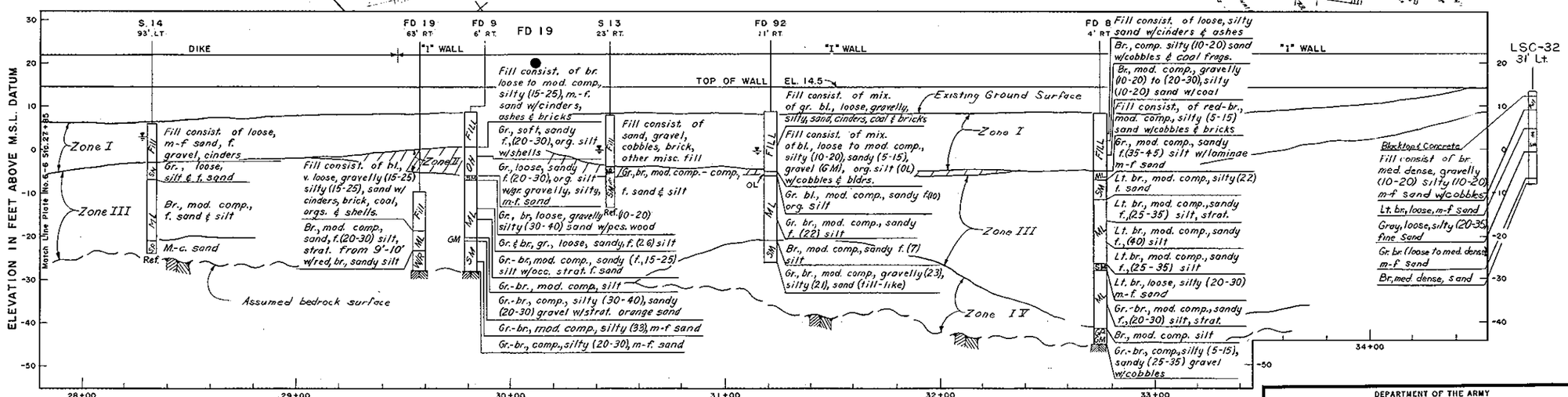


CORPS OF ENGINEERS
U. S. ARMY
FD 89
(D = 47.4)
FD 91
FD 95
P 19A
(D = 35.5)
(EL. -30±)
S 15
CURVE DATA
T = 44.40
R = 130.00
L = 85.57
Δ = 37° 42' 57.0"
CURVE DATA
T = 17.87
R = 30.00
L = 32.23
Δ = 61° 33' 51.0"
Match Line Plate 6-5 Sta. 22+75
Match Line Plate 6-7 Sta. 27+85
N 188900
E 778800
E 778900
N 189000
E 779000
E 779100
N 189042.50
E 779082.00
N 188884.00
E 779036.00
Et. -15.0
S = 1 on 3
PLAN
SCALE 1" = 20'
FD 89
47' Lt.
FD 91
19' Rt.
FD 95
20' Rt.
P 19A
61' Lt.
S 15
TOP OF DIKE EL. 14.5
Existing ground surface
Zone I
Zone II
Zone III
Zone IV
Fill consist of br. loose, gravelly (15-30) silty (5-15) sand w/bricks wood and conc. frags.
Gr. bl. loose, gravelly (30-40) silty (5-15) sand w/oil stain, roots, brick frags.
Dk. gr. v. soft to soft, org. silt w/shells
Dk. gr. v. soft, org. silt w/shells
Dk. gr. loose, silty (10-20) m-f sand
Gr., mod. comp., silt w/f. sand seams
Bl., soft, gravelly (30-40) org. silt w/marine & oil odor
Br. gr. v. soft, sandy f. (10-20), org. silt w/shells, pcs. of wood & marine odor
Br. gr. v. soft, sandy (5-15) org. silt w/shells & marine odor
Gr. v. soft, org. silt w/shells & marine odor
Dk. br. loose, gravelly 19 silty 14 sand w/marine odor
Gr. & grayish br. mod. comp., sandy f., 7, silt
Br. mod. comp., sandy f. (10-20) 6 silt
Br. mod. comp., gravelly 24, silty 33, sand till-like
Fill consist of cinders, bricks ashes; bldrs. & wood
Gr. sand & gravel
Gr. br. org. silt
Gr. br. f. sand & silt
Gr. comp., gravelly (0-10) silt (10-40) f. sand
Fill consist of sand silt, ashes cinders, wood other misc. (fill)
Gr. br., silty (10-40) f. sand
B/R (seamy)
Fill consist of mix. of br. & bl. loose, coal, cinders, f. sand w/pcs. of wood and debris
Fill consist of mix. of br. & bl. v. loose, coal, cinders, f. sand, org. silt shells
Bl., mod. comp., silty (10-30), sand w/cinders
Br. mod. comp., silty (30-40), f. sand
Gr. & red, mod. comp., sandy (f. 35-45), silt
Gr. bl. comp., silt w/strata of f. sand (SM)
Gr. br., mod. comp., gravelly (10-20), silty (10-20), m-f sand till-like
Assumed bedrock surface
ELEVATION IN FEET ABOVE M.S.L. DATUM
23+00
24+00
25+00
26+00
27+00
GRAPHIC SCALES
1" = 20'
1" = 10'
ENGINEERING LOG PROFILE A-A ALONG ℄ OF STRUCTURES
SCALE HOR. 1" = 20' VERT. 1" = 10'
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
NEW LONDON
HURRICANE PROTECTION
SHAW COVE
ENGINEERING LOG PROFILE A-A
NEW LONDON
CONNECTICUT
SCALE AS SHOWN
SHEET


PLATE C-6

CORPS OF ENGINEERS — U. S. ARMY




ENGINEERING LOG PROFILE A-A ALONG ℄ OF STRUCTURES

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

GRAPHIC SCALES
1" = 20' — 20' 0 20' 40'
1" = 10' — 10' 0 10' 20'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

