SOUTHEAST LOUISIANA URBAN FLOOD CONTROL PROJECTS

DESIGN REPORT
FOR
IMPROVEMENTS TO SUBURBAN CANAL
CANAL NO. 3 TO CANAL NO. 2

CONTRACT NO: DACW 29-97-B-0000

PREPARED FOR:

JEFFERSON PARISH DRAINAGE CAPITAL PROGRAM
JEFFERSON PARISH, LA.
AND
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT

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1. <u>Introduction</u>

Authorization

This design report is a part of the detailed design of features and associated physical improvements to Suburban Canal. This project is a part of a three-parish urban flood control project known as the Southeast Louisiana Urban Flood Control Project (SELA) that was authorized by the U.S. Congress in the aftermath of the catastrophic flood of May 8 and 9, 1995. The firms of Brown, Cunningham, Gannuch and Gulf Engineers and Consultants were awarded the design contract for that portion of the Suburban Canal improvements which lie between the north right- of-way of Veterans Blvd., and the north right-of-way of West Esplanade Ave.

Project Location

This project is located in Jefferson Parish, Louisiana on the east bank of the Mississippi River in the unincorporated area known as Metairie. This portion of the Jefferson Parish drainage system is an intertwined network of subsurface culverts, ditches, canals and pumping stations. Similar to the New Orleans system and unique to all others in the United States, the system's operation depends on the collection and pumping of all storm water falling on the area.

In most areas of Jefferson parish, land elevations are lower than the surrounding water surface elevations. Levees protect much of the Parish from hurricane and Mississippi River flooding. However, the levees assume an opposite role, that of retaining water, where rainfall is concerned.

The Jefferson Parish East Bank drainage basin is subdivided into storage areas by natural ground contours and drainage canals. Flow in the subbasins is generally away from higher ground elevations at the Mississippi River. This project involves a portion of the subbasin drained by Suburban Canal and Pump Station No. 2. Suburban Canal flows north from the vicinity of West Metairie Avenue to Pump Station No. 2 at Lake Pontchartrain.

Jefferson Parish operates its pumping stations to maintain a specific water surface elevation in the major outfall canals. Once those elevations are exceeded the pumps are engaged to discharge the excess. Subsidence problems in the parish dictate this operation, so that ground water is not drawn out of areas adjacent to the canals.

The east bank storage areas are laterally connected by a "grid" of canals. The lateral canals equalize flow between the major outfall canals. This allows rain water to flow in different or opposite directions depending on rainfall patterns and available capacities at the pumping stations.

The proposed work involves (See Plate No. 1) Reach No. 11 of Suburban Canal from Canal No. 3 to Canal No. 2. The limits of this contract are from the north right-of-way of Veterans Boulevard to the north right-of-way of West Esplanade Avenue. During the preliminary phase of the project, it was separated into two separate contracts to facilitate construction and coordination with adjacent projects. Contract No. 1 will be for the design of the canal section from approximately the north right-of-way of Veterans Boulevard to approximately the south right-of-way of West Esplanade Avenue. Contract No. 2 will be for the design of the Suburban Canal and West Esplanade Avenue intersection.

The land use in this reach of Suburban Canal is both commercial and residential. The property on the east side of the canal is primarily residential. On the west side it is a mixture of commercial establishments, apartments, and medical offices. East Jefferson General Hospital is located at the southwest corner of the intersection of Suburban Canal and West Esplanade Avenue. The two major roadways that run perpendicular to the ends of the canal in this reach are predominately commercial along their entire length.

Adjacent to the east side of the canal and separating it from the residential sub-division is a dedicated right-of-way for a future roadway. A road has never been developed in this right-of-way and it exists as a buffer between the canal and the residential area east of the canal.

Purpose and Scope

The purpose of this project is to increase the hydraulic capacity of the existing canal system on the East Bank of Jefferson Parish. The increased capacity is being achieved by improving the hydraulic flow in the canals. The pumping capacity at Pump Station Nos. 2 and 3 are being increased in other SELA projects.

The Suburban Canal pump station capacity is being increased by 2400 cubic feet per second(cfs). To provide the additional flow required to the pump station, this reach of Suburban Canal is being improved to handle 4100 cfs, for a ten year storm between Veterans Blvd., and West Esplanade Avenue, and 5200 cfs, north of West Esplanade. Because there is very little natural slope in this area, these increases must be achieved with minimal head losses. The allowable headloss, as determined by the Corps of Engineers, in this reach of Suburban Canal is only 1.8 feet between Veterans Blvd. and West Esplanade Avenue.

II. Design Alternatives

During the preliminary design phase, the project was divided into two contracts. Contract No. 1 is from approximately the north right-of-way of Veterans Blvd., to approximately the south right-of-way of West Esplanade Ave. Contract No. 2 is located at the intersection of West Esplanade Ave., and Suburban Canal primarily within the right-of-way of West Esplanade Ave. The division into two contracts was recommended to better coordinate with other construction contracts at the Suburban Canal/West Esplanade Ave. intersection. Louisiana DOTD is scheduled to receive bids in early 1998 on the West Esplanade Canal adjoining this project on the west. The COE is scheduled to receive bids in early 1998 on the Suburban Canal reach immediately north of West Esplanade Ave. In order to avoid monumental traffic disruptions on West Esplanade Ave. with three construction contracts occurring at approximately the same time, it was proposed to delay the intersection improvements proposed for this reach until the work on West Esplanade to the west was nearing completion. The alternatives for each contract section are discussed separately.

Contract No. 1

This project was originally proposed as a paved trapezoidal section in the COE's SELA Technical Report dated May, 1996. The report required a 40 foot bottom width with paved side slopes of 1V to 2H and 10 foot maintenance beams on both sides. It was determined early in the design phase that this section would not fit within the existing rights-of-way. A similar proposal was also contained in the COE's Value Engineering Report for this reach of the Suburban Canal.

After reviewing the proposed design sections evaluated in the Value Engineering Team Study Report and meeting with personnel at the New Orleans District Office familiar with the soils in the New Orleans area, it was determined that the section best suited for this reach was a reinforced concrete flume section (See Plate No. 2). This structure would fit within the existing canal right-of-way and not encroach on the road right-of-way east of Suburban Canal.

During this phase, Jefferson Parish requested that the placement of a road adjacent to the canal be investigated to determine the feasibility and cost of constructing the projects together. The Parish has determined that there is a need for a new connector between West Esplanade Ave., and Veterans Blvd., that would serve as direct access to the East Jefferson General Hospital. Two alternative's were developed using the existing canal right-of-way and the adjacent east-side road right-of-way. Alternate number one placed the canal on the extreme east side of the combined rights-of-way with the road on the west side of the canal. Alternate number two placed the canal on the extreme west side of the combined rights-of-way with the road on the east side of the canal.

Layout's of both alternatives were prepared on aerial photographs at a scale of 1"=40 and preliminary cost estimates for each were developed. This information was transmitted to the Parish for their review and comment. Copies of the plan view and profile view of the western alignment are shown in Plates 3 and 4. The same views of the eastern alignment are shown in Plates 5 and 6. Cost estimates for these alternatives are listed in Tables 1 and 2, respectively.

In addition, a third alternative was evaluated as a way to improve Suburban Canal and develop a new connection between Veterans Blvd. and West Esplanade Ave. This alternative involved construction of a box culvert in the existing canal right-of-way with a roadway on top of the box. A concrete flume would be designed so that at a future date it could be converted to a box culvert by the addition of interior walls and a roof. The roadway would be constructed on the top of the box at a future date (See Plate 7). A comparison of costs between the concrete flume section and the reinforced bottom section to allow for a future box is shown in Table 3. This comparison is for the structure only since miscellaneous costs would be essentially the same for both structure types. In addition the estimated cost for the top of the box culvert, interior walls, and future roadway were included for information.

After reviewing these alternatives the Parish decided that none of the alternatives were feasible at this time due to both cost and public concern over through streets in residential areas.

It was decided that the improvements in this section of the canal would consist of a concrete flume section located within the limits of the existing canal right-of-way. The proposed flume is located 49.5 feet west of the project baseline. This location was selected as the best fit within the existing canal right-of-way while allowing for constructablility without requiring construction servitudes.

The reaches of the canal upstream and downstream of this reach have wider rights-of-way and are offset further west within the right-of-way. The flume has been placed as far to the west as possible, within the limits of constructability, to minimize the transitions between the adjacent sections. These transitions can be incorporated with the improvements under Veterans Blvd. and West Esplanade Avenue.

A preliminary construction cost estimate for the recommended canal section is provided in Table 4.

Contract No. 2

This project was separated into two contracts so that work could proceed on the canal section while alternatives were investigated for the West Esplanade and Suburban Canal intersection. West Esplanade Avenue is the only east-west roadway between Veterans Blvd., and Lake Pontchartrain. Any work involving this roadway and Suburban Canal must take this fact into consideration and include plans for traffic maintenance during construction. As previously discussed, coordination with other construction contracts at this intersection is essential.

The COE's Technical Report for Suburban Canal called for the replacement of the west bound bridge on West Esplanade Avenue and the extension by one bent of the east bound bridge to provide the required channel section. The Technical Report did not address maintenance of traffic during construction of the new bridge or extension of the existing bridge.

Alternative No. 1 will carry the 58-foot flume section through the east-bound bridge which will widen to a 85-foot flume beneath the west-bound bridge. The widening is required to accommodate the additional flow from Canal No. 2. The 58-foot flume will not fit within the existing east-bound bridge because of the batter piles at the end bents of the bridge. The batter piles will conflict with the finished flume and the temporary sheet piles during construction. In order to build the flume both end spans including the bents, piles, and approach slabs will have to be replaced. After the flume is completed, new end spans will be constructed. The west bound bridge will need to be replaced entirely in order to accommodate the flume section. In order to maintain traffic during construction a temporary bridge will be required while the bridges are replaced. This alternate requires that pilings will remain in the flume section after construction thereby inpeding flow. The calculated headloss across the east bound bridge is eight-tenths of a foot. The headloss across the west bound bridge is fourth-tenths of a foot. This additional headloss was not accounted for in the COE's hydraulic modeling.

Alternative No. 2 would provide for a box culvert under both bridges at West Esplanade Ave. with transitions to the upstream and downsteam flume sections. By constructing the center portion (area between existing bridges) of the box culvert first and using it to support a temporary roadway, four lanes of traffic can be maintained throughout construction. One of the bridges could be removed and the box culvert extended and the road reconstructed on the box before the other bridge is removed. Plate No. 8 shows a plan view of this intersection. Plate No. 9 shows the profile view of the two box culvert sections required at this intersection. Preliminary construction cost estimates for the box culvert section and the concrete flume section and bridge replacement are shown in Table 5 and Table 6 respectively.

III. HYDRAULIC DESIGNS

Pertinent Design Data

Basic hydrologic design flows and target flowline data were furnished by the U.S.

Army Corps of Engineers, New Orleans District, for this design. The 10-year design flow south to north along Suburban Canal from Veterans Blvd. to West Esplanade Ave. is approximately 4,100 cubic feet per second(cfs). Canal No. 2, which occupies the space between the east and westbound lanes of West Esplanade Ave. contributes 300 cfs from the east direction and 800 cfs from the west direction. See map of project area on Plate 1. This combined flow of approximately 5,200 cfs flows north into the suction basin of drainage Pump Station No. 2, which is approximately 1,300 feet north of the downstream limit of this project. The design flows and target water surface elevations at the boundaries and key locations within the project area are given in Table 7 for the 10-year design flood. Similar data are given in Table 8 for the 100 year synthetic flood. Also included in Table 7 are the design inverts of the conveyance channel at key locations. The Corps of Engineers has recommended a Mannings N-value of 0.015 so that all segments of the Suburban Canal have the same level of design protection. The channel invert will have a slope equal to 0.00025 FT/FT.

