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Coal Combustion Residue Impoundment
Round 9 - Dam Assessment Report

Limestone Generating Station
DSDA & ST-18 Ponds

NRG Texas Power LLC
Jewett, Texas

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

Dewberry & Davis, LLC
Fairfax, Virginia

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INTRODUCTION, SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The release of over five million cubic yards of coal combustion waste from the Tennessee Valley Authority's Kingston, Tennessee facility in December 2008 flooded more than 300 acres of land, damaging homes and property. In response, the U.S. EPA is assessing the stability and functionality of coal combustion ash impoundments and other management units across the country and, as necessary, identifying any needed corrective measures.

This assessment of the stability and functionality of two Limestone Generating Station impoundment structures: the Dewatered Sludge Disposal Area (DSDA) pond and Secondary Dewatering Area pond (ST-18) Pond were based on a review of available documents and on the site assessment conducted by Dewberry personnel on Tuesday, February 22, 2011. We found the supporting technical documentation adequate (Section 1.1.3). As detailed in Section 1.2.5, there are three (3) recommendations based on field observations that may help to maintain a safe and trouble-free operation.

In summary, the Limestone Generating Station's DSDA and the ST-18 Ponds are rated **POOR** for continued safe and reliable operation. These ratings are based only on the lack of critical studies and investigations available to the assessors to determine the inundation potential of the dams and potential for dam safety deficiencies. For each of the ponds the following recent and current information, studies and analysis are needed: a breach analysis and inundation map including hydraulic and hydrological studies for each of the drainage areas. Upon receipt of data showing adequate hydraulic and structural soundness the rating can be changed to satisfactory.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is embarking on an initiative to investigate the potential for catastrophic failure of Coal Combustion Surface Impoundments (i.e., management unit) from occurring at electric utilities in an effort to protect lives and property from the consequences of a dam failure or the improper release of impounded slurry. The EPA initiative is intended to identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures (if present); to note the extent of deterioration (if present), status of maintenance and/or a need for immediate repair; to evaluate conformity with current design and construction practices; and to determine the hazard potential classification for units not currently classified by the management unit owner or by a state or federal agency. The initiative will address management units that are classified as having a Less-than-Low, Low, Significant or High Hazard Potential ranking. (For Classification, see pp. 3-8 of the 2004 Federal Guidelines for Dam Safety.)

In early 2009, the EPA sent its first wave of letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion residue. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units. The EPA used the information received from the utilities to determine preliminarily which management units had or potentially could have High Hazard Potential ranking.

The purpose of this report is **to evaluate the condition and potential of residue release from management units for hazard potential classification**. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided in person and via telephone communication with the Management Units owner. Also, after the February 22, 2011 field visit, additional information was received on March 16, 2011 by Dewberry & Davis LLC about the Limestone Generating Station's DSDA and ST-18 Pond that was reviewed and used in preparation of this report.

Factors considered in determining the hazard potential classification of the management units included the age and size of the impoundment, the quantity of coal combustion residuals or by-products that were stored or disposed of in these impoundments, its past operating history, and its geographic location relative to down gradient population centers and/or sensitive environmental systems.

This report presents the opinion of the assessment team as to the potential of catastrophic failure and reports on the condition of the management unit(s).

LIMITATIONS
The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion residue management unit(s). Qualified Dewberry engineering personnel performed the field observations and review and made the assessment in conformance with the required scope of work and in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is made with regard to our assessment of dam safety.

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit on February 22, 2011, and review of technical documentation provided by NRG Texas Power LLC.

1.1.1 Conclusions Regarding the Structural Soundness of the Management Unit(s)

The impoundment embankments appear to be structurally sound based on a review of the engineering data provided by the owner's technical staff and Dewberry engineers' observations during the site visit.

1.1.2 Conclusions Regarding the Hydrologic/Hydraulic Safety of the Management Unit(s)

No hydrologic or hydraulic analyses were provided to Dewberry. Therefore, no determination can be made regarding Hydrologic/Hydraulic Safety of the Management Units.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

The supporting technical documentation is adequate with the exception of a Hydrologic/Hydraulic safety assessment of the Management Units. Engineering documentation reviewed is referenced in Appendix A.

1.1.4 Conclusions Regarding the Description of the Management Unit(s)

The description of the Management Units provided by the owner was an accurate representation of what Dewberry observed in the field.

1.1.5 Conclusions Regarding the Field Observations

Dewberry staff was provided access to all areas in the vicinity of the management units required to conduct a thorough field observation. The visible parts of the embankment dikes and outlet structure were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability. Embankments appear structurally sound. There are no apparent indications of unsafe conditions or conditions needing remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The current maintenance and methods of operation appear to be adequate for the DSDA pond and the ST-18 pond. There was no evidence of significant embankment repairs or prior releases observed during the field inspection. However, there was extensive brushy vegetation and trees on the ST-18 pond embankments. Trees and brushy vegetation should be cleared, although remaining stumps and root balls may become an issue once deterioration begins.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The surveillance program appears to be adequate. Groundwater monitoring wells were installed in 1988. MW-6 was installed down-gradient of the DSDA and MW-4 down-gradient of the ST-18 pond. Semi-annual samplings are conducted by taking static water level measurements and groundwater samples.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

The facility is satisfactory with the exception of providing a Breach Analysis and Inundation Map including a Hydraulic and Hydrologic analysis. Therefore, the Management Units is rated **POOR** for continued safe and reliable operation until the receipt of the deficient documentation.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Hydrologic/Hydraulic Safety

It is recommended that the operator conduct a Hydraulic and Hydrologic study that would include a Breach Analysis and Inundation Map.

1.2.2 Recommendations Regarding the Maintenance and Methods of Operation

The following recommendations are warranted:

1. Clear brushy vegetation and trees from ST-18 pond's outer embankment.
2. Observe remaining tree stumps and root balls for deterioration.

3. Excavate deteriorated organic matter, fill and compact as needed with select material with high Bentonite content.

1.2.3 Recommendations Regarding the Surveillance and Monitoring Program

It is recommended that a document outlining maintenance and operations procedures be developed. Also note the recommendations in Section 1.2.6.

1.2.4 Recommendations Regarding Continued Safe and Reliable Operation

No recommendations appear warranted at this time, other than the actions cited above.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Ted Long, NRG Energy Corporation
David Burton, NRG – Limestone Engineering Manager
Bob Eyeington, NRG – Limestone
Gary Mechler, NRG – Limestone
Chris Vasquel, NRG
Bill Odom, NRG
Charles Little, NRG
Jeffery Davis, NRG
Kyle Shepard, P.E., PSA-Dewberry Inc.
Andrew Cueto, P.E., Dewberry

1.3.2 Acknowledgement and Signature

I acknowledge that the Management Units referenced herein have been assessed on February 22, 2011.

____

Andrew Cueto, P.E., PMP
TX PE # 68920

2.0 DESCRIPTION OF THE COAL COMBUSTION RESIDUE MANAGEMENT UNIT(S)

2.1 LOCATION AND GENERAL DESCRIPTION

The Limestone Generating Station is located in Limestone and Freestone Counties, northwest of Jewett, Texas. The plant is operated by NRG Texas Power LLC. The ST-18 and Dewatered Sludge Disposal Areas are located directly east of the generating station. An aerial photograph of the impoundments is provided in Appendix A – Doc 01.

The plant property covers a total of approximately 3,800 acres and includes a main plant yard and a materials handling area. The main plant yard includes two generating units, a switch yard, a lignite storage yard, two cooling towers, an FGD system, a bottom ash cooling pond, an ash handling area, and several wastewater treatment systems. The material handling area includes the solid waste disposal area active landfill, bottom ash and FGD processing areas, and several clay-lined runoff/sedimentation ponds. Two ponds receive CCR byproducts: DSDA and ST-18. Note the ponds are not used for CCR disposal, but the CCR is added for water treatment due to its high pH in one pond, and is a runoff contaminant in the other, as described below.

Limestone Generating Station adds fly ash to the DSDA pond to stabilize high chloride wastewater from the cooling tower blowdown. Fly ash is introduced into the wastewater to bind up the waste into a stable sludge. The sludge is then windrowed and dewatered via evaporation and absorption. Once water content drops below 25%, the sludge is transported to the solid waste disposal area. Sludge removal and disposal is performed about twice per year.

ST-18 receives CCR byproducts as a result of stormwater runoff from a transfer station concrete hardstand. Fly ash is pneumatically conveyed to the hardstand to be loaded via frontend loaders into trucks and then either transported dry for beneficial reuse or disposed of in the solid waste disposal area. Stormwater runoff washes the CCR into the detention basin during an event. The CCR settles and the supernatant is decanted off to the wastewater processing plant. The pond is primarily dry and cleaned out when needed via a bobcat. Sludge is transported dry to the solid waste disposal area.

The DSDA pond has a random fill (unclassified material) embankment that impounds flue gas desulfurization sludge, fly ash, cooling tower sludge, and stormwater sludge. It was designed on July 10, 1985 and constructed shortly thereafter in December 1985 as noted in Document 04 of Appendix A. The ST-18 pond has a random fill (unclassified material) embankment. It was designed on April 26, 1982 and constructed shortly thereafter in December 1982 as noted in Document 04 of Appendix A.

The table below provides the dimensions of the embankments:

Table 2.1: Summary of Dam Dimensions and Size		
	DSDA	**ST-18**
Dam Height (ft)	24 feet	24 feet
Crest Width (ft)	21 feet	22 feet
Length (ft)	1730 feet	500 feet
Side Slopes (upstream) H:V	3 : 1	3 : 1
Side Slopes (downstream) H:V	3 : 1	3 : 1

2.2 COAL COMBUSTION RESIDUE HANDLING

2.2.1 Fly Ash

The Fly Ash disposal process is a dry train procedure.

1. The fly ash is pneumatically conveyed to a hardstand,
2. The ash is then picked up via truck (third party) to be transported offsite for beneficial use or to the generating station's landfill located in the northeast quadrant of the facility.

2.2.2 Bottom Ash

The Bottom Ash disposal process is a wet train procedure.

1. The bottom ash is wet conveyed via conduit to conical dewatering units.
2. The ash is then sold for beneficial use and picked up via truck and transported offsite.
3. The ash that remains is loaded into trucks (third party) for transport to the generating station's landfill.

2.2.3 Boiler Slag

The Boiler Slag disposal process is a wet train procedure.

1. The boiler slag is wet conveyed via conduit to conical dewatering units.

2. The slag is then sold for beneficial use and picked up via truck and transported offsite.

3. The slag that remains is loaded into trucks (third party) for transport to the generating station's landfill.

2.2.4 Flue Gas Desulfurization Sludge

The Flue Gas Desulfurization (FGD) Sludge disposal process is a wet train procedure.

1. The FGD sludge is wet conveyed to a belt press and centrifuge dewatering units.

2. The sludge is then sold as gypsum for beneficial uses, being transported offsite via truck,

2.3 SIZE AND HAZARD CLASSIFICATION

The classification for size, based on the height of the dam is "Small" and based on the storage capacity is "Small" in accordance with the USACE Recommended Guidelines for Safety Inspection of Dams ER 1110-2-106 criteria summarized in Table 2.2a.

Table 2.2a: USACE ER 1110-2-106 Size Classification		
	Impoundment	
Category	**Storage (Ac-ft)**	**Height (ft)**
Small	50 and < 1,000	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

The State of Texas maintains a Dam Safety program through the Texas Commission on Environmental Quality. Neither of the embankments for the DSDA nor the ST-18 at the NRG Texas Power LLC Limestone Generating Station are on the National Inventory of Dams and therefore do not have an established hazard classification.

Dewberry conducted a qualitative hazard classification based on the 2004 Federal Guidelines for Dam Safety classification system (shown in Table 2.2b).

Table 2.2b: FEMA Federal Guidelines for Dam Safety Hazard Classification		
	Loss of Human Life	**Economic, Environmental, Lifeline Losses**
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable. One or more expected	Yes (but not necessary for classification)

Loss of human life is not probable in the event of a catastrophic failure of the embankment; a failure of the embankment is expected to have a low economic and environmental impact. Therefore, Dewberry evaluated both impoundments as "**low hazard potential**."

2.4 AMOUNT AND TYPE OF RESIDUALS CURRENTLY CONTAINED IN THE UNIT(S) AND MAXIMUM CAPACITY

The data reviewed by Dewberry did not include the volume of residuals stored in the DSDA or the ST-18 at the time of inspection.

Table 2.3: Maximum Capacity of Unit		
	DSDA	**ST-18**
Surface Area (acre)[1]	3.96	0.92
Current Storage Capacity (cubic yards)[1]	N/A *	N/A *
Current Storage Capacity (acre-feet)	N/A *	N/A *
Total Storage Capacity (cubic yards)[1]	1,057,300	369,000
Total Storage Capacity (acre-feet)	24.3	8.5
Crest Elevation (feet)	483.41 (measured)	438.00 (design)
Normal Pond Level (feet)	478.00 (measured)	433.00 (measured)

* *Each unit is cleaned out of CCR sludge periodically. Units are not used as storage units but rather as process units.*

2.5 PRINCIPAL PROJECT STRUCTURES – DEWATERED SLUDGE DISPOSAL AREA

2.5.1 Earth Embankment

Embankment is earthen filled with random fill (unclassified) with a 3-foot layer of clay compacted to 95% standard proctor on the upstream slope of the impoundment. Approximate crest width is 15 feet. Approximate embankment height is 13 feet.

2.5.2 Outlet Structure

Water generated by the DSDA is contained within the embankment boundaries. It has no outlet. DSDA water is stored until it evaporates from this pond.

2.6 PRINCIPAL PROJECT STRUCTURES – ST-18

2.6.1 Earth Embankment

Embankment is earthen filled with random fill (unclassified) with a 3-foot layer of clay compacted to 95% standard proctor on the upstream slope of the impoundment. Approximate crest width is 15 feet. Approximate embankment height is 13 feet.

2.6.2 Outlet Structure

The water level in the ST-18 is controlled by sump pumps that can be either automatically or manually operated. The utility provided a Standard Operating Procedure Manual for the ST-18 Pond operations for review.

2.7 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

The NRG Texas Power LLC Limestone Generating Station is located upstream of the Lambs Creek arm of Lake Limestone. Lake Limestone is a Brazos River Authority reservoir that is primarily fed by the Navasota River. The DSDA and ST-18 are off channel impoundments from Lynn Creek which outfalls to Lambs Creek. Regional maps provided by NRG Texas Power LLC shows a number of petroleum or natural gas well sites downstream as well as an impoundment for the Texas Westmoreland Coal Company Jewett Mine, but there do not appear to be any inhabited structures between the impoundments and Lake Limestone. Lake Limestone falls within the 5-mile downstream gradient.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

Summary of Reports on the Safety of the Management Units

- Field Evaluation of the Co-management of Utility Low-Volume Wastes with High-Volume Coal Combustion By-Products: LS Site, TR 108422, WO 4147 and 9055, Final Report, August 1997, Prepared By: GEI Consultants, Inc. and Battelle Pacific Northwest National Laboratories.

- TCEQ Exit Interview Form: Potential Violations and/or Records Requested, December 7, 2010, Prepared By: Texas Commission on Environmental Quality.

- Work Scope and Schedule for Geotechnical Investigations and Hydrologic Analysis, DSDA and ST-18 Ponds, March 8, 2011, Prepared By: Tolunay-Wong Engineers, Inc – for future Hydraulic and Hydrologic and Breach Analysis including an inundation map.

3.1 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS

While the State of Texas has a Dam Safety Program that is the responsibility of the Texas Commission on Environmental Quality (TCEQ), this embankment is not permitted by the TCEQ.

Stormwater discharges from the DSDA and the ST-18 ponds are regulated by the TCEQ. These are covered under TCEQ Permit Number TXR05V737. The impoundment has been issued a National Pollutant Discharge Elimination System Permit, TPDES Permit No. 02430, and has been issued an EPA I.D., No. TX0082651.

3.2 SUMMARY OF SPILL/RELEASE INCIDENTS

Data reviewed by Dewberry did not indicate any spills, unpermitted releases, or other performance related problems with the dam over the last 10 years.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The Limestone Generating Station DSDA was constructed in 1985. The original design did not include an overflow structure.

The Limestone Generating Station ST-18 was constructed in 1982. The original crest elevation was 438.00. (See Appendix A – Doc 04).

4.1.2 Significant Changes/Modifications in Design since Original Construction

DSDA - A number of changes have occurred to this impoundment since it was designed on July 10, 1985.

- The maximum impoundment capacity has been reduced from 29.0 acre-feet to 24.3 acre-feet.
- The minimum freeboard elevation has been reduced from 483.50 to 481.00.
- The minimum dam crest elevation has been reduced from 485.50 to 483.41.
- The minimum crest width has been increased from 15.00 feet to 21.00 feet.
- The average crest width has been increased from 15.00 feet to 22.50 feet.

ST-18 - A number of changes have occurred to this impoundment since it was designed on April 26, 1982.

- The minimum freeboard elevation has been increased from 438.00 to 441.00.
- The maximum dam height has been increased from 15.00 feet to 24.00 feet.
- The minimum dam crest elevation has been increased from 440.00 to 443.00.

- The minimum crest width has been increased from 12.8 feet to 22 feet.
- The average crest width has been increased from 15 feet to 26 feet.
- The emergency spillway shown on the design drawings has been eliminated. No overflow structure exists for this embankment.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

No information was provided by the utility that described repairs or rehabilitation completed since the original construction.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

DSDA - NRG Texas Power LLC provided documents describing the operation of the DSDA. (See Appendix A – Doc 05 and Doc 06.)

ST-18 - NRG Texas Power LLC provided documents describing the operation of the ST-18. (See Appendix A – Doc 05 and Doc 06.)

4.2.2 Significant Changes in Operational Procedures and Original Startup

No documents were provided by the utility to indicate any operational procedures have been changed.

4.2.3 Current Operational Procedures

Current operational process and procedures are described in the documents referenced in Section 4.2.1.

4.2.4 Other Notable Events since Original Startup

No additional information was provided to Dewberry of other notable events that have impacted either impoundment's operations.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Andrew Cueto, P.E. and Kyle Shepard, P.E. performed a site visit on Tuesday, February 22, 2011 in company with the participants.

The site visit began at 8:30 AM. The weather was partly sunny and cool. Photographs were taken of conditions observed. Please refer to the Dam Inspection Checklist in Appendix B for additional information obtained during the site visit. Selected photographs are included here for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit.

The overall assessment of the embankments was that both were in satisfactory condition and no significant findings were noted.

5.2 DSDA EMBANKMENT

5.2.1 Crest

The embankments' crests showed no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition. Vegetation, for the most part, was not present due to high amount of vehicular traffic (sludge haul trucks and process equipment). Figure 5.2.1-1 shows the typical conditions of the embankments crests.

Figure 5.2.1-1 Photo showing the lack of vegetation on the crest of the embankment.

5.2.2 Upstream/Inside Slope

The impoundment's inside slope is generally bare earth, with the exception of a small corner of the east cell. Figures 5.2.2-1 and 5.2.2-2 show examples of these areas.

Figure 5.2.2-1. Inside slope bare earth.

Figure 5.2.2-2. Sporadic area of vegetation on an inside slope.

5.2.3 Downstream/Outside Slope and Toe

There were no observed scarps, sloughs, bulging, cracks, or depressions indicating slope instability or signs of erosion. The outside slope of this impoundment was uniformly graded and covered with mowed grass. The outside slope and toe appear to be in satisfactory condition. Figure 5.2.3-1 shows the general condition of the outside slope and toe.

Figure 5.2.3-1 Outside slope condition.

5.2.4 Abutments and Groin Areas

There were no observed abutments or groins for this area.

5.3 ST-18 EMBANKMENT

5.3.1 Crest

The crest of the ST-18 embankment showed no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition. Vegetation was not present. Figure 5.3.1-1 shows the conditions of the embankment's crest on the west side.

Figure 5.3.1-1 Crest condition on the west side of the embankment.

5.3.2 Upstream/Inside Slope

The embankment's inside slope is generally clear of any vegetation, with the exception of around the inlet pipe. Figure 5.3.1-1 shows the inside slope condition.

Figure 5.3.1-1. Figure showing the embankment's inside slope condition.

5.3.3 Downstream/Outside Slope and Toe

There were no observed scarps, sloughs, bulging, cracks, or depressions indicating slope instability or signs of erosion. While the outside slope of the embankment was uniformly graded, it was covered with various forms of vegetation including heavy woody brush and trees. Figure 5.3.3-1 shows the general condition of the outside slope and toe of the embankment.

Figure 5.3.3-1 Photo shows the general condition of the embankment's outside slope and toe.

5.3.4 Abutments and Groin Areas

There were no observed scarps, sloughs, bulging, cracks, or depressions indicating slope instability or signs of erosion. While the groin area of the embankment was uniformly graded and transitioned smoothly into the slope, it was covered with grassy vegetation. Figure 5.3.4-1 shows the general condition of the groin areas of the embankment.

Figure 5.3.4-1 General condition of the embankment in groin area.

5.4 DSDA OUTLET STRUCTURE

5.4.1 DSDA Overflow Structure

The DSDA does not have an overflow structure.

5.4.2 Outlet Conduit

The outlet pipe shown in the original design drawings appears to have been removed. No outlet pipe was observed during Dewberry's inspection.

5.4.3 Emergency Spillway

The DSDA does not have an emergency spillway.

5.4.4 Low Level Outlet

No low level outlet is present.

5.5 ST-18 OUTLET STRUCTURE

5.5.1 ST-18 Overflow Structure

ST-18 does not have an overflow structure.

5.5.2 Outlet Conduit

The level of ST-18 is controlled through the operation of sump pumps. Water is discharged into the plant's wastewater system. There were no observed cracks or depressions indicating concrete instability or signs of failure. Figure 5.5.2-1 shows the general condition of the ST-18 Outlet Structure.

Figure 5.5.2-1 General condition of the ST-18 Outlet Structure

5.5.3 Emergency Spillway

ST-18 does not have an emergency spillway.

5.5.4 Low Level Outlet

No low level outlet is present.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

DSDA (DSDA). The historical maximum pond elevation provided by the utility was 19.00 feet (date not noted).

ST-18. The historical maximum pond elevation provided by the utility was 8.00 feet (date not noted).

6.1.2 Inflow Design Flood

No documentation has been provided for either impoundment.

6.1.3 Spillway Rating

Not applicable. Neither impoundment has a spillway.

6.1.4 Downstream Flood Analysis

No downstream flood analysis data was provided for review.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Little documentation has been provided. Therefore, the supporting documentation reviewed by Dewberry is inadequate.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

No documentation has been provided. Therefore, no assessment can be made.

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7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

Original stability and load case design analyses were not provided by the utility. In March 2011 AEP awarded a Slope Stability Analysis and Hydrologic Analysis contract to Tolunay-Wong Engineers, Inc. for the two ponds.

7.1.2 Design Parameters and Dam Materials

Documentation provided to Dewberry for review included the following documents for the DSDA:

- EBASCO Design Assumptions (Appendix A – Doc 05)
- EBASCO Civil Design Criteria, CDC-2, Site Investigations, Excavation, and Foundation Design Parameters (Appendix A – Doc 09)

Documentation was not provided by the utility for the ST-18.

7.1.3 Uplift and/or Phreatic Surface Assumptions

No documentation of uplift calculations was provided to Dewberry for review. Based on the geotechnical borings (See Appendix A – Doc 07) the initial phreatic surface was assumed to be at the elevation measured in the borings.

7.1.4 Factors of Safety and Base Stresses

No documentation of slope stability safety factors were provided to Dewberry for review.

7.1.5 Liquefaction Potential

The documentation reviewed by Dewberry did not include an evaluation of liquefaction potential. Foundation soil conditions do not appear to be susceptible to liquefaction.

7.1.6 Critical Geological Conditions

A report (Appendix A - Doc 07) prepared by Espey, Huston & Associates, Inc. in May 1986 assessed the geologic and hydrogeologic conditions of the proposed Limestone Generating Station site. This assessment was provided for review by the utility.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Structural stability documentation is inadequate.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Visually the structural stability of both embankments appear to be satisfactory based on the following observations made during the February 22, 2010 field visit by Dewberry:

- The crest appeared free of depressions and no significant vertical or horizontal alignment variations were observed,
- There were no major scarps, sloughs, or bulging along the embankments, and
- Boils, sinks, or uncontrolled seepage were not observed along the slopes, groins, or toes of the embankments.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

8.1.1 *DSDA*

The facility is operated as a sludge disposal area with two cells. Fly ash, bottom ash, pyrites, and flue gas desulfurization sludges are pneumatically or hydraulically conveyed to the basins for disposal. Sludge is stored until moisture evaporates and the sludge hardens. Once the disposal cells are filled, they are cleaned out and solids are hauled to the landfill and new cells are opened for processing.

8.1.2 *ST-18*

This facility is operated as a stormwater collection basin. Once the pond level exceeds 2 feet, sump pumps are activated manually or automatically to lower the water level in the pond. Solids are dewatered via evaporation and then hauled to the landfill.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

While no maintenance plan was supplied to Dewberry for review, based upon observations made during the February 22, 2010 site visit and discussions with plant representatives, embankment maintenance for both impoundments appears to be adequate.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operating Procedures

Operational procedures were supplied to Dewberry for review for both impoundments (Appendix A – Doc 06). These procedures were found to be adequate.

8.3.2 Adequacy of Maintenance

No record of maintenance was supplied to Dewberry for review. However, a verbal description of maintenance procedures and methods were presented at the time of inspection. It was observed that the existing operating procedures adequately maintain the management units. It was recommended that these procedures be documented and put into checklists.

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Emergency Action Plan

NRG Texas Power LLC provided a written Emergency Action Plan for Extended Rainfall Events and Impoundment Failure that applies to the DSDA and the ST-18 (Appendix A – Doc 11). The impoundment embankments are visually inspected following any rainfall event greater than ½ inch or a minimum of once a week for signs of wind or water erosion (Appendix A – Doc 10).

9.2 INSTRUMENTATION MONITORING

The Limestone Generating Station DSDA and the ST-18 embankments each have a monitoring well downstream. Water level measurements are collected semi-annually.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Based on the data reviewed by Dewberry, including observations during the site visit, the inspection program is adequate.

9.3.2 Adequacy of Instrumentation Monitoring Program

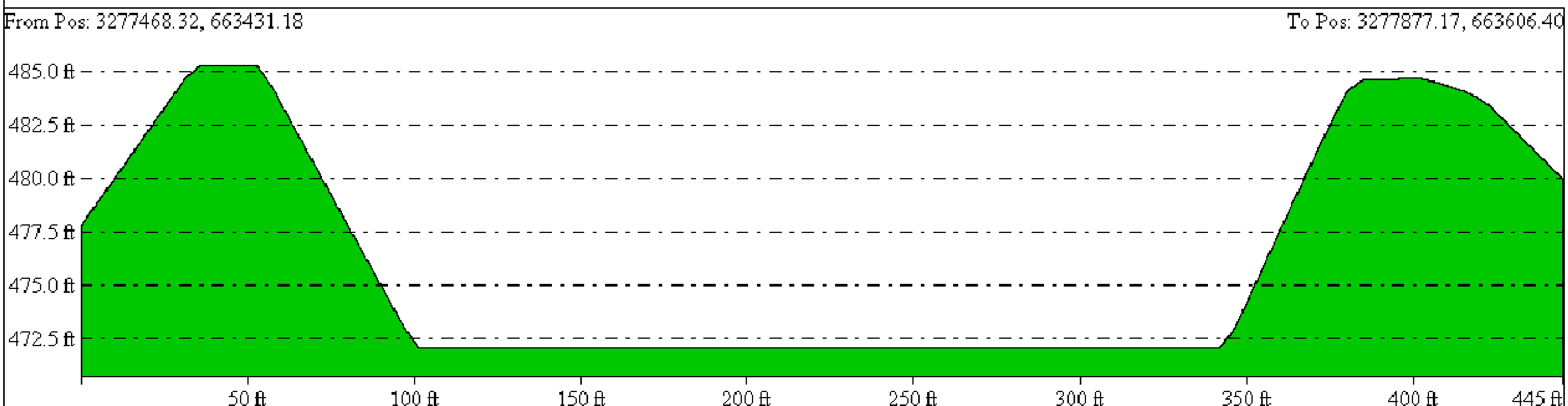
Based on the data reviewed by Dewberry, including observations during the site visit, the instrumentation monitoring program appears to be adequate.


DSDA Pond
ST-18 Pond
County Rd 795
Farm-To-Market Rd 39

Line Data
Start Position: 3277468.32, 663431.18
Start Height: 477.787 ft
End Position: 3277877.17, 663606.40
End Height: 480.001 ft
Straight-Line Distance: 444.86 ft
3D Distance on Surface: 449.62 ft
Vertical Difference (Start to Finish): 2.2 ft
Minimum Elevation on Path: 472 ft
Maximum Elevation on Path: 485.294 ft
Azimuth: 68° 54' 41.0"
Slope/Tilt: 0.29°

1 Cross Section N-N'

Scale: 1:1



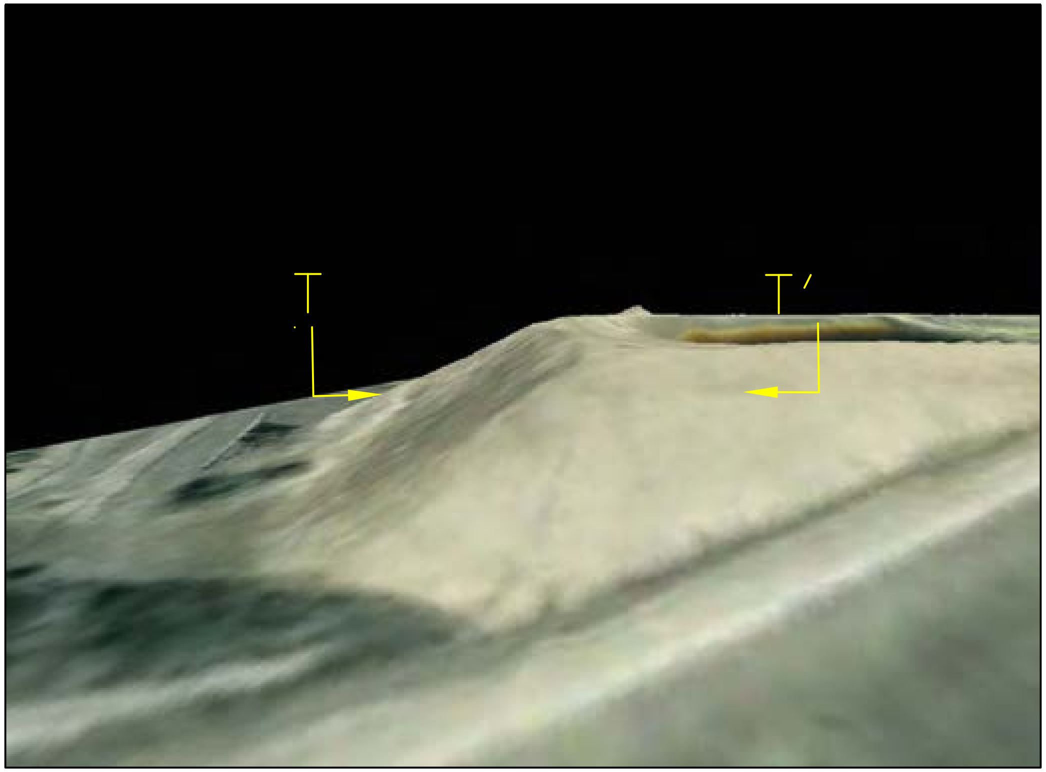
NO.	DATE	REVISIONS	BY	CHK	APP	APP
0	2/22/2011		CMV	CMV	CMV	CMV

DATE: 2-21-2011
BY: C.Vasquez
CHK: CMV
APP:
APP:
DISK ID:

NRG Energy, Inc.

DSDA Pond
North Holding Area
Section Cutout
N-N'

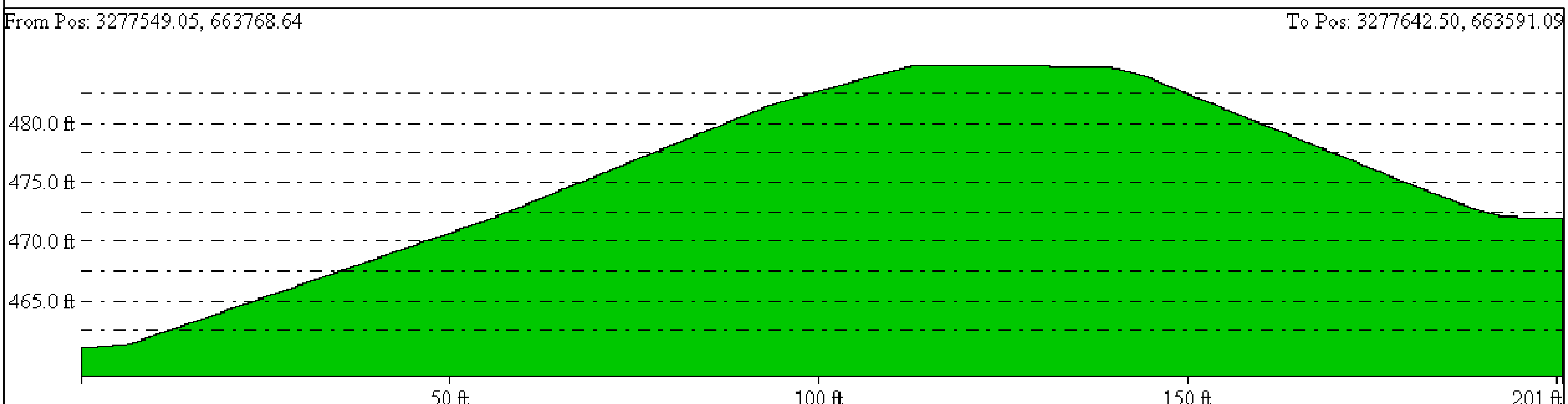
DRAWING NO.
SHEET 102
FILE: LMS



NORTH

<u>Line Data</u>
Start Position: 3277549.05, 663768.64
Start Height: 460.984 ft
End Position: 3277642.50, 663591.09
End Height: 472 ft
Straight-Line Distance: 200.67 ft
3D Distance on Surface: 204.77 ft
Vertical Difference (Start to Finish): 23.87 ft
Minimum Elevation on Path: 460.984 ft
Maximum Elevation on Path: 484.853 ft
Azimuth: 154° 21' 5.7"
Slope/Tilt: 3.14°

1 Cross Section T-T'
Scale: 1:1



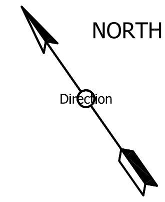
NO.	DATE	REVISIONS	BY	CHK	APP	APP
0	2/22/2011		CMV	CMV	CMV	CMV

DATE: 2-21-2011
BY: C.Vasquez
CHK: CMV
APP:
APP:
DISK ID:

NRG Energy, Inc.