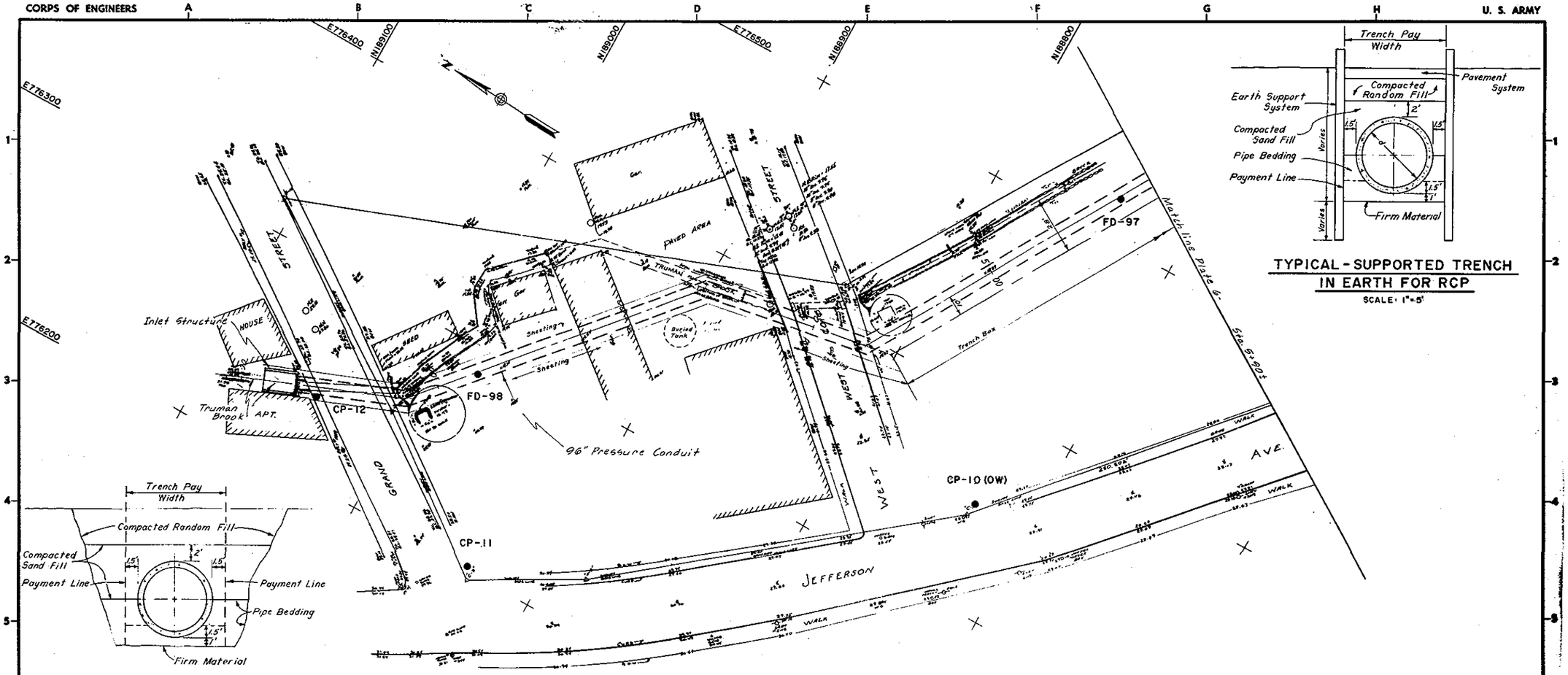
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

# NEW LONDON HURRICANE PROTECTION
## SHAW COVE
## ENGINEERING LOG PROFILE A-A

NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE AS SHOWN SPEC. NO.
DRAWING NUMBER
SHEET

PLATE C-7

CORPS OF ENGINEERS U. S. ARMY



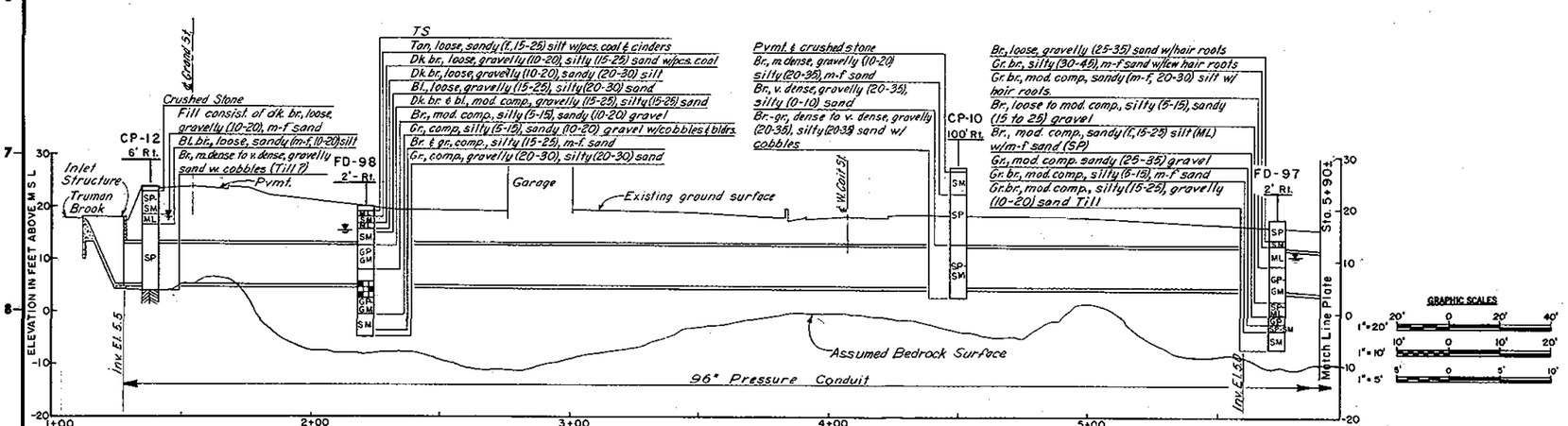

PLAN
SCALE: 1"=20'




TYPICAL - UNSUPPORTED TRENCH (USING TRENCH BOX) IN EARTH FOR 96' RCP
SCALE: 1"=5'.