Project Requirements

In order to increase the hydraulic efficiency of the canal to the required levels and due to the extreme soil conditions in the project area, all flow will be conveyed in concrete lined flumes or box culverts within the limits of the project. Also, because W. Esplanade Ave. is a major traffic artery within the Parish, and Suburban Canal is the only feeder canal to Drainage Pumping Station No. 2, traffic and flow must be maintained through the project during construction. In order to accommodate traffic, a traffic bypass will be used that can straddle the Canal No. 2 cross-section. Two means to achieve single direction traffic in the West Esplanade-Canal No. 2 intersection were considered. One plan would require construction and removal of a temporary bridge that would provide dual lane one-way traffic while new permanent bridges would be constructed. The recommended plan however, is to construct permanent box culverts within the Suburban Canal and Canal No. 2 channels before interrupting existing dual lane two-way traffic on West Esplanade Ave.

When these permanent culverts are completed, they would provide a dual lane one-way bypass that would not require removal. The box culverts would be extended upstream and downstream alternately to accommodate permanent dual-lane traffic.

Hydraulic Analyses

Two hydraulic analyses were made with the XP-SWMM computer modeling system. One model included bridges at West Esplanade Ave. and the second model included box culverts at West Esplanade Ave. Both models included the concrete flume between the north right-of-way at Veterans Blvd. and same 58'x14' the south right-of-way at West Esplanade Ave. The models were constructed to the prescribed inverts provided by the Corps of Engineers. The first application of the model with bridges was to verify that the hydraulic flowline provided by the Corps of Engineers could be achieved with the bridge and the 58'x14 flume section. Design cross sections were applied in the model at approximately 700 foot intervals beginning at Drainage Pump Station No. 2. Within the Canal No. 2. junction, cross-sections were applied at 70' to 100' intervals as needed to describe the junction hydraulically. Because XP-SWMM does not have provisions to model bridges, the hydraulic losses due to bridge piers were computed by hand with Yarnell's bridge loss equation. The results of modeling with the box culverts produced an eight-tenths foot loss across the junction due to the increase discharge and the boxes, as compared to 1.2 feet for the model with bridges. At the upstream end of the project, both models produced a stage less than the target water surface elevation of 12.8 ft Cairo Datum. Only the model results with the box culvert alternative are presented in Tables 7 and 8.

Project Plan

The box culvert segment will be approximately 210 feet in length and in order to minimize the effect of the added wetted perimeter of multiple box culverts, the 58'x14' flume had to transition to a 75-foot wide box culvert and then to a 90-foot wide box culvert. See the plan and section of the transition, Plates 8 and 9. Each of the segments would be composed of 3 barrels with either parallel, expanding, or in the case of the culverts in Canal No. 2, contracting horizontally while expanding vertically to meet the junction elevation of 0.0 feet Cairo Datum. The transition between the 58'x14' flume and the 75-foot clear span box culverts will occur over a distance of approximately 80 feet with slight eccentricity on the east side due to R.O.W. limitations on the west side of the Suburban Canal At West Esplanade Ave. The middle 25' wide box will carry through the entire junction and the two outer boxes will expand to two 32.5' wide boxes in the canal junction to accommodate the lateral inflow. The transition section between the 90' clear bottom width of the 3 barrel culvert and the downstream open rock-lined trapezoidal channel will be 110 feet in length. Because the bottom width converges from 90' to 56' and the top width diverges from 90' to 146', concrete wingwalls will be required due to poor bank stability and steep side slopes. The upstream transition will begin at Station 137+50 and the downstream transition will terminate at Station 141+75. Typical design sections are shown on Plate 9.

IV. Conculsions and Recommendations

This design report is intended to provide an overall summary of the tasks and alternatives which were considered during the preliminary phase of the Project. As a result of this analysis the following are our recommendations for construction of this reach of the Suburban Canal:

1. Design the project as two separate construction contracts as discussed herein and proceed with the design of Project No. 1. Proceed with the design for Project No. 2 after agreement by the Corps of Engineers and Jefferson Parish on the scope of work at the Suburban Canal/W. Esplanade Ave intersection.

2. We recommend proceeding with the box culvert alternative for the intersection improvements. This alternative provides for maintenance of traffic on the heavily - traveled W. Esplanade Ave. and eliminates obstructions in the canal while maintaining hydraulic efficiency. It is also the most cost effective method of construction.

3. Due to design schedules, allow the transition from the Veterans Memorial Blvd. box culvert to the flume section to be designed under the upstream box culvert contract.

4. To allow for a proper hydraulic transition between the West Esplanade Ave. box culvert and the downstream trapezoidal section, delete approximately 110 feet from the COE project and allow to be constructed under this contract.

5. Replace the pedestrian bridge at Kawanee Ave. to provide access across the canal for school children from Meisler Jr. High School and Lutheran High School.

PLATES

TABLES

TABLE 1
January, 1998

PRELIMINARY
CONSTRUCTION COST ESTIMATE
SUBURBAN CANAL REACH NO.11
ROADWAY AND CONCRETE FLUME SECTION
WESTERN ROADWAY ALIGNMENT

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Mobilization and Demobilization	Lump Sum	Lump	$100,000.00	$100,000.00
2	Construction Photographs and Video Taping	Lump Sum	Lump	$25,000.00	$25,000.00
3	Sheeting, Shoring & Bracing	3,625	L.F.	$350.00	$1,268,750.00
4	Excavation	118,960	C.Y.	$5.00	$594,800.00
5	Riversand Backfill	25,700	C.Y.	$9.00	$231,300.00
6	Bedding Material	19,611	C.Y.	$34.00	$666,774.00
7	Engineering Fabric	31,014	S.Y.	$2.00	$62,028.00
8	Structural Concrete Flume	23,200	C.Y.	$325.00	$7,540,000.00
9	4" Concrete Slope Paving	4,024	S.Y.	$12.00	$48,288.00
10	8' Chain Link Fence	7,250	L.F.	$12.00	$87,000.00
11	Asphaltic Concrete Pavement	7,900	Ton	$40.00	$316,000.00
12	Class I Base Course	6,000	C.Y.	$30.00	$180,000.00
13	Stone Base Course	6,000	C.Y.	$34.00	$204,000.00
14	GM Barrier	3,500	L.F.	$50.00	$175,000.00
15	Dewatering	Lump Sum	Lump	$100,000.00	$100,000.00
16	Seeding & Fertilizing	Lump Sum	Lump	$10,000.00	$10,000.00
17	Remove and Replace Pedestrian Bridge	Lump Sum	Lump	$100,000.00	$100,000.00
18	Adjust Existing Drainage Structures	Lump Sum	Lump	$50,000.00	$50,000.00
			Subtotal		$11,758,940.00
			Contingencies (10%)		$1,175,894.00
			Total Construction Cost		$12,934,834.00 *

* This cost does not include any work at the W. Esplanade Ave. Intersection or a transition from the Veterans Blvd. box culvert

PRELIMINARY
CONSTRUCTION COST ESTIMATE
SUBURBAN CANAL REACH NO.11
ROADWAY AND CONCRETE FLUME SECTION
EASTERN ROADWAY ALIGNMENT

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Mobilization and Demobilization	Lump Sum	Lump	$100,000.00	$100,000.00
2	Construction Photographs and Video Taping	Lump Sum	Lump	$25,000.00	$25,000.00
3	Sheeting, Shoring & Bracing	3,625	L.F.	$350.00	$1,268,750.00
4	Excavation	116,160	C.Y.	$5.00	$580,800.00
5	Riversand Backfill	15,400	C.Y.	$9.00	$138,600.00
6	Bedding Material	19,611	C.Y.	$34.00	$666,774.00
7	Engineering Fabric	31,014	S.Y.	$2.00	$62,028.00
8	Structural Concrete Flume	23,200	C.Y.	$325.00	$7,540,000.00
9	4" Concrete Slope Paving	4,024	S.Y.	$12.00	$48,288.00
10	8' Chain Link Fence	7,250	L.F.	$12.00	$87,000.00
11	Asphaltic Concrete Pavement	9,000	Ton	$40.00	$360,000.00
12	Class I Base Course	6,900	C.Y.	$30.00	$207,000.00
13	Stone Base Course	6,900	C.Y.	$34.00	$234,600.00
14	GM Barrier	4,000	L.F.	$50.00	$200,000.00
15	Dewatering	Lump Sum	Lump	$100,000.00	$100,000.00
16	Seeding & Fertilizing	Lump Sum	Lump	$10,000.00	$10,000.00
17	Remove and Replace Pedestrian Bridge	Lump Sum	Lump	$100,000.00	$100,000.00
18	Adjust Existing Drainage Structures	Lump Sum	Lump	$50,000.00	$50,000.00
			Subtotal		$11,778,840.00
			Contingencies (10%)		$1,177,884.00
			Total Construction Cost		$12,956,724.00 *

* This cost does not include any work at the W. Esplanade Ave. Intersection or a transition from the Veterans Blvd. box culvert.

PRELIMINARY
CONSTRUCTION COST ESTIMATE COMPARISON
CONCRETE FLUME SECTION Vs BOX CULVERT BOTTOM

Concrete Flume Section Only

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Stuctural Concrete Flume	23,925	C.Y	$325.00	$7,775,625.00
2	Bedding material	23,000	C.Y	$34.00	$782,000.00
3	Excavation	47,650	C.Y	$5.00	$238,250.00
4	Riversand Backfill	13,200	C.Y	$9.00	$118,800.00
			Total		$8,914,675.00 *

Bottom Section of Future Box Culvert

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Stuctural Concrete Box Bottom	37,250	C.Y	$325.00	$12,106,250.00
2	Bedding material	49,750	C.Y	$34.00	$1,691,500.00
3	Excavation	88,000	C.Y	$5.00	$440,000.00
4	Riversand Backfill	28,000	C.Y	$9.00	$252,000.00
			Subtotal A		$14,489,750.00 *

Future Top of Box Culvert and Roadway

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Stuctural Concrete Top of Box	17,250	C.Y	$325.00	$5,606,250.00
2	Riversand Backfill	9,650	C.Y	$9.00	$86,850.00
3	Asphaltic Concrete Pavement	4,700	Ton	$35.00	$164,500.00
4	Curb and Gutter	4,000	L.F.	$15.00	$60,000.00
5	Drainage	Lump Sum	Lump	$50,000.00	$50,000.00
			Subtotal B		$5,967,600.00
	Total Cost Box Culvert and Future Roadway (Subtotal A + B)				$20,457,350.00 *

* These costs are for the comparison of the concrete flume section and the box culvert and future roadway only, and do not include shoring costs and a tie-in at W. Esplanade or at Veterans Blvd. A contigency is not include in the cost.