DSDA Pond
North Slope
Section Cutout
T-T'

DRAWING NO.
SHEET 104
FILE: LMS

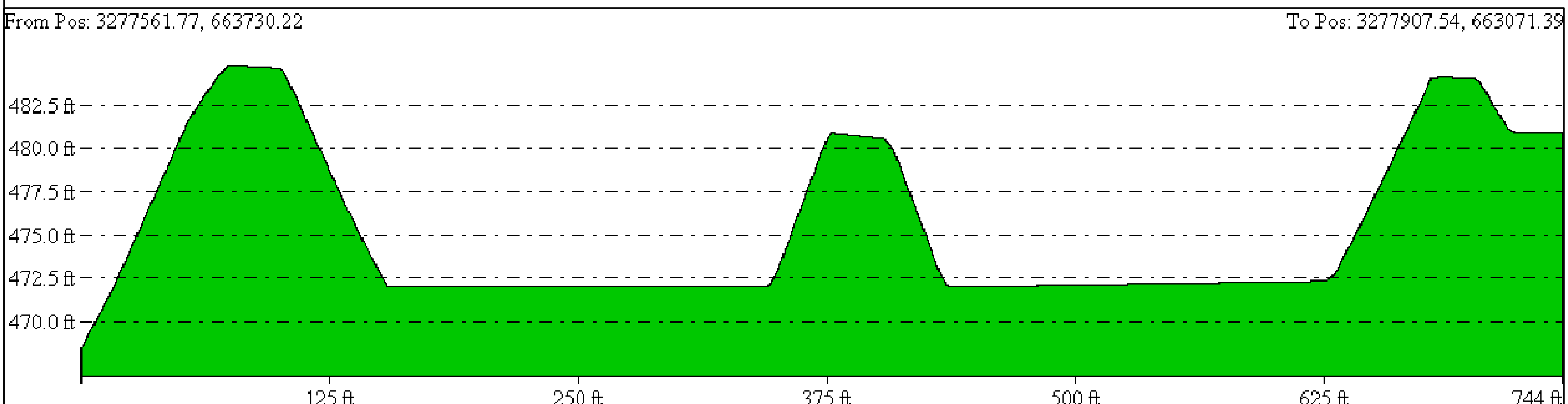


Line Data

Start Position: 3277561.77, 663730.22
Start Height: 468.455 ft
End Position: 3277907.54, 663071.39
End Height: 480.916 ft
Straight-Line Distance: 744.12 ft
3D Distance on Surface: 751.37 ft
Vertical Difference (Start to Finish): 12.5 ft
Minimum Elevation on Path: 468.455 ft
Maximum Elevation on Path: 484.787 ft
Azimuth: 154° 25′ 7.1″
Slope/Tilt: 0.96°

1 Cross Section C-C'

Scale: 1:1



NO.	DATE	REVISIONS	BY	CHK	APP	APP	
0	2/22/2011		CMV	CMV	CMV	CMV	

DATE: 2-21-2011
BY: C.Vasquez
CHK: CMV
APP:
APP:
DISK ID:

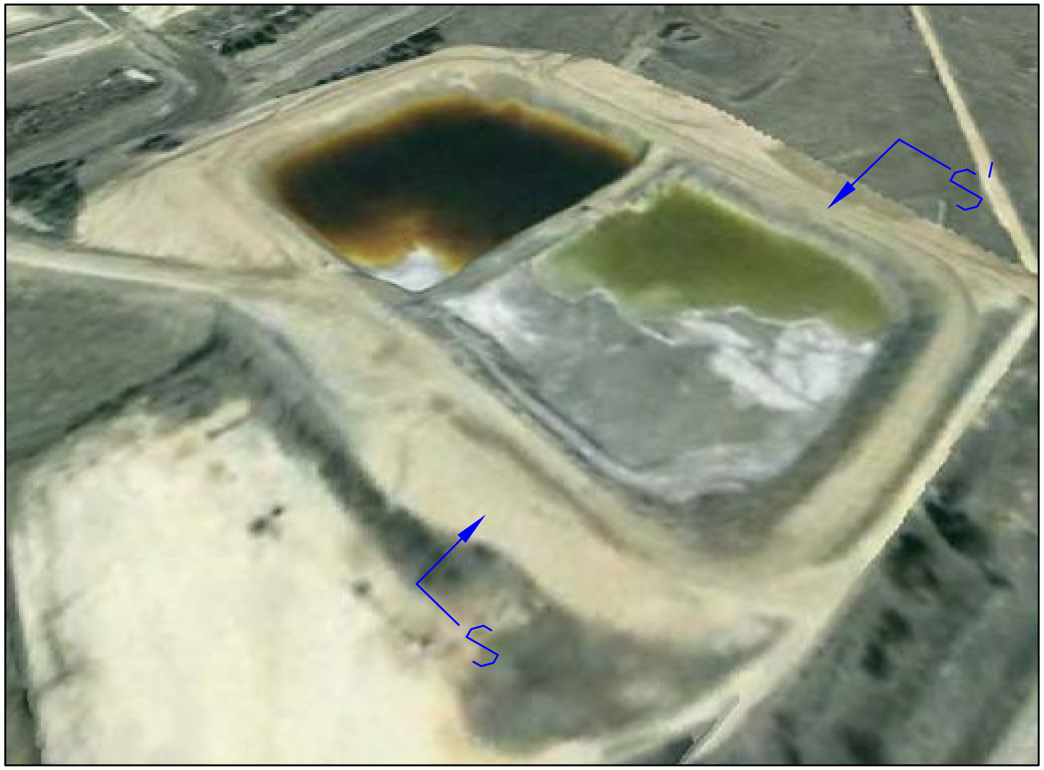
NRG Energy, Inc.

DSDA Pond
Cross Section
C-C'

DRAWING NO.

SHEET 101

FILE: LMS



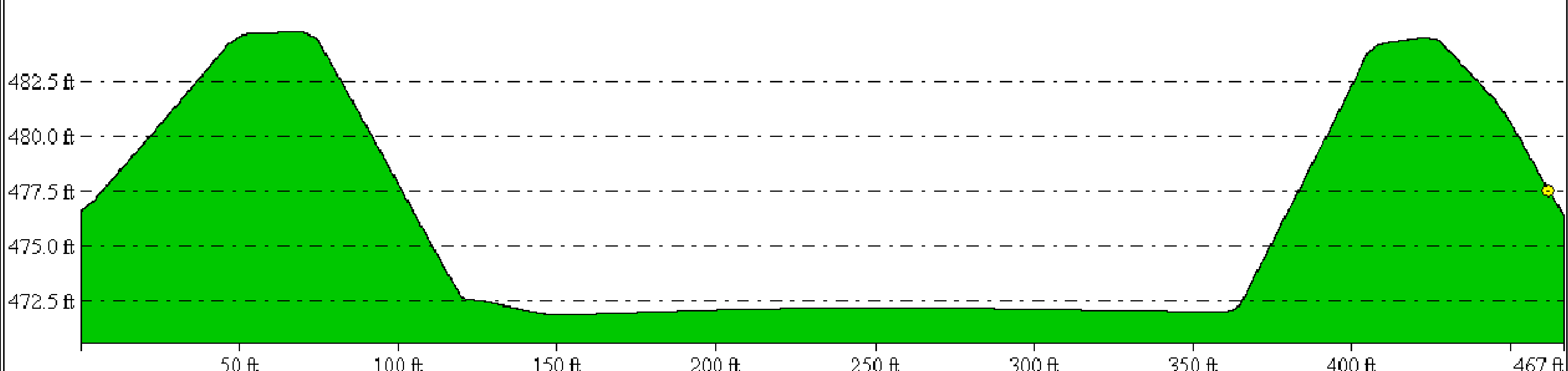
NORTH

Direction

<u>Line Data</u>
Start Position: 3277606.16, 663127.46
Start Height: 476.605 ft
End Position: 3278017.35, 663347.07
End Height: 476.404 ft
Straight-Line Distance: 466.2 ft
3D Distance on Surface: 471.41 ft
Vertical Difference (Start to Finish): -0.2 ft
Minimum Elevation on Path: 471.874 ft
Maximum Elevation on Path: 484.771 ft
Azimuth: 64° 00' 14.1"
Slope/Tilt: -0.02°

1 Cross Section S-S'

Scale: 1:1



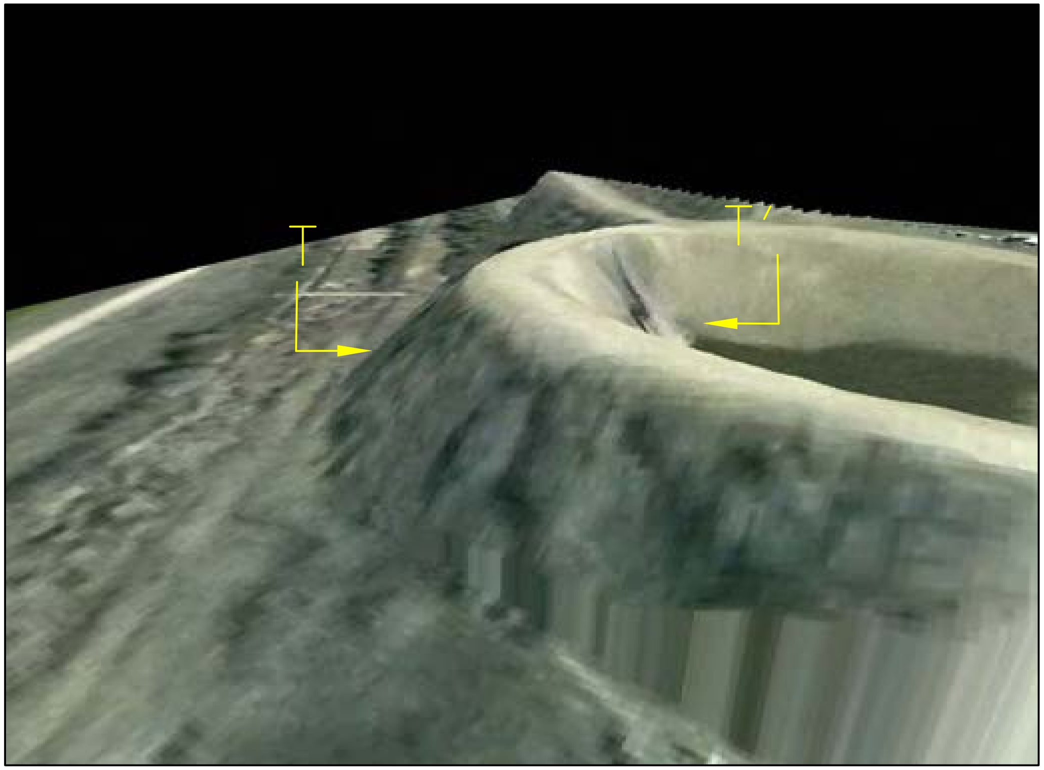
NO.	DATE	REVISIONS	BY	CHK	APP	APP
0	2/22/2011		CMV	CMV	CMV	CMV

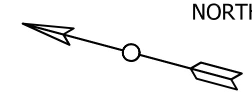
DATE: 2-21-2011
BY: C.Vasquez
CHK: CMV
APP:
APP:
DISK ID:

NRG Energy, Inc.

DSDA Pond
South Holding Area
Section Cutout
S-S'

DRAWING NO.
SHEET 103
FILE: LMS



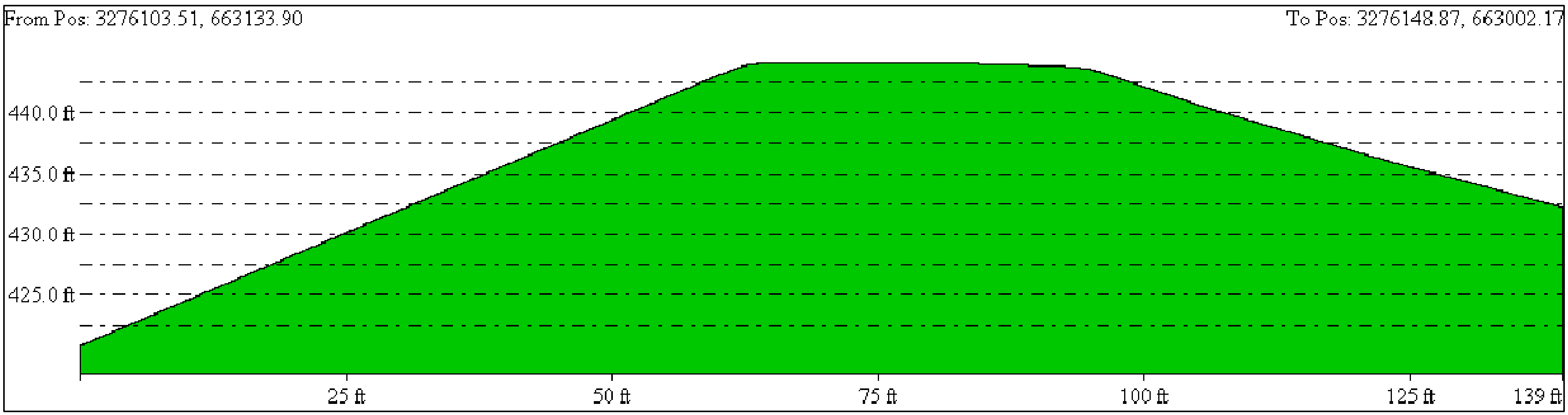


<u>Line Data</u>

Start Position: 3276103.51, 663133.90
Start Height: 420.855 ft
End Position: 3276148.87, 663002.17
End Height: 432.237 ft
Straight-Line Distance: 139.33 ft
3D Distance on Surface: 144.9 ft
Vertical Difference (Toe to Crest): 23.5 ft
Minimum Elevation on Path: 420.855 ft
Maximum Elevation on Path: 444.106 ft
Azimuth: 163° 06′ 19.7″
Slope/Tilt: 4.67°

1 Cross Section T-T'

Scale: 1:1



NO.	DATE	REVISIONS	BY	CHK	APP	APP
0	3/9/2011		CMV	CMV	CMV	CMV

DATE: 3-12-2011
BY: C.Vasquez
CHK: CMV
APP:
APP:
DISK ID:

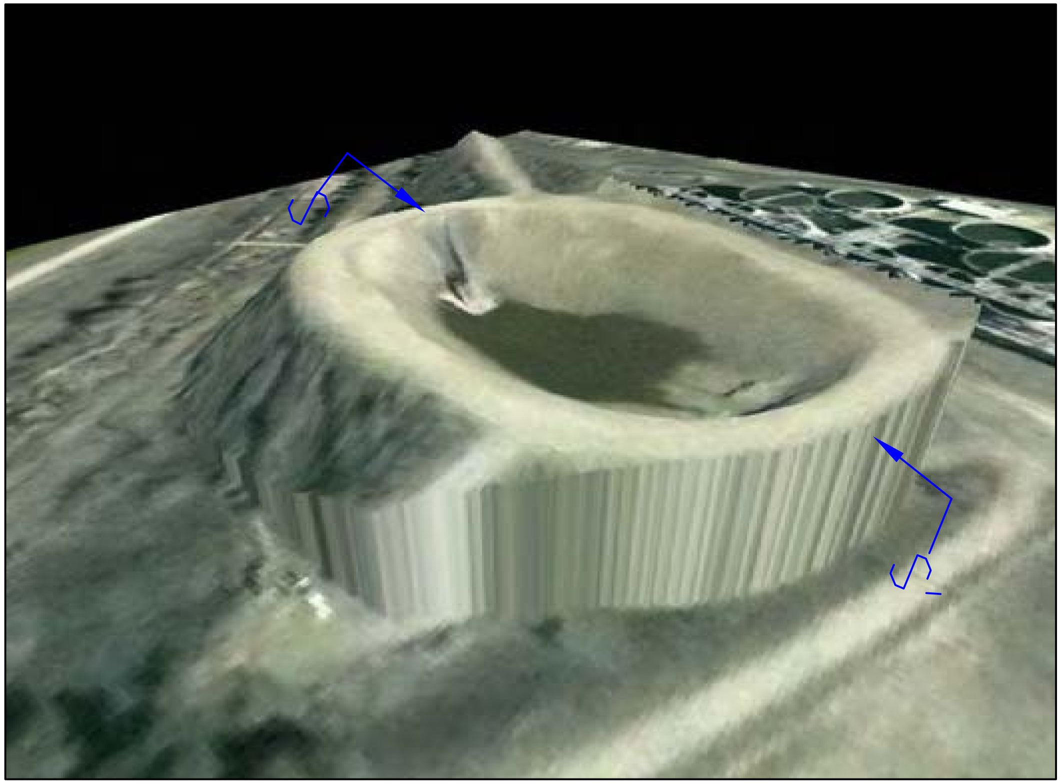
NRG Energy, Inc.

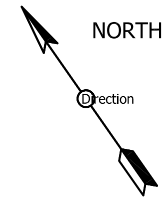
ST-18
West Slope
Section Cutout
T-T'

DRAWING NO.

SHEET 200

FILE: LMS



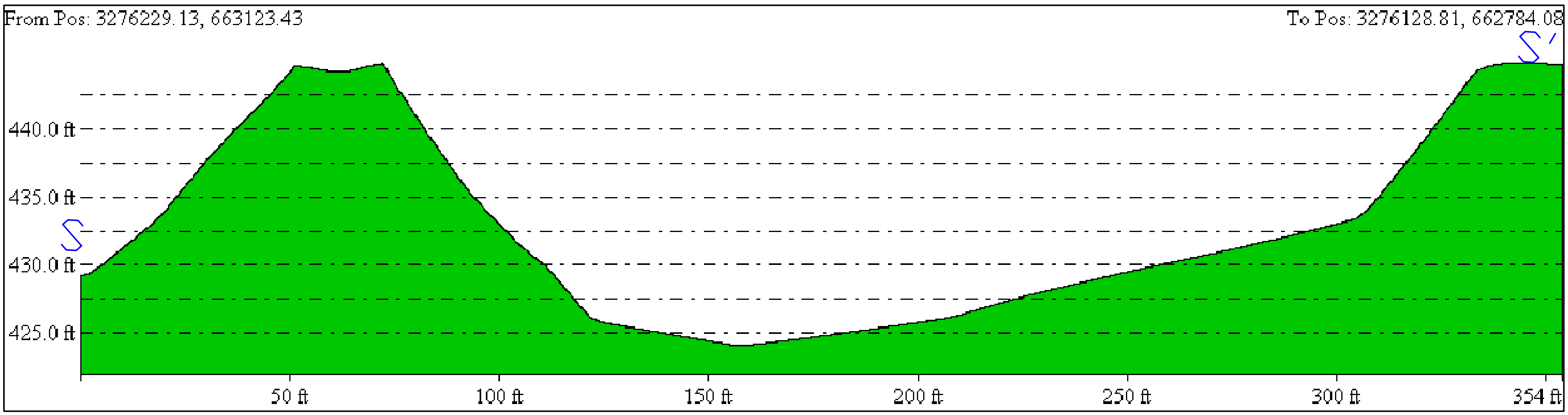


Line Data

Start Position: 3276229.13, 663123.43
Start Height: 429.221 ft
End Position: 3276128.81, 662784.08
End Height: 444.762 ft
Straight-Line Distance: 353.9 ft
3D Distance on Surface: 362.28 ft
Vertical Difference (Start to Finish): 15.5 ft
Minimum Elevation on Path: 424.046 ft
Maximum Elevation on Path: 444.895 ft
Azimuth: 198° 34′ 37.8″
Slope/Tilt: 2.51°

1 Cross Section S-S'

Scale: 1:1



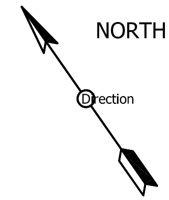
NO.	DATE	REVISIONS	BY	CHK	APP	APP
0	3/9/2011		CMV	CMV	CMV	CMV

DATE: 3-9-2011
BY: C.Vasquez
CHK: CMV
APP:
APP:
DISK ID:

NRG Energy, Inc.

ST-18
Length Cross Section
Section Cutout
S-S'

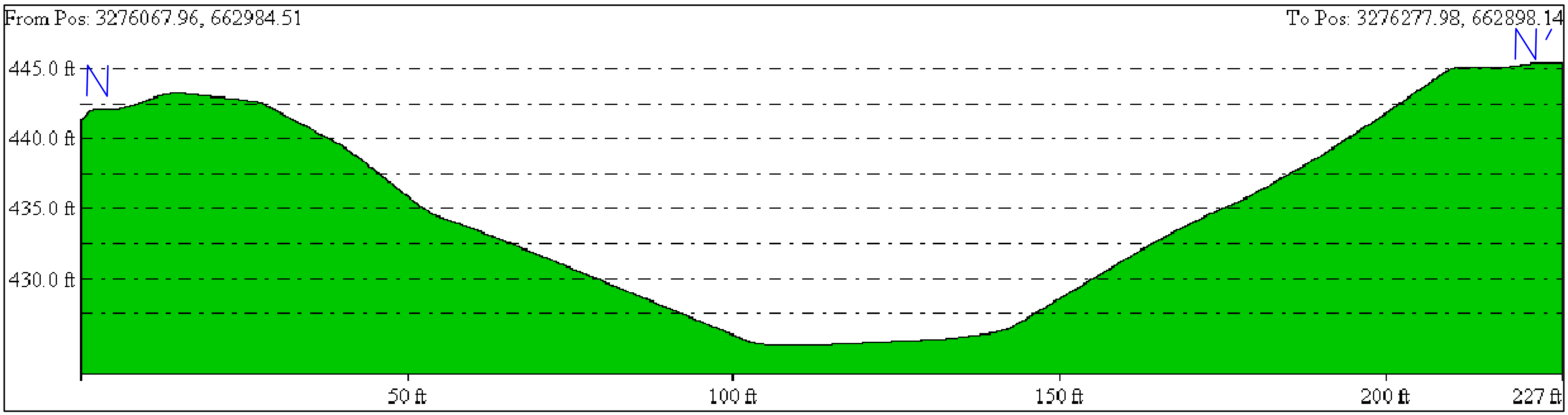
DRAWING NO.
SHEET 201
FILE: LMS



Line Data

Start Position: 3276067.96, 662984.51
Start Height: 441.373 ft
End Position: 3276277.98, 662898.14
End Height: 445.376 ft
Straight-Line Distance: 227.1 ft
3D Distance on Surface: 231.96 ft
Vertical Difference (Start to Finish): 4.0 ft
Minimum Elevation on Path: 425.255 ft
Maximum Elevation on Path: 445.418 ft
Azimuth: 114° 27' 39.0"
Slope/Tilt: 1.01°

1 Cross Section N-N'
Scale: 1:1



NO.	DATE	REVISIONS	BY	CHK	APP	APP
0	3/9/2011		CMV	CMV	CMV	CMV

DATE: 3-9-2011
BY: C.Vasquez
CHK: CMV
APP:
APP:
DISK ID:

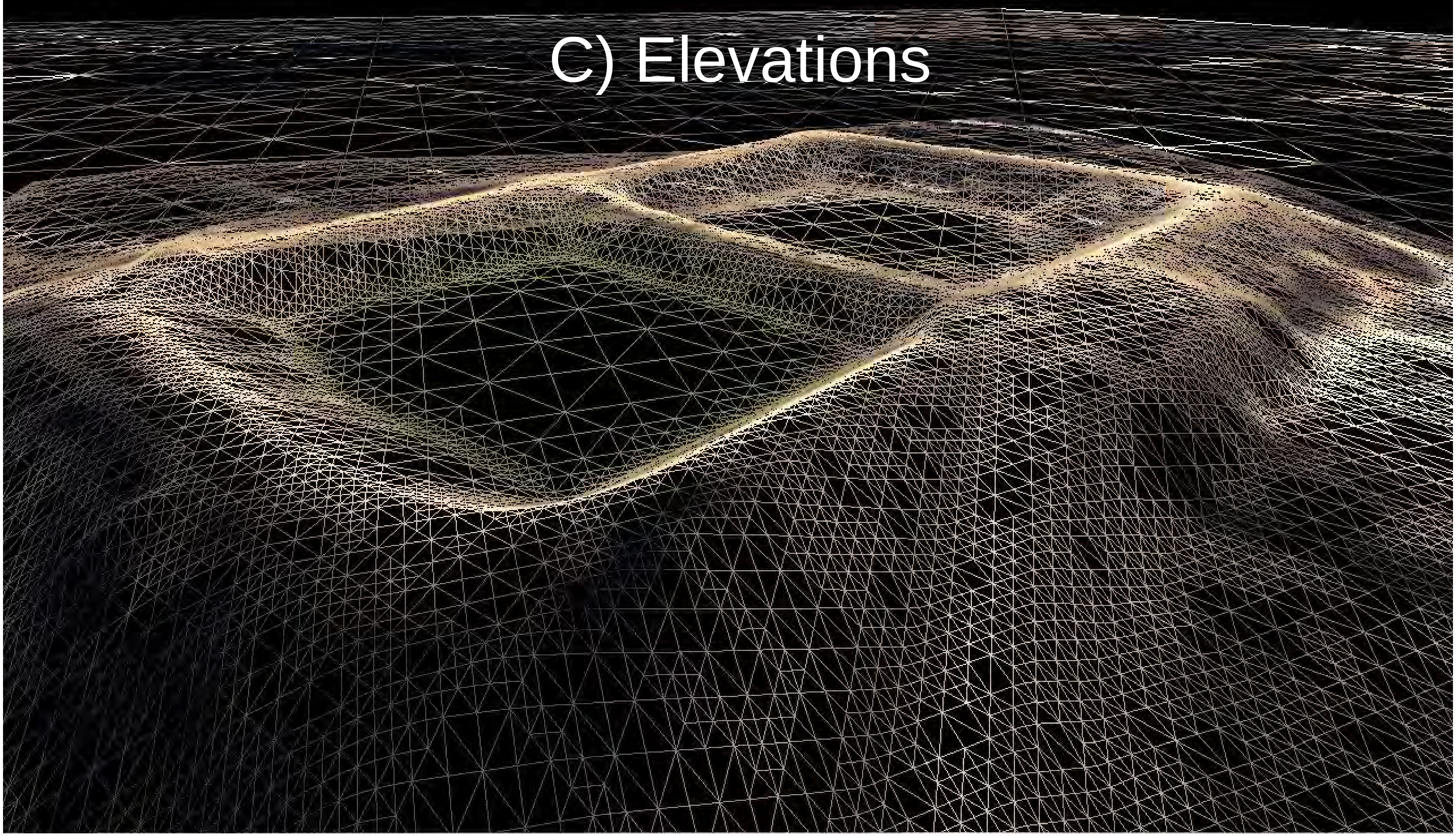
NRG Energy, Inc.

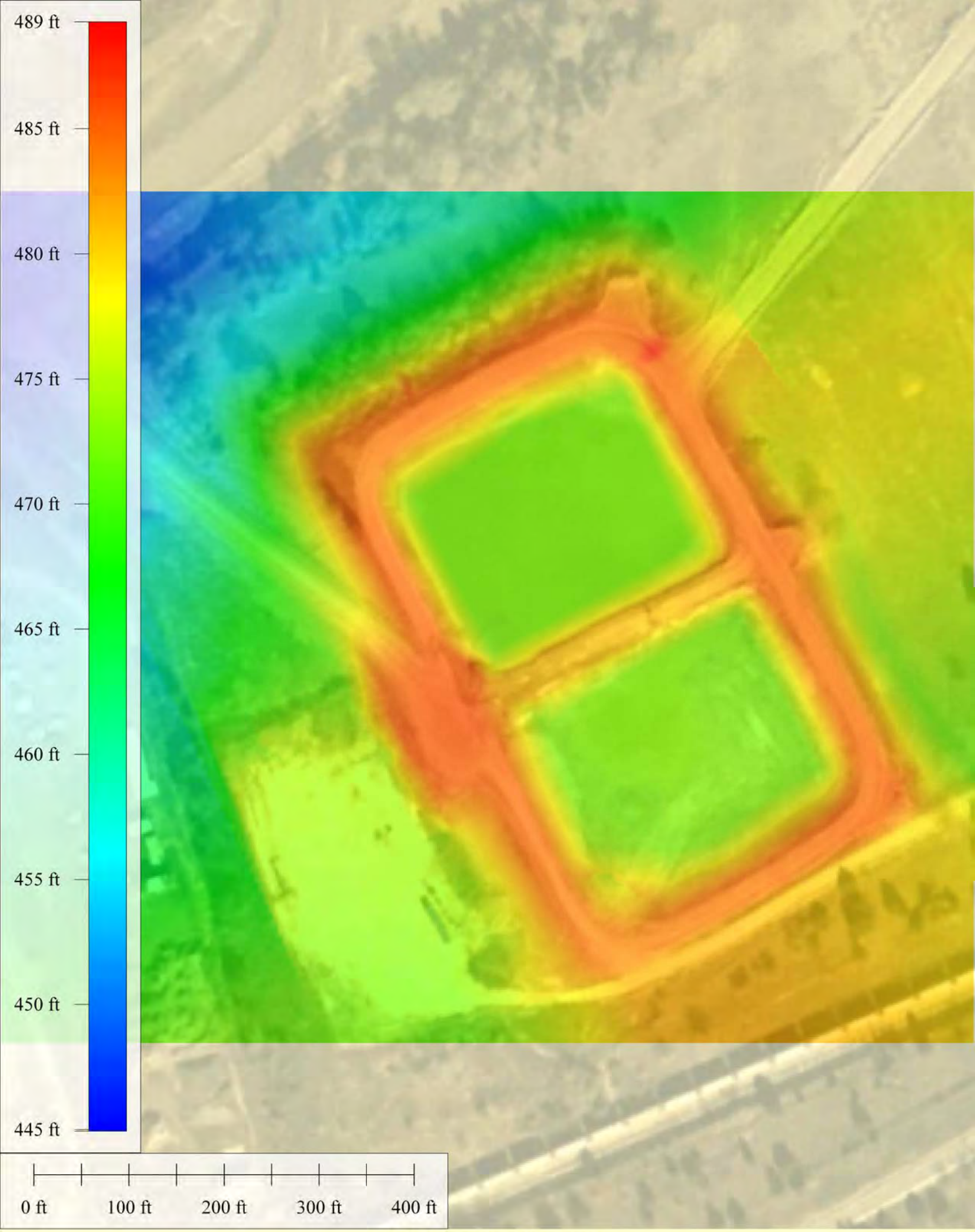
ST-18
Width Cross Section
Section Cutout
N-N'

DRAWING NO.
SHEET 202
FILE: LMS

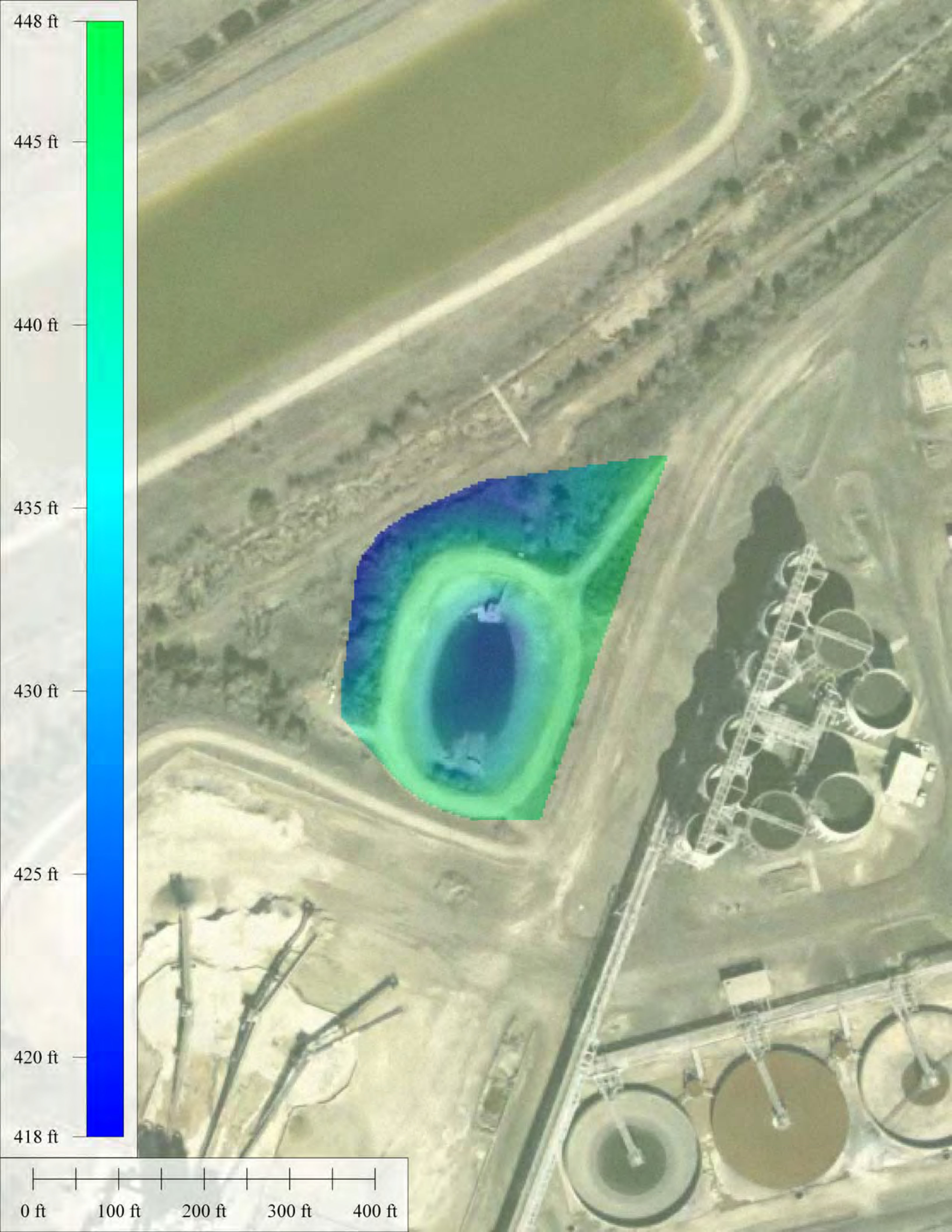
Section 3

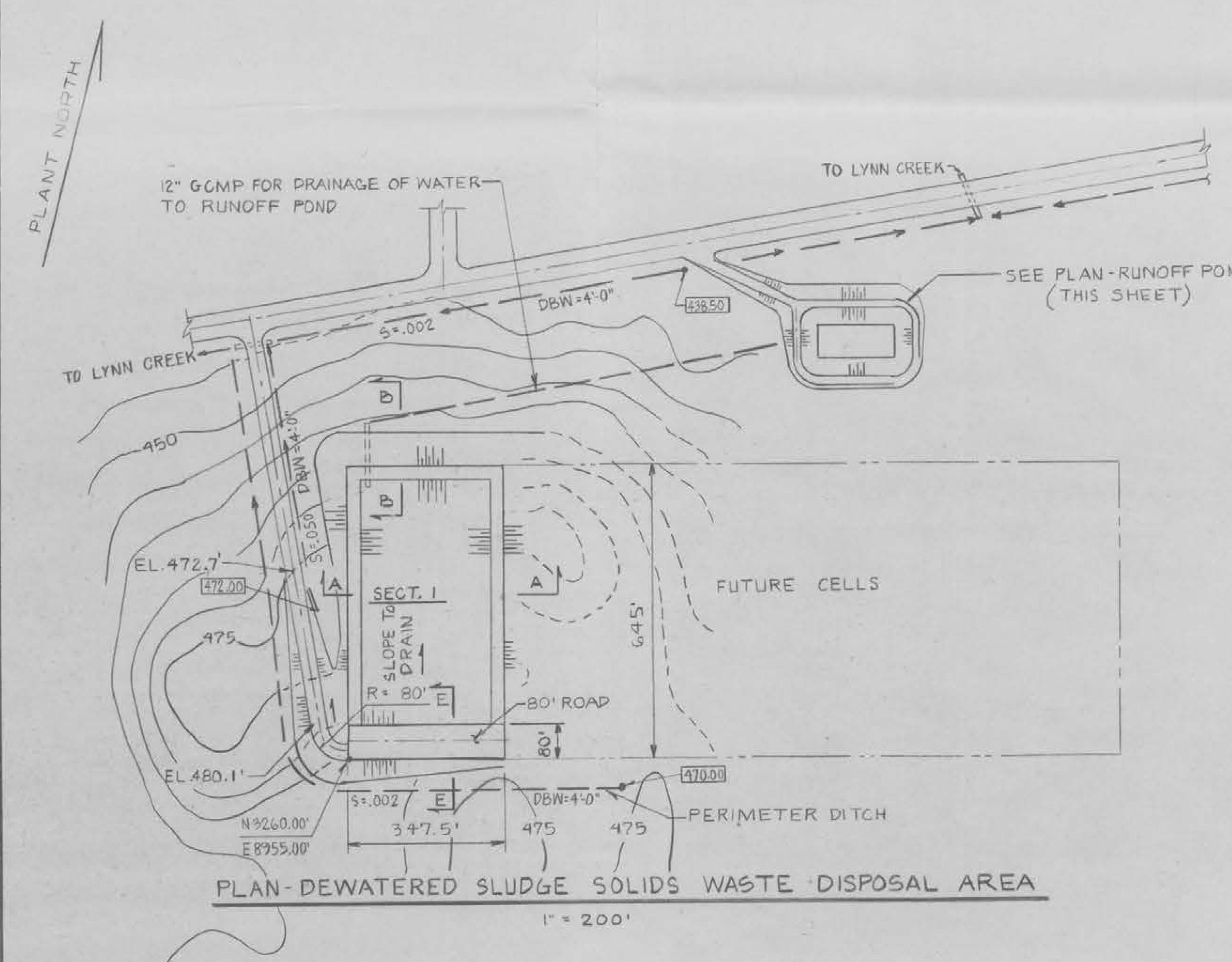
C) Elevations





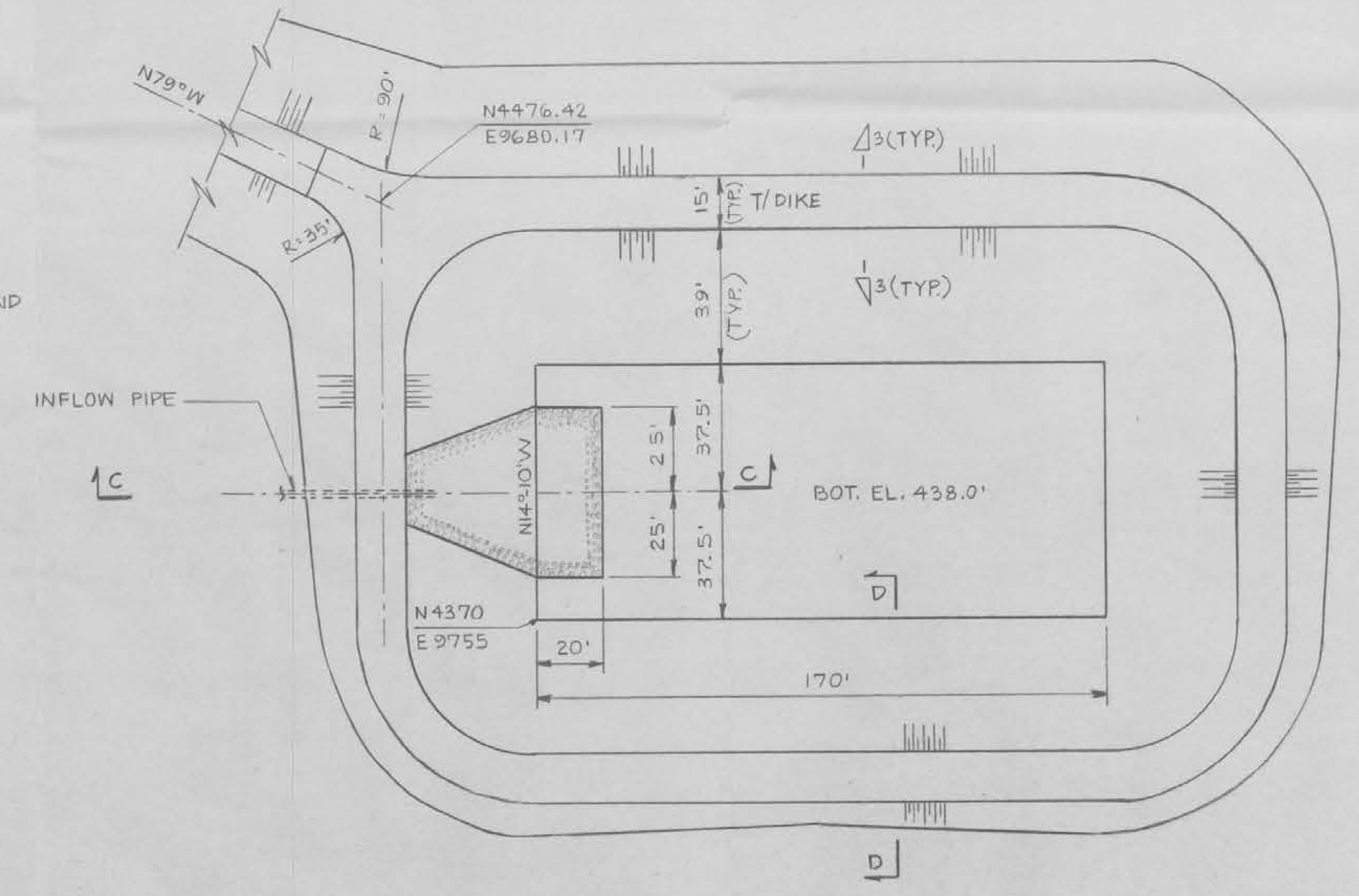
Left click to start adding points.