TYPICAL - SUPPORTED TRENCH IN EARTH FOR RCP
SCALE: 1"=5'




GRAPHIC SCALES
1"=20' 20' 0 20' 40'
1"=10' 10' 0 10' 20'
1"=5' 5' 0 5' 10'

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

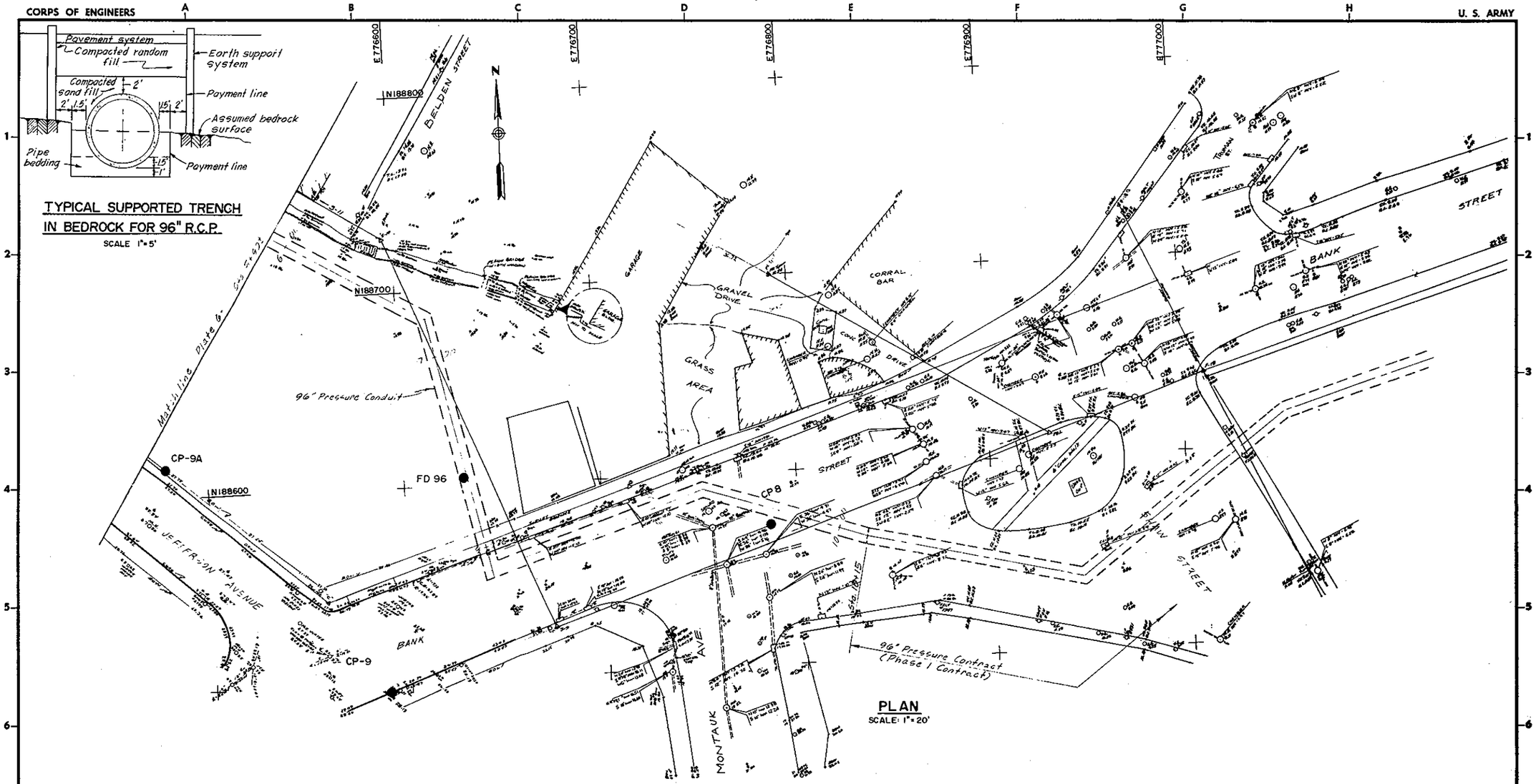
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

# NEW LONDON HURRICANE PROTECTION
## SHAW COVE
## 96" PRESSURE CONDUIT
## PLAN AND PROFILE NO. 1

NEW LONDON CONNECTICUT
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE: AS SHOWN SPEC. NO.
DRAWING NUMBER
SHEET

PLATE C-8

CORPS OF ENGINEERS — U. S. ARMY




| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, LAYOUT SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF PROJECT BRANCH