TABLE 4
January, 1998

PRELIMINARY
CONSTRUCTION COST ESTIMATE
SUBURBAN CANAL REACH NO. 11
CONCRETE FLUME SECTION

Sta 101+25 to Sta 137+50

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Mobilization and Demobilization	Lump Sum	Lump	$100,000.00	$100,000.00
2	Construction Photographs and Video Taping	Lump Sum	Lump	$25,000.00	$25,000.00
3	Sheeting, Shoring & Bracing	3,625	L.F.	$350.00	$1,268,750.00
4	Excavation	59,120	C.Y.	$5.00	$295,600.00
5	Riversand Backfill	6,200	C.Y.	$9.00	$55,800.00
6	Bedding Material	19,611	C.Y.	$34.00	$666,774.00
7	Engineering Fabric	31,014	S.Y.	$2.00	$62,028.00
8	Structural Concrete Flume	23,200	C.Y.	$325.00	$7,540,000.00
9	4" Concrete Slope Paving	4,024	C.Y.	$12.00	$48,288.00
10	8' Chain Link Fence	7,250	S.Y.	$12.00	$87,000.00
11	Dewatering	Lump Sum	Lump	$100,000.00	$100,000.00
12	Seeding & Fertilizing	Lump Sum	Lump	$10,000.00	$10,000.00
13	Remove and Replace Pedestrian Bridge	Lump Sum	Lump	$100,000.00	$100,000.00
14	Adjust Existing Drainage Structures	Lump Sum	Lump	$50,000.00	$50,000.00

to high
Break up
in to
Base slab
+
walls

Subtotal	$10,409,240.00
Contingencies (10%)	$1,040,924.00
Total Construction Cost	$11,450,164.00

3750
10125

PRELIMINARY
CONSTRUCTION COST ESTIMATE
SUBURBAN CANAL AND W. ESPLANADE AVE.
BOX CULVERT SECTION

Sta 137+50 to Sta 141+75

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Mobilization and Demobilization	Lump Sum	Lump	$25,000.00	$25,000.00
2	Construction Photographs and Video Taping	Lump Sum	Lump	$5,000.00	$5,000.00
3	Sheeting, Shoring & Bracing	410	L.F.	$350.00	$143,500.00
4	Excavation	8,992	C.Y.	$5.00	$44,960.00
5	Riversand Backfill	1,827	C.Y.	$9.00	$16,443.00
6	Bedding Material	2,630	C.Y.	$34.00	$89,420.00
7	Engineering Fabric	4,125	S.Y.	$2.00	$8,250.00
8	Structural Concrete Box Culvert	3,578	C.Y.	$325.00	$1,162,850.00
9	Structural Concrete Flume	1,312	C.Y.	$325.00	$426,400.00
10	Concrete Roadway	230	S.Y.	$35.00	$8,050.00
11	Roadway Base	60	C.Y.	$34.00	$2,040.00
12	Roadway Subbase	165	C.Y.	$9.00	$1,485.00
13	Curb	520	L.F.	$6.00	$3,120.00
14	Approach Slabs	231	S.Y.	$130.00	$30,030.00
15	Detour Roadway	Lump Sum	Lump	$15,000.00	$15,000.00
16	Remove Bridges and Piles	Lump Sum	Lump	$100,000.00	$100,000.00
17	Utility Relocation	Lump Sum	Lump	$10,000.00	$10,000.00
18	Dewatering	Lump Sum	Lump	$20,000.00	$20,000.00
19	Remove Pedestrian Bridge	Lump Sum	Lump	$10,000.00	$10,000.00
20	Remove Utility Crossing	Lump Sum	Lump	$5,000.00	$5,000.00
21	Sidewalk	67	S.Y.	$12.00	$804.00

Subtotal	$2,127,352.00
Contingencies (10%)	$212,735.20
Total Construction Cost	$2,340,087.20

PRELIMINARY
CONSTRUCTION COST ESTIMATE
SUBURBAN CANAL AND W. ESPLANADE AVE.
CONCRETE FLUME SECTION AND BRIDGE REPLACEMENT

Sta 137+50 to Sta 141+75

ITEM	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	TOTAL PRICE
1	Mobilization and Demobilization	Lump Sum	Lump	$25,000.00	$25,000.00
2	Construction Photographs and Video Taping	Lump Sum	Lump	$5,000.00	$5,000.00
3	Sheeting, Shoring & Bracing	410	L.F.	$350.00	$143,500.00
4	Excavation	6,168	C.Y.	$5.00	$30,840.00
5	Riversand Backfill	3,760	C.Y.	$9.00	$33,840.00
6	Bedding Material	2,415	C.Y.	$34.00	$82,110.00
7	Engineering Fabric	3,785	S.Y.	$2.00	$7,570.00
8	Structural Concrete Flume	2,890	C.Y.	$350.00	$1,011,500.00
9	Drive Concrete Piles West Bound Bridge	2,240	L.F.	$45.00	$100,800.00
10	Pile Bents West Bound Bridge	40	C.Y.	$600.00	$24,000.00
11	Slab Spans West Bound Bridge	244	C.Y.	$600.00	$146,400.00
12	Approach Slabs West Bound Bridge	154	S.Y.	$130.00	$20,020.00
13	Remove Bridge and Piles West Bound Bridge	Lump Sum	Lump	$50,000.00	$50,000.00
14	Drive Concrete Piles East Bound Bridge	1,120	L.F.	$45.00	$50,400.00
15	Pile Bents East Bound Bridge	20	C.Y.	$600.00	$12,000.00
16	Slab Spans East Bound Bridge	80	C.Y.	$600.00	$48,000.00
17	Approach Slabs West Bound Bridge	154	S.Y.	$130.00	$20,020.00
18	Remove Bridge and Piles East Bound Bridge	Lump Sum	Lump	$20,000.00	$20,000.00
19	Detour Roadway and Bridge	Lump Sum	Lump	$225,000.00	$225,000.00
20	Utility Relocation	Lump Sum	Lump	$40,000.00	$40,000.00
21	Dewatering	Lump Sum	Lump	$20,000.00	$20,000.00
22	Remove and Replace Pedestrian Bridge	Lump Sum	Lump	$50,000.00	$50,000.00
23	Remove Utility Crossing	Lump Sum	Lump	$50,000.00	$50,000.00
24	Remove and Replace Concrete Roadway	320	S.Y.	$50.00	$16,000.00
25	Guard Rail	200	L.F.	$50.00	$10,000.00
26	8' Chain Link Fence	700	L.F.	$12.00	$8,400.00
				Subtotal	$2,250,400.00
				Contingencies (10%)	$225,040.00
				Total Construction Cost	$2,475,440.00

TABLE 7
10-YR DESIGN PARAMETERS AND WATER SURFACE PROFILE
(IN FEET CAIRO DATUM)
SUBURBAN CANAL - VETERANS R/W NORTH TO
W. ESPLANDE R/W NORTH
VETERANS R/W NORTH = STA 100+50

STA.	INVERT	TARGET W.S.	DISCHARGE	COMPUTED WATER SUR.
100+50	1.01	12.8	4,100 cfs	12.3 ft, C.D.
107+17			4,100 cfs	12.1 ft, C.D.
113+84			4,100 cfs	11.9 ft, C.D.
120+51			4,100 cfs	11.8 ft, C.D.
127+18			4,100 cfs	11.6 ft, C.D.
133+85			4,100 cfs	11.45 ft, C.D.
R/WS. 138+55	0.0	11.0	4,100 cfs	11.3 ft, C.D
139+30				
139+90	0.0	10.8	5,200 cfs	10.9 ft, C.D.
140+50				
R/WS. 140+65	0.0	10.6	5,200 cfs	10.5 ft, C.D
Pump Sta. No. 2		(1)	5,200 cfs	5.7 ft, C.D.

(1) Not available
'Critical depth start stage at Drainage Pump Station No. 2

TABLE 8
100-YR DESIGN PARAMETERS AND
WATER SURFACE PROFILE
(IN FEET CAIRO DATUM)
SUBURBAN CANAL VETERANS R/W NORTH
TO W. ESPLANADE R/W NORTH
VETERANS R/W NORTH = STA. 100+50

STA	TARGET W.S.	DISCHARGE	COMPUTED WATER SURFACE
100+50		4,300 cfs	12.8 ft. C.D.
107+17		4,300 cfs	12.6 ft. C.D.
113+84		4,300 cfs	12.5 ft. C.D.
120+51		4,300 cfs	12.3 ft. C.D.
127+18		4,300 cfs	12.2 ft. C.D.
133+85		4,300 cfs	12.0 ft. C.D.
R/W S. 138+55		4,300 cfs	11.9 ft. C.D
139+30	14.3		
139+90		5,200 cfs	11.4 ft. C.D.
140+50	14.1		
R/W N.140+65		5,500 cfs	10.9 ft.C.D.
Pump Sta. No. 1	(1)	5,500 cfs	7.7 ft. C.D.**

(1) Not available
**Critical depth start stage assumed at Drainage Pump Station No. 2

GEOTECHNICAL ENGINEERING ANALYSES

JEFFERSON PARISH

URBAN FLOOD CONTROL

SUBURBAN CANAL FEASIBILITY STUDY

VETERANS MEMORIAL BOULEVARD TO LAKE AVENUE

METAIRIE, LOUISIANA

FOR
BROWN, CUNNINGHAM & GANNUCH, INC.
METAIRIE, LOUISIANA

19 DECEMBER 1997

EUSTIS ENGINEERING COMPANY, INC.
GEOTECHNICAL ENGINEERS
CONSTRUCTION QUALITY CONTROL & MATERIALS TESTING
3011 28th Street • Metairie, Louisiana 70002 • 504-834-0157 / FAX 504-834-0354

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19 December 1997

Brown, Cunningham & Gannuch, Inc.
Suite 100
9181 Interline Avenue
Baton Rouge, Louisiana 70809

Attention Mr. James Smith

Gentlemen:

Geotechnical Engineering Analyses
Jefferson Parish
Urban Flood Control
Suburban Canal Feasibility Study
Veterans Memorial Boulevard to Lake Avenue
Metairie, Louisiana

Transmitted are three copies of our engineering report covering a geotechnical investigation for the subject project. Two copies are also being sent to GEC, Baton Rouge, Louisiana, to the attention of Mr. Keith Rebelle.

Thank you for asking us to perform these services.

Yours very truly,

EUSTIS ENGINEERING COMPANY, INC.

WILLIAM W. GWYN, P.E.

STATE OF LOUISIANA
WILLIAM W. GWYN
REG. NO. 14601
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

RPB:ejg/aln

EE 14890

GEOTECHNICAL ENGINEERING ANALYSES

JEFFERSON PARISH

URBAN FLOOD CONTROL

SUBURBAN CANAL FEASIBILITY STUDY

VETERANS MEMORIAL BOULEVARD TO LAKE AVENUE

METAIRIE, LOUISIANA

FOR
BROWN, CUNNINGHAM & GANNUCH, INC.
METAIRIE, LOUISIANA

By
Eustis Engineering Company, Inc.
Metairie, Louisiana

19 DECEMBER 1997

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METAIRIE, LOUISIANA

INTRODUCTION

1. This report contains the results of geotechnical engineering analyses performed for the proposed improvements of Suburban Canal between Veterans Memorial Boulevard and Lake Avenue in Metairie, Louisiana. This work was done in accordance with Eustis Engineering Company, Inc.'s letter of proposal dated 8 July 1997. This proposal was authorized on 18 July 1997 by Mr. James Smith of Brown, Cunningham & Gannuch, Inc., Baton Rouge, Louisiana, the project engineers. This report contains the results of engineering analyses for the reinforced concrete U-section which is proposed for the majority of the canal in this reach. A separate report containing the results of the engineering analyses for the West Esplanade Avenue bridge will be provided at a later date.