448 ft
445 ft
440 ft
435 ft
430 ft
425 ft
420 ft
418 ft
0 ft
100 ft
200 ft
300 ft
400 ft



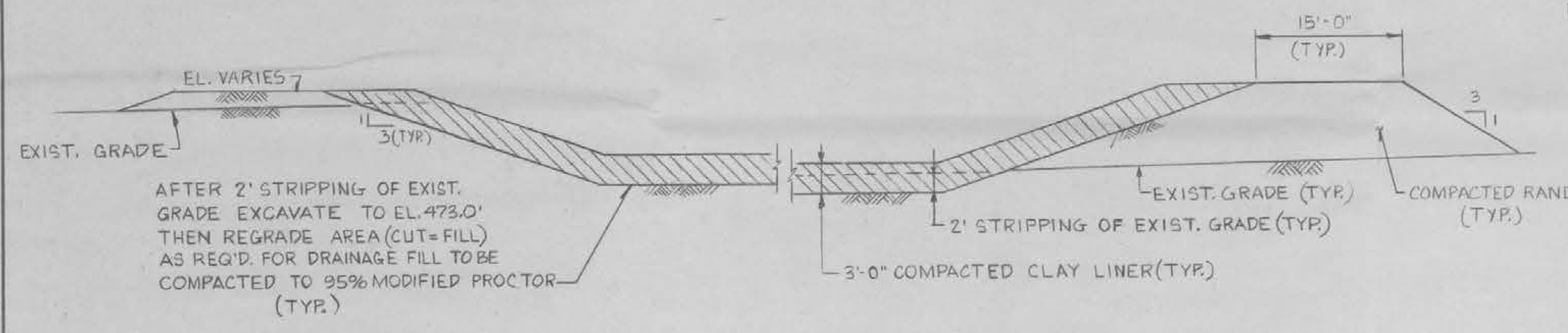
PLAN-DEWATERED SLUDGE SOLIDS WASTE DISPOSAL AREA

1" = 200'



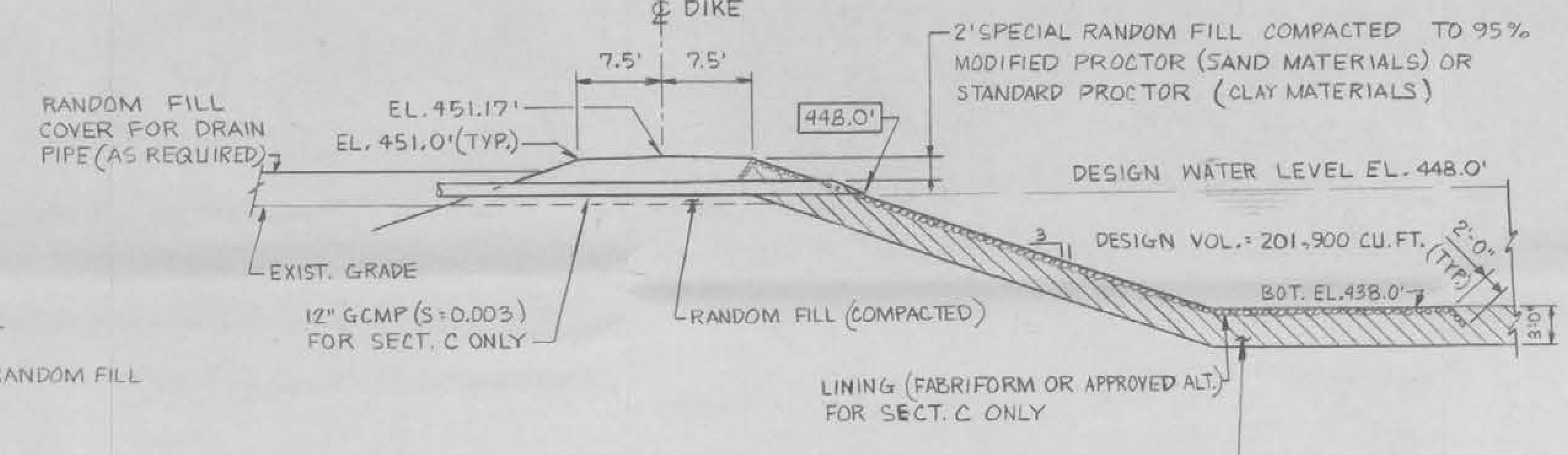
PLAN-RUNOFF POND

1" = 30'



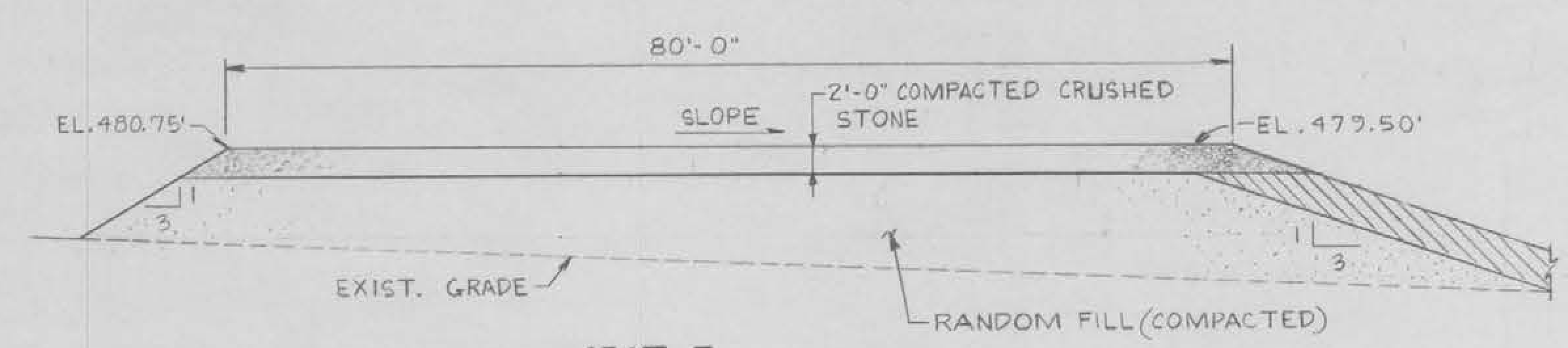
SECT. A

1" = 10'



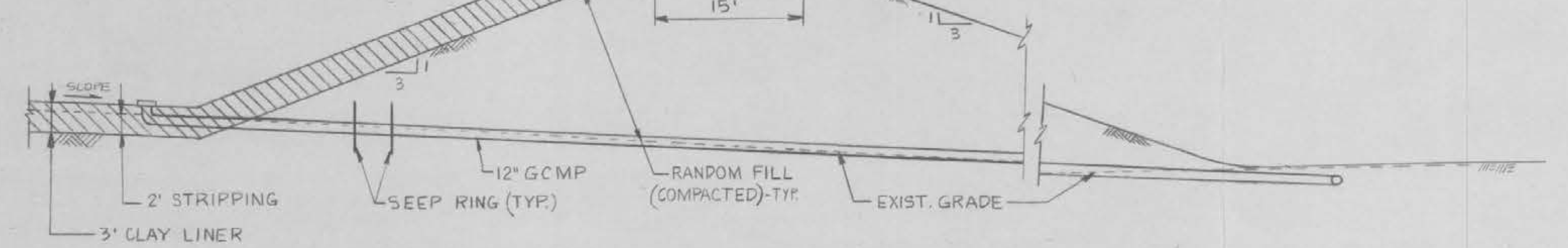
SECT. C AS SHOWN
SECT. D SIMILAR

1" = 10'



SECT. E

1" = 10'-0"



NOTE: FOR ADDITIONAL INFO. SEE SECT. A (THIS SHEET)

SECT. B

1" = 10'

NOTES:

Clay for liner shall be free of muddy material, organic matter, rubbish, debris or other unsuitable materials In addition, the following placement and material requirements shall be met.

1. Placement

   A. The area where the liner is to be placed shall be cleared and prepared such that the subgrade shall be free of roots, stumps, branches, organics or other deleterious materials which could puncture, damage or otherwise inhibit the liner from functioning properly. The area shall then be loosened to a depth of 12 inches by discing and then compacted.

   B. The clay liner material shall be placed in lifts not to exceed 6 inches in thickness prior to compacting (U.O.N).

   C. Each lift shall be compacted to a minimum of 95% of the maximum density obtained in the standard Proctor Compaction Test.

   D. Successive lifts shall be made in accordance with the above until the liner thickness required on the drawing is obtained.

2. Material Requirements

Percent Passing #4 sieve	$\geq 85\%$
Percent Passing #200 sieve	$\geq 55\%$
Liquid Limit	≥ 30
Plasticity Index	≥ 15
Permeability	$<1X10^{-7}$ cm/sec

[- - -] = INVERT ELEV.

DBW = DITCH BOTTOM WIDTH

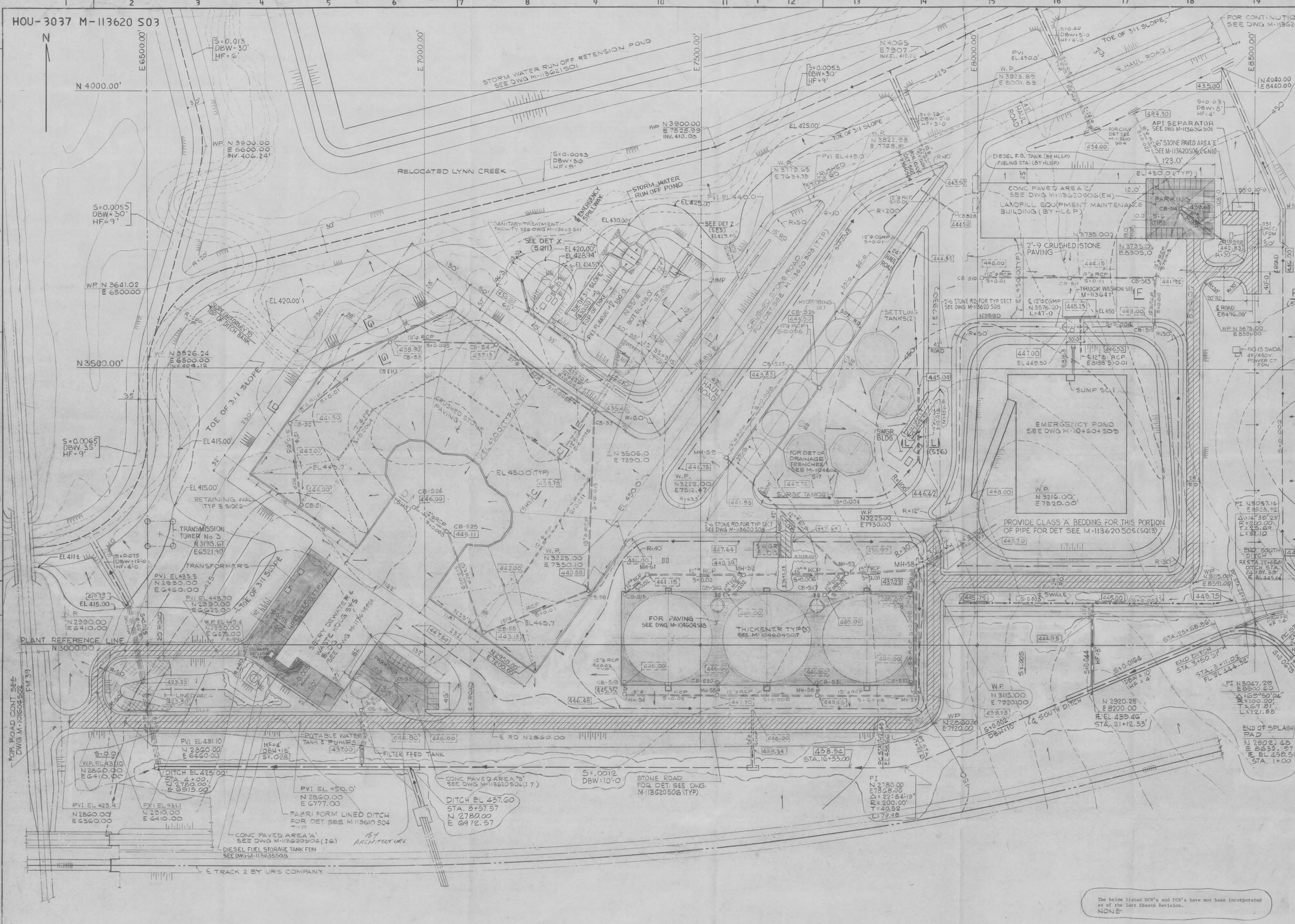
LIMESTONE ELECTRIC GENERATING STATION
S.W.D.A. DEWATERED SLUDGE SOLIDS
DISPOSAL AREA & RUNOFF POND
INITIAL GRADING SECT. I

HOUSTON LIGHTING & POWER CO.
HOUSTON, TEXAS

DRAWN 6-24-85	K.A. BRIDGES	SCALE: AS NOTED	
CHECKED 7-10-85	R.B. BLAND	SHEET 1 OF 1 SHEETS	
CORRECT 7-10-85	[signature]	DRAWING NUMBER	
APPROVED 7-10-85	[signature]	HEP-14037	

NO.	DATE	REVISION	BY	CH	COR	APP

HOU-3037 M-113620 S03



The below listed DCN's and FCN's have not been incorporated as of the last Ebasco Revision.
NONE

PLAN - SLUDGE STABILIZATION FACILITY

NO	DATE	REVISION	BY	CH	APPROVED
1	9-21-82	REV: (H12,H14) ROAD; (I7,I9) DRAINAGE; (G3) CREEK WIDTH; (D8,G4) LOC. OF SAN WASTE TREAT PLANT; (B19,I2,D19 THRU I19) DITCH; (E18,G9,J8) PIPE; (J4) HP EL; (D18,E15,E16,F17,I9,J8,J9,L10,L17) SLOPE & INV EL. ADD: (H12) DRAINAGE; (H14) SWGR BLDG; (C14) NOTE; (K2) LINED AREA; (J5, J12) DWG NO.; (L20) REF DWG; (K5) PIPE; (A16,B14,B17,K19,L2,L12,L14,M6) DITCH & COORD; (I11,I15,J15 THRU J18,K9) SLOPE & INV EL. DEL: (E13) NOTE N R	PSH	HM	JK
2	12-29-82	REV: DCN'S C-235, C-275, C-313 & FCN-059 INCORP.; (H6,H8,K10, J10~J14) DRAIN PIPE; (J14~J18, H14, D14, D2, C4, B4) DITCH; (G2,C9~C13) LYNN CREEK SLOPE & INV. (F8) SAN TREAT. FAC AREA; (G14, H13~H14) ROAD RAD & W.P. ADD: (H14) CULV; (F11) SUMP; (F11) NOTE-N.R.; (I3) TRANSMISSION TWR; (G20) NOTE. DEL: (F11) POND DISCHARGE & OVERFLOW PIPES; (H16) W.P.	B.F.	SKB	JK
3	5-16-83	DCN#C-534 & FCN#168 INCORP REV: (D14) CRUSHED STONE PVMT, (D14, E16,H18) LOC OF CULV; DIESEL FUEL STORAGE TK, (F18,I18) RC PAVED RD & COORD; (K9) DITCH, (I11) INV EL; (F9 TO I4) SLOPE EDGE & TOE LINE. ADD: (E23) DWG NO; (D19) CONC PAVED AREA 'E'; (I20) REF DWGS; (E9) ACCESS; (D15) CB-S28; (D19) RC PAVED RD. & COORD, CB-S29; (N20) SCOPING NOTE; (J3,M4) DIESEL FUEL STORAGE TK. DEL: (G18) GASOLINE TANK; (I19) EQUIP & FACILITY BY HL&P	PSH	HM	JK
4	6-29-83	ADD: (D9) EMERGENCY SPILLWAY; (N20) REF DWG. DEL: (K3,D10) NOTE-N.R.	BF	SKB	JK
5	12-9-83	DCN C-745, C-758, C-779 & C-797 INCORP. REV: ROAD PAVEMENT AS PER HL&P'S REQUEST; (E8) SAN TREAT FACIL; (E16) DRAINAGE; (C18,D16,F20) NOTE; (H15) DITCH INV. (J4) D.G ROOM SIZE. ADD: (E16) TRUCK WASHDOWN AREA; (E20,G20,I16,I11,E15) NOTES; (I14) DIM; (N20) REF DWG; (D19) 131 MCC FDN; (F19) POWER CT FDN; (K7,D18) NOTE-NR. DEL: (E20) QTY; (H16,I14) NOTE.	HM	SKB	JK
6	2-14-84	REV: (L11,N20) NOTE. DEL: (K7,D18) NOTE-NR	PSH	HM	JK

NOTES

FOR QUANTITIES SEE M-113620S05 & S06

FOR ROADS AND CONCRETE PAVING SEE NOTES ON DWG M-101604 S01.

ALL VERTICAL CURVES FOR ROADS TO BE 100' LONG.

GEODETIC EL 450.00' CORRESPONDS TO PLANT REFERENCE EL 100.00'.

TOP OF DITCH BANK TO BE AT LEAST 1'-0 ABOVE TOP OF FABRIFORM LINING (HF).

DENOTES 6" CRUSHED STONE ROAD OR PAVING

DENOTES CONCRETE PAVING

FOR HAUL ROAD DUST CONTROL PAVING SEE M-113620S07

FOR GRADING NOTES SEE DWG M-113600 S04

FOR DRAINAGE NOTES SEE DWG M-101600 S01

REFERENCE DRAWINGS:

BAR BENDING SCHEDULE	B-148620-130
ENLARGED SITE PLAN PLANT AREA (MECH)	M-001600
PLOT PLAN SH 3 (MECH)	M-001601S03
GRADING & DRAINAGE-GENERAL PLAN	M-101600S01
GRADING & DRAINAGE-PLANT AREA SECTS & DETS SH. 1	M-101602S01
ROADS - PLAN	M-101604S01
SITE - PLAN	M-101609
SWDA-GRADING PLAN	M-113600S04
SWDA-DRAINAGE PLAN	M-113610S03
SWDA-RAILROAD SPUR PLAN SECTS & DETS	M-113620S04
SWDA-SLUDGE STABILIZATION FACILITY DRAINAGE-SECTS & DETS	M-113620S05
SWDA-SLUDGE STABILIZATION FACILITY ROADS AND PAVING-PLAN, SECTS & DETS	M-113620S06
SWDA-HAUL ROADS PLAN	M-113620S07
SWDA-HAUL ROAD SECTS & DETS	M-113620S08
SWDA-RUNOFF POND AREA 1 PLAN, SECTS & DETS	M-113621S01
SWDA-DEWATERED SLUDGE SOLIDS DISPOSAL AREA-PLAN SECTS & DETS	M-113621S0[illegible]
AQCS SWDA DRAINAGE TRENCHES PLAN, SECTS, DETS	M-104604S17
SWDA DRAINAGE SECT & DET SH 1	M-113610S04
SWDA SECONDARY DEWATERING & WASTE HANDLING SYSTEM SH 1	M-113635S01
AQCS-SWDA THICKENER FOUNDATION SH 1	M-104604S01
SWDA-SANITARY TREATMENT FACILITY	M-113605S01
SWDA-API SEPARATOR-MASONRY	M-113636S01
SWDA-API SEPARATOR AREA MISC EQUIP FDNS	M-113636S03
SWDA-STORM WATER RUN OFF POND STACK AREA SUMP STRUCTURE	M-113622S01
AQCS SWDA THICKENER AREA PAVING PLAN, SECTS & DETAILS	M-104604S18
HYDROBIN SWGR BLDG - PLAN & SECT (HVAC)	M-057789

ALL WORK BY
SWDA FDN CONTRACTOR
EXCEPT AS NOTED

NO	DATE	REVISION	BY	CH	APPROVED
7	9-7-84	FCNS 068, 126 & 262 INCORP. REV: (L2~L15) DRAINAGE DITCH; (K4) TANK LOC & GRADING; (K14~K19) GRADING & DRAINAGE DITCHES. (J15, J17, J18) DITCH EL & SLOPE. ADD: (P13, N16) NOTES DEL: (J16) CATCH BASIN TRANSFER REVISION TO HL&P	VP	SKB	JK
8	5-1-85	ADDTNL. ROADS INCORP.			

After Rev 7, dated 9/7/84 to this drawing, full responsibility for the maintenance of this drawing and for subsequent modifications made or required to be made to this drawing is assumed by Houston Lighting and Power Company (HL&P). Ebasco Services Incorporated has no responsibility for maintenance and modifications after said drawing revision number. All Design Change Notices (DCN's) and field originated changes which have been considered for the current or prior revisions of this drawing are identified in the drawing revision block. All DCN's and those field originated changes identified to Ebasco, which have not yet been incorporated on this drawing, have been identified by drawing note.

REV	DATE	CONSTRUCTION CONTRACT ISSUES	BY
		PBOA AWARD	
		PBOA BID	
		FUG AWARD	
		FUG BID	
		SITE PREP AWARD	
1A	8-26-82	SITE PREP BID EAST	PSH

WORK THIS DWG WITH DWGS M-113610S03, M-113620S05 & M-113620S06.

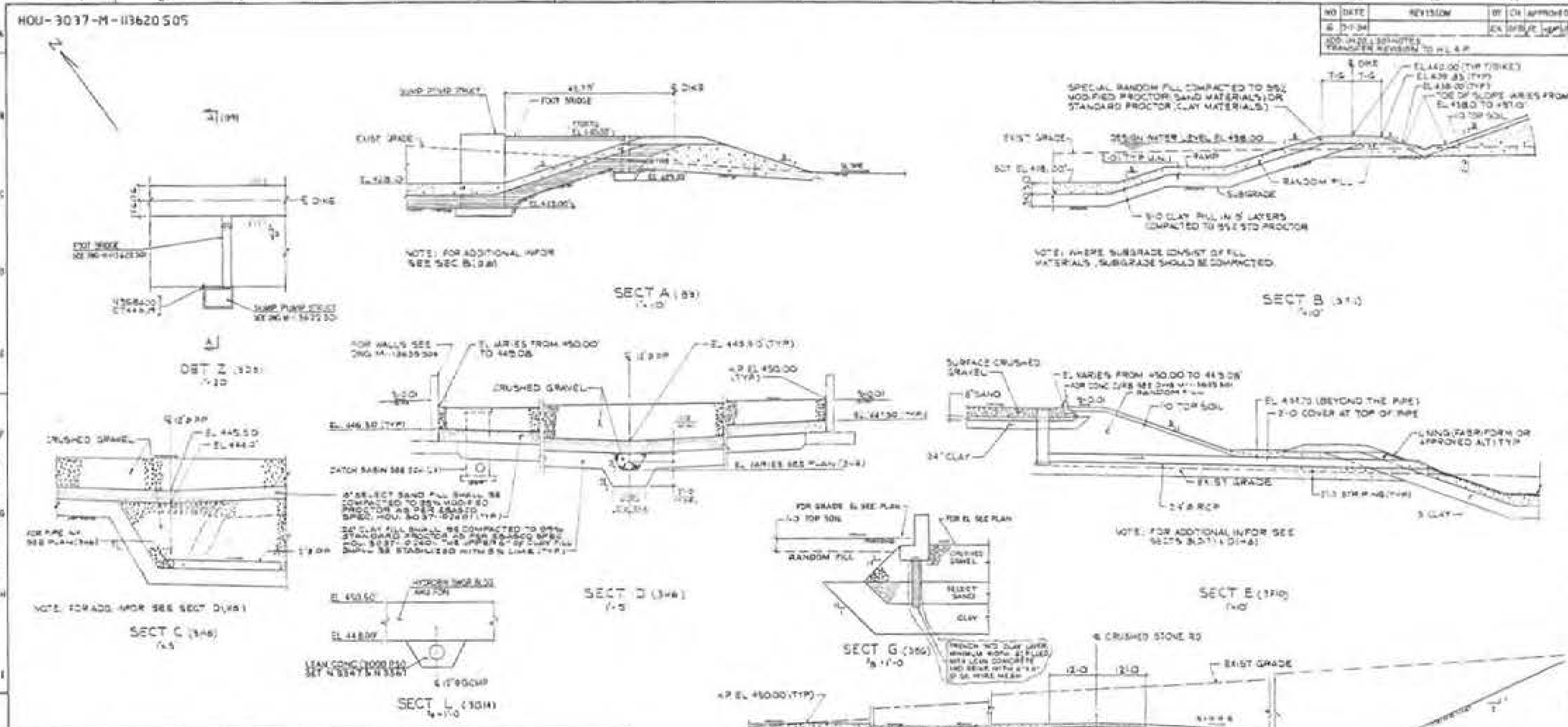
HOUSTON LIGHTING & POWER CO.
LIMESTONE ELECTRIC GENERATING STATION
UNIT 1, 750 MW 1985 INSTALLATION
UNIT 2, 750 MW 1986 EXTENSION

SOLID WASTE DISPOSAL AREA
SLUDGE STABILIZATION FACILITY
ROADS, PAVING & DRAINAGE - PLAN

EBASCO SERVICES INCORPORATED

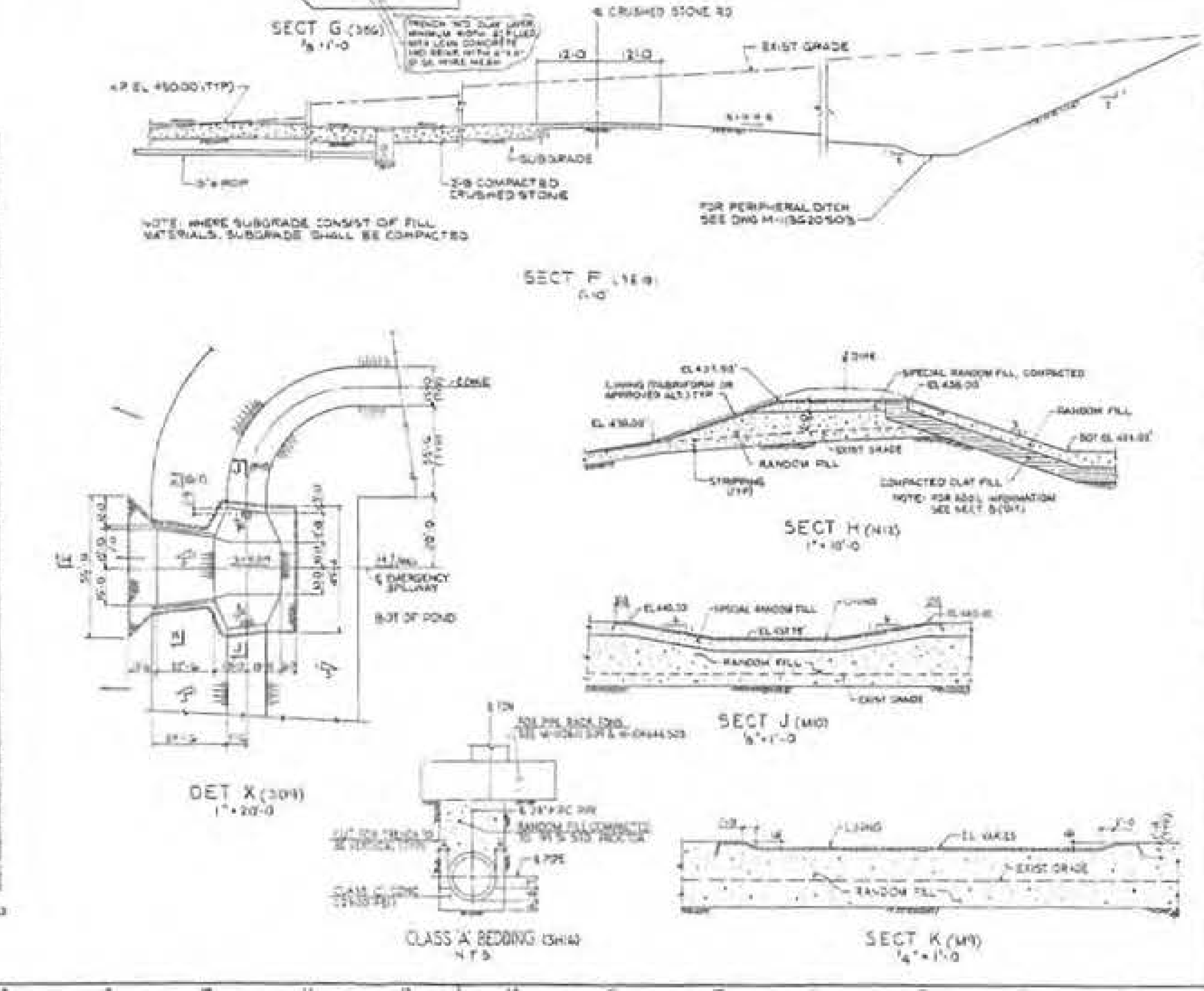
SCALE 1"=60'	APPROVED	DATE Apr/26/1982
DIV. CIVIL		HOU-3037
DR. FRAISTAT, OMID		M-113620 S03
CH P.S. HUANG	SKB JK	

HOU-3037-M-113620 505



MARK	TYPE	H.P. LOCATION NORTH	H.P. LOCATION EAST	FRAME & COVER TYPE	TOP EL	DEPTH D	BASE BOT EL	R/C PIPE DIA	R/C PIPE LENGTH	REINFORCING V BARS	REINFORCING H BARS	REMARKS
CB-S1	1	3046.82	6788.0	A	449.50	6.67	441.83	36"	4'-0	—	—	
CB-S2		3200.19	6757.17			6.47	439.83		6'-0	—	—	
CB-S3		3553.50	6945.46			7.67	435.83		15'-0	—	—	
CB-S4		3549.88	7136.39			4.67	433.83		14'-0	—	—	
CB-S5		3070.63	7107.35			8.67	439.83		8'-0	—	—	
CB-S6	1	3086.12	7296.18			10.67	437.83	36"	10'-0	—	—	
CB-S7	3	3478.53	7312.71			4.21	434.73	-	-	30-AC401'6	36-AC403'6	
CB-S8	1	2950.00	6950.00			6.67	443.83	36"	4'-0	—	—	
CB-S9		1551.00	6988.00		449.50	6.57	441.83		8'-0	—	—	
CB-S10		3661.00	8007.00		449.70	6.67	444.03		4'-0	—	—	
CB-S11		3661.00	8161.00			5.67	443.03		5'-0	—	—	
CB-S12		3578.00	8320.00		446.00	4.67	440.83		4'-0	—	—	
CB-S13		3661.00	8318.00		449.28	7.67	440.03		8'-0	—	—	
CB-S14		3790.00	8166.00		444.70	10.67	433.03		13'-0	—	—	
CB-S15		3083.00	7358.00		449.50	6.67	443.83		4'-0	—	—	
CB-S16		3093.00	7544.00							—	—	
CB-S17		3093.00	7728.00							—	—	
CB-S18		3093.00	7881.00							—	—	
CB-S19		2830.00	7359.00							—	—	
CB-S20		2930.00	7130.00							—	—	
CB-S21		2830.00	7710.00							—	—	
CB-S22		2850.00	7881.00		449.50		443.93			—	—	
CB-S23		3075.00	8200.00		447.15		442.98			—	—	
CB-S24		3160.00	6580.00		449.40	6.67	444.23		4'-0	—	—	
CB-S25		1508.33	7243.00		449.40	6.67	341.73		6'-0	—	—	
CB-S26		3463.14	7713.93		446.83	4.67	441.66		4'-0	—	—	
CB-S27		1486.22	7679.68		446.73	4.67	441.56		4'-0	—	—	
CB-S28		3750.00	7960.00		449.83	6.67	442.08		6'-0	—	—	
CB-S29	1	3724.00	8450.00	A	449.30	8.07	439.63	36"	9'-0	—	—	
MH-S1	1	3177.20	7402.00	B	449.50	6.67	442.33	36"	6'-0	—	—	
MH-S1	1	3127.30	7578.00			9.67	438.33	36"	10'-0	—	—	
MH-S3	2	3120.30	7756.00			25	437.92	-	—	32-AC402'6	36-AC403'6	
MH-S2	1	2773.00	7359.00			6.67	442.33	36	6'-0	—	—	
MH-S5	1	2913.00	7530.22			10.67	438.33		10'-0	—	—	
MH-S6		2913.00	7710.00			13.67	435.33		10'-0	—	—	
MH-S7	1	2913.00	7850.00			11.67	436.33	36"	13'-0	—	—	
MH-S5	2	3127.00	7883.00			11.77	433.98	-	—	32-AC402'6	36-AC403'6	
MH-S8	1	2837.81	7849.00	B	449.50	6.67	442.33	36"	5'-0	—	—	

* FOR DETAILS OF CATCH BASINS & MANHOLES SEE DRAWING M-10160 2 502
REBAR MARKS AC403 AC404 AC405, AC406 AC407 AND AC408 CORRESPOND TO 4106 4105 4106 4107 4101 AND 4103 RESPECTIVELY AS SHOWN ON M-10160 2 502



NO	DATE	REVISION	BY	CH	APPROVED
6		ADD M-20 & 30 NOTES TRANSFER REVISION TO H.L.&P.			