# NEW LONDON HURRICANE PROTECTION SHAW COVE

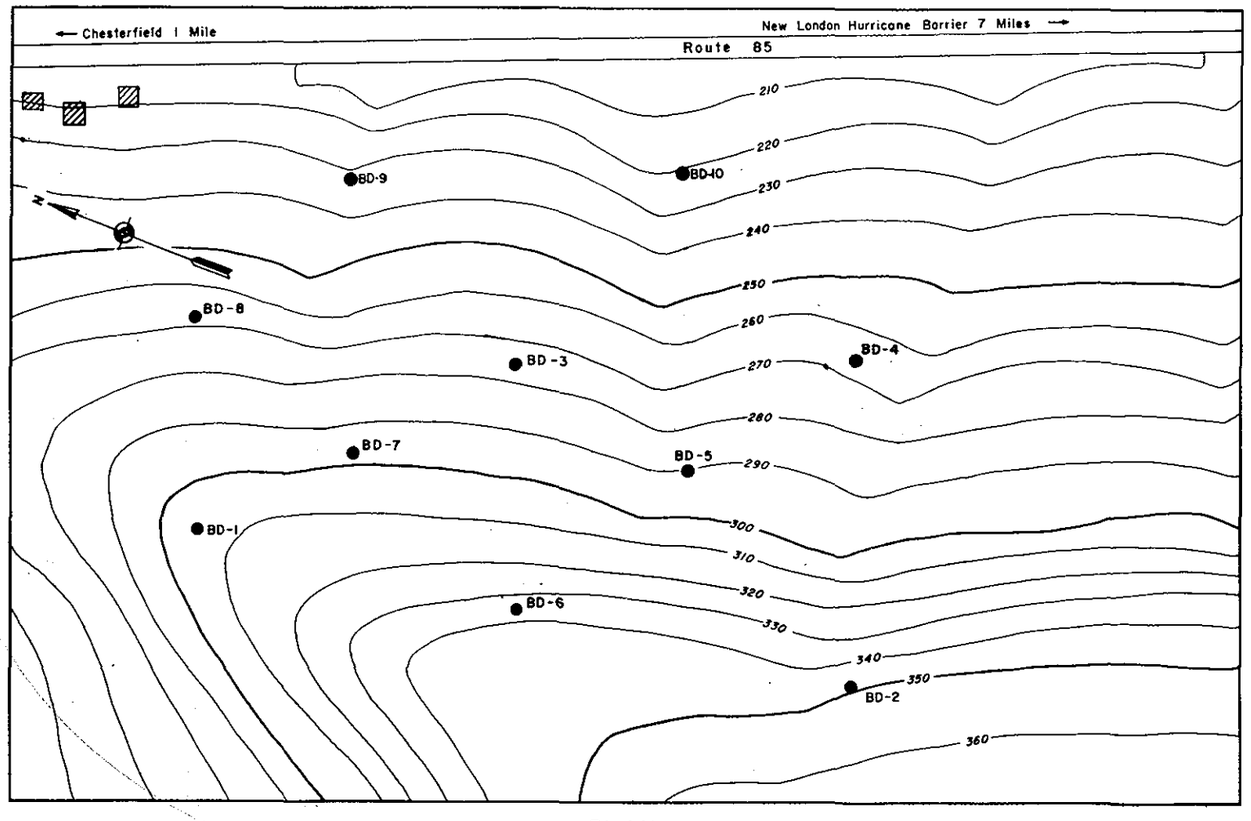
## 96" PRESSURE CONDUIT PLAN AND PROFILE NO.2

NEW LONDON CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

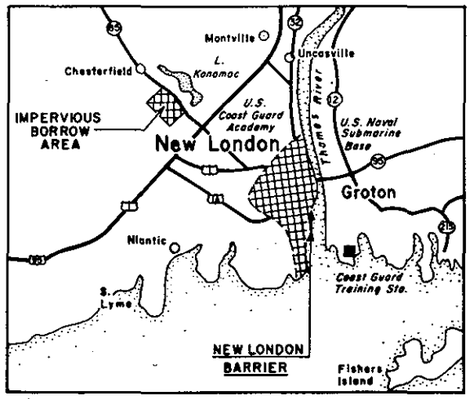
SCALE: AS SHOWN | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE C-9




## PLAN

SCALE 1"=100'




## VICINITY MAP

SCALE 1"=2 MILES

**LEGEND**

● BD *Borrow Test Boring*

**NOTES**

*Elevations refer to Mean Sea Level Datum.*
*Contour interval is 10 feet.*
*Contours drawn from USGS Topographic Map entitled Montville Conn. Quadrangle.*

GRAPHIC SCALES

1" = 100' — 100' 0 100' 200'