2. These engineering analyses relied upon information from previous soil borings and laboratory tests performed by Eustis Engineering. This previous work was done for BCG, Metairie, Louisiana. The results of the laboratory tests were originally transmitted to BCG in a letter entitled "Jefferson Parish, Urban Flood Control Feasibility Study, Suburban Canal, Canal No. 3 to Pump Station No. 2, Jefferson Parish, East Bank, Louisiana" dated 25 January 1995.

3. This report has been prepared in accordance with generally accepted geotechnical engineering practice for the exclusive use of Jefferson Parish and BCG for specific application to the proposed facility. In the event any changes in the nature, design, or location of the proposed facility are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report are modified or verified in writing. Should these data be used by anyone other than Jefferson Parish or BCG, they should contact Eustis Engineering for interpretation of data and to secure any other information which may be pertinent to this project.

4. Recommendations and conclusions contained in this report are to some degree subjective and should not be included in the contract plans and specifications. However, the results of the previous soil borings and laboratory tests contained in the Appendix of this report may be included in the plans and specifications.

5. The analyses and recommendations contained in this report are based in part on data obtained from the previous soil borings. The nature and extent of variations in the subsurface conditions between and away from the boring locations may not become evident until construction. If variations then appear, it will be necessary to reevaluate the recommendations contained in this report.

SCOPE

6. The geotechnical engineering analyses, based on the previous soil borings and laboratory test results, included slope stability analyses to evaluate the

stability of the proposed U-section and calculation of earth pressures and allowable bearing capacity for design of the rigid, reinforced concrete U-section.

PREVIOUS SOIL BORINGS

7. General. Between 25 October and 2 November 1994, eleven undisturbed borings were drilled by Eustis Engineering along Suburban Canal between Canal No. 3 and Pump Station No. 2. The borings were made at locations furnished to Eustis Engineering by BCG. The locations of the borings are shown on Figure 1. Detailed descriptive logs of the borings are provided in the Appendix of this report.

8. Five of these borings, SUB3-U, SUB5-UA, SUB7-U, SUB9-UA, and SUB12-UA, were drilled in the canal bank. Each was terminated 50 feet below grade. The average surface elevation of the canal bank at the boring locations was el 15, Cairo Datum.

9. Six other borings were drilled in the canal. SUB8-UA and SUB11-UA were terminated 63 and 57 feet, respectively, below the water surface in the canal. The remaining borings, SUB2-U, SUB4-U, SUB6-U, and SUB10-U, were terminated 17 to 19 feet below the water surface in the canal, which was at approximate el 8.5 during the field investigation.

10. Drilling Methods. Seven of the borings were made using a truck mounted rotary type drill rig. Upon completion of drilling operations, these borings were backfilled with a cement-bentonite grout in accordance with existing

regulatory requirements. The remaining four borings, SUB2-U, SUB4-U, SUB6-U, and SUB10-U, were drilled using a hand auger.

11. Sampling Methods. The borings with the -UA suffix were 5-in. diameter borings. In these borings, cohesive and semi-cohesive subsoils were continuously sampled using a 5-in. diameter thinwall, stationary piston sampler. The ends of each sample, which were still in the tube, were inspected and visually classified by Eustis Engineering's soil technician. Pocket penetrometer tests were performed on the samples to give a general indication of their shear strength and consistency. The results of these tests are shown on the boring logs under the column heading "PP." Each tube was then capped and transported to Eustis Engineering's laboratory, where the enclosed sample was extruded. The natural moisture content of each sample was then determined and the sample was classified in accordance with U.S. Army Corps of Engineer's (USACE) criteria. A representative, 1-ft long sample was then cut from each sample and placed in a container sealed with paraffin.

12. The borings with the -U suffix were 3-in. diameter borings. In these borings, undisturbed samples of cohesive and semi-cohesive subsoils were obtained at close intervals or changes in strata using a 3-in. diameter thinwall Shelby tube. These samples were immediately extruded, inspected and visually classified by Eustis Engineering's soil technician. Pocket penetrometer tests were performed on the samples to give a general indication of their shear strength and consistency. The results of these tests are shown on the boring logs under the column heading "PP." Representative samples were then cut and placed in moisture proof containers for transportation to our laboratory.

13. In all of the borings, samples of cohesionless or semi-cohesive subsoils were obtained during the performance of in situ Standard Penetration Tests. This test consists of driving a 2-in. diameter sampler 1 foot into the soil after first seating it 6 inches. A 140-lb weight dropped onto the drill rods from a height of 30 inches is used to advance the sampler. The number of blows required to drive the sampler the final 12 inches is defined as the penetration resistance. The penetration resistance is indicative of the relative density of cohesionless soils and the consistency of cohesive soils. The penetration resistances are shown on the boring logs under the column heading "SPT." These samples were inspected and visually classified by Eustis Engineering's soil technician. Representative samples were placed in sealed glass jars for transportation to the laboratory.

LABORATORY TESTS

14. A series of soil mechanics laboratory tests was conducted on samples obtained from the borings. Included in these laboratory tests were natural water content, unit weight, unconfined compression shear (UC) and one-point and three-point unconsolidated undrained triaxial compression shear (OB and UU, respectively). Atterberg liquid and plastic limits were also determined for some selected samples. The Atterberg limits and natural water content determinations aid in the classification of the soils and provide an indication of their relative compressibility. The summarized results of the laboratory tests are shown on the individual boring logs in Appendix I. The complete results of all three-point unconsolidated undrained triaxial compression tests and of some one-point unconsolidated undrained triaxial compression tests are provided in Appendix II.

DESCRIPTION OF SUBSURFACE CONDITIONS

Geology

15. General. According to these borings, the banks of the existing canal are underlain by 2 to 5 feet of fill. The fill overlies Holocene deltaic and marine deposits which extend to the suballuvial surface of the Pleistocene Prairie Complex. The Holocene deltaic deposits are composed of inland swamp and interdistributary (including interdistributary marsh) deposits. Generally, these deltaic deposits are underlain by bay-sound deposits. However, in Boring SUB3-U, these deltaic deposits are underlain by relic beach deposits, which are in turn underlain by bay-sound deposits. Both the relic beach and the bay-sound deposits are Holocene marine deposits. The bay-sound deposits directly overlie the Pleistocene Prairie Complex. The suballuvial surface of the Prairie Complex was encountered at el -34.5 and -32 in Borings SUB3-U and SUB5-UA, respectively, and was encountered at el -41.5 in Borings SUB8-UA and SUB11-UA.

16. Geologic Stress History. The Holocene deposits are normally consolidated. However, in areas where additional fill has been recently placed or ground water levels have been recently lowered, the Holocene deposits may still be consolidating under the increased vertical effective stress and could, therefore, be underconsolidated. The Pleistocene deposits near the surface of the Prairie Complex are overconsolidated.

Stratigraphy

17. Interdistributary Marsh. The banks are underlain by 2 to 5 feet of fill composed of medium dense tan sands, medium dense white and gray shells, very soft to medium stiff brown, tan and gray clays. The fill overlies inland swamp and interdistributary marsh deposits. These deposits consist of very soft gray organic clays, very soft gray clays with organic matter, and loose gray silty sand with humus. Where the ground water level has been lowered due to drainage, deposits which have been exposed for prolonged periods have oxidized and are now more brown than black or gray in color. The surface of these organic deposits was once near el 20. However, due to the placement of fill and the lowering of the ground water elevation from 20 to current levels, these organic deposits have consolidated and, where exposed above ground water, biodegraded substantially. The surface of these organic deposits now appears to be between el 6 and 13.

18. Interdistributary and Relic Beach. These organic deposits grade into the underlying interdistributary deposits. The interdistributary deposits are composed of very soft to soft gray clays with silt and sand lenses and pockets with interbedded layers of loose gray clayey silt, sandy silt, and silty sand. With the exception of the southern end of the reach, the interdistributary deposits are underlain by bay-sound deposits. In the area of SUB3-U, the interdistributary deposits are underlain by relic beach deposits. The surface of the relic beach lies at el -18. Here, the relic beach is 2 feet in thickness. These deposits are composed of loose to gray clayey sands.

19. Bay-Sound. Bay-sound deposits underlie the interdistributary and relic beach. The surface of the bay-sound deposits lies between el -20 and -26.5. The

bay-sound deposits are composed primarily of medium stiff gray clays with sand lenses and pockets. Shell fragments are present in varying degrees throughout the bay-sound deposits. The bay-sound deposits overlie the Pleistocene Prairie Complex.

20. Prairie Complex. Only Borings SUB3-U, SUB5-UA, SUB8-UA, and SUB11-UA extended into the suballuvial surface of the Prairie Complex. None of these borings penetrated more than 13 feet into the Prairie Complex. In Borings SUB3-U and SUB5-U, the suballuvial surface was encountered at el -34.5 and -33, respectively. In Borings SUB9-UA and SUB11-UA, the Prairie Complex surface was encountered at el -41.5. The Prairie Complex is composed primarily of soft to very stiff gray and tan clays, and stiff greenish-gray silty clays. However, loose gray clayey sands, and soft gray and tan sandy clays were encountered in Boring SUB5-UA.

Ground Water

21. In order to evaluate the ground water conditions in the project area at the time of the previous investigation, ground water observations were made in auger borings drilled near the location of undisturbed Borings SUB5-UA and SUB12-UA. The auger borings were drilled to depths of 7 and 9.5 feet without the addition of water. During drilling of the auger borings, ground water was encountered at a depth of 6 feet in both borings. Subsequent observations, 45 minutes to one hour later, showed the ground water surface at a depth of 4 to 4.2 feet below grade. This depth corresponds to approximate el 11, based on a ground surface elevation of 15. The ground water elevation may vary due to climatic conditions, drainage improvements, and other factors.

ENGINEERING ANALYSES

Furnished Information

22. In the reach between Veterans Memorial Boulevard and Lake Avenue, the proposed channel section is a rigid, reinforced concrete U-section. The top of the walls of the U-section will be at approximate el 14.5. The invert elevation of the U-section will slope northward from el 1.29 to 0.00. The U-section is to be 56 feet wide with a wall thickness of 2 feet and a base thickness of 2 feet. The walls of the U-section are to be backfilled with free draining, granular material. This backfill will create a vertical 2-ft wide drainage layer. The backfill will tie into a bedding layer which will be composed of a 2-ft thickness of similar material. This drainage layer around the sides and base of the U-section will connect to the interior of the canal through a series of weepholes located on all three surfaces of the U-section. This is intended to create a pressure relief system to minimize hydrostatic uplift pressures on the base of the structure. The design low water level for this reach is el 7.5.

23. General. Eustis Engineering performed slope stability analyses to determine the factor of safety against heave of the rigid reinforced concrete U-section. The results of these analyses are shown on Figure 2.

24. Method of Analysis. In these analyses, the downward vertical force (the reaction of F_V) required to achieve a minimum factor of safety of 1.3 against heave of the U-section was first calculated based on slope stability analyses using the computer program "Slope Stability with Uplift Computations." The factor of safety against heave of the U-section was then calculated based on the ratio of

resisting moments to driving moments about the opposite heel of the U-section. For this computation, it was assumed that active earth pressures would develop on the heaving side of the U-section and passive earth pressures would develop on the opposite side of the U-section as the U-section begins to rotate due to heave. The resisting moments were generated by the weight of the U-section (W_C), the resultant of the horizontal passive earth pressures (F_{PH}), and the resultant of the wall friction developed by the active earth pressures (F_{AV}). The driving moment was generated by the heaving force F_V.