NO	DATE	REVISION	BY	CH	APPROVED
1		FINAL			
2		REV. DCN NOS. C-355, C-372 & C-313 INCORP.			
3		DCN C-334 & FCN ... INCORP. ... SECT D, ADD NOTES ...			
4		[illegible]			
5		DCNS C-378 & C-391 INCORP. ...			

QUANTITIES (NET BY FIELD UNLESS NOTED)

CONCRETE CLASS "A" (3500 PSI)	45 CU YD
CONCRETE CLASS "C" (1500 PSI)	7 CU YD
CONCRETE CLASS "D" (3000 PSI)	17 CU YD
FOR REINF STEEL SEE BAR BENDING SCHEDULE S-[illegible]	
30" FRAME & PLANE GRATING ROAD TYPE (FLOCKHART A2-H-6-972 OR APPRD ALTERNATE)	17 REQ
30" FRAME & COVER ROADWAY TYPE (FLOCKHART A2-H-6-971 OR APPRD ALTERNATE)	8 REQ
36" PRECAST R/C PIPE - CLASS 3	244 FT
24"	270 FT
21"	315 FT
18"	1050 FT
15"	1135 FT
12"	1247 FT
12" PERFORATED PIPE (CONC.)	1000 FT
60" CORRUGATED ... BITUMINOUS COATED	683 FT
24"	182 FT
18"	30 FT
15"	167 FT
CRUSHED STONE	15,000 CU YD
SAND FILL	11,000 CU YD
CLAY FILL	11,000 CU YD
LINING (FABRIFORM W/ FILTER POINTS 3.5" OC OR APPROVED ALTERNATE)	7471 CU YD
RANDOM FILL	3500 CU YD
SPECIAL RANDOM FILL	300 CU YD

NOTES:
FOR NOTES AND ADDITIONAL REFERENCE DRAWINGS SEE DWG M-113620 503
GEODETIC EL 450.00 CORRESPONDS TO PLANT REFERENCE EL 100.00
FOR GALV CORRUGATED METAL PIPE NOTES SEE DWG M-113610 504
ALL GALV CORRUGATED METAL PIPES TO BE BITUMINOUS COATED UNLESS NOTED OTHERWISE

REFERENCE DRAWINGS:
FGDS PIPE RACK FDNS SH 3 — M-104646 503
YARD PIPE SUPPORTS FDN SH 9 — M-112611 509

NONE

SEE DWG M-113620 501 FOR LIMITS OF SCOPE OF WORK

REV	DATE	CONSTRUCTION CONTRACT ISSUES	BY
		PROA AWARD	
		PROA BID	
		FUG AWARD	
		FUG BID	
		SITE PREP AWARD	
4	5-31-82	SITE PREP BID & AST	PHH

ST-18

HOUSTON LIGHTING & POWER CO.
LIMESTONE ELECTRIC GENERATING STATION
UNIT 1, 750 MW 1985 INSTALLATION
UNIT 2, 750 MW 1986 EXTENSION
SOLID WASTE DISPOSAL AREA
SLUDGE STABILIZATION FACILITY
DRAINAGE - SECT'S & DET'S
EBASCO SERVICES INCORPORATED

HOU-3037
M-113620 505

Project Identification
No. HOU-3037-102200

HOUSTON LIGHTING & POWER COMPANY
LIMESTONE ELECTRIC GENERATING STATION
UNIT 1, 750 MW 1985 INSTALLATION
UNIT 2, 750 MW 1986 EXTENSION

CIVIL DESIGN CRITERIA
CDC - 2
SITE INVESTIGATIONS, EXCAVATION,
AND FOUNDATION DESIGN PARAMETERS

Status	Date	Prepared By	Reviewed By	Pages Affected
Original	2/28/80	W Broderick	A A Toth	
R1	1/22/81	D Broderick DB	A A Toth	1,2,4,5,6,7

EBASCO SERVICES INCORPORATED
NEW YORK, NEW YORK

TABLE OF CONTENTS

1.0 GENERAL DESCRIPTION

At the beginning of a project, a subsurface investigation program is designed to evaluate the proposed power plant site in relation to the soil and/or rock materials which are present and what properties they possess. This knowledge is gained partly by reference to geologic and engineering literature, but mainly by extracting, examining, and testing representative samples.

The site investigation program, then, consists of drilling borings and obtaining soil and/or rock samples. Based on the information obtained from the boring logs and the laboratory testing of selected samples, foundation profiles are developed under all plant related structures including main plant structures, coal storage and handling facilities, solid waste disposal areas, and cooling tower basins. The design data required for plant grading, foundation type, slope stability analysis, seepage analysis, embankment design, and borrow area definition is developed. 1

2.0 DESIGN BASIS

2.1 Subsurface Investigations

The subsurface investigation is performed in two phases. Phase One is a preliminary exploration program while Phase Two is a more detailed boring and sampling program. Each phase includes field and laboratory testing for classification and strength determinations of in-situ materials.

2.1.1 Preliminary Exploration

The program is preceded by a fact-finding survey to determine available information on soil conditions near the site and on the behavior of other structures in the vicinity. This includes, but is not limited to, maps and publications of state and federal geological surveys or reports of soil surveys prepared in connection with agriculture or highway construction, technical journals and published reports.

The boring program consists of 10 to 20 borings in the main plant area and 30 to 40 borings in the remaining areas on the site, depending on the extent of the solid waste disposal area requirements. R1

Most soil deposits can be appropriately explored by means of a split-barrel sampler and standard penetration tests carried out in holes made by wash-boring methods. The properties of fairly uniform deposits of soft clay and plastic silt are investigated by field vane tests or by obtaining continuous samples in thin-walled tubes and performing appropriate laboratory tests. Erratic deposits are examined by means of standard penetration tests combined with enough tube borings to permit interpretation of the penetrometer data. Standard penetration tests are appropriate for sands. Rotary or percussion core barrels are normally used to sample rock, and special peat samplers are available for highly organic deposits.

2.0 DESIGN BASIS (Cont'd)

2.1 Subsurface Investigations (Cont'd)

2.1.1 Preliminary Exploration (Cont'd)

The boring logs show pertinent data, such as soil classifications, standard penetration blow counts, and ground water elevations, as observed during drilling operations. Samples are also taken in the bedrock. The core recovery and Rock Quality Designation (RQD) values are shown on the boring logs.

This phase of investigation program also includes the development of generalized geologic conditions, topographic surveys, including aerial photographs and detailed contour maps.

The information obtained from the Phase One boring program is utilized to assess general characteristics of various strata and to determine siting of the plant structures, solid waste disposal areas, and other facilities. R1
Possible borrow area locations are also identified.

2.1.2 Detailed Exploration

The detailed subsurface investigation program includes borings at the location of all the major plant structures, the coal storage and coal handling areas, R1
the solid waste disposal areas and the make-up water pipeline corridor. The drilling and sampling techniques employed during Phase Two are similiar to that developed during Phase One.

The Phase Two drilling and soil sampling program more fully defines the various strata, groundwater information and quality of deposits. It establishes the location and extent of borrow areas for the various soils used in embankments, determines strength and settlement properties, and established permeability values for in-situ and recompacted soils.

If the borings encounter rock and the conditions are such that the structures may be founded on rock, cores are obtained to make sure that sound bedrock, rather than a boulder or a piece of detached rock, has been reached. If there is evidence of solution channels or deep weathering, the cores should be continued into sound bedrock.

As the exploratory program develops, it may be advisable to obtain large-diameter undisturbed samples from critical strata, to conduct load tests, to construct test pits, to make field pumping tests or to conduct other special tests.

Sufficient data should be obtained to permit consideration of various practical foundation types and for the possibility that there may be changes in preliminary structural layouts, including column spacing and loadings.

2.0 DESIGN BASIS (Cont'd)

2.1 Subsurface Investigations (Cont'd)

2.1.3 Laboratory Tests

The laboratory tests performed on representative undisturbed and recompacted samples include but is not limited to:

- classification tests, such as water content, grain size analysis, Atterberg limits, specific gravity, void ratio and density;
- permeability;
- relative density;
- strength determinations, such as unconfined compression, direct shear and triaxial shear;
- and consolidation.

2.2 Foundations

Based on subsurface investigation data, a technical and economic evaluation is performed to determine the type of foundation to be used for the plant. The normal approach to foundation determination for the plant structures is to select a single type of foundation concept for each site. However, based on economic evaluations, different types of foundations for the various structures may also be considered.

The following types of foundations are considered:

- pile foundations with individual pile caps;
- mat foundations on controlled compacted backfill;
- mat foundations on in-situ soils;
- mat foundations on piles;
- individual spread footings on controlled compacted backfill;
- individual spread footings on in-situ soils
- concrete caissons.

The principal considerations in designing pile foundations are:

- the probable relative depths, characters, consistencies and load carrying capabilities of the various strata.

2.0 DESIGN BASIS (Cont'd)

2.2 Foundations (Cont'd)

- Selection studies, by means of an adequate dynamic pile-driving formula, for suitable types of piles and driving equipment.
- A study of the static-friction values required to be developed, in the strata selected for load carrying, based on the embedded surface areas of pile.

If a pile foundation is selected, the type of piling and its load carrying capacity is verified by a pile test program. The types of piles considered are: step tapered piles; tube piles and mandrel piles. R1

The principal considerations in designing plant structures supported by controlled compacted backfill are: deep-seated settlement; placement; and compaction of the fill.

In general, the maximum allowable bearing capacity specified for the plant structures is 4,000 lbs/sq ft (psf) for dead plus live load and 6,000 psf for dead plus live plus wind (or earthquake) loads.

2.3 Dams, Dikes and Embankments

Stability must be considered in the design of all earth structures. The factors which affect slope stability include failure criteria, plant geometry, non-homogeneity of soil layers, tension cracks, dynamic loading or earthquakes, and seepage flow.

The slopes for all embankments are analyzed using both the slip circle analysis and the Army Corps of Engineers sliding wedge analysis. Allowable factors of safety range from 1.0 to 1.5 depending upon design conditions.

2.0 DESIGN BASIS (Cont'd)

2.3 Dams, Dikes and Embankments (Cont'd)

Seepage from the solid waste disposal areas is controlled by encapsulating all bottom ash in an impervious layer of stabilized sludge. The seepage is modeled using horizontal and vertical flow nets. Seepage from the pond is controlled to meet the criteria of the State agency responsible for review and approval of the plant ash pond. R1

3.0 CONSTRUCTION FEATURES

3.1 Foundations

The foundations for most plant structures are established below the surface of the selected plant grade. The natural terrain is first cleared and grubbed, then cut and backfilled, as required, to the design foundation grades. Shallow excavations can be made without supporting the surrounding material if there is adequate space to establish slopes at which the material can stand. The steepness of the slope is a function of the type and character of the soil or rock, the climatic and weather conditions, the depth of the excavation, and the length of time it must remain open. Sheeting and bracing may be required in certain areas and conditions where vertical cuts are inappropriate.

When the depth of excavation is greater than the distance to the free water surface in a pervious soil having a coefficient of permeability greater than about 10^{-3} cm/sec, the soil must be drained to permit construction of foundations in the dry. If the coefficient of permeability of the soil is within the range of 10^{-3} to 10^{-5} cm/sec, the quantity of water that seeps into the excavation may be inconsequential but drainage may still be required to maintain the stability of the sides and bottom of the excavation. If the coefficient of permeability is smaller than about 10^{-7} cm/sec, the soil is likely to possess sufficient cohesion to overcome the influence of the seepage forces and major drainage may not be required.

The most suitable materials for backfilling are well-graded sands and gravels, possibly containing a small percentage of fines. However, most inorganic soils are acceptable with the exception of highly plastic swelling clays and clays at natural moisture contents well above the Standard Proctor optimum in localities where the climatic conditions preclude drying by manipulation and exposure to the atmosphere. Cohesionless silts and very fine uniform sands are also undesireable because they are difficult to compact.

Fill is placed in layers, not thicker than 12 inches after compaction and compacted to 95 percent of the maximum Modified Proctor density by equipment suited to the type of soil. The placement moisture content should be close to the optimum value corresponding to the type of soil and compaction procedures being used. In-situ soils are to be proof-rolled prior to placement of fill or construction of foundations.

3.0 CONSTRUCTION FEATURES (Cont'd)

3.1 Foundations (Cont'd)

Exterior footings must be carried below the frost level. Footings, piles, piers must be carried into the fill or the natural ground until adequate support was found. In the case of pile foundations, a pile load test will be conducted.

3.2 Dams, Dikes and Embankments

The solid waste disposal area embankments are constructed from flue gas desulfurization sludge mixed with fly ash to form stabilized sludge. The design of the solid waste disposal area embankments are in compliance with the published regulatory requirements and codes. R1

The embankment slopes are designed and constructed as a function of stability and material requirements. The required soil compaction criteria for dams, dikes, and embankments is 95 percent of the maximum Standard Proctor density. All exposed slopes are covered with topsoil and seeded to provide erosion protection. Additional slope protection is provided if required, based on the wave run-up analysis.

A monitoring program is established to measure settlement, seepage horizontal movement, groundwater levels and quality. Data is obtained before the start of construction, during construction, and during plant operation.

In zoned embankments, the impervious core or liner, required for seepage control, is generally constructed from the soils obtained at the site, however, in some cases, synthetic material liners are also used. The impervious core or liner is adequately tied into an impervious in-situ clay strata or treated impervious strata which covers the entire pond area.

4.0 REFERENCES

4.1 Codes and Standards

American Society for Testing and Materials (ASTM)

4.2 Ebasco Specifications

Ebasco Specifications	HL&P No.	
Clearing & Grubbing	HOU-3037-101400	
Subsurface Investigation & Drilling	HOU-3037-102400	
Excavation & Backfill	HOU-3037-102401	
Solid Waste Disposal System	HOU-3037-102408	R1
Pile Test Program	HOU-3037-102410	
Piling	HOU-3037-102412	

APPENDIX B

Project Identification
No. HOU 3037 - 102408

EBASCO SERVICES INCORPORATED

EBASCO SPECIFICATION NO. ____

SOLID WASTE DISPOSAL

SYSTEM

PURCHASER:	HOUSTON LIGHTING & POWER COMPANY
OWNER:	HOUSTON LIGHTING & POWER COMPANY
OPERATING COMPANY:	HOUSTON LIGHTING & POWER COMPANY
PROJECT:	LIMESTONE ELECTRIC GENERATING STATION
UNIT NO:	1 & 2 NOMINAL MW 1500 (TOTAL)
LOCATION:	LIMESTONE COUNTY, TEXAS

Specification Status	Date	Prepared By	Reviewed By	Pages Affected
Original	9/29/81	V Bolano VB	W Petroski	
R1	11/30/81	V Bolano VB	W Petroski	i,1,3,4,5,6,7,8,9,10,11
R2				
R3				
R4				

EBASCO SERVICES INCORPORATED

EBASCO SPECIFICATION

SOLID WASTE DISPOSAL SYSTEM

CONTENTS

1.0 Scope

1.1 General

The solid waste disposal system includes:

.11 Two bottom ash and stabilized solids disposal areas, designated as areas 1 and 2, including two runoff ponds

.12 A dewatered sludge solids waste disposal area with a runoff pond R1

.13 Stabilization facility

.14 Emergency pond R1

.15 Equipment maintenance area

The location of the above mentioned is shown on the following Ebasco drawing: M-001601S03 Plot Plan

1.2 Site Specific R1

This specification covers the site preparation, construction, and reclamation of the solid waste disposal system. The work includes, but is not restricted to, the following items:

.21 Construction sequencing for bottom ash and stabilized solids disposal areas, and dewatered sludge solids waste disposal area R1

.22 Liner requirements for bottom ash and stabilized solids disposal areas, dewatered sludge solids waste disposal area, runoff ponds, and emergency pond

.23 Drainage system including ditches, dikes, and pipelines

.24 Haul roads for bottom ash waste disposal areas R1

.25 Testing requirements for proposed stabilized sludge liner

.26 Groundwater monitoring

.27 Ground preparation for soil bearing foundations

It is not Purchaser's intent to specify all the technical requirements nor set forth those requirements adequately covered by applicable codes, specifications, and standards. Contractor shall furnish high quality work and materials to meet the requirements covered in this specification.

In addition to the general requirements of this specification, additional specific requirements pertaining to clearing, grubbing, and excavating in Ebasco Specifications "Clearing and Grubbing" (HOU-3037-101400) and "Excavation, Backfill, Filling, and Grading" (HOU-3037-102401) shall also apply.

2.0 Codes, Specifications and Standards

2.1 General

.01 Material and services furnished in accordance with this specification shall comply with the codes, specifications and standards listed in Paragraph 2.2. Later editions may be used by mutual consent in writing between Contractor and the Purchaser.

.02 Any conflict between this specification and the referenced codes, specifications and standards shall be immediately brought to the Purchaser's attention for written resolution.

2.2 Listing

ASTM - American Society for Testing and Materials

D-422-72	Standard Method for Particle - Size Analysis of Soils
D-423-72	Standard Test Method for Liquid Limit of Soils
D-424-71	Standard Text Method for Plastic Limit and Plasticity Index of Soils
D-698-78	Standard Test Methods for Mositure-Density Relations of Soils and Soil-Aggregate Mixtures using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop
D1140-71	Standard Test Method for the Amount of Material in Soils Finer than the No. 200 (75-mm) Sieve
D1556-74	Standard Test Method for the Density of Soil in Place by the Sand-Cone Method
D1557-78	Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
D2167-77	Standard Test Method for Density of Soil in Place by the Rubber - Balloon Method
D2216-80	Standard Test Method of Laboratory Determination of Moisture Content of Soil
D2435-70	Standard Method of Test for One-Dimensional Consolidation Properties of Soils
D2850-70	Standard Method of Test for Unconsolidated, Undrained Strength of Cohesive Soils in Triaxial Compression

D2922-78	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D2937-76	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
D3017-78	Standard Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

OSHA – Occupational Safety and Health Administration

Regulation 29 CFR Part 1926 – Occupational Safety and Health Regulations for Construction (February 9, 1979)

Texas Highway Department Standard Specifications for Construction of Highways, Streets and Bridges, 1972

3.0 Reference Drawings

M – 104604S00	thru	S11	AQCS	FDN
M – 113600S01	thru	S03	SWDA	Grading
M – 113605S01	&	S02	SWDA	Sanitary System
M – 113610S01	thru	S06	SWDA	Drainage
M – 113620S01	thru	S08	SWDA	Road and RR
M – 113621S01	&	S02	SWDA	Runoff Ponds

4.0 Construction Sequencing of Waste Disposal Areas

4.1 General

During the initial construction phase, the stabilization facility, emergency pond, and equipment maintenance area shall be completed. The preparation of the initial cells to be used in both the bottom ash and stabilized solids disposal area 1, and the dewatered sludge solids waste disposal area shall be also completed, including associated runoff ponds, haul roads, and drainage systems. Following the start up of the plant a test section shall be designated in the bottom ash waste disposal area 1 cell to test the permeability and structural properties of the flue gas desulfurization solids stabilized with fly ash. R1

4.2 Bottom Ash and Stabilized Solids Disposal Areas

The development of the bottom ash waste disposal cells in both areas 1 and 2 shall continue on a sequential basis. As a particular cell is being filled, the clearing, grubbing, placement of the liner, and drainage system for the adjoining cell shall commence. During the filling of a cell, all surface runoff from the cell shall be directed by dikes to a pipe which will discharge to the area's runoff pond. After a cell has been completed, including final soil cover and seeding, the drainage system shall be changed and set by sloping the ground surface, as shown on Drawing HOU-3037-M-113600S04, so as to have all the runoff directed towards the permanent perimeter drainage system. R1

The filling of a particular cell in the bottom ash waste disposal areas shall proceed as follows: R1

.01 Clearing and grubbing as per Ebasco Specification "Clearing and Grubbing" (HOU-3037-101400) such that the subgrade shall be free of roots, stumps, branches, organics or other deleterious materials which could puncture, damage or otherwise inhibit the liner from functioning properly.

.02 Placement of the clay or stabilized solids liner as specified in Section 5.2.

.03 Dumping, spreading, and compaction of flue gas desulfurization solids stabilized with fly ash and mixed with bottom ash.

The material shall be spread in layers of 12 inches maximum thickness and promptly compacted to a minimum density of 90 percent of the maximum obtained in the standard Proctor Compaction Test, ASTM D-698 (Method C). Initial compaction shall be accomplished by using the weight of the spreading equipment passing over the waste material. Final compaction shall be accomplished by using a roller or vibratory compactor. R1

A test section shall be selected to determine the optimum number of passes required by the equipment to compact the stabilized flue gas desulfurization solids mixed with fly ash to 90 percent of the maximum density obtained in the standard Proctor Compaction Test, ASTM D-698 (Method C).

No field testing program shall be required to ensure that the density requirements are being met. However, the Owner may implement a testing program, if deemed necessary, so as to ensure the design life of the area.

At the time of final filling, and prior to placing soil cover and seeding, the cell surface shall be sloped at a 1 percent grade to form a ridge running along the middle of the cell as shown on drawing HOU-3037-M-113600S04.

All bottom ash waste disposal cells shall not have side slopes steeper than one (1) vertical to three (3) horizontal. A terrace ten (10) feet wide shall be constructed for all slopes, for every 30 feet of vertical distance. R1

.04 Placement and compaction of 24 inch waste cover stabilized flue gas desulfurization solids.

The cover lining shall be compacted to a minumum density of 95 percent of the maximum obtained in the standard Proctor Compaction Test, ASTM D-698 (Method C).

The stabilized flue gas desulfurization solids shall be spread, leveled in layers not exceeding twelve (12) inches in thickness, and compacted using previously developed, optimized compaction methods. R1

.05 Placement and firm compaction of 18 inch soil cover.

The material to be used for this cover shall be a SC type soil as per the Unified Soil Classification System. It shall be obtained, in so far as possible, from the on site clayey sands and shall have no more than 40 percent of the material passing the No. 200 sieve in accordance with ASTM D-1140.

The material shall be spread and leveled in layers not exceeding six (6) inches in thickness before compaction and shall be compacted to a minimum density of 90 percent of the maximum obtained in the modified Proctor Compaction Test, ASTM D-1557 (Method C). R1

.06 Placement, loose compaction, and seeding of 12 inch final soil cover.

The material to be used for this cover shall be a CL material as per the Unified Soil Classification System and shall be obtained, in so far as possible, from the on site silty clays. The gradation, moisture content, liquid limit, and plasticity index shall meet the same requirements as for the clay liner in Section 5.2.

The material shall be compacted to a minimum density of 85 percent of the maximum obtained in the standard Proctor Compaction Test, ASTM D-698 (Method C). The seeding shall conform to Item 164 of the Texas Highway Department Standard Specifications for Construction of Highways, Streets, and Bridges, 1972.

4.3 Dewatered Sludge Solids Waste Disposal Area

The dewatered sludge solids waste disposal area shall include five (5) cells each covering a two (2) acre area to be developed sequentially. R1

The filling of a cell in the dewatered sludge solids waste disposal area shall proceed as follows:

.01 Clearing and grubbing as per Ebasco Specification "Clearing and Grubbing (HOU-3037-101400) such that the subgrade shall be free of roots, stumps, branches, organics or other deleterious materials which could puncture, damage or otherwise inhibit the liner from functioning properly.

.02 Placement of the clay liner as specified in Section 5.3.

.03 Dumping and spreading of dewatered sludge solids.

All dewatered sludge solids waste disposal cells shall not have side slopes steeper than one (1) vertical to three (3) horizontal. A terrace ten (10) feet wide shall be constructed for all slopes for every 30 feet of vertical distance. R1

.04 Placement and firm compaction of 18 inch soil cover.

The material to be used for this cover shall be a SC type soil as per the Unified Soil Classification System. It shall be obtained, in so far as possible, from the on site clayey sands and shall have no more than 40 percent of the material passing the No. 200 sieve in accordance with ASTM D-1140. The material shall be spread and leveled in layers not exceeding six (6) inches in thickness before compaction and shall be compacted to a minimum density of 90 percent of the maximum obtained in the modified Proctor Compaction Test, ASTM D-1557 (Method C). R1

.05 Placement, loose compaction, and seeding of 12 inch final soil cover.

The material to be used for this cover shall be a CL material as per the Unified Soil Classification System and shall be obtained, in so far as possible, from the on site silty clays. The gradation, moisture content, liquid limit, and plasticity index shall meet the same requirements as for the clay liner in Section 5.2.

The material shall be compacted to a minimum density of 85 percent of the maximum obtained in the standard Proctor Compaction Test, ASTM D-698 (Method C). The seeding shall conform to Item 164 of the Texas Highway Department Standard Specifications for Construction of Highways, Streets, and Bridges, 1972.

5.0 Clay Liner

5.1 General

A clay liner shall be required for the cells in the bottom ash and stabilized solids areas and their runoff ponds, the dewatered sludge solids waste disposal area and its runoff pond, and the emergency pond. Upon appropriate authorization, alternate liner material may be used for future cells in the bottom ash and stabilized solids areas. R1

5.2 Bottom Ash and Stabilized Solids Disposal Areas R1

The clay liner shall be constructed of material obtained from on-site silty clays in so far as possible and shall be free of muddy material, organic matter, rubbish, debris or other unsuitable materials. The gradation of the material shall consists of soil particles with a minumum of 85% passing through a No. 4 sieve and minimum of 55% passing a No. 200 sieve in accordance with ASTM D-422 or D-1140 as designated by the Purchaser. The permeability of the material shall be less than 1 x 10^{-7} cm/sec. The material's liquid limit shall be equal to or greater than 30 and the plasticity index equal to or greater than 15. The average moisture content for the clay liner material may vary from an average of plus three (3) to minus three (3) percent from optimum at the time of placement.

The area where the liner is to be placed shall be prepared by discing or scarifying to loosen the surface to a depth of twelve (12) inches and then compacted. Immediately after such scarifying and compaction, the first layer of material shall be placed and compacted. The clay liner shall be compacted to a minimum of 95 percent of the maximum density obtained in the standard Proctor Compaction Test, ASTM D-698 (Method C).

The clay liner material shall be spread and leveled in layers not exceeding six (6) inches in thickness before compacting with sheepsfoot or wedgefoot rollers. The total liner thickness shall be three (3) feet as shown on the drawings. R1

Should the field permeability tests on the flue gas desulfurization solids stabilized with fly ash yield permeabilities less than 1 x 10^{-7} cm per second, said stabilized solids shall be used for the lining of the remaining cells in the bottom ash waste disposal area 1 and the entire bottom ash waste disposal area 2. R1

The method of placement and compaction for the flue gas desulfurization stabilized solids liner shall be the same as for the clay liner previously described in this section.

5.3 Dewatered Sludge Solids Waste Disposal Area R1

The five (5) cells in the dewatered sludge solids waste disposal area shall have a clay liner meeting the material, placement, and compaction requirements specified in Section 5.2.

5.4 Runoff Ponds

The clay liner for the runoff ponds in the bottom ash and stabilized solids disposal areas, and the dewatered sludge solids waste disposal areas shall meet the material, placement, and compaction requirements as specified in Section 5.2. A random fill shall be placed above the clay liner as shown on the design drawings. R1

5.5 Emergency Pond

The clay liner for the emergency pond shall also have a thickness of three (3) feet and meet all other material, placement, and compaction requirements specified in Section 5.2. The clay liner shall be sloped so as to direct the leachate to a sump to allow its removal from the emergency pond. A random fill shall be placed above the clay liner as shown on the design drawings. R1

6.0 Drainage

6.1 General

Work shall include but not necessarily be limited to the construction and maintenance of temporary and permanent drainage, and sediment control for the solid waste disposal area. Such work will involve the construction of ditches, dikes, traps, slope drains, preparing slopes, compacting top soil, seeding and fertilizing to as to comply with this specification and drawing HOU-3037-M-11361OS03, or as directed by the Engineer.

Temporary control measures shall be used to correct conditions which develop during construction and filling and have not been foreseen during the design stage.

6.2 Bottom Ash and Stabilized Solids Disposal Areas R1

A permanent drainage system consisting of peripheral ditches and dikes shall be constructed in the bottom ash waste disposal area. The peripheral ditches shall serve to convey all runoff, from the finished reclaimed cells and all other cells which are neither being developed nor filled, to the area's natural runoff system. The ditches, dikes, stilling basins, catch basins and drop structures shall be as shown on the design drawings. R1

The area's natural runoff system, Lynn Creek, shall be rerouted to the dimensions and elevations shown on the design drawings.

The runoff from the cell which is at any point being filled and from the cell being cleared and grubbed shall be directed to dikes within the disposal area, which shall be in turn conveyed to a pipe running along the area haul road and discharging to the area's runoff pond. The size and type of pipe shall be as shown on the design drawings.

As an area is filled and covered the drainage system shall be re-routed so as to discharge into the peripheral ditch system.

Maintenance shall be provided as needed for both the permanent and temporary ditch systems.

As construction of the cell rows proceeds towards the area's runoff pond, the temporary drainage system shall sequentially be routed towards the pipe by providing inlets at the new location and relocating pipe sections as required.

The seeded reclaimed cells shall have two sides sloped at a 1 percent grade to form a ridge running along the middle of the cell from east to west and allowing the surface runoff to be conducted via ditches on the edge to the permanent peripheral ditch.

7.0 Haul Roads

The main haul road thru the bottom ash waste disposal area 1 shall be an R1 unsurfaced type, two lane, all weather, 42 feet right-of-way width designed for 85 ton truck capacity. The preliminary construction of these roads shall use native soil and be adequate to allow satisfactory passage for vehicles hauling materials to the cell being filled. Should the testing of the stabilized flue gas solids, as outlined in Section 8.2, yield satisfactory structural properties, the stabilized flue gas solids shall be used in completing, the construction of the haul road in area 1, and the entire area 2 haul road to the grades shown on the design drawings.

The spurs leading from the main haul road to the various disposal cells within the area shall be constructed as needed. As a particular cell is being filled the road spur within the cell will be constantly raised and continuous maintenance of this road shall be provided by the on-site spreading equipment to ensure the satisfactory passage of the hauling trucks. A turn-around area shall be provided at the end of the spur. Once a cell is filled the haul road shall be covered and seeded as specified in Sections 4.2.05 and 4.2.06.

Periodic maintenance of these roads shall be performed so as to permit normal vehicular use at all times and shall include dust control.

8.0 Testing

8.1 Liner Testing

Field control testing of densities and moisture contents shall be conducted as the work progresses to assure that required densities, moisture contents and any other restrictions outlined in this specification are being achieved.

For the lining material in the bottom ash waste disposal area, one (1) density and moisture test shall be made for every 40,000 square feet of compacted fill area, however, at least one (1) density test shall be made for every area less than 40,000 feet placed in one day. R1

For the lining material in the runoff ponds, emergency pond and dewatered sludge solids waste disposal area a minimum of one (1) density and moisture test shall be made for every 10,000 square feet of compacted fill area.

8.2 Stabilized Sludge Testing

Various laboratory testing including grain size, liquid limit, plasticity index, water content, density, compaction, strength and permeability shall be conducted on the flue gas desulfurization solids stabilized with fly ash. These tests shall be conducted at 0, 1, 3, 7, 14 and 28 days following the stabilization process. Chemical analyses shall also be performed for total alkalinity, total dissolved solids, alkalinity (phenolphthalein and methyl orange), calcium, magnesium, sulfates and sulfides.

Once the results of the material's structural properties are available, the Engineer will determine whether the stabilized sludge can be used as a liner and the optimum time period for placing it following the stabilization process.

The in situ permeability of the stabilized sludge and the compaction characteristics of the ash waste shall then be tested by selecting a square area in the first ash disposal cell of approximately 100 feet by 100 feet. A five (5) foot layer of the stabilized sludge shall be placed and disposal of ash continued. When the test portion is nearly filled, borings shall be drilled and undisturbed samples obtained to test the compaction characteristics of the ash waste. Piezometers shall then be installed at the depth of the stabilized sludge and field permeability tests conducted. The results of field and lab permeability shall be compared.

Additional testing may be required at the discretion of the Owner or Engineer.

9.0 Groundwater Monitoring System

A groundwater monitoring system shall be installed in the vicinity of the dewatered sludge solids waste disposal cells so as to comply with Texas Department of Water Resources Regulations (Groundwater Monitoring 156.22.12.001-.005, Texas Administrative Code Sections 335.191-.195). R1

Three monitoring wells hydraulically downgradient and one monitoring well hydraulically upgradient shall be installed near the boundary of the area perimeter to the depth of the uppermost aquifer. In case the uppermost aquifer is not found within a 50 foot depth, the well shall be installed at a 50 foot depth.

A program shall be implemented to obtain and analyze samples from the installed groundwater monitoring system.

All monitoring wells shall be sampled and the samples analyzed to establish groundwater quality and to determine groundwater contamination on a quarterly basis.

The parameters to be established during the analysis shall meet the requirements of the Texas Department of Water Resources Regulations.

Monthly water samples shall be collected at least 12 months prior to the initiation of disposal operations and analyzed to establish baseline conditions against which to compare subsequent samples obtained during the operational life of the cell. R1

10.0 Soil Bearing Foundations

Areas where foundations for buildings and other structures are to be located shall be cleared and grubbed as per Ebasco's Specification, "Clearing and Grubbing" (HOU-3037-101400) to the grade shown on the drawings, and as required to permit placement of concrete foundations and conduits.

Any existing unsuitable soils such as soft clays or loose sands shall be removed and replaced with either site sand fill or select sand fill as per Ebasco's Specification "Excavation, Backfill, Filling and Grading" (HOU-3037-102401). This material shall then be compacted to meet the requirements of the previously mentioned specification. Any other clays encountered on which foundations are to be placed shall be removed to a depth of two (2) feet, replaced with either a site sand fill or select sand fill and compacted. The Engineer shall inspect the bottom of the excavation prior to backfilling and compaction. R1

The allowable bearing capacity shall not exceed two (2) tons per square foot. The requirements for soil bearing foundations can be upgraded by the Engineer.

bcc: R. J. Snokhous
L. B. Horrigan, Jr.
D. R. Betterton
D. G. Tees
J. D. Parsons
J. M. Newton
G. B. Painter
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*J. H. Moser
*R. W. Lawhn
*R. C. Patyrak
*D. B. Wright
*D. A. Dickson
*J. P. Plumb
*L. Marcus (AMS)
(*w/attachment)

The Light company Houston Lighting & Power P.O. Box 1700 Hou

September 3, 1985
LW-HL-TX-157

Mr. Bryan W. Dixon
Director, Hazardous and Solid Waste Division
Texas Water Commission
P. O. Box 13087, Capitol Station
Austin, Texas 78711

SUBJECT: **LIMESTONE ELECTRIC GENERATING STATION TDWR NO. 32940 - NOTIFICATION OF WASTE MANAGEMENT ACTIVITIES (31 TAC 335.6)**

Dear Mr. Dixon:

By letter of July 16, 1985, Houston Lighting & Power Company (HL&P) provided notification, pursuant to the requirements of 31 TAC 335.6, of the onsite storage, processing, and disposal of solid wastes generated by operation of various waste management systems at the Limestone EGS. At this time, HL&P is providing additional information concerning the onsite storage, processing, and disposal of lignite combustion by-products (fly ash, bottom ash, pyrites, and flue gas desulfurization (FGD) sludge). HL&P anticipates testing will result in designation of these materials as Class II wastes.