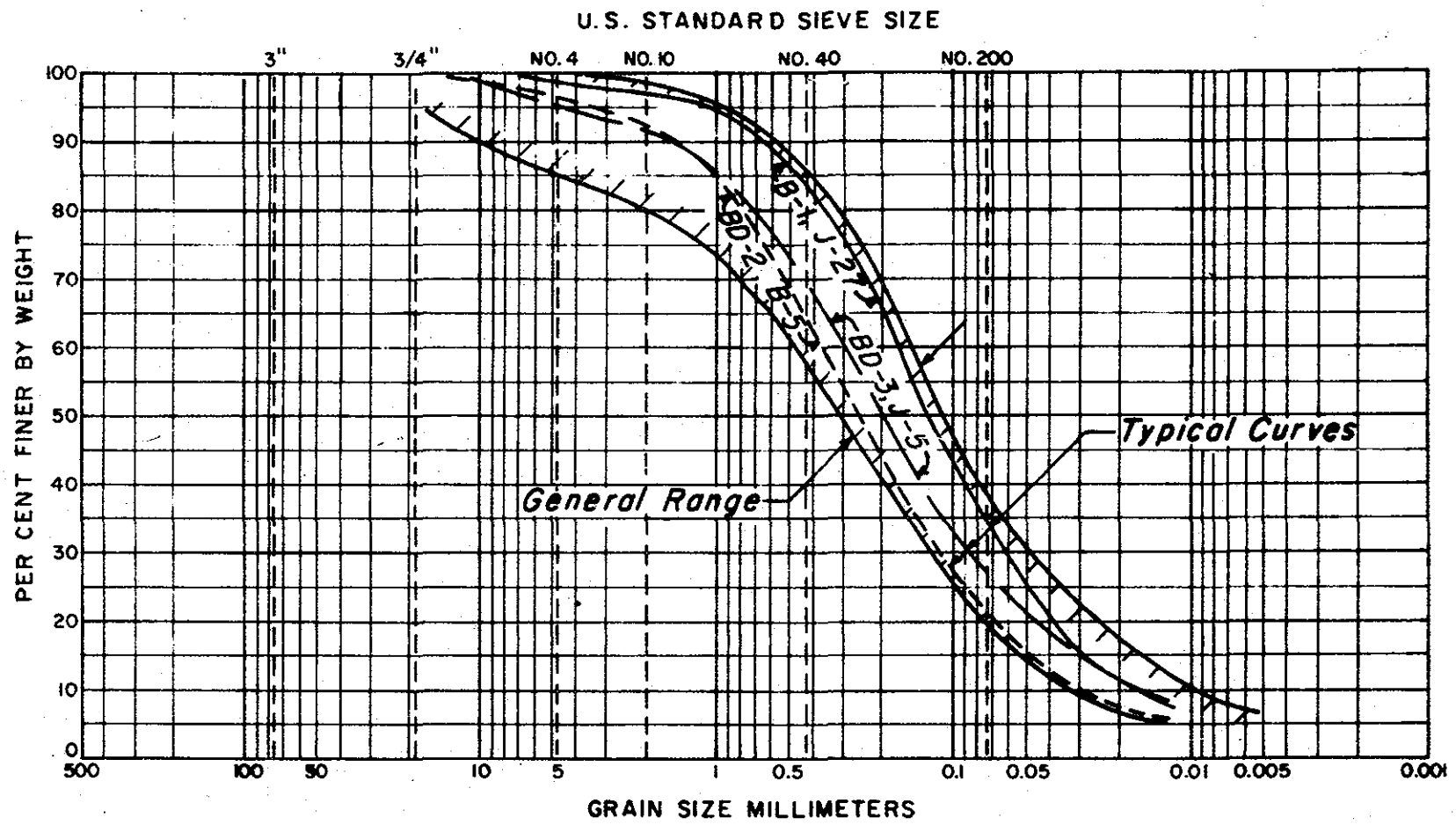
1" = 2 MILES — 1 0 1 2 3 4 5 Miles

NEW LONDON HURRICANE BARRIER

PLAN OF BORROW EXPLORATIONS

IMPERVIOUS BORROW AREA

NEW LONDON CONNECTICUT




GRAVELLY SILTY SAND AND SILTY SAND (SM)