25. Results. Our analyses yielded a minimum factor of safety of 2.04 against heave of the U-section. These analyses assumed the pressure relief system incorporated in the design of the U-section was working properly and that, consequently, the hydrostatic pressures on the exterior and interior surfaces of the U-section would be equal. The analyses also assumed the reinforced concrete U-section was ***rigid*** with moment connections at the corners. It is the responsibility of the structural engineer to design a structure with sufficient rigidity to behave as anticipated in these analyses.

26. Earth Pressures. Under the analyzed loading conditions, active earth pressures act on the exterior of the heaving side of the U-section and passive earth pressures act on the exterior of the opposite side of the U-section. If no rotation of the U-section due to heaving occurs, at-rest earth pressures will act on the exterior of both sides of the U-section. Design earth pressure diagrams for active, passive and at-rest conditions are provided on Figure 3. The U-section must be designed to resist these loads in addition to the heaving force (F_V), the subgrade reaction, and any expected internal hydrostatic pressures. The internal hydrostatic pressures may be determined from the various flow conditions to be developed by the hydraulic

engineer. Consideration of potential flow conditions are not within the scope of these geotechnical engineering analyses.

27. Backfill. The walls of the U-section should be backfilled with free draining granular material. This material should be crushed stone like that used for the bedding. Recommendations for bedding material are provided below. The backfill should be placed in 6 to 8-in. thick loose lifts and compacted to 95% of the maximum dry density in accordance with ASTM D 698. A geotextile filter should be placed behind the backfill to retain the surrounding natural soils and prevent clogging of the backfill with fines. If the backfill is clogged, it will no longer function as an effective part of the pressure relief system. The geotextile filter should be a non-woven fabric meeting or exceeding the material requirement for Class D geotextiles as presented in Section 1019.01 of the Louisiana Standard Specifications for Roads and Bridges, 1992 edition (LSSRB).

28. Allowable Bearing Capacity. The proposed U-section will be constructed on a 2-ft thick bedding layer overlying very soft clays. The allowable bearing capacity for a flexible foundation bearing over these clays would be very low. However, considering the U-section is to be rigid, the failure surface will extend much deeper than that of a flexible foundation and will mobilize the higher undrained shear strength of the deeper clays. The rigid reinforced concrete U-section should be designed using a maximum gross allowable bearing capacity of 2,000 psf. This allowable bearing capacity has a factor of safety of 3. The bedding layer should be considered part of the underlying soil.

29. Settlement. Settlement of the proposed U-section due to the applied load of the U-section itself should be negligible. However, in those areas where the

proposed U-section is much narrower than the existing channel and significant volumes of backfill will be placed, settlement of the U-section due to this additional fill will occur. We estimate this settlement will be ¾ to 1 and 3½ to 4½ inches at the center and edges of the U-section, respectively. This estimate is for 15 feet of fill placed over an existing 2 horizontal to 1 vertical slope with the toe of the existing slope at the edge of the proposed U-section. Settlement of the U-section could also occur due to the temporary lowering of ground water during construction. This settlement is discussed later in the section "Lateral Movement and Settlement of Adjacent Ground." According to furnished information, the ground water level within the proposed canal should not differ significantly from that within the existing canal. Therefore, no additional settlement due to permanent ground water drawdown should occur. If the foundation soils are underconsolidated with respect to the increased vertical effective stresses induced by the original ground water drawdown, residual settlement will still occur. This remaining settlement cannot be computed from the available information.

30. Uplift. Without a pressure relief system, hydrostatic uplift pressures equal to the difference in elevation between the surrounding ground water level and the base of the U-section times the unit weight of water (62.4 pcf) would develop on the base of the U-section. These uplift pressures could be significant. Considering a typical ground water elevation of 11, the resulting hydrostatic uplift pressure would be 780 psf at el -1.5. The base of the proposed U-section is 60 feet wide. On this surface, the corresponding hydrostatic uplift force would be 46.8 kips/ft. The proposed reinforced concrete U-section will weigh only 26.7 kips/ft, and the total wall friction on both walls under at-rest conditions would be 7.0 kips/ft. Based on these numbers, the U-section would have a factor of safety against uplift of 1.0 when the water level within the canal was at el 4.25. This is

below the design low water elevation of 7.5. If a factor of safety against uplift less than 1.0 occurred, the U-sections would become buoyant. However, the U-sections would not noticeably rise because the ground water flow from the surrounding clays would be too low to rapidly fill the channel, and the uplift pressures would be dissipated by flow through any open joints between the buoyant U-sections.

31. Pressure Relief System. An effective pressure relief system must be incorporated in the design of the U-section. This system should include weepholes in both the bottom and sides of the U-section. These weepholes should permit flow from the drainage layer, which will surround the U-section, into the canal. The critical condition for the pressure relief system will be a rapid drawdown condition, when the ground water is high and the canal is rapidly drained. In this case, the external water pressures will be greatest at the beginning of drawdown and will dissipate as flow through the weepholes occurs and the surrounding ground water is consequently draw down.

32. Weepholes. Two rows of 6-in. diameter weep holes should be placed in the bottom slab. These rows should be positioned midway of the centerline and flume wall. We also recommend a row of 6-in. diameter weepholes be placed in both sides of the U-section at a level 2 feet above the interior base of the sides. This will allow for 2 feet of sedimentation in the bottom of the canal before the weepholes become blocked by sediment. If the depth of sedimentation is expected to be greater than 2 feet, the elevation of the weepholes should be raised accordingly. The horizontal center-to-center spacing of the weepholes should be no greater than 8.5 feet. A galvanized steel or copper mesh screen should be placed over the weephole opening to retain the backfill. The mesh screen should have an opening size no greater than the D_{85} of the backfill.

33. Subgrade Preparation. Prior to construction of the base of the cast-in-place, reinforced concrete U-section, the base of the excavation should be cleared of all debris, water, and foreign matter for placement of a geotextile ground stabilization and separator fabric. Prior to geotextile placement, the base of the excavation should be inspected by the geotechnical engineer. The geotextile should be a non-woven fabric meeting or exceeding the material requirements for Class D geotextiles as presented in Section 1019.01 of the LSSRB. Once the excavation bottom is cleared, the geotextile should be placed directly on the undisturbed soils in accordance with the manufacturer's construction recommendations. Sufficient geotextile should be placed to line the excavation along its bottom and sides up to the level corresponding to the top of the bedding and should overlap the geotextile filter placed behind the backfill.

34. Bedding. Free draining, granular material should be used as bedding beneath the base of the U-section. A minimum of 2 feet of crushed stone should be placed over the geotextile to provided a working platform for construction. Deeper bedding may be required, depending on the construction methods used for excavation and base preparation. The crushed stone bedding should conform to the requirements of Section 1003.08 of the LSSRB. An initial 12-in. thick loose lift should be placed over the geotextile. This thicker initial lift is required to prevent damage of the geotextile which will overlie very soft clays by construction traffic. The remaining crushed stone bedding should be placed in 6 to 8-in. thick loose lifts and compacted to 95% of the maximum dry density in accordance with ASTM D 698. The bedding may be compacted using vibratory compactors mounted on or pulled by lightweight, low ground pressure vehicles.

CONSTRUCTION RECOMMENDATIONS

Inspection and Monitoring of Existing Structures

35. Prior to any construction operations, it is recommended existing structures near the proposed channel excavations be thoroughly inspected to establish their existing condition. A sufficient number of photographs and videotapes of the surrounding structures should be taken prior to construction to accompany these inspections. It is further recommended a select number of ground elevation control stations be established so ground loss and lateral movements in the vicinity of the excavations can be detected and monitored during construction. A set of zero readings should be taken on all control points prior to construction. Elevation control stations should be monitored by benchmarks established a minimum of 300 feet from the edge of each proposed channel excavation.

Excavations

36. The U-section excavation will be approximately 19 feet deep and 64 feet wide at its base. This excavation will require temporary excavation sheeting and bracing until the reinforced concrete U-section has been constructed. Excavation sheeting and bracing should be designed by a registered professional engineer. The design should be submitted to the owner for review in order to evaluate the design and its impact on adjacent structures, pavements, and utilities. The boring logs and laboratory test results contained in the Appendix may be used in determining the structural requirements for the excavation bracing.

Dewatering and Pressure Relief

37. Dewatering will be required to construct the cast-in-place, reinforced concrete U-section. In general, dewatering may be achieved by pumping from open sumps. However, isolated lenses of pervious or semi-pervious soils may require cutoff by construction sheeting or limited pressure relief by wells or wellpoints. The duration of dewatering or pressure relief should be as short as possible in order to minimize settlement of the adjacent ground due to ground water lowering. It is recommended the contractor submit detailed plans of dewatering or pressure relief systems to the owner for review. The boring logs and laboratory test results provided in Appendix I of this report may be used for the design of dewatering and pressure relief systems. Dewatering and pressure relief systems should be installed and operated by a qualified and experienced contractor.

Lateral Movement and Settlement of Adjacent Ground

38. The excavation bracing and dewatering systems employed by the contractor during construction should be properly designed to maintain a stable excavation in order to prevent lateral movement of the surrounding soils. The subsidence and lateral movement of the soils surrounding an excavation should be controlled and minimized by careful attention to all details of excavation, bracing, dewatering, backfilling, and installation and removal of sheetpiles. Even with careful attention, available literature indicates settlement adjacent to sheetpile cofferdams can be as much as 2% of the excavation depth. Removal of sheetpiles may result in additional settlement of the surrounding ground surface and adjacent structures. If such settlement is of concern, consideration should be given to leaving the sheetpiles in place.

39. Lowering of the ground water during dewatering or pressure relief will also cause settlement of the ground surrounding the excavation. The settlement of the adjacent ground should be monitored during and after construction. If settlement due to drawdown of the ground water surface becomes a problem, dewatering should be discontinued and other construction methods should be considered. To minimize settlement due to ground water lowering, construction within the excavations could be performed underwater or the dewatering operations could be modified to minimize the extent of the ground water drawdown.

<u>Vibrations</u>

40. Sheetpile installation will cause vibrations that may affect nearby structures, pavements, and underground utilities. It is recommended peak particle velocities due to sheetpile driving be monitored with a seismograph at critical structures and pavements during driving. The record of peak particle velocities will provide information in assessing potential damage and the need for changes in the installation operations.

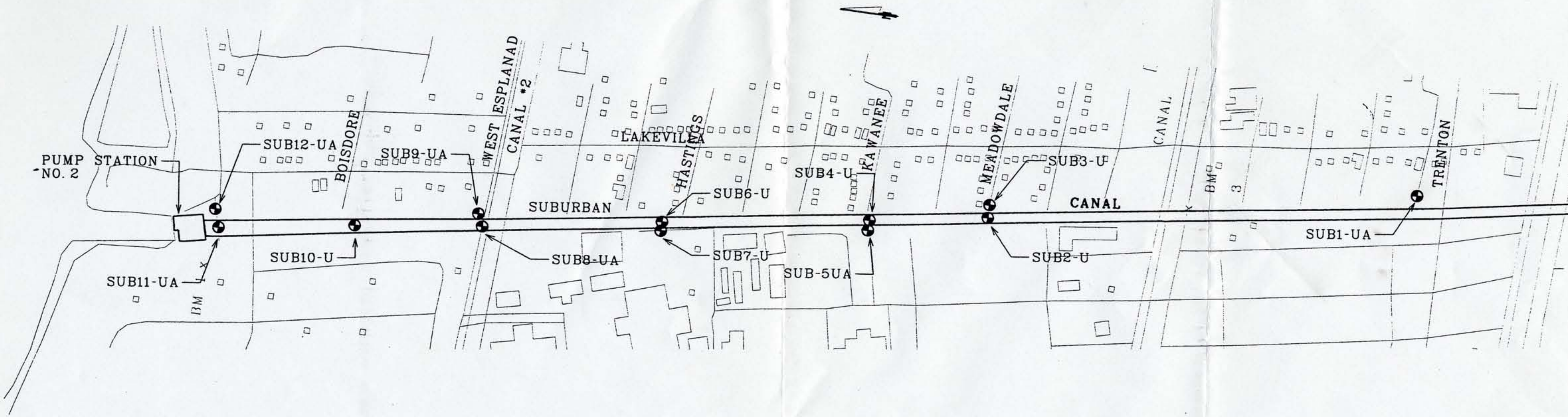
41. A peak particle velocity of 0.25 in./sec as measured by a seismograph is considered the minimum vibration level uncomfortable to humans. Available literature documents densification of cohesionless soils encountered near the surface. Such densification can occur at peak particle velocities of 0.25 in./sec. Densification may result in settlement of structures, utilities, or pavements founded in or above these deposits. Peak particle velocities in excess of 0.5 in./sec measured at a structure may induce damage to the structure. Therefore, for sustained peak particle velocities in excess of 0.25 in./sec at a structure, pavement,

or utility of concern, Eustis Engineering should be notified, sheetpile driving terminated and consideration given to altering installation methods.