HL&P has prepared a Limestone EGS Solid Waste Disposal Plan (attached) which addresses in detail the generation, processing and disposal of the combustion by-products. Final disposition of these wastes consists of placement in an above-grade landfill, as described in Section 4.0 of the Disposal Plan. Construction of the initial cells of the landfill began in March, 1985. Initial waste material placement is anticipated for October, 1985.

HL&P will provide notice of any revisions to the systems discussed in this notification. Please contact Mr. E. A. Feith (922-2205) with regard to any questions.

Sincerely,

W. F. McGuire, Manager
Environmental Protection Department

SSD/sls

SOLID WASTE
DISPOSAL PLAN

LIMESTONE ELECTRIC GENERATING STATION

1.0 Scope

Operation of the Limestone EGS will result in the production of large quantities of lignite combustion by-products, specifically fly ash, bottom ash, pyrites and FGD sludge. This plan describes the collection, processing, transport and disposal of these wastes. Section 2.0 of this plan provides a brief description of the major components of the Solid Waste Disposal System. Section 3.0 discusses waste product handling and Section 4.0 discusses landfill design and operation.

2.0 Solid Waste Disposal System Description

As shown on Figure 14039, the Limestone EGS is divided into a plant area and a solid waste disposal area (SWDA). Fly ash, bottom ash, pyrites, and FGD sludge generated in the plant area are pneumatically conveyed or sluiced to the SWDA. The following facilities are located in the SWDA:

- Secondary Dewatering & Waste Handling System (SDWHS) - this system creates a stabilized product from fly ash and FGD sludge suitable for landfill disposal.
- Bottom Ash Settling Tanks & Dewatering Bins - this equipment dewaters bottom ash and pyrites prior to disposal in the landfill.
- Combustion Solid Waste Landfill (CSWL)
- Stormwater runoff ponds

3.0 Waste Product Handling

3.1 Fly Ash

The Limestone EGS utilizes electrostatic precipitators designed to remove suspended fly ash in the flue gases discharged from the steam generator regenerative air heaters. The particles are attracted to collecting surfaces where they adhere until removed. Removal is accomplished by rapping the collecting surfaces periodically in a sequential manner, causing fly ash to drop into hoppers. Ash collected in the precipitator hoppers and the economizer hoppers is conveyed pneumatically to the main fly ash silo. From this silo ash is pneumatically conveyed to the fly ash feed tanks of the Secondary Dewatering & Waste Handling System to be used in blending with FGD scrubber sludge. If desired, fly ash can be unloaded from the main fly ash silo by means of a dry unloading telescopic spout.

3.2 FGD Sludge

The Limestone EGS utilizes an SO_2 Absorber System from the flue gases. After passing through the precipitators, flue gas enters the Absorber System at the discharge of the ID fans. Flue gas enters the bottom of the absorbers and passes upward, flowing countercurrent to the limestone slurry being pumped through the absorbers by the recycle pumps. The saturated flue gas, after passing through several banks of mist eliminators, leaves the top of the absorbers.

Limestone slurry is pumped to the slurry spray headers at the top of each absorber. The slurry passes through full cone, wide angle spray nozzles and falls through the tower. SO_2 in the flue gas is absorbed by the slurry droplets. Spent slurry is blown down from the reaction tanks of each spray tower to a common agitated Waste Slurry Tank. Waste slurry is pumped to thickeners for initial dewatering, with reclaimed water pumped back to the absorber area and concentrated slurry pumped to the vacuum filters of the Secondary Dewatering and Waste Handling System (SDWHS).

The SDWHS further dewaters concentrated slurry using vacuum filters to provide filter cake having 50-65% solids by weight. Filtrate is pumped back to the SO_2 Absorber System to be used as makeup. Conveyors feed filter cake from the vacuum filters to pug mills. Screw conveyors transport fly ash from the fly ash feed tanks to the pug mills.

The pug mills produce a stabilized product suitable for landfill by blending scrubber waste sludge and fly ash. Fly ash contains lime, which when mixed with scrubber sludge, produces a pozzolanic reaction. This pozzolanic reaction results in a chemically stable product. Fly ash provides structural strength to the stabilized product whereas lime imparts impermeability. The stabilized product, after being cured for sometime (seven hours to three days depending upon moisture content and air circulation), can be compacted to achieve desired strength characteristics. Final product solids content is expected to range between 65 to 75 percent by weight. It is anticipated that when the lime content in the fly ash is less than 19% by weight, additional lime can be added to achieve a permeability of $1x10^{-6}$ cm/sec or less. A permeability of $1x10^{-5}$ cm/sec is expected to be achieved without lime addition. A test program will be developed and implemented to verify achieved permeability.

The pug mills are capable of mixing waste slurry from the SO_2 Absorber System (bypassing vacuum filters) with fly ash to produce a stabilized product provided that sufficient amount of fly ash is available. In case of excess fly ash production, fly ash can be blended with water in the pug mill to produce a stable, non-liquid material which can be landfilled.

Each pug mill has a discharge conveyor which delivers stabilized product onto a radial stacking conveyor. The radial conveyor stacks the stabilized sludge in storage piles from which it is transported by truck to the landfill.

3.3 Bottom Ash/Pyrites

Bottom ash from each boiler is collected in a water-impounded, gravity-fed, triple "V" ash hopper located directly beneath the boiler. Bottom ash is unloaded separately and in sequential order from each "V" section. A clinker grinder is provided at each hopper outlet to crush ash prior to entering the ash conveying pipe. Water from high pressure jet pump nozzles assist in the ash removal cycle. The force of the water jet pushes ash to the top of the ash holding tanks, which serve as a transfer station before conveying the ash to the dewatering bins located in the SWDA. Excess water is removed from the ash in the dewatering bins, discharged into a settling and surge tank system and ultimately recycled in the bottom ash system. Sludge accumulations in the settling and surge tanks are returned to the dewatering bins or to the ash holding tanks. Bottom ash is discharged from the dewatering bins into trucks for transport to the CSWL.

Mill rejects (pyrites) from the pulverizers are collected in separate storage hoppers located at each mill. Jet pumps are used at each pyrites storage hopper to sluice collected material to the pyrites storage/transfer tank. Jet pumps located at the outlet ot the pyrites storage/transfer tank convey the pyrites directly to the bottom ash holding tanks for disposal via the bottom ash system. If desired, pyrites flow into the ash holding tanks can be temporarily stopped, allowing only bottom ash to be transported to the dewatering bins.

4.0 Combustion Solid Waste Landfill Design & Operation

The Combustion Solid Waste Landfill (CSWL) is an aboveground landfill divided into two areas (see Figure 14039). Area 1 and Area 2 cover approximately 232 acres and 630 areas, respectively, and are expected to accommodate approximately 16,000 ac.-ft. and 27,000 ac.-ft. of material respectively. Landfill operation will begin in Area 1 and will consist of sequential cell development for a total of 12 cells. A detailed plan for the development of the first two cells has been prepared and is presented below. Plans for development of the remaining cells in Area 1 and Area 2 will be finalized at a later date.

4.1 Area 1 Cells 1 and 2 Design and Operation

Design details for cells 1 and 2 are shown on Figure 14040. Following site clearing activities, topsoil is removed and stockpiled for use during cell closure. The area is then prepared by discing or scarifying to loosen the surface to a depth of 12 inches and then compacted. Immediately after scarifying and compaction, the first layer of liner material will be placed and compacted. The liner will be constructed of material obtained from onsite clay deposits in so far as possible and will be free of muddy material, organic matter, rubbish, debris or other unsuitable materials. The permeability of the material will be less than $1x10^{-7}$ cm/sec. The material's liquid limit will be equal to or greater than 30 and the plasticity index equal to or greater than 15. The clay liner will be compacted to a minimum of 95 percent of the maximum density obtained in the standard Proctor Compaction Test, ASTM D-698 (Method C). The clay liner material will be spread and leveled in layers not exceeding six inches in thickness before compacting with sheepsfoot or wedgefoot rollers. The total liner thickness will be three feet.

Following liner completion, a main haul road will be constructed as shown on Figure 14040 utilizing compacted native soils. The main haul road will be an unsurfaced, two-lane, all-weather type with a 42-foot crest width designed for 85-ton truck capacity. Extension of the haul road and construction of any required spurs will be accomplished utilizing a stabilized FGD sludge/fly ash product. As a cell is being filled, the road within the cell will be constantly raised and continuous maintenance of this road will be provided by spreading equipment to ensure the satisfactory passage of the hauling trucks. A turnaround area will be provided at the end of the spur.

As shown on Figure 14040, material placement will proceed such that dikes composed of stabilized sludge will form the outer perimeter of the landfill. Interior slopes of the dikes will be constructed with a 3:1 slope, while the exterior slopes will be less steep than 3:1. Due to bench and clay cover construction, the final exterior slopes will be 3:1. The stabilized sludge will be spread in layers of 12 inches maximum thickness and promptly compacted to a minimum density of 95 percent of the maximum obtained in the standard Proctor Compaction Test, ASTM D-698 (Method C). Initial compaction will be accomplished by using the weight of the spreading equipment passing over the waste material. Final compaction will be accomplished by using a roller or vibratory compactor. The exterior side slopes will receive a clay cover as shown on Figure 14040. The clay cover will vary in thickness from approximately three feet at the slope base to approximately 10 feet at the side slope crest. As a result, all material above the assumed critical erosion line will be clay. The clay cover will incorporate nine-foot wide benches every 30 feet of elevation to facilitate runoff collection and minimize side slope erosion.

At the time of final material placement, a cap slope of 2-5% will be maintained. A cover of liner-quality clay 2-feet thick will then be placed, followed by an 18-inch soil cover. The soil will be spread and leveled in layers not exceeding six inches in thickness before compaction and will be compacted to a minimum density of 90 percent of the maximum obtained in the modified Proctor Compaction Test, ASTM D-1557 (Method C).

The cap and all side slopes will receive a final 12-inch top soil layer. (see Figure 14040). The soil to be used for this cover will be obtained, in so far as possible, from topsoil stockpiled during landfill site preparation. The gradation, moisture content, liquid limit, and plasticity index will meet the same requirements as for the clay liner. The material will be compacted to a minimum density of 85 percent of the maximum obtained in the standard Proctor Compaction Test, ASTM FD-698 (Method C). The seeding will conform to Item 164 of the Texas Highway Department Standard Specifications for Construction of Highways, Streets, and Bridges, 1972.

In cells undergoing material placement activities, a system of dikes, internal ditches, and pipes (see Figure 14040) will direct rainfall runoff to a clay-lined runoff pond. This drainage system is sized to convey a 24-hour, 100-year rainfall event. A permanent drainage system consisting of crest and bench ditches and drop structures (see Figure 14040) is incorporated into the landfill cap and outer slope design.

This system is designed to convey a 24-hour, 100-year rainfall event falling on the landfill to the peripheral ditch. This peripheral ditch, also sized to convey a 24-hour, 100-year event, will intercept and direct surface run-on from areas adjacent to the landfill to existing drainage features (see Figure 14040).

4.2 Groundwater Monitoring

HL&P will retain the services of a consulting engineering firm familiar with both the local hydrogeology and solid waste management practices to determine if groundwater monitoring is appropriate for this site. If so, a groundwater monitoring program will be developed and implemented. Information concerning the program will be made available to the TDWR.

bcc: E.A. Fenn
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J. Malinak
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R. D. Carpenter
T.W. Long
(# RCRA File No. 0

The Light company
Houston Lighting & Power

P.O. Box 1700 Houston, Texas 77251-1700 713-207-

March 26, 1998

CERTIFIED MAIL

Mr. Sonny Rayos
Industrial and Hazardous Waste Division
Texas Natural Resource Conservation Commission
P.O. Box 13087
Austin, Texas 78711-3087

SUBJECT: LIMESTONE ELECTRIC GENERATING STATION SOLID WASTE REGISTRATION NO: 32490 NOTIFICATION OF WASTE MANAGEMENT ACTIVITIES

Dear Mr. Rayos:

Pursuant to the notification requirements of 30 TAC 335.6, Houston Industries Power Generation (HIPG) (formally Houston Lighting & Power Company) is notifying the TNRCC of management changes of our existing nonhazardous waste landfill at the subject facility for the onsite disposal of Class 2 nonhazardous wastes. The landfill is listed as solid waste management unit, 004, on the facility's's Notice of Registration.

The existing landfill is used primarily for the disposal of coal combustion by-products. These wastes, which are classified as Class 2 nonhazardous, consist of fly ash, bottom ash, and flue gas desulfurization (FDG) sludge. In addition, other low-volume, Class 2 nonhazardous sludges are also disposed of within the landfill. We have included with this notification a procedure for stabilizing these additional nonhazardous sludges with coal combustion by-products within the boundaries of active disposal cells. This procedure will reduce sludge handling and greatly facilitate present stabilization operations.

Should you have any questions pursuant to this matter, please contact Mr. Lucien Klejbuk at (713) 945-8199.

Sincerely,

R.T. Bye

R.T. Bye, Manager
Environmental Assessment &
Waste Management
Environmental Department

Attachment

STABILIZATION OF SLUDGES
IN CLASS 2 SOLID WASTE LANDFILL

LIMESTONE ELECTRIC GENERATING STATION
JEWETT, TEXAS
SOLID WASTE REGISTRATION NO: 32490

HIPG will stabilize the following Class 2 industrial sludges in a temporary mixing basin constructed within the existing Class 2 solid waste landfill (NOR Unit # 004):

1.	Water Treatment Sludge	TWC - 02153912
2.	Chemical Waste Treatment Sludge	TWC - 02225192
3.	Cooling Tower Sludge	TWC - 02025192
4.	Storm Water Treatment Sludge	TWC - 02145042
5.	Organic Acid Cleaning Sludge	TWC - 02475192
6.	Inorganic Retention Basin Sludge	TWC - 02565192

A mixing basin within an active, landfill cell will consist of a small bermed platform or shallow depression of sufficient area and volume to hold the amount of sludge to be stabilized. The floor of the basin will be constructed of either clay or stabilized coal combustion by-products to totally contain the sludge prior to stabilization.

Depending upon the material, tank trucks, vacuum or pneumatic trucks, or dumps trucks will transport the sludges and stabilizing media to the active cell. Stabilizing media will consist of either flue gas desulfurization scrubber base (a mixture of FGD sludge and fly ash), economizer ash or bottom ash, all of which are generated at the Limestone facility from the burning of lignite. Mixing ratios will vary depending upon the stabilizing media that will be used.

The sludge and stabilizing media will be mixed together by an excavator or loader positioned adjacent to the mixing basin. The mixture will remain within the mixing basin to solidify. New mixing basins will be constructed within the active cell to accommodate subsequent stabilization efforts.

ESPEY,
HUSTON &
ASSOCIATES, INC.
Engineering & Environmental Consultants

Document No. 860209
EH&A Job No. 7362

GEOLOGIC AND HYDROGEOLOGIC ASSESSMENT
SOLID WASTE DISPOSAL AREAS
LIMESTONE ELECTRIC GENERATING STATION

Prepared for:

Houston Lighting & Power Co.
P.O. Box 1700
Houston, Texas 77001

Prepared by:

Espey, Huston & Associates, Inc.
P.O. Box 519
Austin, Texas 78767

May 1986

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ESPEY,
HUSTON &
ASSOCIATES, INC.
Engineering & Environmental Consultants

6 May 1986

R. Don Groover, Ph.D
Environmental Protection
Houston Lighting & Power Co.
P.O. Box 1700
Houston, Texas 77001

EH&A Job No. 7362

Re: Data Evaluation Project for Limestone Electric Generating Station (HL&P Order No. PPP-1072)

Dear Dr. Groover:

Espey, Huston & Associates, Inc. (EH&A) is pleased to transmit its final report, "Geologic and Hydrogeologic Assessment, Solid Waste Disposal Areas, Limestone Electric Generating Station", in fulfillment of the above referenced project. The report was prepared using existing information for the power station vicinity, including published maps and reports and field data from the plant area. It addresses both site-specific and regional geologic and ground-water conditions.

In addition, EH&A recommended that wells be installed in the vicinity of active disposal areas to monitor ground-water flow and quality. Based on the review of available information, EH&A believes that site conditions will allow for the implementation of an effective monitoring program to detect any potential migration of leachate from disposal areas. General recommendations for monitoring have been included in Section 5.0 of the report.

EH&A has enjoyed performing this project and looks forward to future opportunities to assist HL&P on this and other matters. Please do not hesitate to contact us should you feel the need.

Sincerely,

J. Jackson Harper

J. Jackson Harper
Senior Staff Engineering Geologist

E. Burton Kemp

E. Burton Kemp, III
Geotechnical/Geoscience Group

JJH:cg

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1.0 INTRODUCTION

This report describes the geology, ground-water hydrology, and subsurface soil characteristics at the Limestone Electric Generating Station (LGS). Its purpose is to provide Houston Lighting & Power Co. (HL&P) with a compilation and assessment of available site-specific and regional information pertinent to onsite disposal of lignite combustion byproducts and other Class II and Class III industrial solid wastes.

The LGS site is located in east-central Texas, approximately 95 miles south-southeast of Dallas, 120 miles north-northwest of Houston, and 50 miles east of Waco. The plant is situated near the junction of Freestone, Leon, and Limestone counties (Figure 1-1). Significant population centers in the vicinity include Buffalo, Jewett, Marquez, and Teague. Smaller communities are Donie, 3 miles to the northeast; New Hope, 1.5 miles to the southwest; and Farrar 2.5 miles to the northwest. Lake Limestone is located approximately 4 miles to the west, and the Jewett Mine (lignite surface mine) trends northeast-southwest immediately south of the plant.

The power station occupies two areas on either side of Texas State Highway 39 (Figure 1-2). The plant island is situated on the west side of Highway 39 and includes two 720-MW generating units and auxiliary facilities encompassing about 1950 acres in the southeast corner of Limestone County. The lignite combustion materials handling area is located on the east side of Highway 39 in the southwest corner of Freestone County. This report focuses on the geology, ground-water hydrology, and subsurface soil characteristics of the materials handling area.

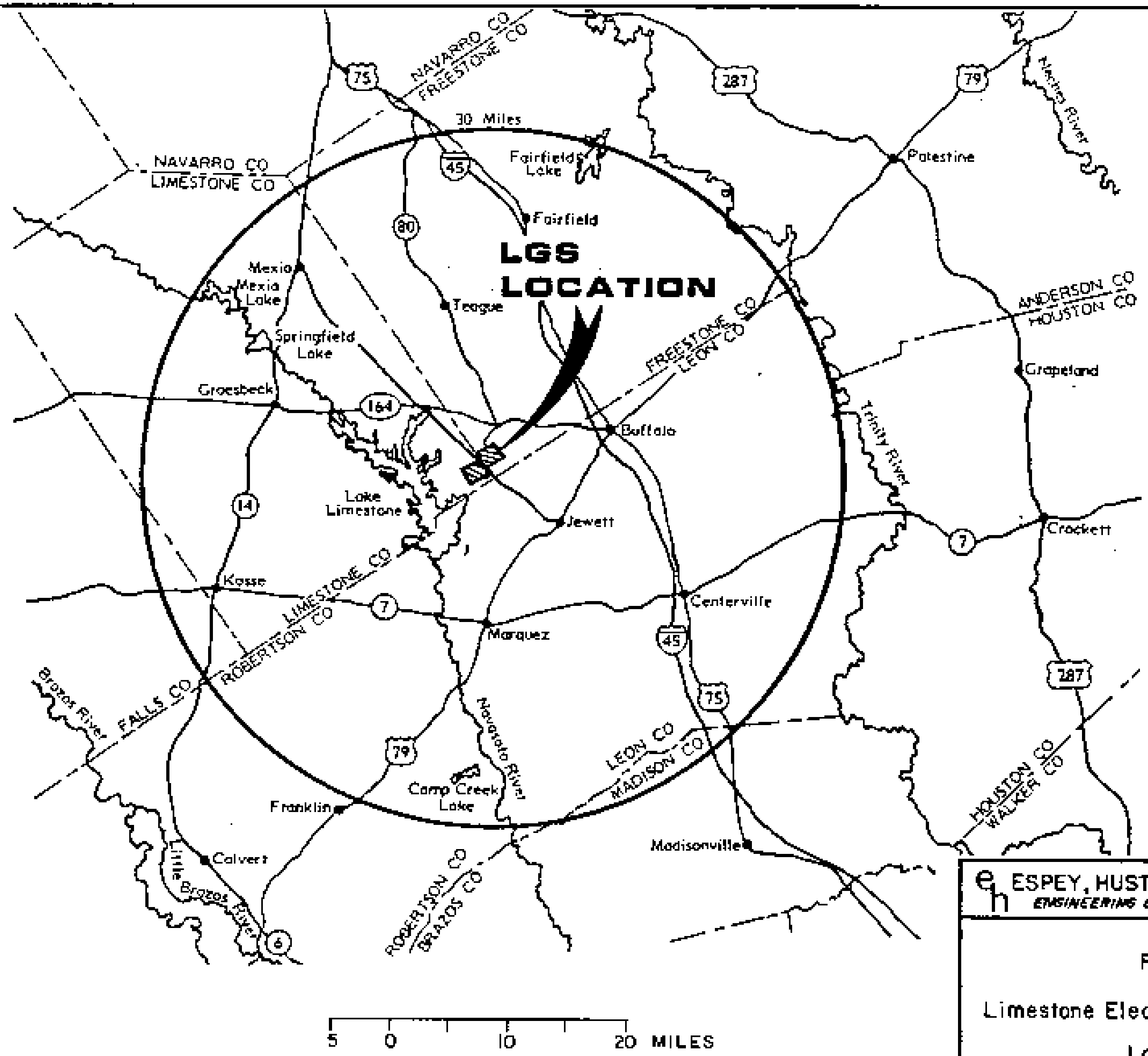

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Figure I-1

Limestone Electric Generating Station

Location Map

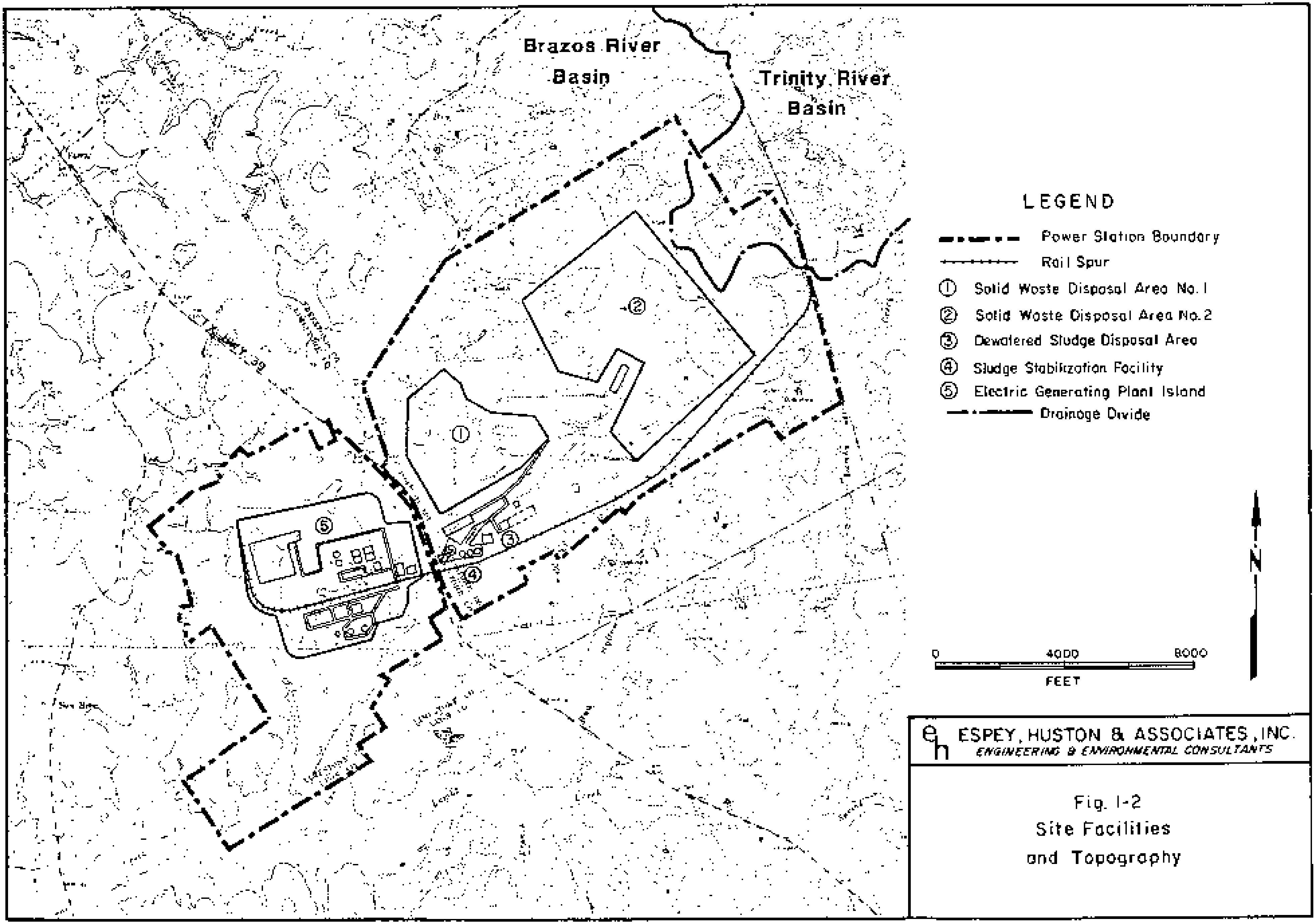

Fig. 1-2
Site Facilities
and Topography

2.0 STUDY SCOPE

The tasks completed by Espey, Huston & Associates, Inc. (EH&A) consisted primarily of reviewing, consolidating, and assessing previously developed information about the LGS site and surrounding region. Site-specific data were provided by HL&P and included facility and topography maps and geotechnical data. Regional information was obtained from published reports and open-file records.

2.1 SITE-SPECIFIC DATA

Plan maps and drawings of the LGS site were provided by HL&P. Surface topography maps of the materials handling area were also available at a 2-foot contour interval for the southwest portion and 5-foot contour interval for the northeast. HL&P also provided geophysical logs of two LGS water-supply wells completed at depths of 861 feet and 920 feet at the southeast margin of the materials handling area.

Prior to power station construction, geotechnical investigations of the LGS site were performed for HL&P by McClelland Engineers, Inc. (1979, 1980). Reports of those studies contain logs of soil borings, ground-water level measurements, field permeability test results, and laboratory soil test results. Methods used in the investigation are summarized below and were consistent with accepted geotechnical engineering practice.

Borings were drilled with rotary drilling equipment and soil samples were generally collected continuously from 0 to 10 feet, at 5-foot intervals from 10 to 100 feet, and at 10-foot intervals at depths greater than 100 feet. Undisturbed samples of cohesive soils were obtained by pushing a 3-inch diameter, thin-walled tube. Granular soils and hard cohesive soils were sampled by driving a 2-inch diameter, split-barrel sampler with a 140-pound hammer dropped 30 inches (standard penetration test). Samples were removed from the samplers and classified in the field. Representative portions of each sample were packaged and delivered to a soils laboratory. Water-levels were measured in most open boreholes at the completion of drilling and at least 24 hours later. Piezometers were installed at several locations to monitor ground-water levels and to perform field permeability tests. Boring locations were given as Texas State Plane Coordinates and ground surface elevations were referenced to mean sea level. Descriptions of the soils encountered were given on individual boring logs.

Laboratory soil tests were directed towards evaluating soil shear strength, compressibility, permeability, and classification. Strength values were generated largely from penetrometer and torvane readings. A few triaxial compression tests were also performed. Compressibility values were obtained by incremental-loading consolidation tests, and falling and constant head tests were used to measure vertical permeability. Classification tests included moisture content, unit dry weight, liquid and plastic limits, and particle-size distribution.

2.2 LITERATURE REVIEW

Published reports on the geology and ground-water hydrology of the region surrounding LGS were used to establish a context for describing site conditions. Ground-water resources and general geology of Freestone, Leon, and Limestone counties have been described in reports from the Texas Water Development Board, Texas Water Rights Commission, and the U.S. Geological Survey, respectively. Maps and reports published by the University of Texas, Bureau of Economic Geology, discuss the stratigraphy, hydrogeology, and environmental geology of the Wilcox Group of east-central Texas in considerable detail.

2.3 OPEN-FILE RECORDS

Water well records on file at the Texas Water Commission (TWC) were reviewed by EH&A to determine locations of wells and ground-water usage within one mile of the power station. Information obtained included well owner, completion date, depth casing data, static water level, and use. Chemical analyses were available for 9 well samples.

3.0 REGIONAL SETTING

The LGS site is located in east-central Texas, within the Texas Gulf Coastal Plain physiographic province. The topography of the region is characterized by low rolling hills and shallow stream valleys. Ground elevations along major streams near the power station vary from about 325 feet to 400 feet msl (mean sea level). Uplands start at elevations of 325-400 feet and reach altitudes of 575 feet msl along major drainage divides (Figure 3-1).

A dendritic network of tributary creeks drain the region and carry surface-water runoff to larger streams that flow southeastward across the Gulf Coastal Plain. The power station is situated near the topographic drainage divide that separates the Brazos River and Trinity River basins. Nearly all of the plant site is situated in the Navasota River watershed of the Brazos River basin. A small portion of the materials handling area straddles the drainage divide and lies within the Trinity River basin.

The climate of the region is subhumid with hot summers and typically mild winters. Temperature data during the 26-year period from 1941 to 1966 at the National Weather Service Cooperative climatic station at Centerville, approximately 20 miles southeast of the power station, are most representative of the area (U.S. Dept. of Commerce, 1967). As shown in Table 3-1, average monthly temperatures at Centerville range from 84.2°F in August to 47.6°F.

Rainfall is generally abundant for the area with most monthly averages in excess of 3 inches (U.S. Dept. of Commerce, 1967). The mean annual precipitation for the LGS area is 40.06 inches, as averaged from observations at the Centerville climatic station. Monthly average rainfall averages at Centerville for the period from 1941 to 1966 are presented in Table 3-2. Monthly means range from 1.89 inches during July to 4.72 inches in May.

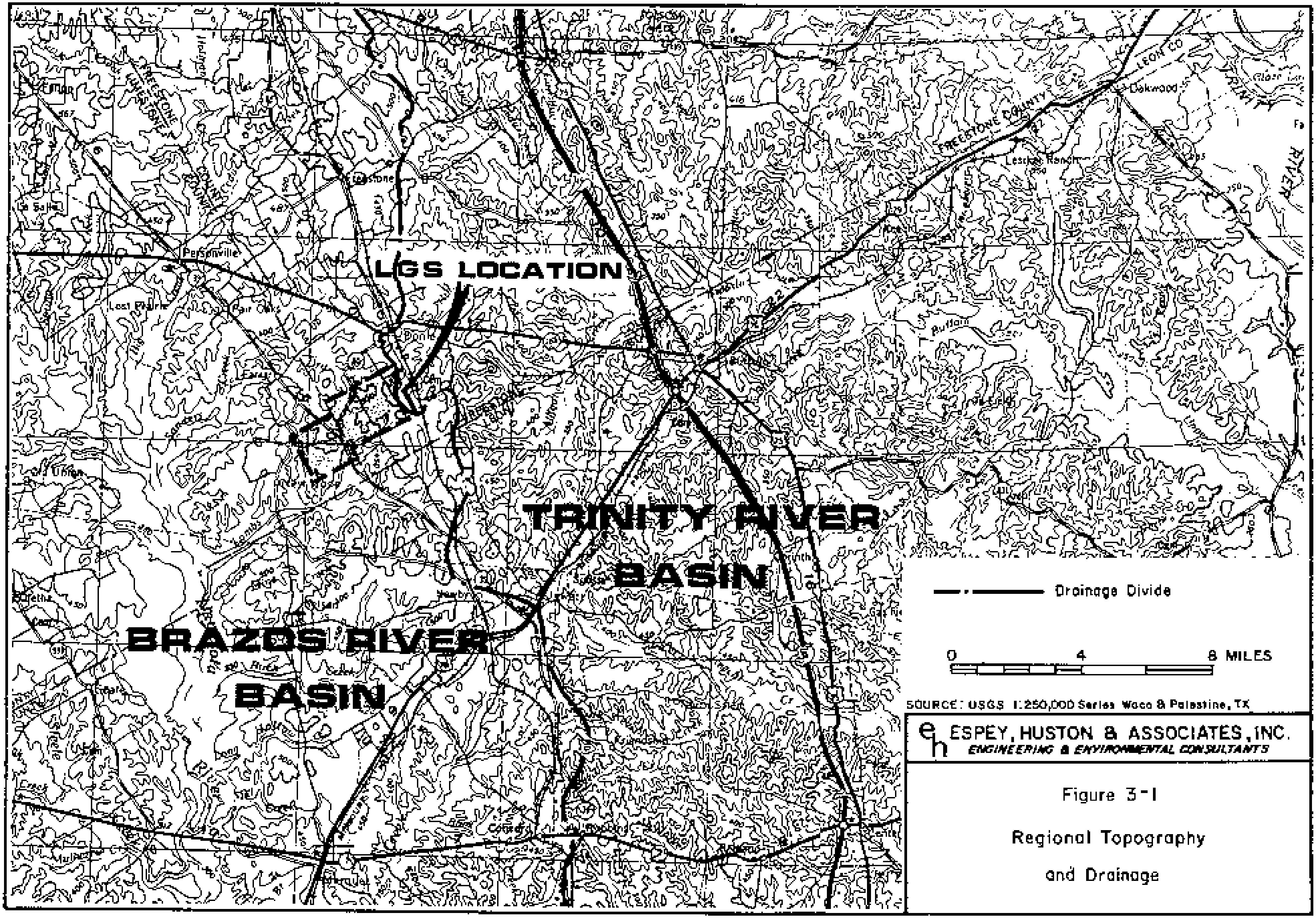

Figure 3-1

Regional Topography and Drainage

TABLE 3-1

MEANS AND EXTREMES OF TEMPERATURE (°F) FOR CENTERVILLE, TEXAS

Parameter	Period of Record	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean Daily	1941-1966	47.6	51.9	58.3	67.1	74.2	80.7	84.0	84.2	78.3	68.8	58.2	50.9	67.0
Mean Daily Maximum	1941-1966	58.9	63.1	70.4	78.4	85.2	91.8	95.7	96.8	90.6	82.5	71.1	62.3	78.9
Mean Daily Minimum	1941-1966	36.2	40.7	46.2	55.7	63.2	69.6	72.2	71.5	66.0	55.0	45.3	39.4	55.1
Record Highest	1941-1966	89	87	98	99	97	102	111	111	108	97	91	84	111
Record Lowest	1941-1966	-3	0	15	32	40	53	60	56	39	29	19	7	-3
Mean Number of Days Max. 90°F & Above	1956-1966	0	0	0	1	8	21	29	27	19	5	0	0	109
Mean Number of Days Min. 32°F & Below	1956-1966	14	9	3	1	0	0	0	0	0	1	4	11	41

1 Average is less than one-half day.
Source: U.S. Department of Commerce, 1967.

TABLE 3-2

MEANS AND EXTREMES OF PRECIPITATION (INCHES)

Parameter	Period of Record	Months												
		J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean Monthly (Centerville)	1941-1966	3.44	3.45	2.83	4.27	4.72	3.17	1.89	2.91	3.14	3.62	3.33	3.29	40.06
Record Highest Daily (Centerville)	1941-1966	3.32	3.86	2.75	5.04	5.23	4.16	3.62	5.27	4.54	8.50	2.78	3.19	8.50
Record Highest Monthly (Centerville)	1941-1966	8.12	6.99	7.74	11.82	11.12	7.78	5.33	8.37	7.86	15.58	8.81	7.11	15.58
Record Lowest Monthly (Centerville)	1941-1966	0.64	0.20	0.42	0.94	0.67	0.41	0.06	0.08	0.47	0.00	0.29	0.18	0.00
Mean Number of Days Precip. 0.10 Inch & Above (Centerville)	1956-1966	5	6	4	6	4	5	3	4	4	3	5	5	54
Mean Number of Days Precip. 0.01 Inch & Above (Waco, TX)	1944-1977	7	7	7	8	9	6	4	5	6	5	6	6	77

Source: U.S. Department of Commerce, 1967 (Centerville).
U.S. Department of Commerce, 1977 (Waco).