GLACIAL TILL

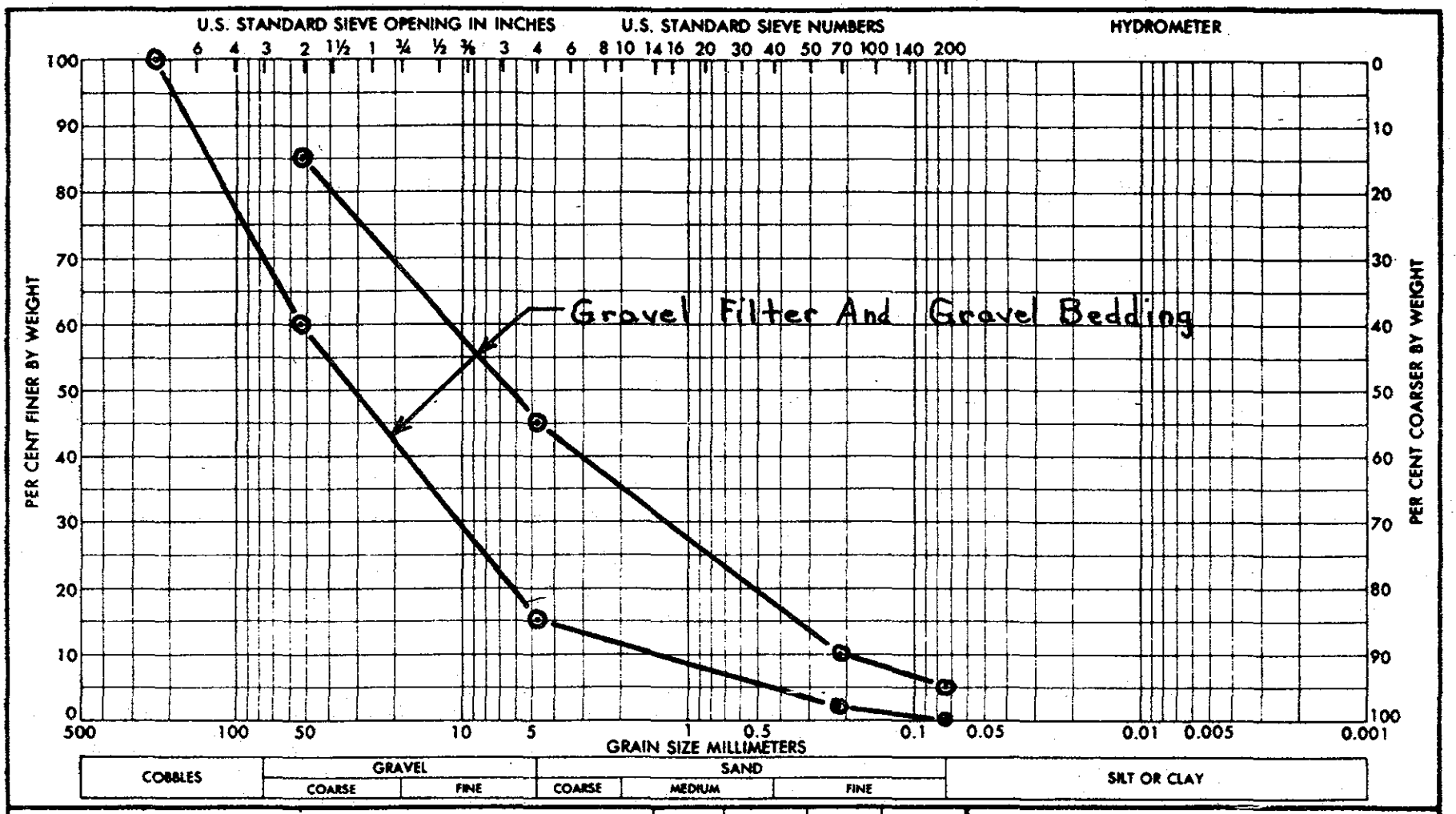
GRADATION RANGE

NEW LONDON HURRICANE BARRIER

SELECTED TEST DATA

IMPERVIOUS EMBANKMENT MATERIALS

NEW LONDON CONNECTICUT




NEW LONDON HURRICANE BARRIER

GRADATION SPECIFICATIONS

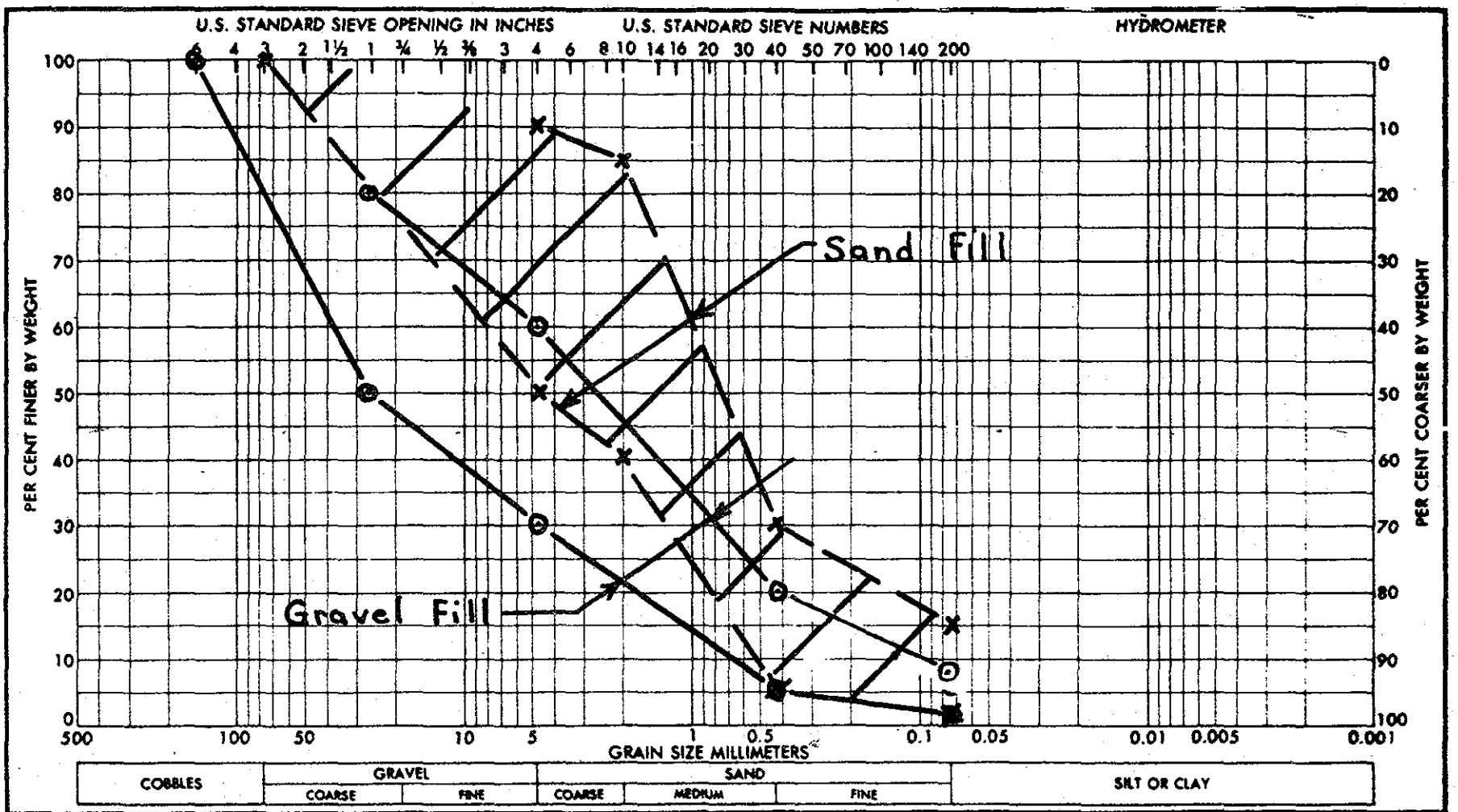
GRAVEL FILTER AND GRAVEL BEDDING

Plate No. C-12

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE 1963 OF—700-126




NEW LONDON HURRICANE BARRIER

GRADATION SPECIFICATIONS

GRAVEL FILL AND SAND FILL

Plate No. C-13

ENG FORM 2087
1 MAY 63

REPLACES WES FORM NO. 1241, SEP 1962, WHICH IS OBSOLETE.