GEOTECHNICAL SERVICES DURING CONSTRUCTION

42. To provide continuity between the design and construction phases, Eustis Engineering should be retained to provide geotechnical consultation during final design, inspect the excavation bases, perform compaction and density tests of bedding and backfill, and monitor vibrations during sheetpile installation. Eustis Engineering may also be retained to provide additional services during construction, such as inspection and testing of concrete, and other soil and materials testing services which will provide quality control during construction and conformance to design specifications.

43. If any construction problems arise, Eustis Engineering should be notified immediately so appropriate actions can be taken. This permits the geotechnical engineer to be available quickly, evaluate unanticipated conditions, conduct additional testing when required, and recommend alternative solutions to problems when necessary.



BORINGS DRILLED 25 OCTOBER - 2 NOVEMBER 1994

600' 0 600'

SCALE

UA = 5-IN. DIAMETER BORINGS

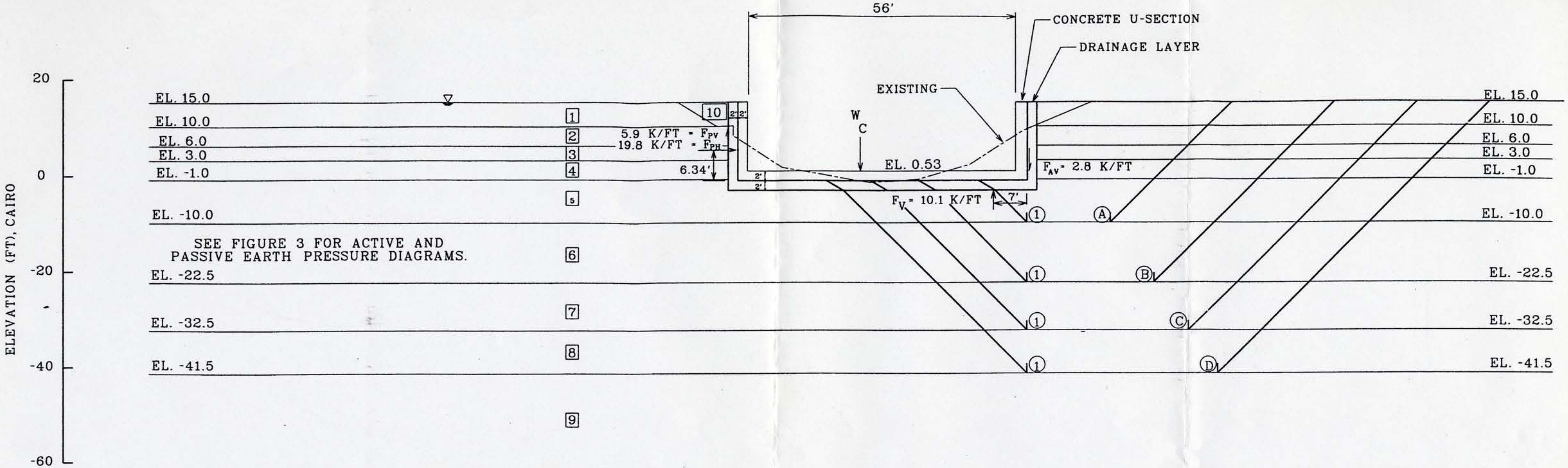
U =3-IN. DIAMETER BORINGS

LOCATION OF BORINGS

JEFFERSON PARISH
URBAN FLOOD CONTROL FEASIBILTY STUDY
SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2
JEFFERSON PARISH, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 1



STRATUM NUMBER	FRICTION ANGLE DEGREES	TOTAL UNIT WEIGHT (PSF)	COHESION (PDF)	
			AVERAGE	BOTTOM
1	0	112	425	425
2	0	66	150	150
3	0	97	175	175
4	0	112	200	225
5	0	105	275	325
6	0	97	375	425
7	0	101	475	525
8	0	101	565	600
9	0	121	1225	1225
10	35	120	0	0

FAILURE SURFACE	SUMMATION OF FORCES (LB/FT)		FACTOR OF SAFETY	UNBALANCED FORCE, F_V FOR F.S. - 1.3	SUMMATION OF FORCES (LB/FT)		FACTOR OF SAFETY
	DRIVING F_D	RESISTING F_R			DRIVING	RESISTING	
A 1	26227	22312	0.85	9064	518	1095	2.11
B 1	45937	46531	1.01	10144	538	1095	2.04
C 1	61638	71831	1.17	6383	317	1095	3.45
D 1	75716	98443	1.30				

$I_V = F_D - F_R/1.30$

0 20'

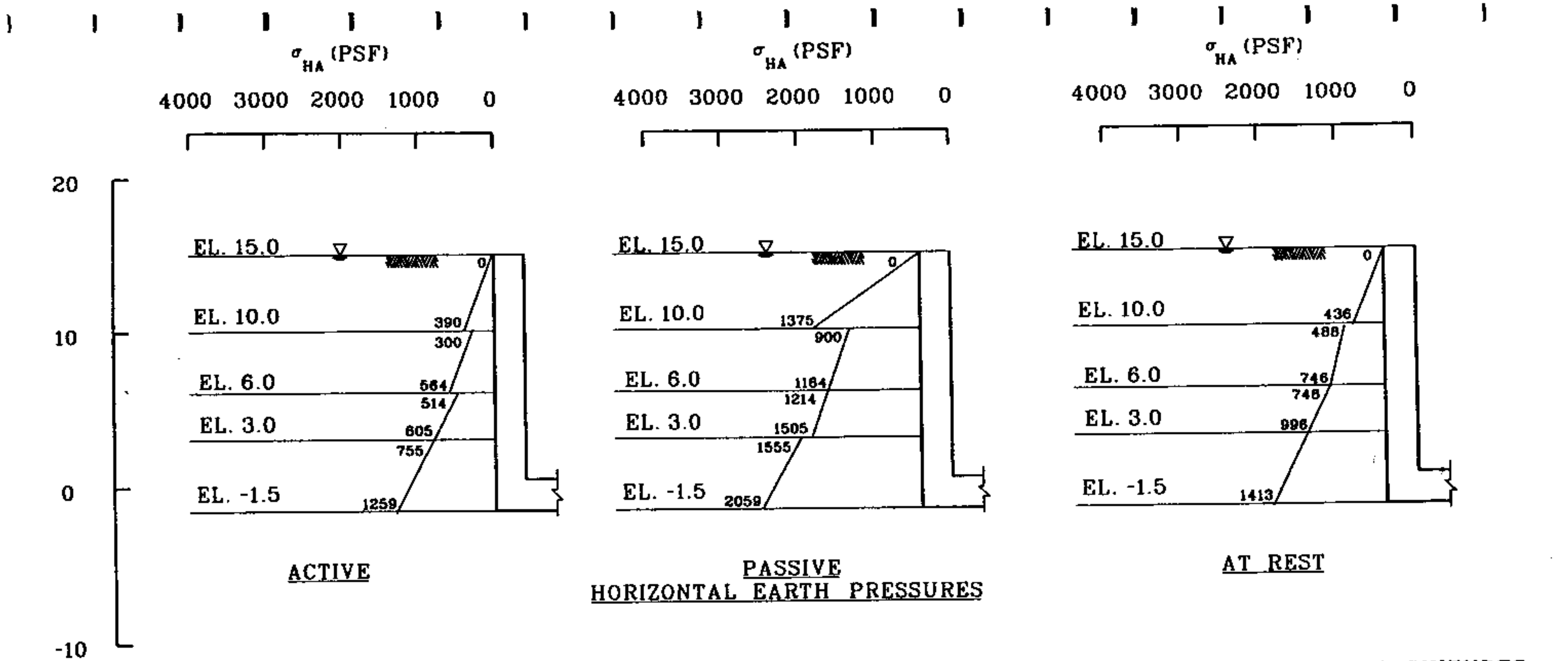
SCALE

STABILITY ANALYSES
U-SECTION
STATION 120+00

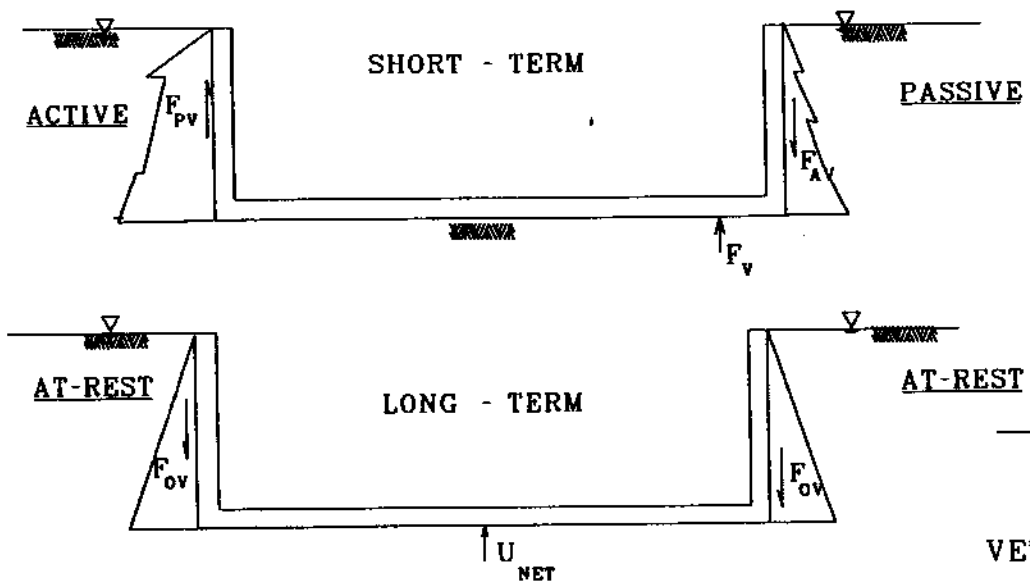
JEFFERSON PARISH
URBAN FLOOD CONTROL
SUBURBAN CANAL FEASIBILITY STUDY
VETERANS MEMORIAL BOULEVARD TO LAKE AVENUE
METAIRIE, LOUISIANA

EUSTIS ENGINEERING COMPANY, INC.