Daily evaporation observations are available from two nearby localities; Sommerville Dam and Navarro Mills Dam (Table 3-3). Sommerville Dam is located about 75 miles south-southwest of Jewett, and Navarro Mills Dam is located about 52 miles northwest of Jewett. Observations at these stations are measured using a standard NWS Class-A, 4-foot diameter pan. The Texas Water Development Board (Doughtery, 1975) reported on the evaporation records for these stations for the following periods: January 1965 through December 1970 for Sommerville Dam and January 1964 through December 1970 for Navarro Mills Dam.

During the 6-year period of record for Sommerville Dam, total annual pan evaporation ranged from 68.01 inches to 75.92 inches. For Navarro Mills Dam, total annual pan evaporation for the 7-year period of record ranged from 73.91 inches to 83.28 inches. The evaporation rates take daily rainfall into account so that the values in Table 3-3 are estimates of actual evaporation.

3.1 GEOLOGY

The regional terrain has developed on a thick sequence of unconsolidated sedimentary strata of sand, silt, clay, and lignite composition. Geologic units of interest to the study were of two types: Tertiary age "bedrock" strata and Quaternary age fluviatile deposits. Tertiary age units included formations of the Midway, Wilcox, and Claiborne groups, and Quaternary deposits included stream valley alluvium and terrace deposits (Figure 3-2).

Bedrock units crop out in northeast-southwest trending belts that roughly parallel the Texas coastline, and progressively younger strata crop out coastward of older units (Figure 3-3). Alluvium and terraces unconformably overlie eroded bedrock along the valleys of larger streams in the region. Bedrock strata dip coastward from their outcrops at an angle slightly greater than the general slope of the land surface (Figure 3-4).

TABLE 3-3

AVERAGE DAILY PAN EVAPORATION RATES (INCHES BY MONTH)

Parameter	Period of Record	Months											
		J	F	M	A	M	J	J	A	S	O	N	D
Navarro Mills Dam	1964-1970	.09	.12	.19	.23	.26	.33	.40	.36	.25	.21	.14	.10
Somerville Dam	1965-1970	.08	.12	.17	.20	.23	.30	.34	.32	.23	.18	.13	.09

Source: Dougherty, 1975.

ROCK-STRATIGRAPHIC UNITS

SYSTEM	SERIES	GROUP	FORMATION	APPROXIMATE THICKNESS IN STUDY AREA (FEET)
Quaternary	Recent		Alluvium	0-50
	Pleistocene		Fluviatile Terrace Deposits	--
Tertiary	Eocene	Claiborne	Queen City Sand	--
			Reklaw Formation	--
			Carrizo Sand	0-20
		Wilcox	Calvert Bluff Formation	550-690
			Simsboro Formation	200-260
			Hooper Formation	400
	Paleocene	Midway	Wills Point Formation	850
			Kincaid Formation	

Note: Areal distribution of stratigraphic units are shown on Figure 3-3.

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Figure 3-2

Regional Stratigraphy

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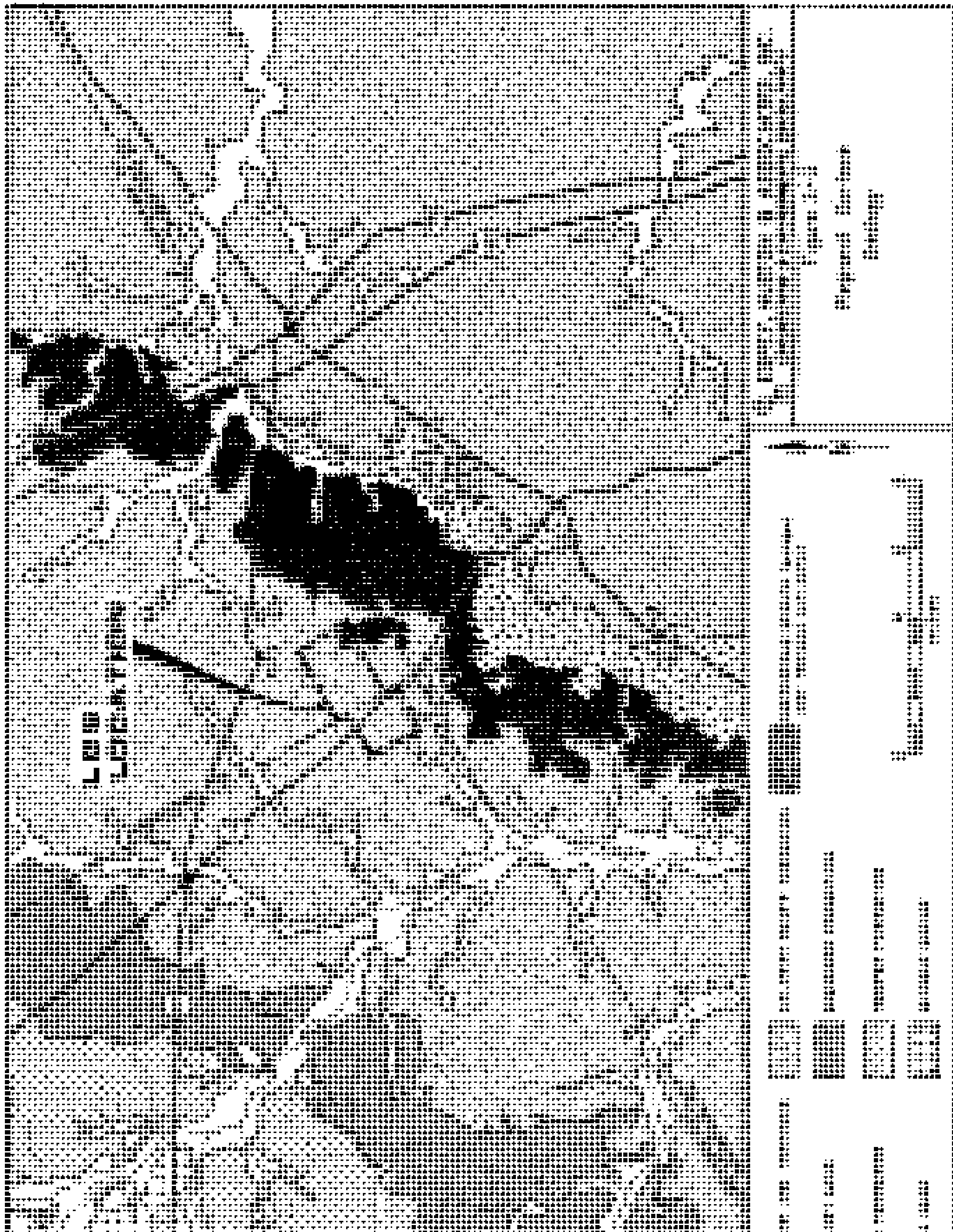

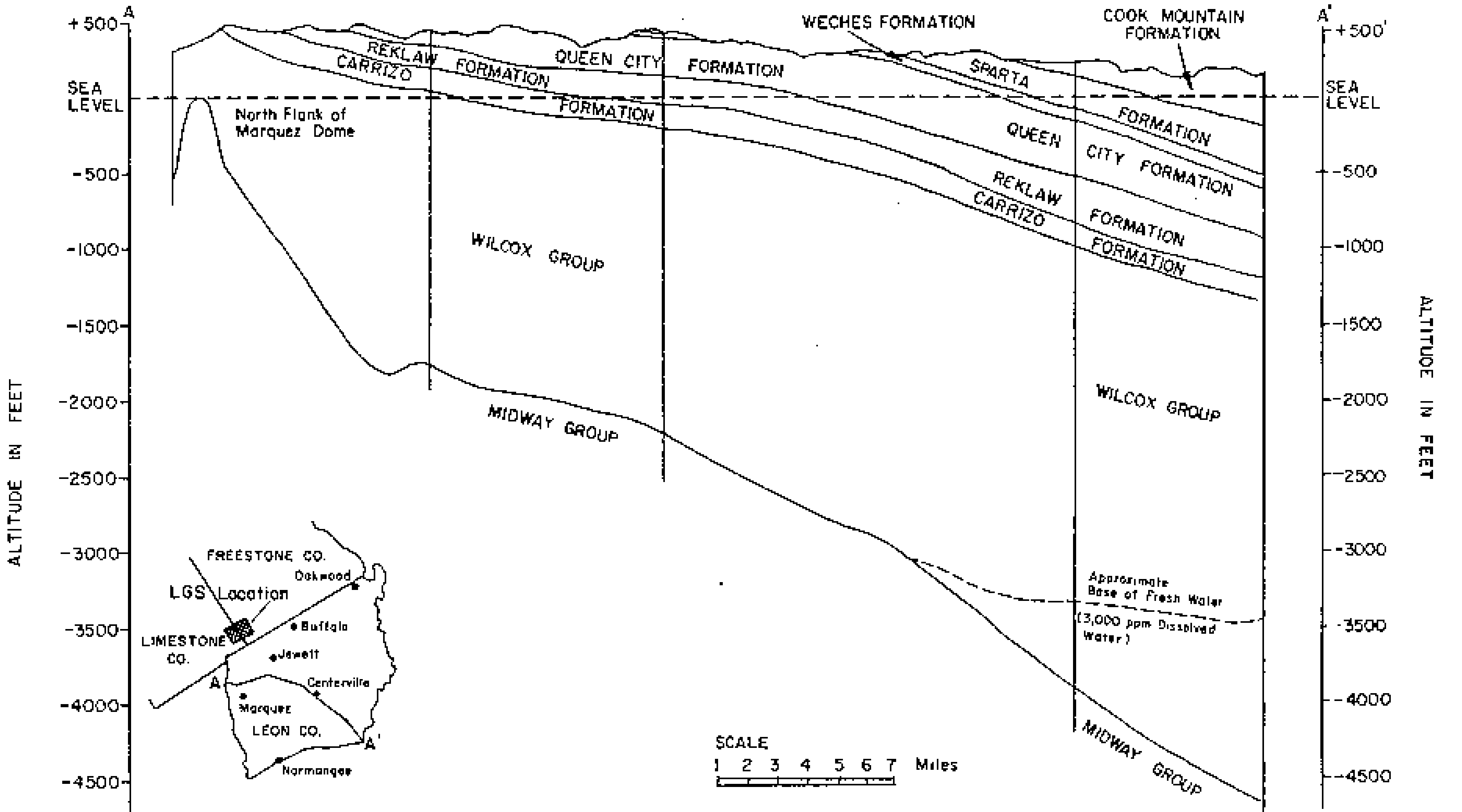

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Figure 3-4

Regional Geologic Cross Section

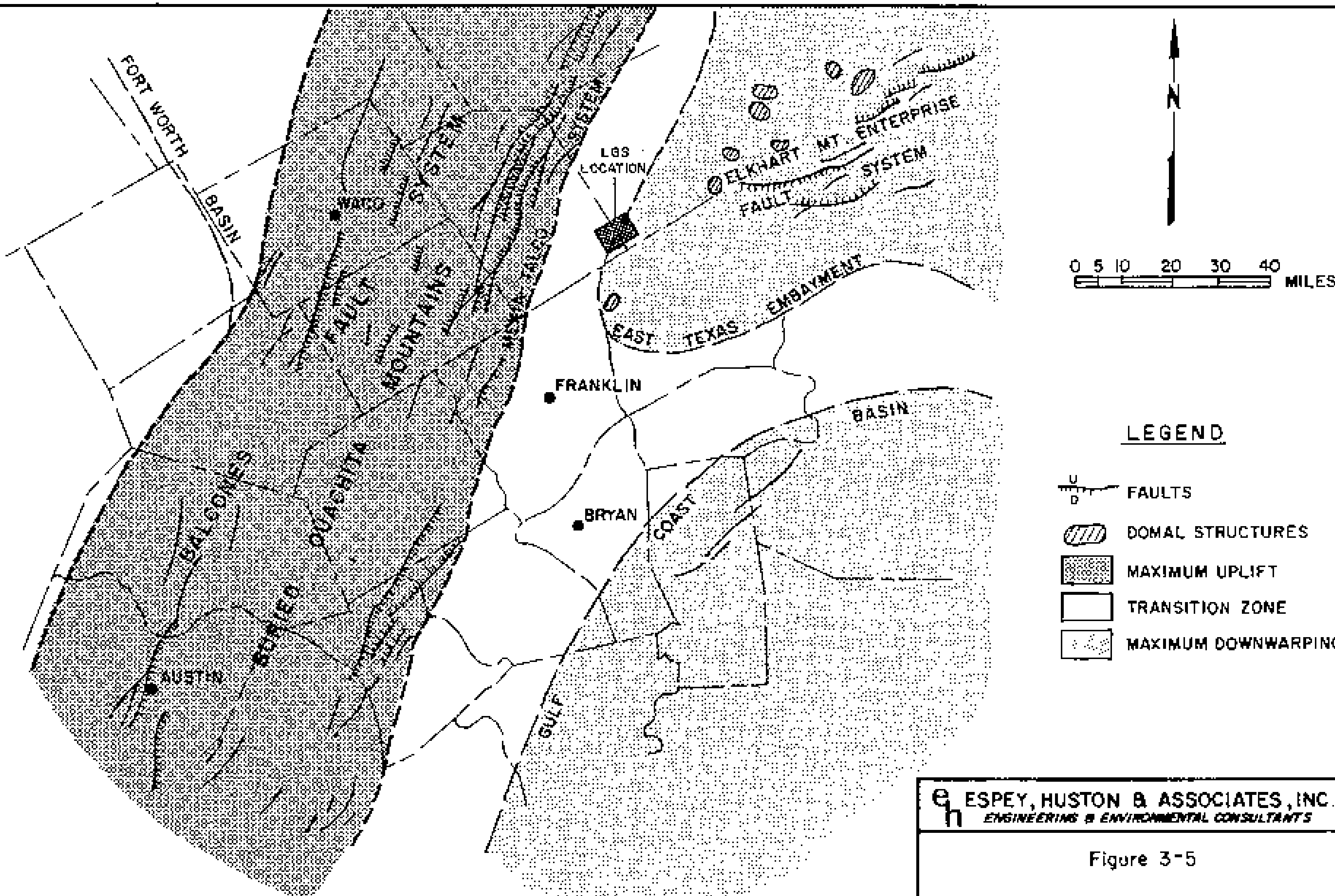
Regional faulting, regional subsidence, and localized domal uplifts have modified the generalized geologic structure of the Gulf Coastal Plain (Figure 3-5). The geologic structure in the LGS vicinity is relatively simple, however, and no structurally related or other geologic hazards have been identified that would hinder onsite waste disposal operations.

3.1.1 Stratigraphy

The Midway Group is the lowest stratigraphic unit of Tertiary age in the study region. It crops out across central Limestone County about 17 miles northwest of the LGS site and overlies older Cretaceous strata. In the proximity of the LGS site, the Midway is estimated to be about 850 feet thick (Rettman, 1984), and its upper surface is at an approximate elevation of -700 feet msl (Guyton and Associates, 1972). Midway sediments were deposited in a marine environment and are differentiated into upper and lower formations. The lower Kincaid Formation is approximately 400 feet thick and is composed of soft gypsiferous clays (50%), glauconitic sands (40%) and indurated limestones (10%). The upper Wills Point Formation is primarily clay and silty clay (Sellards, et al., 1932).

The marine clays of the Midway Group grade upward into the delatic and fluvial-deltaic sediments of the Wilcox Group, which have been differentiated (Barnes, 1970) into the Hooper, Simsboro, and Calvert Bluff formations. The basal Hooper Formation is about 400 feet thick and is present between elevations of -300 feet and -700 feet msl. The Hooper consists of interbedded sand, clay, silty clay, and some lignite; and clayey strata are predominant.

The Simsboro Formation is composed principally of fine to coarse grained quartz sand, with relatively minor interbedded clays, and silty clays. The thickness of the Simsboro in the LGS vicinity is estimated to vary from about 200 feet to 280 feet. The elevation of the upper surface of the unit is believed to be about -50 feet msl and -150 feet msl in updip and downdip areas, respectively.



SOURCE: Renfro et al, 1973; Fisher, 1965

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Figure 3-5

Regional Geologic Structure

The Calvert Bluff Formation overlies the Simsboro and is the only Wilcox unit that crops out in the immediate vicinity of the LGS. The Calvert Bluff is composed of interbedded muds, very fine to fine grained quartz sands, and lignite. Detailed study of the Calvert Bluff (Kaiser et al., 1978) indicates that it was deposited in a fluvial-deltaic environment. It exhibits major channel deposits of thick sand surrounded by extensive interchannel flood basin deposits of sandy muds, laminated sands and muds, and lignite. Because of its complex stratigraphy, the vertical and lateral extents of individual beds within the Calvert Bluff are highly variable.

The Claiborne Group crops out immediately southeast of the LGS site. Only the lower most unit of this group, the Carrizo Formation, is of concern to this study. Other stratigraphically higher units within the Claiborne include the Reklaw and Queen City Sand formations (Figure 3-3). The Carrizo Formation unconformably overlies the Calvert Bluff Formation and is composed of generally medium to fine grained quartz sand with minor amounts interbedded sandy clay. Sands in the Carizo may also be coarse grained. Its thickness in the LGS vicinity is believed to be between 0 feet and 20 feet.

Alluvial deposits of Quaternary age are found in the Navasota River and Trinity River valleys, as well as major tributary creeks. The alluvium consists of sand, silt, silty clay and sandy clay and is not easily differentiated from the underlying bedrock strata in many instances. Terrace deposits do not occur with significant frequency along stream valleys in the vicinity of the LGS site. However, a small terrace has been mapped (Barnes, 1970) in the Navasota River valley about 2.5 miles downstream of the Leon-Limestone county boundary.

3.1.2 Structure

Geologic structure in the Texas Gulf Coastal Plain is very generally characterized by gentle stratigraphic dip toward the Gulf of Mexico. Subregional tectonic features within the province complicate this simple structure, however (Figure 3-5). The LGS site is located about 15 miles southeast of the Mexia-Talco fault system and 25 miles west-southwest of the Elkhart-Mount Enterprise fault system. Two salt domes are also located 10 miles southwest and 20 miles east-northeast of the LGS site; Marquez and Oakwood salt domes, respectively.

The above domes and fault systems do not measurably influence the LGS site, and structure near the site is controlled principally by the East Texas Embayment. The study area is located on the southwest margin of the embayment and stratigraphic dip is to the east-southeast into the syncline (Figure 3-4). The Wilcox Group in the power station vicinity dips at a rate of about 70-100 feet per mile.

3.1.3 Geologic Hazards

Based on the known distribution of damaging earthquakes and their corresponding intensities, there is no significant seismic risk associated with the siting of waste disposal facilities in the LGS vicinity (Algermission, 1969). Due to the limited amount of ground-water withdrawal in the power station vicinity, measurable ground subsidence as a result of pumpage is not likely to occur.

3.2 GROUND-WATER RESOURCES

The Hooper, Simsboro, Calvert Bluff, and Carrizo formations yield variable amounts of fresh (less than 1,000 mg/l dissolved solids) ground water in the region and are commonly referred to collectively as the Carrizo-Wilcox Aquifer. The formations are comprised of sand, silt, clay, and lignite strata having considerable vertical and lateral heterogeneity. The units attain a thickness of nearly 1400 feet in the LGS vicinity.

The Hooper is the stratigraphically lowest unit of the Carrizo-Wilcox Aquifer, and it yields small to large amounts of water to wells on its outcrop. In the LGS vicinity, however, it occurs at depths below 950 feet and is not utilized for supply. Subsurface geophysical logs (Rettman, 1984; Guyton and Associates, 1972) indicate the Hooper consists mainly of clays and silty clays and has few permeable interbeds as compared to other Wilcox units. The relevance of the Hooper to onsite waste disposal at the LGS is negligible.

The Simsboro is the most important water-producing unit of the three Wilcox formations. Its composition is principally quartz sand, some mudstone, clay, and a small amount of gravel. It provides water for industrial use at the LGS and municipal and domestic use in nearby areas of Freestone County.

The Calvert Bluff Formation contains zones of varying permeability that correlate well with the geologic environments of deposition exhibited by the formation. The most permeable parts of the Calvert Bluff are sand-rich, buried, ancestral stream channels. Typically these are sinuous, northwest-southeast elongated sand bodies surrounded by less permeable silt, clay, and slightly sandy sediments. The less permeable sediments occur between the sand channels and represent interchannel floodbasin deposits. The Calvert Bluff underlies the surface at the LGS site, where it has a thickness of 550-690 feet.

The Carrizo Formation crops out primarily downdip of the LGS, but a small portion of the materials handling area is mapped as intersecting an outlier of the unit (Figure 3-3). The Carrizo is a uniform, well-sorted quartz sand that contains only a few thin beds of clay or shale. It attains a thickness of over 150 feet along the southeast edge of its outcrop (Figure 3-4), but is estimated to be less than 20 feet thick at the LGS. The Carrizo has limited significance at the LGS site because it is hydrologically unconnected with the main body of the formation. Its character can be expected to be similar to sands within the Calvert Bluff, and it is likely to be in hydrologic communication with the underlying Calvert Bluff.

However, for the purposes of this report, there is little reason to differentiate the Carrizo from large sand bodies that are present in the Calvert Bluff. Southeast of the power station, the Carrizo is an important regional aquifer.

3.2.1 Hydrology

Ground water at shallow depths in the region usually occurs under water-table (unconfined) conditions. Perched water tables and local artesian (confined) conditions can also occur at shallow depth as a result of the presence of relatively impermeable strata. Confined and semi-confined conditions generally prevail downdip (i.e., southeast) of outcrop areas, where overlying strata provide more complete confinement of water-bearing units.

Recharge to aquifers of the region occurs principally from precipitation on outcrop areas. Other sources of recharge include infiltration of surface waters from streams and lakes. Although a large portion of potential recharge is lost by runoff and evapotranspiration (Guyton and Associates, 1972), some of the water moves along the dip of stratigraphic units in response to hydraulic gradients created by ground-water discharges as ground-water pumpage, upward leakage through semi-confining layers, and surface seeps or springs.

The movement of shallow unconfined ground water is largely topographically controlled and is generally from points of higher elevation to discharge points along surface-water drainages. Some water also moves in a downdip direction in response to the regional hydraulic gradient to the southeast. In the confined portions of each aquifer vertical flow gradients may induce downward or upward seepage of water across semi-permeable boundaries from units having greater head to those having lower head. Available information concerning the hydraulic properties of the water-bearing units in the LGS vicinity are discussed in Section 4.4.

Peckham (1965) reported that east of the topographic divide between the Brazos River and Trinity River basins, ground water moves to the east and southeast from the higher elevations near the divide. Similarly, ground water moves to the south-southwest from the west side of the divide. Based on limited water-level data, the hydraulic gradient averages approximately 5 feet per mile in downdip areas of the Carrizo Sand and the Wilcox Group (Peckham, 1965).

Discharge from aquifers in the region is mostly through springflow, wells, or movement downdip. Evaporation and transpiration by trees and plants whose roots tap the water table also provide a means of discharge. Significant amounts of natural ground-water discharge into the Navasota River drainage where it crosses the Carrizo and Wilcox aquifers (Rettman, 1984). Fluctuation in the volume of discharge can be expected with seasonal water-level changes.

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3.2.2 Water Usage

Ground water in the LGS region is used for municipal public supply, rural domestic and livestock, irrigation, and industrial purposes. The estimated ground-water pumpage in Freestone, Leon, and Limestone counties in 1980 was 1,363 acre-feet, 1,435 acre-feet, and 1,570 acre-feet, respectively (Fogg and Kreitler, 1982). Due to the rural character of the region, the primary use is for rural domestic and livestock water supply, although in some areas pumpage for municipal supply approaches that for rural domestic and livestock supply. Historically, ground water for human and livestock consumption was obtained from individual wells. However, in recent years, rural water-supply corporations have begun to supply water over wide areas, and many individually owned wells have been abandoned or taken out of regular use.

Industrial ground-water use in the region is relatively limited, and many wells classified as industrial are actually temporary supply wells for oil and gas drilling operations. Irrigation use is also limited, since the area receives abundant rainfall and land use for crop production is not widespread.

Earlier in this century, most of the water used for domestic purposes was obtained from shallow, hand-dug wells, and many of these wells are still in existence. Most present-day wells, however, are drilled using rotary-wash methods, constructed with casing and well screen, and equipped with electrically powered submersible pumps. Most domestic and livestock wells have a nominal diameter of 4 inches. Many are not cemented or gravel packed. Larger municipal and industrial wells use 14-inch to 18-inch steel casing and 8-inch to 12-inch screens and liners. The casing of most large wells is cemented, and the producing intervals are often gravel packed.

3.2.3 Water Quality

Fresh ground water having dissolved solids concentrations less than 1,000 mg/l, is available from all Carrizo-Wilcox units in the LGS region. Normally, the freshest water is found at shallow depths in or near outcrop areas, and the water becomes more mineralized at greater depth and downdip distance from the outcrop area or source of recharge. In addition, the concentrations of dissolved minerals are greater in stratigraphic units in which ground-water circulation is restricted.

As ground water moves along its flow paths in the saturated zone, increases of dissolved solids and most major ions normally occur. In the stratified sandstone aquifers of the Texas Gulf Coastal Plain, a geochemical evolution to sodium-bicarbonate type waters is typical (Fogg and Kreitler, 1982). The longer that water is in an aquifer, or the greater the distance that it travels, the higher the sodium and bicarbonate concentrations become. Conversely, newly recharged ground water has low bicarbonate concentrations, and calcium predominates over sodium.

In outcrop areas and to some extent downdip of outcrop areas, the Simsboro and Calvert Bluff aquifers generally contain less than 500 mg/1 of dissolved solids. In southeast Leon County, dissolved solids concentrations of Wilcox ground waters begin to exceed 3,000 mg/l at altitudes of about -3,000 feet msl or less (Peckham, 1965) (Figure 3-4). Generally, fresh water from Wilcox aquifers is suitable for most uses with little or no treatment. Exceptions can occur in localized areas and when water of a certain quality is needed for some specific applications. Hardness can be low to high, and pH values are usually slightly acidic to slightly alkaline (5.5-8.5). The only naturally occurring constituent that often presents limitations to use is iron.

The chemical character of Carrizo ground water is similar to that of the Wilcox Group. However, the water has generally lower concentrations of dissolved solids. In addition, some wells in the Carrizo can contain small amounts of hydrogen sulfide and produce a sulfur odor.

4.0 SITE DESCRIPTION

The materials handling area is located on a portion of the LGS property on the east site of Texas State Highway 39 (Figure 1-2). The area is used to process and dispose of a variety of solid wastes derived from plant operation, including boiler fly ash and bottom ash; flue gas desulfurization (FGD) sludge; and sludges from plant water and inorganic waste treatment systems. Facilities sited in the area are described below.

1. Secondary Dewatering and Waste Handling (SDWH) Area. Approximate 50-acre area located on the north side of the rail spur in the southwest corner of the materials handling area. Facility used to mix fly ash and FGD sludge prior to disposal. A runoff pond is located at the facility's north end. An emergency pond for retention of FGD-system process water is located east of the facility.

2. Dewatered Sludge Disposal Area (DSDA). Consists of 5, 2-acre cells constructed above grade primarily for the disposal of lake water pretreatment sludge and other miscellaneous Class II and Class III sludges. It is located immediately east of the SDWH area. As of the date of this report, only the southeast cell has been constructed. Runoff from this facility is directed to a small impoundment on its north side.

3. Combustion Solid Waste Landfill (CSWL). Consists of two areas, designated as Area 1 and Area 2, having a combined surface area of about 862 acres. Cells constructed above grade within these areas are to be used for disposal of boiler bottom ash and stabilized FGD sludge. As of the date of this report, two cells have been

constructed at the north end of Area 1. Area 2 will not be constructed until Area 1 is near capacity. A runoff pond is located south of Area 1 to collect water during disposal operations. After closure of this area, surface water will be diverted to a perimeter ditch.

4.1 TOPOGRAPHY AND DRAINAGE

The materials handling area is situated in flat to gently rolling terrain with low-relief valleys. Natural topography of the site (Figure 1-2) has been partially altered by the construction of existing site facilities. Topographic changes are associated with the construction of perimeter dikes and disposal cells for CSWL Area 1, construction of the SDWH and DSDA facilities, and the realignment of Lynn Creek. The topography of the southwest end of the materials handling area, as of October 1985, is shown on Plate 1. The topography of the northeast end of the materials handling area is currently unchanged and is shown in detail on Plate 2. Topographic changes have occurred only in areas southwest of CSWL Area 2, and are shown in detail on Plate 1. Topographic detail for CSWL Area 2 is shown on Plate 2.

Ground elevations in the materials handling area vary between 402 feet and 535 feet msl. The lowest elevations occur along Lynn Creek, where it exits the site just west of the SDWH area. The hills located on the north, northeast, and east edges of the site exhibit maximum elevations of 530-535 feet.

The site is located near the crest of the drainge divide between the Trinity River and Navasota River basins. Except for a small area in the northeast portion of the property, the materials handling area is within the Navasota River watershed. The upper reaches of several small drainages occur within the site.

Runoff to the Trinity River enters the headwaters of Buffalo Creek and flows northeast across the east property line. Buffalo Creek turns just north of the site and flows east to its confluence with Upper Keechi Creek about 25 miles east of the power station. Upper Keechi Creek then flows 9 miles southeastward to its confluence with the Trinity River.

A small portion of the property just north of CSWL Area 2 drains to the north. Runoff from this area enters the headwaters of Dry Creek and flows about 3 miles northwest to the confluence with Sanders Creek. Sanders Creek flows 5 miles to the southwest and empties into Lake Limestone on the Navasota River.

Runoff at the southeast corner of the tract flows south to Lambs Creek. Two small areas along the south property line drain southward to Lambs Creek via Red Hollow and an unnamed tributary. The remaining (and largest) portion of the property drains southwest via Lynn Creek and an unnamed tributary of Lynn Creek. Once it leaves the site, Lynn Creek flows 2.5 miles southwest to its confluence with Lambs Creek. In turn, Lambs Creek flows west-southwest about 1.7 miles before entering an arm of Lake Limestone on the Navasota River.

4.2 SURFACE SOILS

Figure 4-1 is a general soils map of the power station area based upon the latest general soils map published for Freestone and Limestone counties by the U.S. Department of Agriculture Soil Conservation Service (USDA-SCS) in cooperation with the Texas Agricultural Experiment Station. The following associations are found in the power station area.

1. Padina - Silstid Association. Padina soils have a brown sandy surface 40-80 inches thick over a moderately permeable, mottled gray, red, and yellow, strongly acid, sandy clay loam subsoil. Silstid soils have a pale to very pale brown sandy surface about 30 inches thick over a moderately permeable, yellow, medium acid, sandy clay loam subsoil.

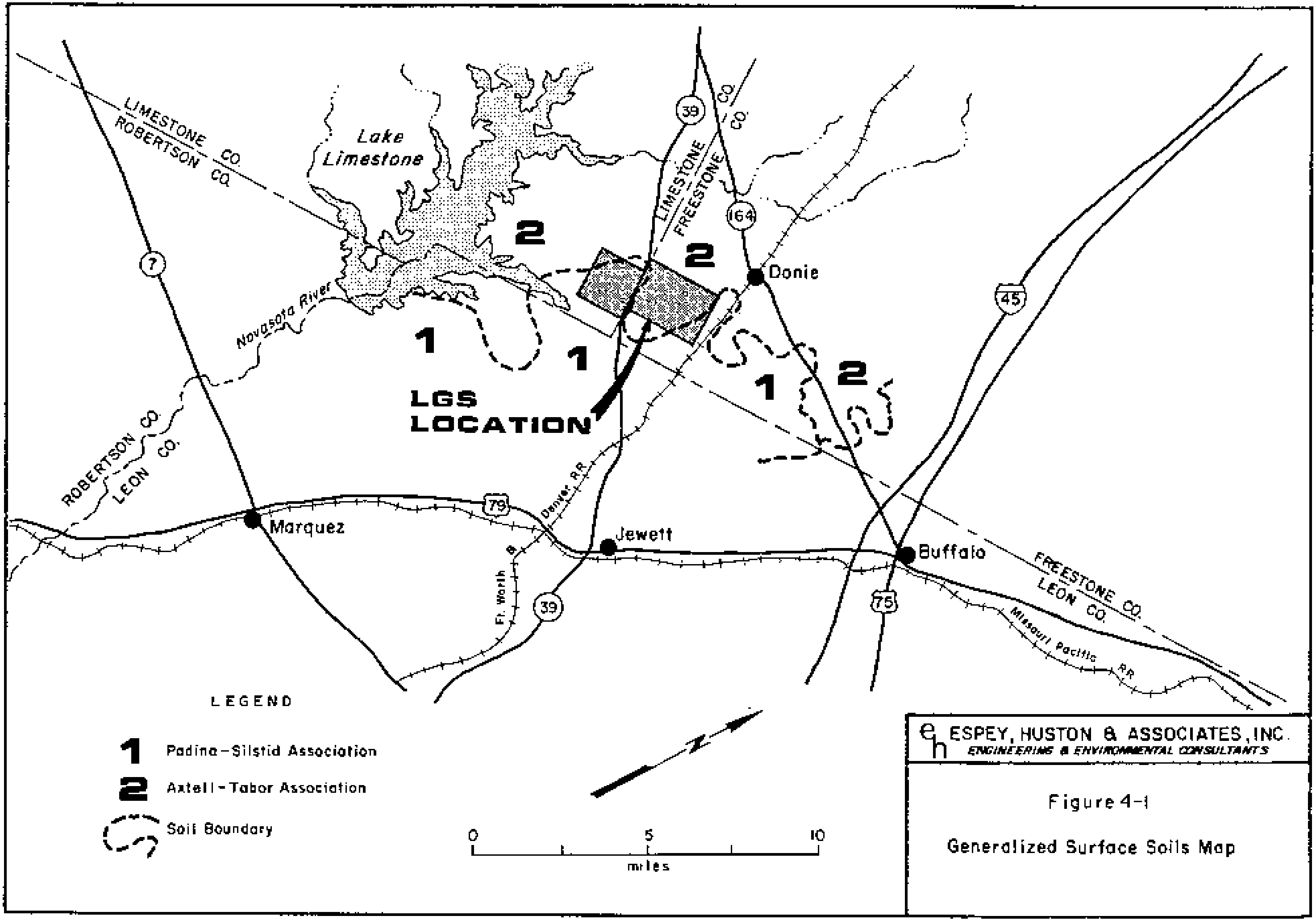


Figure 4-1

Generalized Surface Soils Map

2. Axtell - Tabor Association. Axtell soils have a grayish brown, massive, very hard, fine sandy loam surface less than 10 inches thick over a mottled, red, yellow, and gray, strongly acid, clayey subsoil which is very slowly permeable with a high shrink-swell potential. Tabor soils have a grayish brown, fine sandy loam surface more than 10 inches thick over a mottled, yellow and gray, strongly acid subsoil that is very slowly permeable and has a high shrink-swell potential.

The soils in the power station vicinity are light colored, medium to slightly acid soils that are found throughout parts of the Claypan and Cross Timbers regions of Texas. At the site, the range includes sands, silts, silty clays, and sandy clays that are typical of fluvial deposits. These deposits are usually gray to dark gray; however, the upper zones have been subjected to weathering and exhibit colors ranging from light gray to light brown and red.