U.S. GOVERNMENT PRINTING OFFICE 1963 OF—700-128

# SOIL TESTS RESULTS

| EXPL. NO. | TOP ELEV. FT. | SAMPLE NO. | DEPTH FT. | SOIL SYMBOL | MECHANICAL ANALYSIS GRAVEL % | SAND % | FINES % | $D_{10}$ mm. | ATT. LIMITS LL | PL | SPECIFIC GRAVITY | NAT. WATER CONTENT % DRY WT TOTAL | - NO4 | COMPACTION DATA STND. AASHO OPT. WATER % DRY WT | MAX. DRY DENS. LBS/CU FT | * PVD LBS/CU FT | NAT. DRY DENSITY LBS/CU FT TOTAL | - NO4 | OTHER TESTS SHEAR | CONSOL. | PERM. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FD-8 | +8.4 | J-9 | 15.6-20.0 | SM | 0 | 78 | 22 | 0.04 | | | | | | | | | | | | | |
| | | J-12 | 25.0-30.0 | ML | 0 | 40 | 60 | 0.025 | | | | | | | | | | | | | |
| | | J-17 | 36.2-36.8 | SP-SM | 11 | 82 | 7 | 0.10 | | | | | | | | | | | | | |
| | | J-23 | 45.0-50.0 | ML | 0 | 4 | 96 | 0.0054 | | | | | | | | | | | | | |
| FD-9 | +8.7 | J-5 | 10.5-15.0 | SM | 26 | 45 | 29 | 0.015 | | | | | | | | | | | | | |
| | | J-11 | 20.0-22.5 | ML | 0 | 26 | 74 | 0.0098 | | | | | | | | | | | | | |
| | | J-18 | 30.0-35.0 | SM | 8 | 59 | 33 | 0.02 | | | | | | | | | | | | | |
| FD=22 | -12.7 | J-4 | 5.6- 9.8 | SM | 0 | 84 | 16 | 0.064 | | | | | | | | | | | | | |
| | | J-9 | 15.0-20.0 | SM | 0 | 79 | 21 | 0.051 | | | | | | | | | | | | | |
| | | J-11 | 25.0-30.0 | SM | 0 | 51 | 49 | | | | | | | | | | | | | | |
| | | J-13 | 30.0-35.0 | ML | 0 | 11 | 89 | 0.009 | | | | | | | | | | | | | |
| | | J-17 | 45.0-50.0 | SW-SM | 0 | 88 | 12 | | | | | | | | | | | | | | |
| FD-91 | -7.± | J-4 | 10.0-15.0 | OH | 0 | 12 | 82 | 0.001 | 192 | 113 | | Natural | | | | | | | | | |
| | | | | | | | | | 134 | 55 | | Oven Dried | | | | | | | | | |
| | | J-7 | 16.6-19.7 | SM | 19 | 67 | 14 | 0.046 | | | | | | | | | | | | | |
| | | J-9 | 20.0-22.0 | MH | 1 | 6 | 93 | 0.001 | | | | | | | | | | | | | |
| | | J-12 | 25.0-30.0 | MH | 0 | 7 | 93 | 0.005 | | | | | | | | | | | | | |
| | | J-15 | 32.5-35.0 | SM | 24 | 30 | 46 | 0.01 | | | | | | | | | | | | | |
| FD-92 | +8.± | J-4 | 15.0-20.0 | ML | 0 | 22 | 78 | 0.012 | | | | | | | | | | | | | |
| | | J-8 | 25.0-30.0 | MH | 0 | 7 | 93 | 0.007 | | | | | | | | | | | | | |
| | | J-10 | 30.0-35.0 | SM | 23 | 46 | 21 | | | | | | | | | | | | | | |

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

NEW LONDON HURRICANE BARRIER

# SOIL TESTS RESULTS

| EXPL. NO. | TOP ELEV. FT. | SAMPLE NO. | DEPTH FT. | SOIL SYMBOL | MECHANICAL ANALYSIS GRAVEL % | SAND % | FINES % | $D_{10}$ mm. | ATT. LIMITS LL | PL | SPECIFIC GRAVITY | NAT. WATER CONTENT % DRY WT TOTAL | -NO4 | COMPACTION DATA STND. AASHO OPT. WATER % DRY WT | MAX. DRY DENS. LBS/CU FT | * PVD LBS/CU FT | NAT. DRY DENSITY LBS/CU FT TOTAL | -NO4 | OTHER TESTS SHEAR | CONSOL. | PERM. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FD-93 | +6.± | J-5 | 12.0-15.0 | Fill (SM) | 4 | 72 | 24 | 0.02 | | | | | | | | | | | | | |
| | | J-8 | 20.0-25.0 | OH | 0 | 7 | 93 | 0.001 | 165 | 71 | Natural | | | | | | | | | | |
| | | | | | | | | | 125 | 71 | Oven Dried | | | | | | | | | | |
| | | J-14 | 30.0-35.0 | SM | 1 | 83 | 16 | 0.054 | | | | | | | | | | | | | |
| | | J-16 | 35.0-40.0 | SP-SM | 1 | 94 | 5 | 0.14 | | | | | | | | | | | | | |

Plate No. C-15

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

NEW LONDON HURRICANE BARRIER

# SOIL TESTS RESULTS

| EXPL. NO. | TOP ELEV. FT. | SAMPLE NO. | DEPTH FT. | SOIL SYMBOL | MECHANICAL ANALYSIS GRAVEL % | SAND % | FINES % | $D_{10}$ mm. | ATT. LIMITS LL | PL | SPECIFIC GRAVITY | NAT. WATER CONTENT % DRY WT TOTAL | -NO4 | COMPACTION DATA STND. AASHO OPT. WATER % DRY WT | MAX. DRY DENS. LBS/CU FT | * PVD LBS/CU FT | NAT. DRY DENSITY LBS/CU FT TOTAL | -NO4 | OTHER TESTS SHEAR | CONSOL. | PERM. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BD-1 | | J-2 | 2.8- 5.0 | SM | 8 | 64 | 28 | 0.025 | | | | | | | | | | | | | |
| | | J-3R | 2.7- 5.0 | SM | | | | | | | | 8.7 | 9.0 | | | | | | | | |
| | | J-9 | 10.0-15.0 | SM | 6 | 58 | 36 | 0.014 | | | | | | | | | | | | | |
| | | J-10R | 10.0-15.0 | SM | | | | | | | | 9.3 | 9.4 | | | | | | | | |
| | | J-17 | 20.0-22.0 | SM | 3 | 62 | 35 | 0.018 | | | | | | | | | | | | | |
| | | J-18R | 20.0-22.0 | SM | | | | | | | | 8.9 | 9.0 | | | | | | | | |
| | | J-25R | 30.0-35.0 | SM | | | | | | | | 12.0 | 12.3 | | | | | | | | |
| | | J-27 | 35.0-40.0 | SM | 2 | 61 | 37 | 0.015 | | | | | | | | | | | | | |
| BD-2 | | B-5 | 5.0-10.0 | SM | 4 | 74 | 22 | 0.028 | | | | 8.9 | 9.2 | | | | | | | | |
| | | J-11R | 15.0-17.5 | SM | | | | | | | | 8.3 | 8.6 | | | | | | | | |
| | | J-15R | 20.8-22.5 | SM | 6 | 60 | 34 | 0.015 | | | | 5.3 | 5.6 | | | | | | | | |
| BD-3 | | J-4R | 5.0-10.0 | SM | | | | | | | | 8.6 | 9.6 | | | | | | | | |
| | | J-6R | 10.0-15.0 | SM | | | | | | | | 8.6 | 8.9 | | | | | | | | |
| | | J-10R | 16.9-20.0 | SM | | | | | | | | 6.0 | 6.3 | | | | | | | | |
| | | J-12R | 20.0-23.0 | SM | | | | | | | | 6.1 | 6.7 | | | | | | | | |
| BD-4 | | B-3 | 1.0- 5.0 | SM | 4 | 61 | 35 | 0.012 | | | | 7.7 | 8.2 | | | | | | | | |
| | | B-11 | 15.0-20.0 | SM | 7 | 61 | 32 | 0.015 | | | | 8.4 | 9.0 | | | | | | | | |
| BD-5 | | J-2 | 2.6- 5.0 | GP-GM | 52 | 38 | 10 | 0.075 | | | | | | | | | | | | | |
| | | J-7R | 10.0-12.6 | SM | | | | | | | | 8.6 | 9.1 | | | | | | | | |
| | | J-9 | 12.6-15.0 | SM | 3 | 60 | 37 | 0.015 | | | | | | | | | | | | | |
| | | J-10R | 12.6-15.0 | SM | | | | | | | | 8.0 | 8.1 | | | | | | | | |
| | | J-13 | 15.0-17.2 | SM | | | | | | | | 8.5 | 9.0 | | | | | | | | |
| | | J-16R | 18.5-20.0 | SM | | | | | | | | 6.4 | 6.8 | | | | | | | | |
| | | J-17 | 20.0-23.0 | SM | 8 | 51 | 41 | 0.015 | | | | | | | | | | | | | |
| | | J-18R | 20.0-23.0 | SM | | | | | | | | 7.8 | 8.1 | | | | | | | | |
| | | J-21R | 23.0-25.0 | SM | | | | | | | | 6.8 | 7.0 | | | | | | | | |
| | | J-24R | 25.0-28.0 | SM | | | | | | | | 6.3 | 6.7 | | | | | | | | |