FIGURE 2



HORIZONTAL EARTH PRESSURES



LOADING CONDITIONS

SEE FIGURE 6 FOR ACTUAL MAGNITUDES AND LOCATIONS OF F_V, F_{AV}, & F_{PV}

F_{OV} = 3.5 K/FT

U_{NET} = NET UPLIFT FORCE

0 10'

SCALE

EARTH PRESSURES

JEFFERSON PARISH
URBAN FLOOD CONTROL
SUBURBAN CANAL FEASIBILITY STUDY
VETERANS MEMORIAL BOULEVARD TO LAKE AVENUE
METAIRIE, LOUISIANA

FIGURE 3

EUSTIS ENGINEERING COMPANY, INC.

APPENDIX I

LEGEND AND NOTES FOR LOG OF BORING AND TEST RESULTS

PP Pocket penetrometer resistance in tons per square foot

TV Torvane shear strength in tons per square foot

SPT Standard Penetration Test. Number of blows of a 140-lb. hammer dropped 30 inches required to drive 2-in O.D., 1.4-in. I.D. sampler a distance of one foot into the soil, after first seating it 6 inches

SPLR Type of Sampling ■ Shelby ☒ SPT ▱ Auger □ No Sample

SYMBOL Clay Silt Sand Humus — Predominant type shown heavy; Modifying type shown light

DENSITY Unit weight in pounds per cubic foot

USC Unified Soil Classification

TYPE

UC	Unconfined compression shear
OB	Unconsolidated undrained triaxial compression shear on one specimen confined at the approximate overburden pressure
UU	Unconsolidated undrained triaxial compression shear
CU	Consolidated undrained triaxial compression shear
DS	Direct shear
CON	Consolidation
PD	Particle size distribution
k	Coefficient of permeability in centimeters per second
SP	Swelling pressure in pounds per square foot

ϕ Angle of internal friction in degrees

c Cohesion in pounds per square foot

Other laboratory test results reported on separate figure

Ground Water Measurements ▼ Initial ▽ Final

GENERAL NOTES

(1) At the time the borings were made, ground water levels were measured below existing ground surface. These observations are shown on the boring logs. However, ground water levels may vary due to seasonal and other factors. If important to construction, the depth to ground water should be determined by those persons responsible for construction, immediately prior to beginning work.

(2) While the individual logs of borings are considered to be representative of subsurface conditions at their respective locations on the dates shown, it is not warranted that they are representative of subsurface conditions at other locations and times.

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: Job No.: 13149 Date Drilled: 11/02/94 Boring: SUB2-U Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	Ø	C	LL	PL	PI		
0–7				WATER	Water														
7–17					Very soft gray clay w/silty sand lenses	CH	1	11-12	51										
							1A		56	68	107	OB	–	188	81	26	55		
							2	16-17	59	65	104	UC	–	215					

Scale In Feet: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: **Datum:** **Gr. Water Depth: 5.0'** **Job No.: 13149** **Date Drilled: 10/25/94** **Boring: SUB3-U** **Refer To "Legends & Notes"**

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	Ø	C	LL	PL	PI		
		11			Medium dense tan fine sand w/thin shells & humus layers	SP	1	1-2	30										
	0.25				Soft brown organic clay w/humus layers	OH	2	3-4	317	17	70	UC	–	265					
5	0.70				Very soft gray clay w/organic matter	CH	3	5-6	106										
					Loose gray sandy silt w/clay layers	ML	3A		54	69	107	OB	–	124	55	22	33		
							4	8-9	33										
10					Very soft gray clay w/silt layers	CH													
	0.20						5	11-12	81	53	97	UC	–	180					
					Loose gray sandy silt w/silty sand layers	ML													
15							6	14-15	29										
					Very soft gray clay w/silty sand lenses	CH													
	0.20						7	18-19	50	72	108	UC	–	210					
20							7A		61	65	105	OB	–	228	82	26	56		
	0.20				w/silt lenses		8	23-24	57										
25																			
	0.20						9	28-29	73	56	97	UC	–	215					
30							9A		67	61	102	OB	–	244	83	26	57		
					Loose gray clayey sand w/clay pockets & shell fragments	SC	10	33-34	31										
35					Soft to medium stiff gray clay w/sand pockets	CH													
	0.60						11	38-39	60	63	101	UC	–	635					
40							11A		67	61	102	OB	–	647	91	29	62		
	0.70						12	43-44	72										
45							12A		69	60	101	OB	–	715	85	27	58		
	0.70				w/sand pockets & shell fragments		13	48-49	35	87	117	UC	–	360					
50					Stiff tan & gray clay	CH													

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

(SHEET 1 Of 1)

Ground Elev.: Datum: Gr. Water Depth: Job No.: 13149 Date Drilled: 11/02/94 Boring: SUB4-U Refer To "Legends & Notes"

Scale in Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
0–7				WATER	Water														
7–17.5					Very soft gray clay w/sandy silt lenses	CH													
							1	11.5-12.5	51	71	107	UC	–	155					
							2	16.5-17.5	68										
							2A		52	72	109	OB	–	216	68	23	45		

Scale in Feet: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: 4.2' Job No.: 13149 Date Drilled: 10/25/94 Boring: SUB5-UA Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Other Tests
		15			Medium dense white & gray shells	SI	1	0-1.5	11									
					w/crushed concrete	SP	2	1.5-2.5	22									
					Medium dense tan fine sand	CH	3	2.5-3	34	82	111	OB	–	735				
	1.30				Medium stiff gray clay w/silty sand	SM	4	3-4	61									
	0.80				lenses		5	4-5	34									
5					Loose gray silty sand w/humus layers	CH	6	5-5.8	94	48	93	UC	–	185				
	0.30				Very soft gray clay w/organic matter	CH	7	5.8-6.6	81									
	0.70				Very soft gray clay w/silt pockets	CH	8	7-8	62	62	101	UU	0	109	72	25	47	
	0.20				Very soft gray clay w/silt lenses		9	8-9	39									
	0.20						10	9-10	56	67	105	UC	–	115				
10	0.20						11	10-11	60									
	0.20						12	11-12	78									
	0.20						13	12-13	63	63	103	UU	0	154	81	27	54	
	0.20						14	13-14	66									
	0.20						15	14-15	39									
15					Loose gray silty fine sand w/clay	SM	16	15-16	31									
	0.20				layers	CH												
	0.20				Very soft gray clay w/silt layers w/silt layers & pockets		17	18-19	61									
	0.20						18	19-20	49	72	107	UC	–	75				
20	0.20						19	20-21	48									
	0.20						20	21-22	59	64	102	UU	0	146	66	22	44	
	0.20						21	22-23	39									
	0.20						22	23-24	39									
	0.20				Soft gray clay w/sand lenses	CH	23	24-25	55									
25	0.25						24	25-26	48									
	0.30						25	26-27	56									
	0.30						26	27-28	62									
	0.30						27	28-29	79									
	0.30						28	29-30	80	53	95	UC	–	310				
30	0.30						29	30-31	82	52	95	UU	0	228	102	31	71	
	0.30						30	31-32	55									
	0.30						31	32-32.7	51									
	0.30						32	33-34	55									
	0.30						33	34-35	38									
35	0.30						34	35-35.7	51									
	0.30				Medium stiff gray clay w/sand lenses	CH	35	36-37	71									
	0.50				& shell fragments		36	37-38	54									
	0.60						37	38-39	72									
	0.60						38	39-40	68	59	100	UC	–	565				
40	0.60						39	40-41	65									
	0.60						40	41-42	69	60	102	UU	0	713	84	25	59	
	0.60						41	42-43	68									
	0.70						42	43-44	59									
	0.70						43	44-45	69									
45	0.70				Soft gray sandy clay & clayey sand		44	45-46	49									
	0.70				layers		45	46-47	38									
	0.70				Loose gray clayey sand w/clay	CL	46	47-48	28									
	0.70				pockets & shell fragments	SC	47	48-49	26									
50	1.70				Soft gray & tan sandy clay	CL	48	49-50	27	95	120	OB	–	465				

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: Job No.: 13149 Date Drilled: 11/02/94 Boring: SUB6-U Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	Atterberg Limits LL	PL	PI		Other Tests
0–9				WATER	Water														
9–19					Very soft gray clay w/sandy silt lenses	CH	1	13-14	56										
							1A		64	63	103	OB	–	131	73	25	48		
							2	18-19	54	67	104	UC	–	160					

Scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

(SHEET 1 Of 1)

Ground Elev.: Datum: Gr. Water Depth: 4.0' Job No.: 13149 Date Drilled: 10/26/94 Boring: SUB7-U Refer To "Legends & Notes"

Scale In Feet	PP	SPT	Visual Classification	USC	Sample Number	Depth in Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	Atterberg Limits LL	PL	PI	Other Tests
		9	Loose brown sandy silt w/grass		1	0-0.5	14									
		11	Loose tan fine sand	SP	2	2-3										
5	1.10		Stiff gray & tan clay w/humus layers & fine sand pockets	OH	3	5-6	198	21	63	UC	–	380				
			Soft black & gray organic clay w/humus layers	CH												
			Very soft gray clay w/organic matter		4	8-9	93	49	94	UC	–	165				
	0.30				4A		79	55	97	OB	–	184	93	30	63	
10	0.20		Loose gray clayey silt w/clay layers	ML	5	11-12	33	89	118	OB	–	550				
15	0.30		Soft gray clay w/clayey silt layers	CH	6	14-15	65									
			Loose gray silty fine sand w/clay layers	SM	7	18-19	35									
20			Very soft to soft gray clay w/silty sand layers	CH	8	23-24	51	71	107	UC	–	305				
25	0.20				8A		43	79	114	OB	–	277	50	21	29	
30	0.20				9	28-29	67									
			Soft gray clay w/sand layers	CH	10	33-34	76	55	97	UC	–	400				
35	0.25				10A		70	60	101	OB	–	291	87	28	59	
40	0.30		w/fine sand lenses & few thin layers		11	38-39	56									
45	0.50		Medium stiff gray clay w/shell fragments	CH	12	43-44	69	58	98	UC	–	605				
					13	48-49	64									
50	0.50				13A		68	61	102	OB	--	714	83	28	55	

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: Job No.: 13149 Date Drilled: 10/27/94 Boring: SUB8-UA Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	Atterberg Limits LL	PL	PI		Other Tests
5, 10				WATER	Water														
	0.20				Very soft gray clay w/silt lenses	CH	1	13-14	56										
15	0.20						2	14-15	69										
	0.20						3	15-16	76										
	0.20						4	16-17	78										
	0.20						5	17-18	52	69	105	UC	–	255					
	0.20						6	18-19	66										
20	0.20						7	19-20	75										
	0.20						8	20-21	81	54	98	UU	0	329	95	28	67		
	0.20						9	21-22	85										
	0.20						10	22-23	83										
	0.20						11	23-24	81										
25	0.20						12	24-25	64										
	0.25				Soft gray clay w/sand lenses	CH	13	25-26	70										
	0.25						14	26-27	69										
	0.25						15	27-28	50	71	106	UC	–	420					
	0.40						16	28-29	67										
30	0.40						17	29-30	49										
	0.40						18	30-31	61										
	0.50				Soft to medium stiff gray clay w/fine sand lenses & shell fragments	CH	19	31-32	64										
	0.50						20	32-33	71	58	99	UU	0	628	107	32	75		
	0.50						21	33-34	58										
35	0.50						22	34-35	63										
	0.50						23	35-36	66										
	0.50						24	36-37	65										
	0.50						25	37-38	68	59	99	UC	–	400					
	0.50						26	38-39	76	53	94	UU	0	530	91	28	63		
40	0.50						27	39-40	66										
	0.60						28	40-41	64										
	0.60						29	41-42	65										
	0.60						30	42-43	49										
	0.60						31	43-44	47										
45	0.60						32	44-45	49										
	0.75						33	46-47	47										
	0.75						34	47-48	52										
	0.75						35	48-49	55	65	101	UC	–	990					
50	0.75						36	49-50	46	71	105	UU	0	546	63	22	41		