The materials handling area is situated mostly within the Axtell - Tabor Association, consisting of 63% Axtell soils and 37% Tabor soils. Both of these soils have a high shrink-swell potential. The results of site borings and subsurface soil testing in the materials handling area indicate that the area is underlain by a near-surface weathered clay stratum that occurs about 1.5 feet from the surface and ranges from a minimum of 0 feet to as much as 10 feet in thickness. The permeability of this material ranges from 1.84×10^{-8} cm/sec to 4.9×10^{-4} cm/sec.

4.3 GEOLOGY

The discussion of site geology in this section is based on the logs of borings and water-supply wells in the materials handling area. The locations of all borings and wells are shown on Plate 3. Drilling logs were used to interpret stratigraphy and structure and to prepare geologic cross sections (Plates 4 through 7). The results of laboratory tests were used to classify subsurface materials and characterize their properties.

4.3.1 Structure

Geophysical logs of water-supply wells HL&P #2 and #3 and an oil test hole (KA-39-39-403) in CSWL Area 2 indicate that the base of the Calvert Bluff Formation occurs at elevations of -140, -185, and -80 feet msl, respectively. Assuming the base of the Calvert Bluff to be planar, the formation strikes N.30^{o}E. and dips S.60^{o}E. at a rate of 94 feet per mile.

4.3.2 Stratigraphy

Calvert Bluff sediments were deposited by streams and rivers that meandered across an ancestral coastal plain. The resultant stratigraphy is complex and includes several types of depositional environments: paleostream channels, natural levees, crevasse splays, interchannel floodbasins, and freshwater swamps. Site stratigraphy, as interpreted from onsite borings, is illustrated in a series of eight cross sections (Plates 4 through 7). The locations of the sections are shown on Plate 3.

Channel deposits mark the course of paleostreams and consist of fine grained quartz sand and silty sand They are typically elongated in a northwest-southeast direction and vary in thickness from 20 feet to more than 60 feet. Two major channel sequences were identified at the site. The first is located at the southwest end of the materials handling area and is roughly parallel to cross section D-D'. It crops out in the vicinity of boring D-19 and dips into the subsurface to the southeast. Its presence was noted in borings D-17, 19, 20, 25, 29, 43, 44, 34, 1, 2, 3, and 4. The southwest ends of cross sections A-A', B-B', and C-C' intersect this channel at approximately right angles and show the channel to occur at gradually lower elevations in borings D-19, 34, and 4. Section D-D' is adjacent to the main channel between borings D-16 and D-30 and intersects the channel at borings D-34 and D-4. Ten-foot thick sands present in borings D-16 and D-26 are interpreted to represent the lateral fringe of the channel deposit.

A second channel is present beneath CSWL Area 2 and is generally parallel to the first. Cross section A-A' intersects the channel perpendicularly in borings S-9 and S-18. Cross section E-E' and F-F' denote its southeasterly dip. The channel is generally parallel to section F-F' in borings S-5, 9, and 16 and appears to meander slightly to the east toward borings S-47 and S-50.

During periods of flooding, the ancestral streams topped their channels and provided brief influxes of sand and silt to areas adjacent to the channel course (i.e. overbank deposits). These sediments formed natural levees along the stream banks and crevasse splays on the landward sides of the levees. During major flood episodes, sands and silts could be deposited at greater distance from channel courses (i.e. floodbasin deposits). During lesser floods, silts and clays were primarily deposited in interchannel areas. Areas of low elevation between stream courses fostered the development of swamps. Swamps that remained stable for long periods gradually accumulated significant thicknesses of decayed vegetation that was subsequently compressed and transformed to peat and lignite. Southeast of the LGS site, major lignite deposits are being mined to provide boiler fuel for the power station. The lignites in the materials handling area appear to be relatively thin and discontinuous.

Floodbasin sediments comprise the bulk of Calvert Bluff deposition in the materials handling area. They are differentiated on the cross sections into two general categories: (1) massive clays, silty clays, and sandy clays and (2) thinly interbedded sands, silts, and clays. Overbank deposits are highly transitional and difficult to differentiate for mapping purposes. In the geologic cross-sections, overbank deposits were mapped as either channel or floodbasin deposits, depending on their relative permeability.

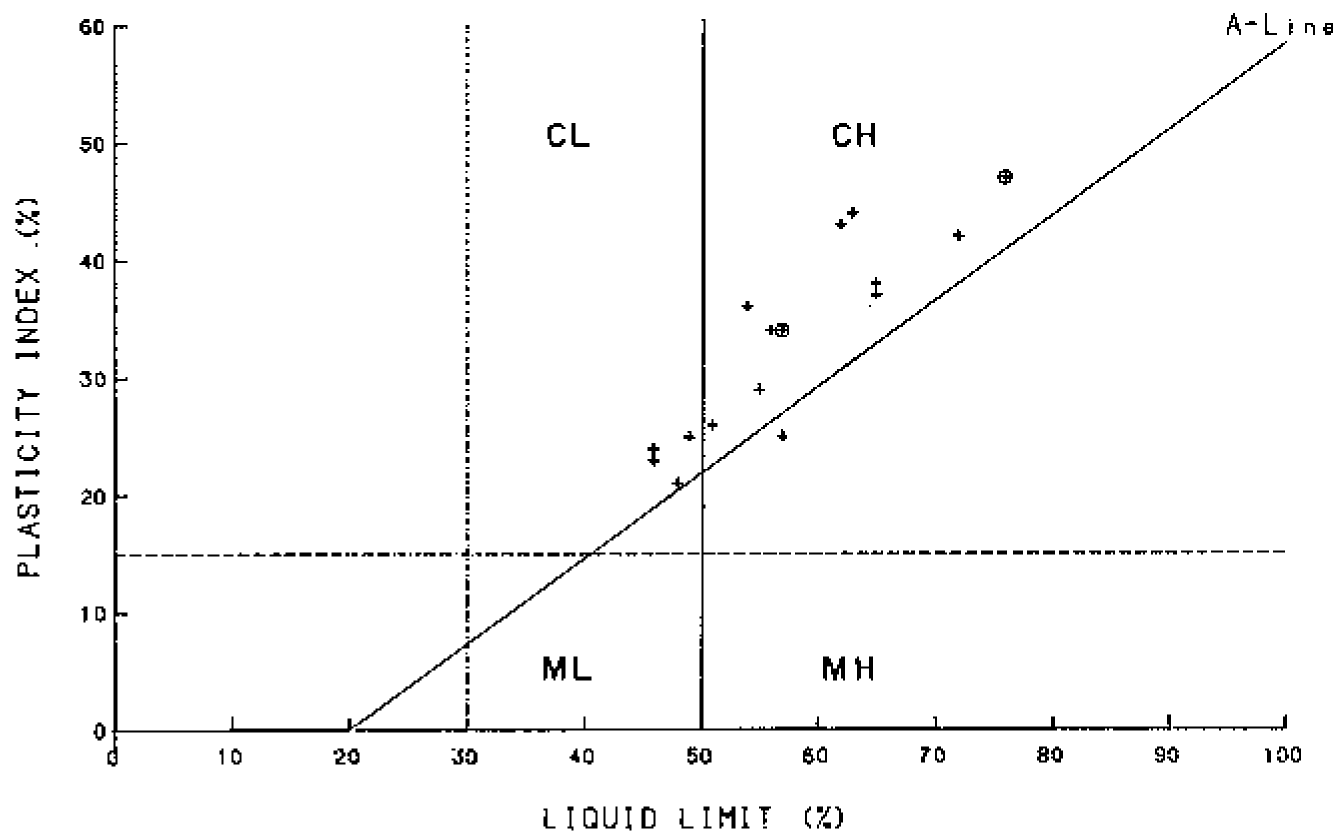
The description of soils on site boring logs and the distribution of boring locations were not sufficient to clearly define the presence or absence of the Carrizo Formation in the southeast corner of the site (Figure 3-3). However, its thickness within the site is expected to be less than 20 feet and its texture is expected to be quite similar to channel sands in the Calvert Bluff.

4.3.3 Soil Properties

More than 150 samples from onsite borings were tested to determine basic physical properties including liquid limit, plastic limit, plasticity index, and grain-size distribution. The results of the tests were used to classify each sample according to the Unified Soil Classification System (USCS). Test data and USGS designations are tabulated in the appendix to this report.

To provide a means of relating tested samples, nonsampled materials, and identifiable sedimentary environments, the soil descriptions on site boring logs were used to define nine discrete soil groups. Groups 1, 2, 3, and 4 include all sand, clayey sand, silty sand, and silt deposits encountered by site borings, and they represent the most permeable strata beneath the site. Groups 5, 6, and 7 comprise all clays, sandy clays, and silty clays and correspond to the least permeable of site materials. Groups 8 and 9 represent stratigraphic units that are notably interbedded and that are composed of varying mixtures of all other soil types. They tend to be fine grained (principally silt and clay) and contain interbeds of silt and clay or sand. Sediments in Group 8 are typically coarser grained than those in Group 9.

To check the validity of these correlations, each tested sample was assigned to a soil group on the basis of its log description, not on the basis of index test results. Plasticity charts were then prepared for all soil groups, to show the relationship between liquid limit and plasticity index values for the tested samples. These charts are presented for soil groups 5 through 9 in Figures 4-2 through 4-6, respectively. The solid lines (A-line and liquid limit = 50) divide each chart into regions that serve as the basis for USCS classification of cohesive soils. The dashed lines (liquid limit = 30 and plasticity index = 15) represent key values recommended by TWC for determining suitability of soils for landfill liner material. Descriptive



⊕ - 2 Samples with the equal values

(3 CH samples were outside plot range
and are not shown)

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Figure 4-2
Plasticity Index vs. Liquid Limit
Soil Group 5

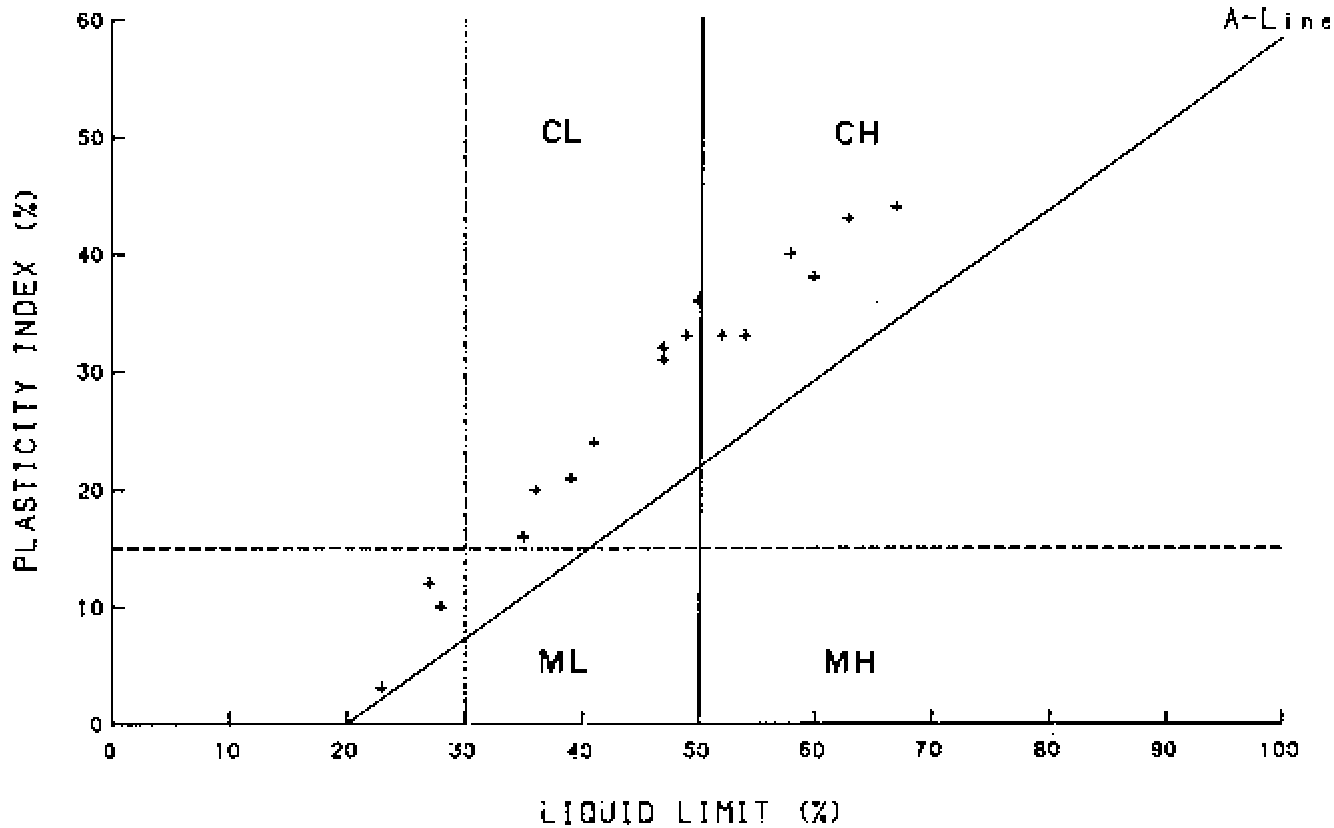

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Figure 4-3
Plasticity Index vs. Liquid Limit
Soil Group 6

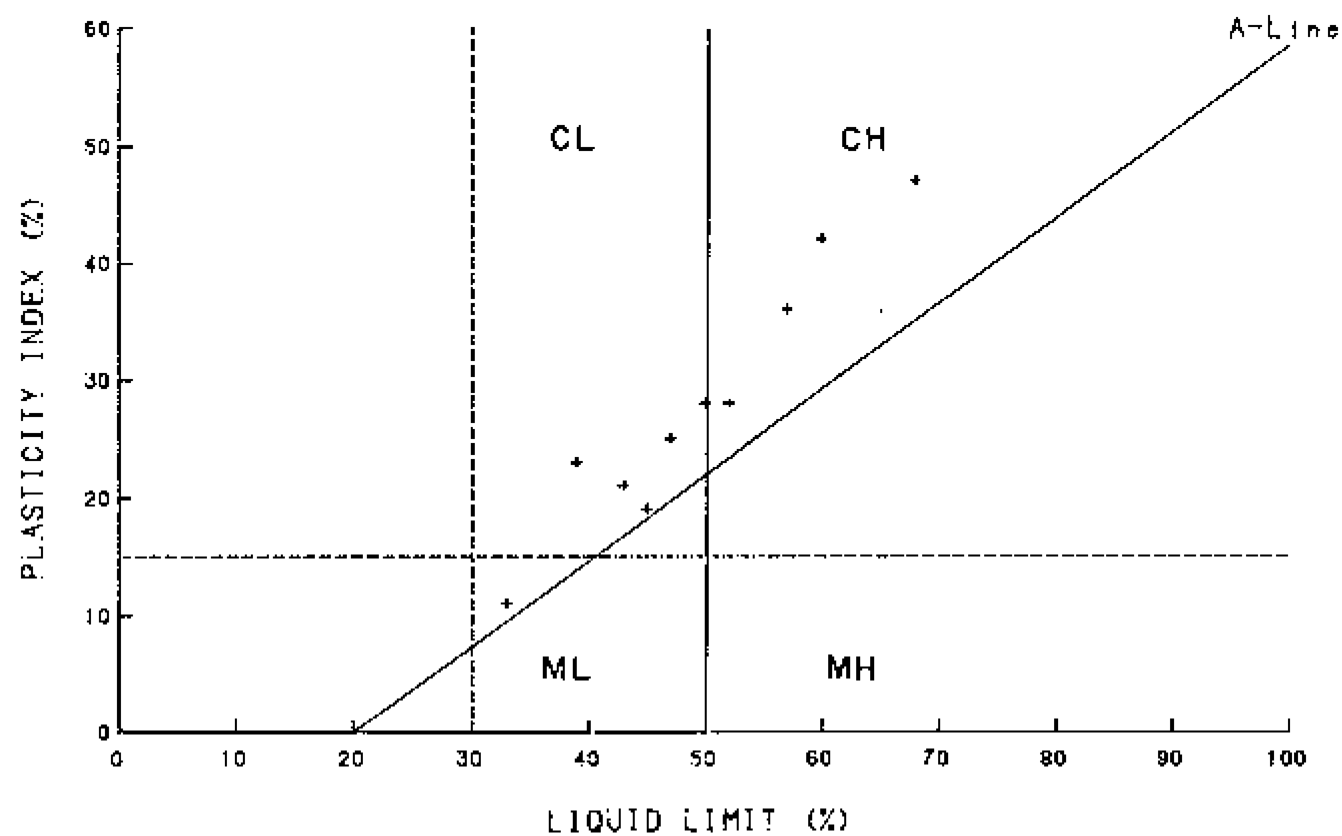

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Figure 4-4

Plasticity Index vs. Liquid Limit
Soil Group 7

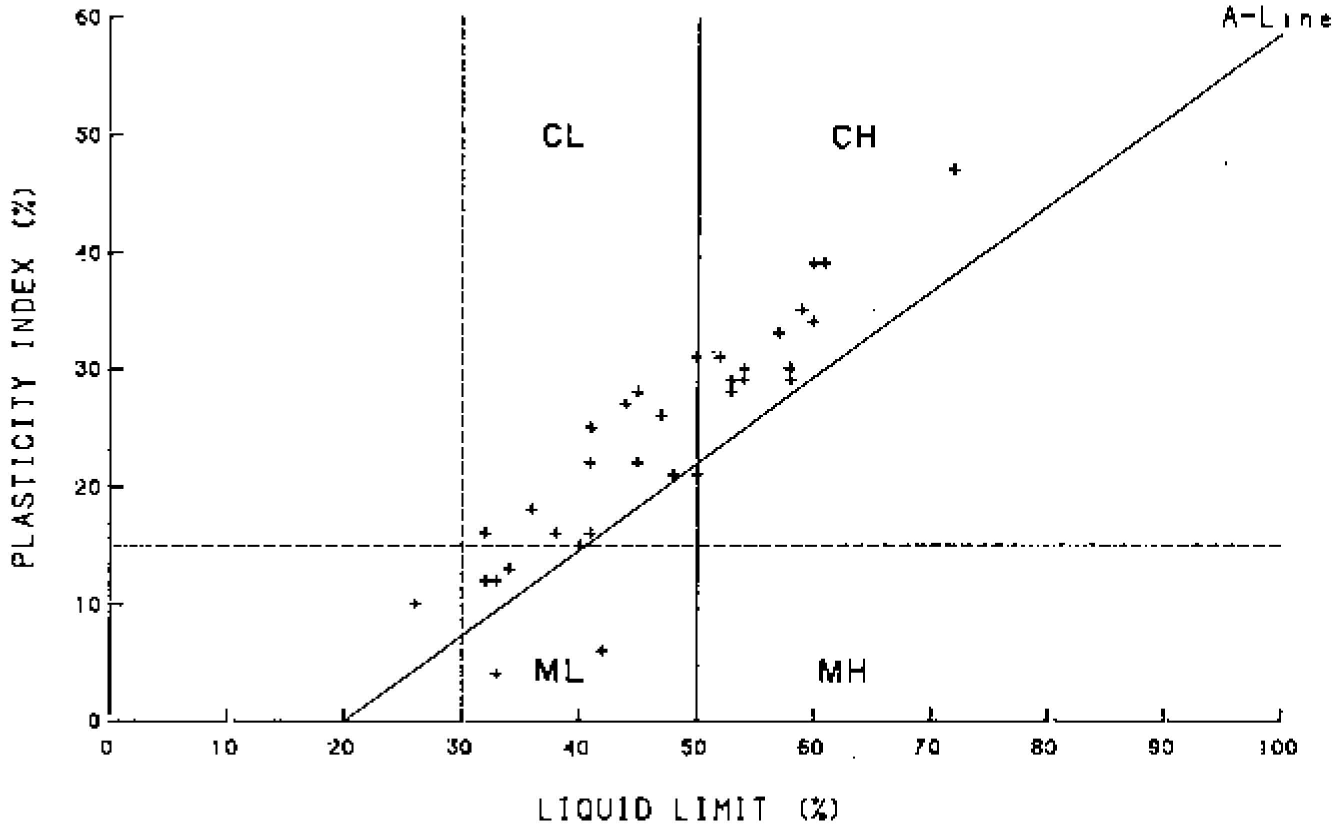

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Figure 4-5

Plasticity Index vs. Liquid Limit
Soil Group 8

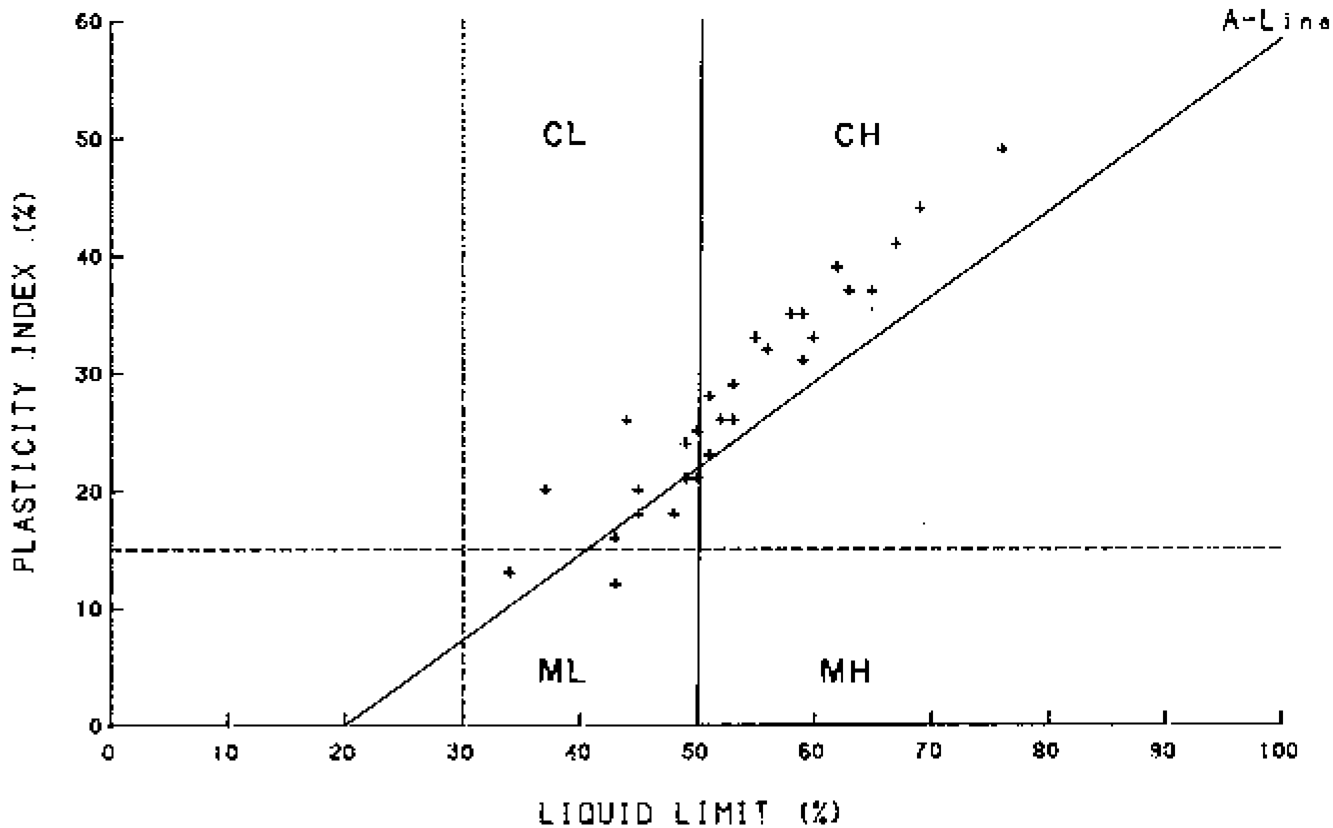

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Figure 4-6
Plasticity Index vs. Liquid Limit
Soil Group 9

statistics of the index soil test data were also computed for each soil group and are presented in Table 4-1.

Soils in groups 1, 2, and 3 can be generally classified as silty sand (SM), clayey sand (SC), or marginal between the two (SM-SC). Grain-size distribution curves for six sand samples are included in the appendix. The curves illustrate the similarity of sands at the site. More than 95 percent of each sample is smaller than the #50 sieve (0.3 mm) and 10-40 percent is smaller than the #200 sieve (0.074 mm).

Only two samples were placed in group 4 (silt), so there is little information to characterize this soil type. Based on the results of samples in other soil groups, which were classified as silt, these materials can be expected to be classified as ML. In addition, these materials are not suitable for use in liner construction.

Soils in groups 5, 6, and 7 are referred to as clays, sandy clays, and silty clays, respectively. With only minor exception, these materials can be classified as CH, CL, or CH-CL. Out of 21 tested samples assigned to group 5, all are classified as CH materials with the exception of 4 CL samples and 1 MH sample. All samples in group 5 were found to meet TWC guidelines. Out of 18 tested samples assigned to group 6, all are classified as CH or CL materials, and only 3 did not meet TWC guidelines. All of the samples placed in group 7 were either CH or CL materials, and only one did not meet TWC guidelines. The statistical summaries of these groups and the charts indicate that these soils can be expected to be generally suitable as liner and cover materials for landfill construction. Out of a total of 49 samples from these groups, only four samples were found to be unsuitable, in accordance with TWC guidelines.

Fine grained soils (principally clay and some silt) that are intermixed or thinly interbedded with sand were categorized under group 8. Liquid limit values for tested samples in this group ranged from 26 to 72 percent and had a mean value of 47.3 percent. Only one sample fell below the TWC guideline of 30 percent. Plasticity index values range from 4 to 47 percent and averaged 24.3. Only 6 out of 35 of the samples did not meet the recommended value of 15 percent, and only three

TABLE 4-1

STATISTICAL SUMMARY OF SOIL INDEX PROPERTIES

Soil Group	Statistical Parameters	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Fraction Passing #200 Sieve (%)
1	N	1	1	1	4
	Min	24	17	7	10
	Max	24	17	7	29
	Mean	—	—	—	18.3
	Std. Dev.	—	—	—	7.9
2	N	3	3	3	5
	Min	23	19	3	26
	Max	46	29	27	45
	Mean	34.3	22.7	11.7	35.2
	Std. Dev.	11.5	5.5	13.3	7.2
3	N	10	10	10	16
	Min	29	20	1	14
	Max	62	30	39	96
	Mean	39.8	25.2	14.6	34.2
	Std. Dev.	12.5	3.5	13.0	15.0
4	N	1	1	1	2
	Min	47	27	20	72
	Max	47	27	20	87
	Mean	—	—	—	79.5
	Std. Dev.	—	—	—	10.6

TABLE 4-1 (Cont'd)

Soil Group	Statistical Parameters	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Fraction Passing #200 Sieve (%)
5	N	21	21	21	21
	Min	46	16	21	44
	Max	106	33	86	99
	Mean	63.8	24.0	39.2	79.6
	Std. Dev.	16.1	4.4	16.2	17.2
6	N	18	18	18	18
	Min	23	14	3	22
	Max	67	23	44	95
	Mean	45.7	17.9	27.8	55.9
	Std. Dev.	12.6	2.6	11.8	16.7
7	N	10	10	10	10
	Min	33	16	11	37
	Max	68	26	47	88
	Mean	49.4	21.4	28.0	61.5
	Std. Dev.	10.4	2.8	10.9	16.9
8	N	35	35	35	40
	Min	26	16	4	16
	Max	72	36	47	89
	Mean	47.3	22.9	24.3	54.8
	Std. Dev.	10.5	4.4	9.8	19.9

TABLE 4-1 (Concluded)

Soil Group	Statistical Parameters	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Fraction Passing #200 Sieve (%)
9	N	30	30	30	31
	Min	34	17	12	25
	Max	90	31	64	100
	Mean	54.5	25.3	29.2	74.3
	Std. Dev.	11.6	3.1	11.2	20.3

Soil Group Descriptors:

1 - Sand
2 - Clayey Sand
3 - Silty Sand
4 - Silt
5 - Clay
6 - Sandy Clay
7 - Silty Clay
8 - Coarse, fine-grained interbeds
9 - Fine, fine-grained interbeds

samples had less than 30 percent finer than the #200 sieve. Although soils in group 8 do not appear to be as favorable as those in groups 5, 6, and 7, blending or reworking of these materials is likely to produce adequate liner and cover material. Samples that met or exceeded TWC guidelines are CH or CL soils, while those that did not satisfy the guidelines were ML soils.

Soils in group 9 are similar to those of group 8, in terms of being interbedded and intermixed. However, group 9 soils contain lesser amounts of sand and silt. Excepting two samples that were tested as ML soils, these materials are classifiable as CH soils. Liquid limit values ranged from 34 to 90 percent and had a mean of 54.5 percent. Plasticity index values ranged from 12 to 64 percent and averaged 29.2 percent. Fractions smaller than the #200 sieve ranged from 25 to 100 percent and averaged 74.3 percent. Only three of 31 samples did not meet the recommended size guidelines of at least 30 percent passing the #200 sieve. Only two of 30 tested samples had plasticity index values below 15 percent. Group 9 materials appear to be adequate for liner and cover purposes.

4.4 GROUND-WATER CONDITIONS

The principal aquifers beneath the materials handling area are the Simsboro Formation and channel sands of the Calvert Bluff Formation. The Carrizo Formation also occurs along the southeast margin of the site, but has limited hydrologic significance. Ground water in the upper Calvert Bluff and Carrizo is unconfined within approximately 100 feet of the surface. The Simsboro is hydrologically separated from near-surface Calvert Bluff and Carrizo sands by several hundred feet of intervening impermeable strata.

Water wells at the LGS site and surrounding area are shown on Figure 4-7. Available construction and water-level data for these wells are described in Table 4-2. Water-quality analyses from wells in this same area are presented in Table 4-3. Water-level measurements from monitoring and supply

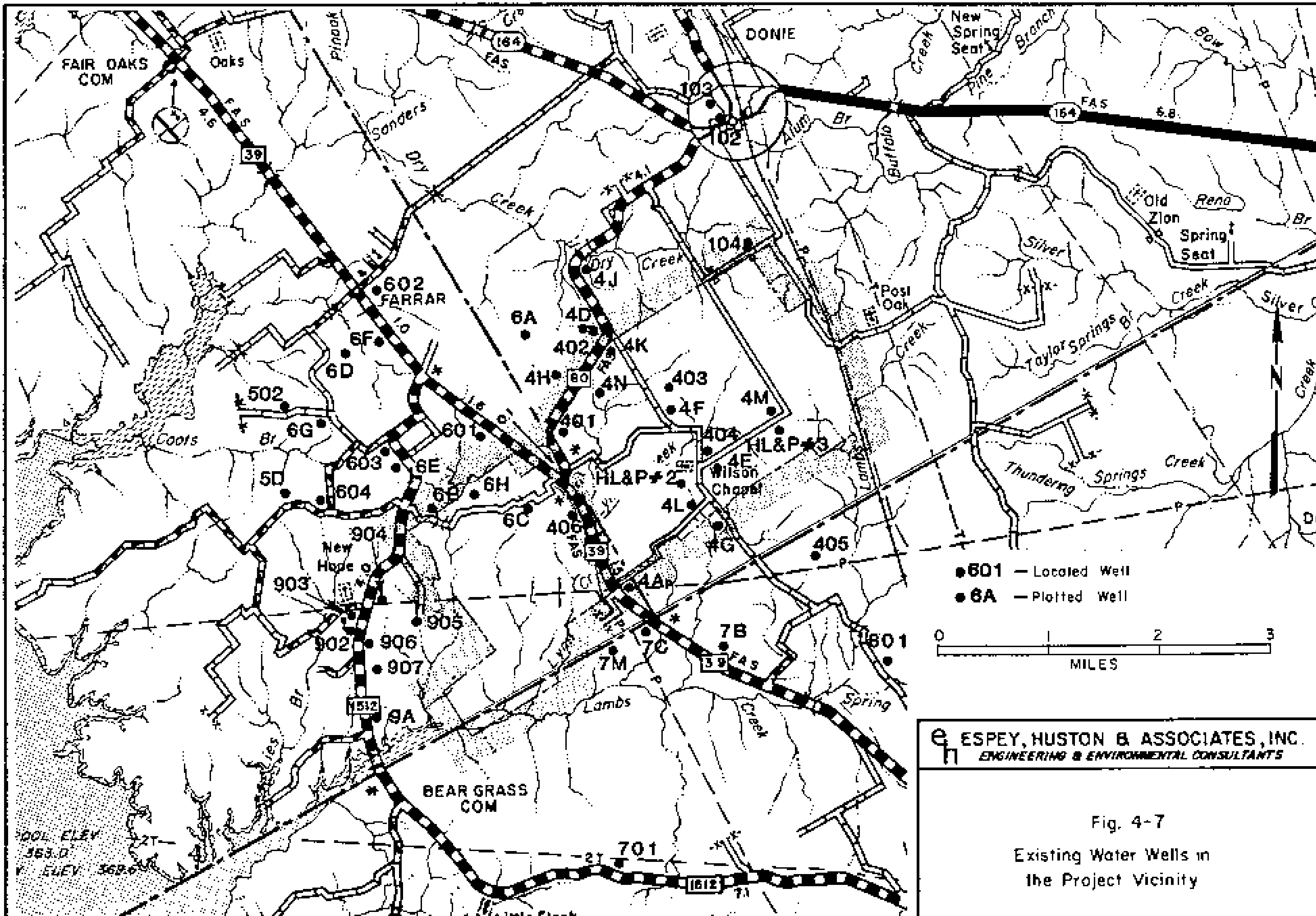

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Fig. 4-7
Existing Water Wells in the Project Vicinity

TABLE 4-2

RECORDS OF WATER WELLS IN THE PROJECT VICINITY

	Owner	Date Completed	Well Depth (feet)	Casing Diameter (inches)	Casing Depth (feet)	Screen Interval (feet)	Altitude of Land Surface (feet)	Water Levels Depth (feet)	Water Levels Date Measured	Water Use	Chemical Analysis
				LIMESTONE COUNTY							
SD-39-38-502	L. Hurst	11-1-74	455	4	455	440-455	452	200	11-1-74	D	*
601	Houston Lighting and Power	--	26	34	26	--	483	20.4	10-2-81	--	
602	Farrar Water Supply Corp.	1967	718	4	718	669-709	438	75	1967	P	*
603	E.H. Chandler	11-20-78	348	4	348	180-327	471	77	11-20-78	D	
604	R.R. Gantt	4-8-65	360	4	360	241-360	470	--	--	--	*
902	A.O. Roberts	11-25-68	265	4	265	245-265	441	60.1	3-9-82	D, S	*
903	New Hope Church	9-6-78	246	4	246	227-246	442	50.2	10-20-81	D	
904	W. Rhodes	2-12-79	277	4	277	226-246	453	60	2-12-79	D	*
905	J. Beddingfield	1970	460	4	460	428-450	431	70	1970	D, S	
906	T.J. Crane	1971	295	4	295	275-295	434	60	1971	--	
907	J. Carpenter	12-16-78	290	4	290	260-290	428	70	12-16-78	D	
5D	J.H. Pruitt	8-16-81	308	4	308	175-308	--	64	8-16-81	D	
6E	Delta Drilling Co.	6-16-77	460	4	460	--	--	80	5-16-77	I	
6F	J. Welter	4-15-81	400	4	400	340-400	--	80	4-15-81	D	
6G	H. Harmon	5-17-82	471	4	471	330-471	--	60	5-17-82	D	
6H	J.L. Meyers Co.	9-10-81	280	4	280	--	--	60	9-10-81	--	
9A	L. Long	9-24-81	390	4	390	375-390	--	50	9-24-81	D	
SD-39-39-406	Houston Lighting and Power	1981	735	18	735	579-735	442	104.3	3-2-81	I	
4A	Houston Lighting and Power	5-13-82	451	4	451	344-451	--	120	5-13-82	I	

TABLE 4-2 (Cont'd)