NED FORM JUL 63 510

* PROVIDENCE VIBRATED DENSITY TEST

NEW LONDON HURRICANE BARRIER

Plate No. C-16

# SOIL TESTS RESULTS

| EXPL. NO. | TOP ELEV. FT. | SAMPLE NO. | DEPTH FT. | SOIL SYMBOL | MECHANICAL ANALYSIS GRAVEL % | SAND % | FINES % | $D_{10}$ mm. | ATT. LIMITS LL | PL | SPECIFIC GRAVITY | NAT. WATER CONTENT % DRY WT TOTAL | -NO4 | COMPACTION DATA STND. AASHO OPT. WATER % DRY WT | MAX. DRY DENS. LBS/CU FT | * PVD LBS/CU FT | NAT. DRY DENSITY LBS/CU FT TOTAL | -NO4 | OTHER TESTS SHEAR | CONSOL. | PERM. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BD-5 | (Continued) | | | | | | | | | | | | | | | | | | | | |
| | | J-26 | 28.0-30.0 | SM | 6 | 64 | 30 | 0.0095 | | | | | | | | | | | | | |
| | | J-29R | 31.0-34.0 | SM | | | | | | | | 6.5 | 7.1 | | | | | | | | |
| | | J-32 | 35.0-38.0 | SM | 12 | 54 | 34 | 0.0075 | | | | | | | | | | | | | |
| | | J-33R | 35.0-28.0 | SM | | | | | | | | 5.7 | 5.8 | | | | | | | | |
| BD-6 | | J-3 | 2.5- 5.0 | SM | 12 | 51 | 37 | 0.013 | | | | | | | | | | | | | |
| | | J-5 | 7.0-10.0 | SP-SM | 2 | 87 | 11 | 0.07 | | | | | | | | | | | | | |
| | | J-7R | 10.0-14.0 | SP-SM | | | | | | | | 6.0 | 6.4 | | | | | | | | |
| | | J-11R | 15.0-17.5 | SM | | | | | | | | 6.6 | 7.4 | | | | | | | | |
| | | J-16R | 20.0-23.0 | SM | | | | | | | | 4.3 | 5.6 | | | | | | | | |
| | | J-18 | 23.0-25.0 | SM | 13 | 57 | 30 | 0.019 | | | | | | | | | | | | | |
| | | J-19R | 23.0-25.0 | SM | | | | | | | | 8.4 | 8.8 | | | | | | | | |
| | | J-21R | 25.0-27.0 | SM | | | | | | | | 9.1 | 9.4 | | | | | | | | |
| | | J-23R | 27.0-30.0 | SM | | | | | | | | 8.6 | 8.7 | | | | | | | | |
| | | J-24 | 30.0-35.0 | SM | 3 | 53 | 44 | 0.014 | | | | | | | | | | | | | |
| | | J-25R | 30.0-35.0 | SM | | | | | | | | 10.3 | 10.7 | | | | | | | | |
| | | J-28R | 35.0-40.0 | SM | | | | | | | | 9.7 | 10.6 | | | | | | | | |
| BD-7 | | J-3 | 2.2- 5.0 | SM | 10 | 63 | 27 | 0.018 | | | | | | | | | | | | | |
| | | J-11 | 15.0-18.0 | SM | 3 | 58 | 39 | 0.013 | | | | | | | | | | | | | |
| | | J-18 | 25.0-28.0 | SM | 0 | 53 | 47 | 0.0061 | | | | | | | | | | | | | |
| | | J-26 | 35.0-38.0 | SM | 15 | 59 | 26 | 0.016 | | | | | | | | | | | | | |
| BD-8 | | J-4 | 5.0-10.0 | SM | 5 | 62 | 33 | 0.018 | | | | | | | | | | | | | |
| | | J-11 | 15.0-20.0 | SM | 4 | 60 | 36 | 0.004 | | | | | | | | | | | | | |
| BD-10 | | J-5 | 10.0-15.0 | SM | 28 | 43 | 29 | 0.025 | | | | | | | | | | | | | |
| | | J-7 | 15.0-18.8 | SP-SM | 23 | 67 | 10 | 0.075 | | | | | | | | | | | | | |

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NEW LONDON HURRICANE BARRIER