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: | Datum: | Gr. Water Depth: | Job No.: 13149 | Date Drilled: 10/27/94 | Boring: SUB8-UA | Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	Atterberg Limits LL	PL	PI		Other Tests
	1.70				Stiff greenish-gray silty clay	CL	37	50-51	29										
	2.20						38	51-51.5	22										
	2.75						39	52-53	20										
	3.10				Stiff tan & gray clay w/silt lenses	CH	40	53-54	27										
55	3.00						41	54-55	35										
	3.40						42	55-56	35	89	120	UU	00	1743	81	27	54		
	3.25						43	56-57	28	96	123	OB	–	1225					
	2.75						44	57-57.5	31										
	3.00						45	58-59	33										
60	4.10				Very stiff tan & gray clay w/silt lenses	CH	46	59-60	28										
	4.25						47	60-60.7	28										
	3.75						48	61-62	27										
	3.70						49	62-63	40										
65																			
70																			
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.:	Datum:	Gr. Water Depth: 4.8'	Job No.: 13149	Date Drilled: 10/31/94	Boring: SUB9-UA	Refer To "Legends & Notes"

Scale In Feet	PP	SPT
4		6
5	0.60	
6	0.50	
7	0.25	
9	0.30	
10	0.20	
11	0.20	
12	0.20	
13	0.20	
14	0.20	
15	0.20	
17	0.20	
18	0.20	
19	0.20	
20	0.20	
21	0.20	
22	0.20	
23	0.20	
24	0.20	
25	0.20	
26	0.25	
27	0.25	
28	0.25	
29	0.25	
30	0.25	
31	0.25	
32	0.25	
34	0.25	
35	0.25	
36	0.25	
37	0.30	
38	0.30	
39	0.30	
40	0.40	
41	0.40	
42	0.40	
43	0.50	
44	0.50	
45	0.50	
46	0.60	
47	0.60	
48	0.60	
49	0.60	
50	0.60	

Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Ø	C	Atterberg Limits LL	PL	PI	Other Tests
Very stiff brown & gray clay w/sand pockets	CH	1	0-2.5	23									
Medium stiff brown & gray clay w/organic matter & shell fragments	OH	2	3-4	44									
		3	4-5	218									
Medium stiff gray organic clay w/humus pockets		4	5-6	243									
Very soft gray clay w/silty clay layers	CH	5	6-7	61	63	101	UC	–	155				
Loose gray clayey silt	ML	6	8-9	37									
Very soft gray clay w/silt lenses & pockets	CH	7	9-10	56									
		8	10-11	66	61	101	UU	0	121	63	23	40	
		9	11-12	88	51	95	UC	–	185				
		10	12-13	77									
w/sandy silt lenses		11	13-14	47									
		12	14-15	45									
Very loose gray sandy silt w/clay lenses	ML	13	15-16	37									
		14	16-17	38									
Very soft to soft gray clay w/silt lenses	CH	15	17-18	43									
		16	18-19	59	66	105	UU	0	210	70	23	47	
		17	19-20	49									
		18	20-21	46									
		19	21-22	75	57	99	UC	–	280				
		20	22-23	46									
		21	23-24	51									
		22	24-25	50									
Very soft to soft gray clay	CH	23	25-26	71									
		24	26-27	64									
		25	27-28	67									
		26	28-29	74	56	97	UU	0	316	83	28	55	
		27	29-30	70									
w/silty sand pockets		28	30-31	71									
		29	31-32	73	56	97	UC	–	225				
		30	33-34	61									
w/sand lenses & shell fragments		31	34-35	42									
		32	35-36	53									
		33	36-37	47									
		34	37-38	64									
		35	38-39	58									
Soft to medium stiff gray clay w/shell fragments	CH	36	39-40	72	58	100	UU	0	537	95	30	65	
		37	40-41	61									
		38	41-42	83									
		39	42-43	70									
		40	43-44	79									
		41	44-45	77	55	97	UC	–	530				
		42	45-46	74									
		43	46-47	69									
		44	47-48	64									
		45	48-49	57									
		46	49-50	67	62	104	UU	0	362	90	27	63	

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: Job No.: 13149 Date Drilled: 11/02/94 Boring: SUB10-U Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
0–8				WATER	Water														
8–18					Very soft gray clay w/sandy silt lenses	CH													
							1	12.5-13.5	57	66	104	UC	–	195					
							1A		55	69	107	OB	–	109	52	23	29		
14.5	0.20																		
							2	17.5-18.5	75										

Scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL (SHEET 1 Of 2)
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: Job No.: 13149 Date Drilled: 10/28/94 Boring: SUB11-UA Refer To "Legends & Notes"

Scale In Feet	PP	SPT	S P L R	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	Ø	C	LL	PL	PI		
5				W A T E R	Water														
10					Very soft gray clay w/silt lenses	CH													
							1	11-12	57										
	0.20						2	12-13	43	78	112	OB	–	225					
	0.20						3	13-13.7	61										
	0.20						4	14-15	56										
15	0.20						5	15-16	41										
	0.20						6	16-17	51										
	0.20						7	17-18	79	56	101	UU	0	205	66	23	43		
	0.20						8	18-19	64										
	0.20						9	19-20	81										
20	0.20						10	20-21	78	55	98	UC	–	205					
	0.20						11	21-22	83										
	0.20						12	22-23	81										
	0.20						13	23-24	82	52	94	UU	0	204	92	28	64		
	0.20				Soft gray clay w/sand lenses	CH	14	24-25	77										
25	0.25						15	25-26	63										
	0.25				w/fine sand lenses & shell fragments		16	26-27	85										
	0.25						17	27-28	39										
	0.25						18	28-29	57										
	0.25						19	29-30	55										
30	0.30						20	30-31	40	76	106	OB	–	585					
	0.30						21	31-32	62										
	0.40						22	32-33	60										
	0.40						23	33-34	69										
	0.40						24	34-35	60										
35	0.40						25	35-36	67										
	0.40				Medium stiff gray clay w/shells	CH	26	36-37	67	60	100	UU	0	603	102	34	68		
	0.50						27	37-38	82										
	0.50						28	38-39	58										
	0.50						29	39-40	68										
40	0.50						30	40-41	68	60	101	UC	–	630					
	0.50						31	41-42	69										
	0.50						32	42-43	52										
	0.50						33	43-43.7	58	66	105	UU	0	655	73	25	48		
	0.50						34	44-45	50										
45	0.50				Medium stiff gray clay		35	45-46	48										
	0.50						36	46-46.7	50										
	0.60						37	47-48	58										
	0.60						38	48-49	59										
50	0.60						39	49-50	59										

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

Ground Elev.: Datum: Gr. Water Depth: 4.8' Job No.: 13149 Date Drilled: 10/28/94 Boring: SUB11-UA Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density		Shear Tests			Atterberg Limits				Other Tests
										Dry	Wet	Type	Ø	C	LL	PL	PI		
	0.70				Soft to medium stiff gray clay w/silt pockets w/shell fragments & trace of wood	CH	40	50-51	36	83	114	UU	0	383	45	16	29		
	0.70						41	51-52	40	80	112	UC	–	805					
	0.70						42	52-52.5	39										
	2.75				Stiff to very stiff gray & tan clay w/silt layers	CH	43	53-54	39										
	3.00						44	54-55	26										
55	3.50						45	55-56	33	90	120	OB	–	1295					
	3.40						46	56-57	33										
60																			
65																			
70																			
75																			
80																			
85																			
90																			
95																			
100																			

EUSTIS ENGINEERING COMPANY, INC.

LOG OF BORING AND TEST RESULTS

JEFFERSON PARISH, URBAN FLOOD CONTROL FEASIBILITY STUDY, SUBURBAN CANAL
CANAL NO. 3 TO PUMP STATION NO. 2, JEFFERSON PARISH, LOUISIANA

(SHEET 1 Of 1)

Ground Elev.: Datum: Gr. Water Depth: 4.0' Job No.: 13149 Date Drilled: 10/26/94 Boring: SUB12-UA Refer To "Legends & Notes"

Scale In Feet	PP	SPT	SPLR	Symbol	Visual Classification	USC	Sample Number	Depth In Feet	Water Content Percent	Density Dry	Density Wet	Shear Tests Type	Shear Tests Ø	Shear Tests C	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI		Other Tests
	0.80				Medium stiff gray & tan clay w/humus layers	CH	1	0-1	31										
	0.80						2	1-1.5	34	84	113	UC	--	1130					
	1.30				Medium stiff to stiff tan & gray clay w/clayey silt layers	CH	3	2-3	42										
	1.30						4	3-4	31	88	116	OB	–	515					
5	0.70						5	4-5	48										
	0.70				Medium stiff black humus	Pt	6	5-6	430	12	65	UC	–	505					
	0.50				Very soft gray & brown organic clay & humus pockets	OH	7	6-7	217										
	0.50						8	7-7.5	332	16	70	UC	–	235					
10	0.20				Very soft gray clay w/trace of organic matter	CH	9	9-10	84	32	96	UU	0	164	105	33	72		
	0.20						10	10-10.5	93										
	0.20				w/silt lenses		11	12-13	41	80	112	UC	–	205					
	0.20				Very soft gray silty clay	CL	12	13-14	36										
15	0.20						13	14-15	40										
	0.20						14	15-16	57										
	0.25				Very soft gray clay w/silt lenses	CH	15	16-17	58										
	0.25						16	17-18	65	62	102	UU	0	207	83	26	57		
	0.20				Very soft to soft gray clay w/silty sand lenses	CH	17	18-19	57										
20	0.20						18	19-20	46										
	0.20						19	20-21	41										
	0.20						20	21-22	68	60	101	UC	–	285					
	0.20						21	22-23	34										
	0.20						22	23-24	52										
25	0.20						23	24-25	60										
	0.20						24	25-26	69	59	100	UU	00	283	86	26	60		
	0.20						25	26-27	48										
	0.20				w/clayey silt lenses		26	27-28	49										
	0.25				Soft gray clay w/silt lenses	CH	27	28-29	70										
30	0.25				Soft gray clay		28	29-30	55										
	0.25						29	30-31	68										
	0.25						30	31-32	60	63	102	UC	–	430					
	0.25						31	32-32.7	74										
	0.25						32	33-34	76										
35	0.25						33	34-35	72	57	98	UU	0	459	83	25	58		
	0.25						34	35-36	68										
	0.25				w/shell fragments		35	36-37	56										
	0.25						36	37-38	56										
	0.25						37	38-39	46										
40	0.50				Soft to medium stiff gray clay w/sand lenses & shell fragments	CH	38	39-40	69										
	0.60						39	40-41	55										
	0.60						40	41-42	57										
	0.70						41	42-43	64										
	0.70						42	43-44	66	59	98	UC	–	565					
45	0.70						43	44-45	66										
	0.75						44	45-46	88	49	93	UU	0	401	121	35	86		
	0.75						45	46-47	73										
	0.75						46	47-48	62										
	0.75						47	48-49	65										
50	0.75						48	49-50	75										