	Owner	Date Completed	Well Depth (feet)	Casing Diameter (inches)	Casing Depth (feet)	Screen Interval (feet)	Altitude of Land Surface (feet)	Water Levels Depth (feet)	Water Levels Date Measured	Water Use	Chemical Analysis
				FREESTONE COUNTY							
KA-39-39-102	City of Donie No. 1	1949	700	4	--	--	505	--	--	P	
103	City of Donie No. 2	1962	852	4	852	792-852	500	146	9-18-62	P	
104	J.G. Voight (T.W. Whitaker No. 1)	1964	9,015	--	--	--	--	--	--	O	
401	C. Walker	11-21-68	410	4	410	390-410	475	118	11-21-68	D, S	*
402	B.W. Moore	8-20-68	690	4	690	645-690	470	120	8-19-68	D	*
403	R.J. Caraway (M.R. Holmes No. 1)	1967	16,018	--	--	--	--	--	--	O	
404	J.B. Lawler	7-17-68	447	4	447	427-447	480	127.0	8-26-70	D	*
HL&P #2	Houston Lighting and Power Co.	1-27-84	836	18	836	600-836	460	130	6-4-84	I	*
HL&P #3	Houston Lighting and Power Co.	11-18-84	920	18	920	685-920	500	166	12-14-84	I	*
KA-39-38-6A	B. Worthy	8-30-80	534	4	534	--	-	58	8-30-80	D	
KA-39-39-4D	J.E. Richardson	2-5-70	674	4	649	--	-	97	2-11-70	D, S	
4E	F. Leggio	6-22-71	480	4	442	--	-	120	6-23-71	--	
4E	G.E. Horton	6-3-71	659	4	608	--	--	116	6-10-71	D	
4F	C.L. Longer	12-14-73	472	4	452	437-452	--	75	12-14-73	D	
4G	J.P. Evans	9-9-74	512	4	440	--	--	158	9-9-74	D	
4H	McCoslin	9-24-74	660	4	640	--	--	105	9-24-74	D	
4J	G. Walker	9-8-77	572	4	520	--	--	77	9-8-77	D	
4K	H.C. Hodge	8-16-83	270	4	270	--	--	93	8-17-73	D	

TABLE 4-2 (Concluded)

	Owner	Date Completed	Well Depth (feet)	Casing Diameter (inches)	Casing Depth (feet)	Screen Interval (feet)	Altitude of Land Surface (feet)	Water Levels Depth (feet)	Water Levels Date Measured	Water Use	Chemical Analysis
					LEON COUNTY						
SA-39-39-405	J.R.B. Consultants	6-18-79	650	4	650	540-650	--	174	11-14-79	I	
701	D. Holmes	1944	70	6	--	--	-	66.6	9-16-59	D	
801	F.M. Kolle	1952	328	4	328	307-328	--	166	1952	D, S	*
7B	L.R. Ericson	1975	690	--	--	--	--	75	--	D	
7C	D. Blackman	12-11-80	61	34	61	--	--	46	12-11-80	D	
7M	Northwestern Resources	7-11-84	800	7	--	--	--	119	7-23-84	I	

Water Use: D - Domestic
I - Industrial
O - Oil Test
P - Public Supply
S - Stock

TABLE 4-3

GROUND-WATER QUALITY ANALYSES FOR THE PROJECT VICINITY

Parameter or Constituent*	SD-39-38-502 Oct 81	SD-39-38-602 Apr 81	SD-39-38-604 Oct 81	SD-39-38-902 Mar 80	SD-39-39-904 May 81	KA-39-39-401 Jul 70	KA-39-39-402 Aug 70	KA-39-39-404 Aug 70	SA-39-39-801 Sep 58	HL&P No. 2 Jun 84	HL&P No. 3 Dec 84
Temperature, °C	23.0	26.0	22.5	--	21.5	--	--	--	--	--	--
Specific Conductance, µmhos/cm	483	643	645	530	570	480	493	278	451	594	524
pH, Units	8.3	8.6	8.3	7.9	7.1	7.8	8.1	8.3	7.7	8.0	8.1
Total Dissolved Solids	298	333	393	346	357	281	299	176	264	473	432
Total Hardness as $CaCO_3$	9	3	42	175	200	99	34	39	138	5	32
Total Alkalinity as $CaCO_3$	220	280	230	220	190	--	--	--	--	214	217
Calcium	2.7	1	13	53	55	29	9	10	40	1.6	10
Magnesium	0.5	0.1	2.4	10	14	6	3	4	9.4	0.2	1.7
Sodium + Potassium	121	131	142	56	43	77	102	51	41	133	107
Silica	11	15	14	28	37	17	12	17	21	12	12
Bicarbonate	--	--	--	--	--	259	235	166	159	261	265
Chloride	11	8.3	5.4	40	61	21	26	6	40	38	26
Fluoride	0.2	0.1	0.2	0.2	0.1	0.2	< 0.1	0.1	--	0.1	0.1
Sulfate	19	9.3	29	26	29	21	31	6	39	27	10
Nitrate	--	--	--	--	--	< 0.4	< 0.4	< 0.4	0.2	< 0.4	< 0.4
Arsenic	--	0.000	--	--	--	--	--	--	--	< 0.01	< 0.01
Barium	--	0.010	--	--	--	--	--	--	--	0.05	0.1
Cadmium	--	< 0.001	--	--	--	--	--	--	--	< 0.01	< 0.01
Chromium	--	0.010	--	--	--	--	--	--	--	< 0.01	< 0.01
Copper	--	0.002	--	--	--	--	--	--	--	< 0.01	< 0.01

TABLE 4-3 (Concluded)

Parameter or Constituent*	SD-39-38-502 Oct 81	SD-39-38-602 Apr 81	SD-39-38-604 Oct 81	SD-39-38-902 Mar 80	SD-39-39-904 May 81	KA-39-39-401 Jul 70	KA-39-39-402 Aug 70	KA-39-39-404 Aug 70	SA-39-39-801 Sep 58	HL&P No. 2 Jun 84	HL&P No. 3 Dec 84
Iron	0.010	0.050	0.032	--	0.690	--	--	0.04	--	0.22	0.04
Lead	--	0.004	--	--	--	--	--	--	--	< 0.01	< 0.01
Manganese	--	0.008	--	--	--	--	--	--	--	< 0.01	0.01
Mercury	--	0.0005	--	--	--	--	--	--	--	< 0.001	< 0.01
Selenium	--	0.000	--	--	--	--	--	--	--	< 0.01	< 0.01
Silver	--	0.000	--	--	--	--	--	--	--	< 0.01	< 0.005
Zinc	--	0.007	--	--	--	--	--	--	--	0.01	< 0.01

* All concentrations expressed as mg/l, unless otherwise noted.

wells in the materials handling area are given in Table 4-4. The results of field and laboratory tests to determine the hydraulic properties of various stratigraphic units are presented in Tables 4-5 and 4-6, respectively.

4.4.1 Hydrology

Water level measurements from 3 power station wells completed in the Simsboro (SD-39-39-406, HL&P #2, and HL&P #3) indicate that the Simsboro's potentiometric surface varies between 330 feet and 340 feet msl. These levels are roughly 100 feet lower than water-level elevations in site monitoring wells completed in the Calvert Bluff, indicating that the Simsboro is hydrologically separated from near-surface Calvert Bluff sands at the power station. Rettman (1984) presented transmissivity and specific capacity data for a power station well (SD-39-39-406) and, one located approximately 7.5 miles to the southwest (SD-39-46-106). Specific capacity data for wells HL&P #2 and #3 were used to estimate additional transmissivity values. Based on the screened interval thickness for each well, hydraulic conductivity values for the Simsboro range from 3.1×10^{-3} cm/sec to 6.1×10^{-4} cm/sec.

Recharge to the Simsboro Formation at the site comes from the flow of ground water in the formation from updip areas to the northwest. Discharge is to wells at the site and adjacent areas and, perhaps, upward leakage into sand strata of the lower Calvert Bluff.

Calvert Bluff water-level data are available from 8 piezometers in the materials handling area (Table 4-4). In addition, water levels were measured in most open borings following the completion of drilling. The lowest level was found to occur at an elevation of 422 feet msl in piezometer D-1B. The piezometer is completed in the upper section of a 50-foot thick sand body between depths of 45 feet and 95 feet. As shown in geologic cross sections D-D' (Plate 5), this sand probably crops out in the vicinity of Lynn Creek, and the water level represents the

TABLE 4-4

GROUND-WATER LEVEL MEASUREMENTS

Piezometer	Ground[1] Elevation (feet)	Approximate Monitoring Zone Elevations (feet)	Ground-water Elevations (feet)										
			Apr 80	May 80	Jun 80	Jul 80	Aug 80	Sep 80	Oct 80	Nov 80	Dec 80	Jan 81	Feb 81
D-1A	440	437-432	Dry	--	--	--	--	--	--	--	--	--	--
D-1B	440	385-377	422	--	--	--	--	--	--	--	--	--	--
D-17A	476.5	383.5-375.5	443.60	443.33	443.20	443.67	443.33	443.23	442.83	442.58	442.67	442.42	442.33
D-17B	476.5	426.5-410.5	458.50	458.50	456.65	458.25	457.58	457.42	456.96	456.83	456.83	455.37	456.00
D-31A	447.5	367-357	436.60	435.92	435.20	434.92	434.25	433.67	433.17	432.50	432.80	431.50	431.00
S-28A	506	500-490	499.30	498.34	498.00	497.75	496.17	Dry	Dry	Dry	Dry	Dry	498.33
S-28B	506	482-470	Dry	Dry	Dry	476.00	475.92	Dry	Dry	Dry	Dry	Dry	Dry
S-31A	483	440-432	445.65	445.92	445.49	444.83	444.92	445.61	445.83	445.67	445.08	445.92	445.58
S-34A	494	423-415	--	--	--	--	--	--	--	459.50	459.92	459.58	459.75
S-34B	494	484.5-476	--	--	--	--	--	--	--	Dry	Dry	Dry	Dry

1. Ground elevations at D-17A and D-17B were surveyed; all other elevations were estimated.

TABLE 4-5

FIELD MEASUREMENTS OF HYDRAULIC PROPERTIES

Aquifer	Well Id	Screened Interval (feet)	Well Discharge (gal/min)	Specific Capacity (gal/min-ft)	Transmissivity (ft^2/day)	Transmissivity (gal/day-ft)	Hydraulic Conductivity (gal/min-ft^2)	Hydraulic Conductivity (cm/sec)	Storage Coefficient	Source
Simsboro	SD-39-39-406	579-735	600	4.6	1,350	(10,100)	(65)	(3.1×10^{-3})	—	Rettman, 1984.
Simsboro	SD-39-46-106	522-670	69	1.2	285	(2,130)	(14)	(6.6×10^{-4})	—	Rettman, 1984.
Simsboro	HL&P #2	600-836	239	1.6	(425)	(3,180)	(13)	(6.1×10^{-4})	—	HL&P
Simsboro	HL&P #3	685-920	603	3.3	(876)	(6,555)	(28)	(1.3×10^{-3})	—	HL&P
Calvert Bluff	—	92-112	23.5	—	(187)	1,400	70	(3.3×10^{-3})	—	EH&A, 1980
Calvert Bluff	—	252-274	64.3	—	(1,692)	12,658	575	(2.7×10^{-2})	—	EH&A, 1980
Calvert Bluff	—	181-204	66.7	—	(277)	2,072	90	(4.2×10^{-3})	—	EH&A, 1980
Calvert Bluff	—	136-146	10.0	—	(21)	157	15.7	(7.4×10^{-4})	.0045	EH&A, 1980
Calvert Bluff	—	175-195	65.1	—	(1,979)	14,805	740	(3.5×10^{-2})	.0006	EH&A, 1980
Calvert Bluff	—	152-172	72.0	—	(1,113)	8,329	416	(2.0×10^{-2})	.0005	EH&A, 1980
Calvert Bluff	—	106-142	32.0	—	(941)	7,043	196	(9.2×10^{-3})	—	EH&A, 1980
Calvert Bluff	D-1B	55-63	—	—	—	—	—	7.6×10^{-6}	—	McClelland, 1980
Calvert Bluff	D-31A	80-90	—	—	—	—	—	4.3×10^{-5}	—	McClelland, 1980
Calvert Bluff	S-31A	43-51	—	—	—	—	—	2.7×10^{-4} to 6.4×10^{-6}	—	McClelland, 1980
Calvert Bluff	S-34A	71-79	—	—	—	—	—	1.5×10^{-4} to 2.1×10^{-5}	—	McClelland, 1980

Note: Values within parenthesis were calculated from reported values.

TABLE 4-6

LABORATORY MEASUREMENTS OF HYDRAULIC CONDUCTIVITY

Boring No.	Sample Depth (feet)	Sample Elevation (feet)	USCS	Soil Grouping	Laboratory Permeability at 20°C (cm/sec)
D-1	7.5	431.5	CL	6	3.8×10^{-7}
D-1	23.5	415.5	CH	9	2.1×10^{-8}
D-4	7.0	465	CH	6	7.3×10^{-7}
D-6	7.0	441.7	CL-ML	7	2.0×10^{-7}
D-21	8.0	425	CL	7	4.0×10^{-7}
D-21	24.5	408.5	CL	7	2.1×10^{-2}
D-26	14.0	429.2	CH	8	1.0×10^{-6}
S-3	14.0	464.2	CL	9	1.1×10^{-5}
S-8	5.5	484.3	CL	6	5.9×10^{-9}
S-8	34.5	455.3	CL	3	1.9×10^{-4}
S-28	9.5	494.5	CL	6	1.6×10^{-8}
S-34	15.0	479	CL-ML	5	1.7×10^{-6}
S-34	44.5	449.5	CH	8	4.9×10^{-4}
S-46	2.5	563.9	CH	5	4.1×10^{-9}

water table at a point of discharge. Water levels in open boreholes D-6, 29, 34, 35, 39, 43, and 44 were within 1 foot of this reading.

The highest piezometer reading was 499 feet msl in S-28A. However, this piezometer is only 16 feet deep and is completed in low permeability sandy clay below 6 feet. It is likely that this water level indicates a temporary, perched water table condition within the 6-foot thick surface sand above the sandy clay. Similarly, the 476-foot water level recorded in S-28B is believed to indicate a temporary, perched water table in a subsurface sand body. The piezometer readings most representative of high ground-water levels are from S-34A, where consistent levels of about 460 feet msl were recorded. In addition, water levels in open borings S-16, 18, 27, 34, 36, and 42 were within 1 foot of this value.

Based on water-level observations, the hydraulic gradient of shallow Calvert Bluff ground water is from topographically high areas of the site to areas of low elevation along Lynn Creek and its unnamed tributary. Accordingly, ground-water recharge can be expected to occur along surface drainage divides and discharge should occur along local creeks. Recharge should also occur in areas where sand channels or other permeable strata crop out over upland areas of the site. Some portion of local recharge can be expected to move along the dip-oriented sand channel deposits, move deeper into the subsurface, and become part of regional ground-water flow.

Hydraulic properties of Calvert Bluff deposits are highly variable. Laboratory permeability tests of different soils encountered at the site measured hydraulic conductivity values ranging from 10^{-2} to 10^{-9} cm/sec (Table 4-6). With the exception of two samples, the lowest permeability values were generally associated with soil groups 5, 6, and 7. Rising-head and falling-head tests of subsurface sand strata were performed in four site piezometers (Table 4-5) and produced field permeability values from 2.7×10^{-4} to 6.4×10^{-6} cm/sec. Due to the nature of these tests, the volume of soil actually tested is rather limited, and the reported values have limited accuracy. More extensive field pumping tests were performed on sand channel deposits in the Jewett Mine area southeast of the LGS site. Those tests generated hydraulic conductivity values from 3.5×10^{-2} to 6.1×10^{-4} cm/sec.

4.4.2 Water Usage

Figure 4-7 shows the locations of water wells and oil tests in the LGS vicinity. Available information for each well is listed in Table 4-2. Of the 41 wells inventoried, more than one-half are used for domestic and livestock purposes. Three public-supply wells were identified at Donie and Farrar north and northwest of the LGS property. Industrial wells in the area are owned by HL&P or are associated with the neighboring Jewett Lignite Mine.

Exclusive of an old, dug well that is 26 feet deep, the wells range in depth from 61-290. The public-supply wells at Donie and Farrar are 700-852 feet deep and are thought to be completed in the Simsboro Formation, as are three industrial wells owned by HL&P. Well KA-39-39-402 may also tap the Simsboro. The remaining wells appear to be completed in the Calvert Bluff, although wells SA-39-701 and 7C are sufficiently shallow (61 and 70 feet deep) to be completed in the Carrizo Formation.

4.4.3 Water Quality

Water chemistry data were available for 11 of the inventoried wells (Table 4-3). The analyses show water quality to be very similar for all wells. However, the total dissolved solids content in wells HL&P #1 and #2 exceeds 430 mg/l, while all other samples contained less than 360 mg/l. Most samples indicate the water to be of sodium-bicarbonate type, excepting wells SD-39-38-502, SD-39-39-904, and KA-39-39-401, which indicate a mixed calcium-sodium-bicarbonate type water. In all cases, the ground water is suitable as drinking water.

Iron exceeded the recommended maximum concentration of 0.3 mg/l in only one of seven samples. Trace element concentrations are very low to undetectable.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The materials handling area at the Limestone Electric Generating Station has a geologic and hydrologic setting that is typical of the Calvert Bluff outcrop belt. Waste handling and disposal areas within the site are underlain by sand, silt, and clay strata that were deposited in stream channel, overbank, and interchannel floodbasin environments. The physical and hydraulic characteristics of subsurface strata can be correlated with the sedimentary environments that are present. Channel and overbank deposits consist primarily of sand, silty sand, clayey sand, and silt and are not suited for use as landfill liner or cover materials. Interchannel floodbasin sediments are marginally to well suited for that purpose.

Shallow ground water at the site is unconfined and has a southwesterly gradient from the topographic divide between the Trinity and Navasota river basins to probable discharge points along Lynn Creek within the site. A much smaller amount of water moves downdip along permeable strata, becomes confined by overlying impermeable strata, and joins the regional ground-water flow system. Confined ground-water flow occurs mainly in the sand channel deposits of the Calvert Bluff. Ground-water quality in the power station vicinity is good and meets drinking water standards.

The presence of permeable sand channel deposits in the shallow subsurface beneath combustion solid waste disposal areas 1 and 2, the sludge stabilization facility, and the dewatered sludge disposal area indicates potential pathways for leachate migration in the subsurface. However, a 4-foot to 12-foot thick sandy clay layer that is present at or immediately below ground level over much of the site should assist in providing a secondary barrier to downward leachate migration.

EH&A also recommends that wells be installed at positions hydraulically downgradient of active waste disposal and handling areas to monitor ground-water quality and provide early detection of any ground-water contamination. Such wells should be located as close as practicable to the disposal and handling areas and should be completed in the same sand channel deposit that underlies and crops out beneath site facilities at the southwest end of the site. Suitable locations would be in the vicinity of borings D-2, D-39, R-4, and R-6. Existing piezometer D-1B (if functional) could also be used to supplement monitoring until such time that disposal cells are needed at its location.

Before disposal commences in the combustion solid waste disposal area 2, wells should be completed to monitor water-quality in the channel deposit that underlies that area. Sufficient time (approximately one year) should be provided to establish baseline water quality prior to disposal.

6.0 REFERENCES

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APPENDIX

SOILS INDEX TEST DATA

SOILS INDEX TEST DATA

BORING NO.	SAMPLE DEPTH (FT)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTIC INDEX (%)	MOISTURE CONTENT (%)	PASSING NO. 200 SIEVE (%)	UNIFIED SOIL CLASS	SOIL GROUP NO.
D-1	9.5	23	20	3	15	39	ML	2
D-1	30.0	46	19	27	25	45	CL	2
D-1	14.0	62	23	39	15		CH	3
D-1	49.0	29	24	5	24	22	ML	3
D-1	59.0	29	25	4	25	26	ML	3
D-1	72.5	57	26	31	27	43	CH	3
D-1	5.0	47	16	31	16	57	CL	6
D-1	7.5	41	17	24	18	64	CL	6
D-1	20.0	90	26	64	25	67	CH	9
D-1	23.5	53	24	29	21		CH	9
D-1	25.0	59	24	35	24		CH	9
D-1	94.0	45	27	18	29	63	CL-ML	9
D-4	44.5	55	26	29	30	45	CH	5
D-4	6.0	67	23	44	25	46	CH	6
D-5	4.5	56	22	34	24	88	CH	5
D-5	7.5	56	24	32	26	88	CH	9
D-5	20.0	76	27	49	29	83	CH	9
D-5	30.0	63	26	37	22	94	CH	9
D-5	34.0	60	27	33	23	90	CH	9
D-5	39.0	49	28	21	25	89	ML	9
D-5	50.0	59	28	31	23	97	CH	9
D-6	7.0	45	26	19	24	61	CL-ML	7
D-9	33.5	52	24	28	21	83	CH	7
D-10	13.0	54	24	30	15	79	CH	3
D-10	24.5	53	24	29	27	48	CH	8
D-11	14.0	34	21	13		46	CL	8
D-11	43.0	67	26	41	20	100	CH	9
D-15	14.5				30	14		3
D-15	30.0	49	30	19	30	96	ML	3
D-15	39.0				24	15		3
D-15	2.5	63	20	43	20	59	CH	6
D-15	7.0	60	21	39	23		CH	8
D-15	50.0	51	23	28	24	99	CH	9
D-16	6.5	54	21	33	31	65	CH	5
D-16	43.0	47	22	25	15	43	CL	7

SOILS INDEX TEST DATA

BORING NO.	SAMPLE DEPTH (FT)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTIC INDEX (%)	MOISTURE CONTENT (%)	PASSING NO. 200 SIEVE (%)	UNIFIED SOIL CLASS	SOIL GROUP NO.
D-16	44.5	50	22	28	15	44	CH	7
D-17	6.5				13	33		2
D-17	10.0				22	33		2
D-17	14.0	34	29	05	21	26	ML	2
D-17	19.0	33	27	06	21	25	ML	3
D-17	25.5	49	24	25	26	55	CL	5
D-17	33.5	65	28	37		85	CH	5
D-17	4.5	57	21	36	21	65	CH	7
D-17	39.5	42	36	06	30	29	ML	8
D-20	7.0	32	20	12	17	16	CL	8
D-21	43.5	72	30	42	26	99	CH	5
D-21	44.0	76	29	47	31	98	CH	5
D-21	45.0	76	29	47	31	98	CH	5
D-21	9.0	43	22	21	24	69	CL	7
D-21	24.5	33	22	11	24	37	CL	7
D-24	6.5	29	20	9	9	40	CL	3
D-24	14.0	30	29	1	23	27	ML	3
D-24	17.0					68		3
D-24	33.5				29	21		3
D-24	50.0	97	33	64	43	83	CH	5
D-24	4.5	50	14	36	12	56	CH	5
D-24	23.5	40	25	15	30	56	CL-ML	8
D-24	43.5	58	29	29	30	60	CH-MH	8
D-26	14.0	54	25	29	27	88	CH	8
D-31	53.0	36	28	8	25	36	ML	3
D-31	2.0	60	18	42	21	77	CH	7
D-31	34.0				27	37		8
D-31	43.0				24	20		8
D-31	49.5	50	29	21	25		MH	8
D-31	7.0	45	25	20	13	62	CL	9
D-31	19.5	49	25	24	22	58	CL	9
D-31	29.5	50	29	21	25	59	MH	9
D-31	63.0	53	27	26	21	75	CH	9
D-31	75.5	51	28	23	23	65	CH-MH	9
D-31	83.5	43	30	13	22	81	ML	9

SOILS INDEX TEST DATA

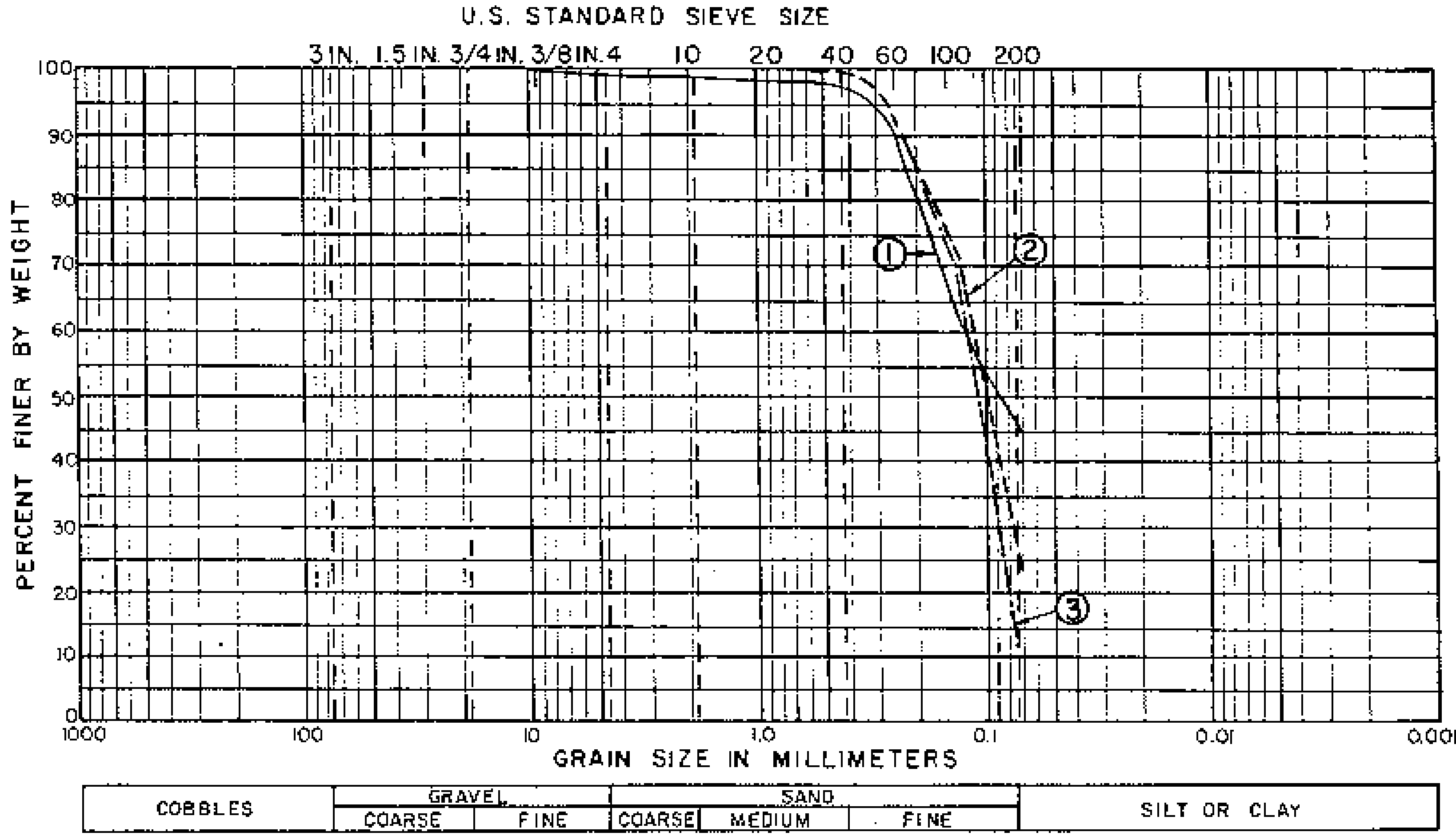
BORING NO.	SAMPLE DEPTH (FT)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTIC INDEX (%)	MOISTURE CONTENT (%)	PASSING NO. 200 SIEVE (%)	UNIFIED SOIL CLASS	SOIL GROUP NO.
D-31	93.5	65	28	37	20	94	CH	9
D-31	109.5				29	29		9
D-31	119.5				30	28		9
D-31	129.5	43	31	12	28	68	ML	9
D-31	139.5	43	27	16	23	72	ML	9
D-31	149.5				23	25		9
D-35	13.0				11	32		3
D-35	23.0				12	28		3
D-35	2.5	68	21	47	15	77	CH	7
D-35	4.5	60	26	34	15	71	CH	8
D-35	33.5	41	25	16	23	53	CL	8
D-35	49.0	33	19	14	23	42	ML	8
D-37	13.0	69	25	44	19	87	CH	9
D-37	17.5	62	23	39	20	92	CH	9
D-37	25.5	58	23	35	15	85	CH	9
D-37	30.0	55	22	33	20	74	CH	9
D-38	15.5	33	21	12	25	54	CL	8
D-38	19.5	34	21	13	24	90	CL	9
D-43	3.0				13			6
D-44	4.0	58	18	40	17	67	CH	6
S-1	24.5	52	19	33	22	95	CH	6
S-1	35.0	50	19	31	25	56	MH	8
S-1	43.5	57	24	33	24	67	CH	8
S-3	9.5	28	18	10	15	47	CL	6
S-3	13.0	37	17	20	15	60	CL	9
S-3	14.0	44	18	26	16	63	CL	9
S-4	13.0	24	17	7	13	29	CL-ML	1
S-4	33.5	41	19	22	18	47	CL	8
S-4	39.5	36	18	18	19	40	CL	8
S-5	6.5	47	27	20	19	87	CL-ML	4
S-6	13.5				22	72		4
S-6	2.5	63	19	44	21	82	CH	5
S-6	19.5	60	27	33	25	91	CH	5
S-6	34.5	50	25	25	21	90	CH	9
S-6	49.5	52	26	26	25	78	CH	9

SOILS INDEX TEST DATA

BORING NO.	SAMPLE DEPTH (FT)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTIC INDEX (%)	MOISTURE CONTENT (%)	PASSING NO. 200 SIEVE (%)	UNIFIED SOIL CLASS	SOIL GROUP NO.
S-3	34.0	44	20	24	25	29	CL	3
S-8	6.0	47	15	32	15	61	CL	6
S-11	34.5	57	23	34	25	89	CH	5
S-11	6.5	35	19	16	17	36	CL	6
S-11	14.5	32	16	16	28	47	CL	8
S-11	19.0	47	21	26	25	70	CL	8
S-11	24.0	45	17	28	22	56		8
S-11	24.5	44	17	27	22	56	CL	8
S-11	28.0	52	21	31	25	58	CH	8
S-11	29.0	38	22	16	24	75	CL	8
S-14	44.0	53	24	29	24	48	CH	6
S-16	38.5				20	17		1
S-16	49.5				20	17		1
S-16	4.5	62	19	43	25	83	CH	5
S-16	6.5	57	22	25	20	78	CH	5
S-16	9.5	57	23	34	22	82	CH	5
S-16	24.5	51	25	26	26	73	CH	5
S-16	1.5	39	16	23	20	54	CL	7
S-23	24.5				10	10		1
S-23	7.0	27	15	12	16	58	CL	6
S-23	9.0	49	16	33	20	70	CL	6
S-28	13.5	26	16	10	16	37	CL	8
S-28	29.0	41	16	25	17	37	CL	8
S-28	49.5				29	31		8
S-31	44.5				30	24		3
S-31	34.5	81	16	65	37	51	CH	5
S-31	2.5	47	16	31	16	47	CL	6
S-31	5.0	60	22	38	25	72	CH	6
S-31	9.5	23	20	3	15	22	ML	6
S-31	19.5	72	25	47	30	52	CH	8
S-31	29.5	61	22	39	22	97	CH	8
S-34	9.5	46	23	23	28	70	CL	5
S-34	14.5	48	27	21	22	93	CL	5
S-34	33.5	46	22	24	22	90	CL	5
S-34	43.5	48	27	21	22	67	CL-ML	5

SOILS INDEX TEST DATA

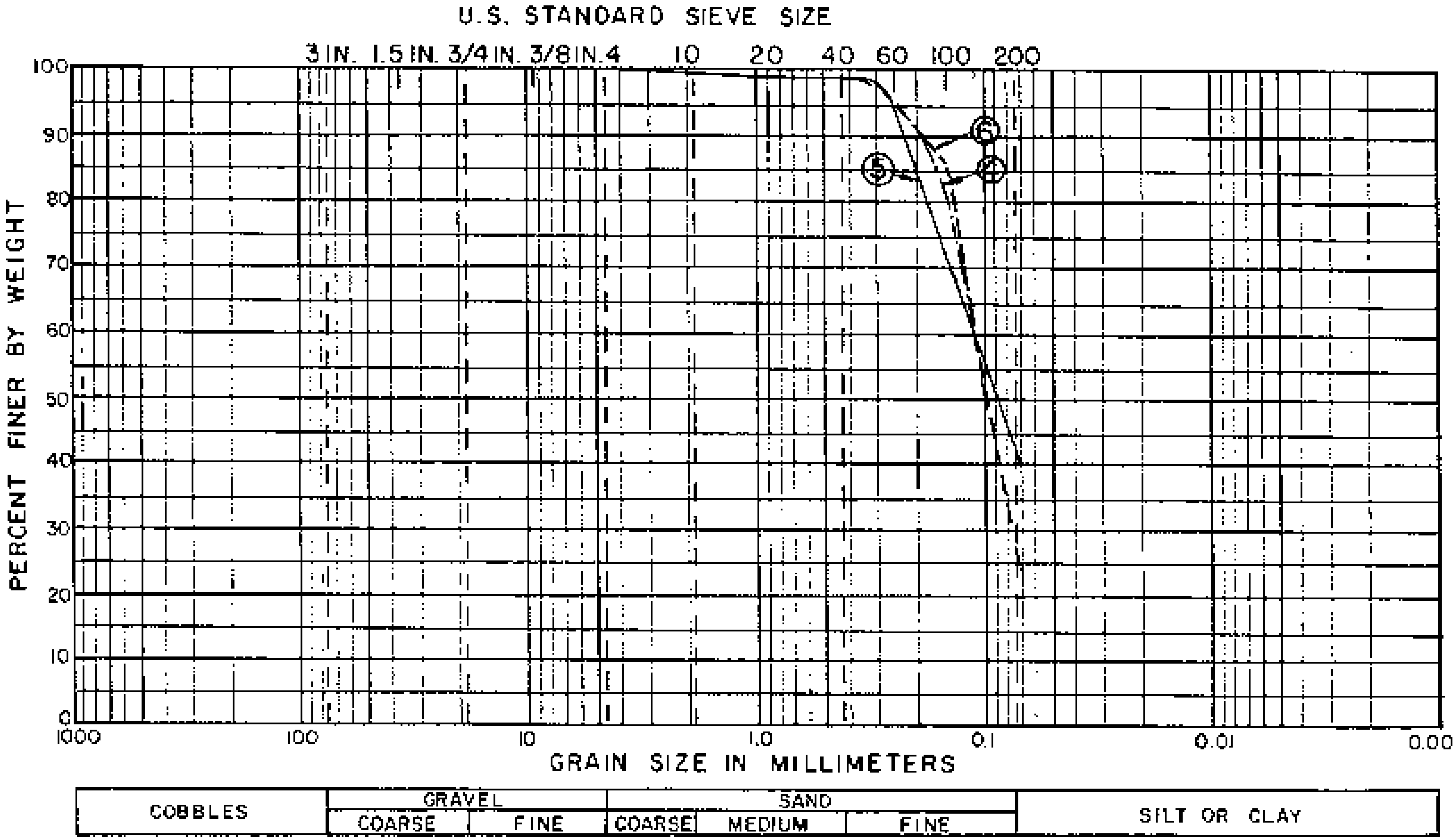
BORING NO.	SAMPLE DEPTH (FT)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTIC INDEX (%)	MOISTURE CONTENT (%)	PASSING NO. 200 SIEVE (%)	UNIFIED SOIL CLASS	SOIL GROUP NO.
S-34	44.5	53	24	29	22	87	CH	8
S-34	53.5	53	25	25	24	66	CH	8
S-34	63.5	53	23	30	22	89	CH	8
S-34	73.5	45	23	22	22	82	CL	8
S-34	88.5				26	20		3
S-46	1.5	106	20	86	23	44	CH	5
S-50	33.0	54	18	36	20	94	CH	5
S-50	4.5	39	18	21	19	54	CL	6
S-50	6.5	35	15	20	14	31	CL	6
S-50	19.5	59	24	35	24	32	CH	8
S-50	29.5				27	58		8
S-50	38.0				20	87		8
S-50	48.5				18	44		8



Curve No.	Boring No.	Sample Depth, Ft	USCS Class
1	D-1	30.0	SC
2	D-1	59.5	SM
3	D-15	15.0	SM

ESPEY, HUSTON & ASSOCIATES, INC.
ENGINEERING & ENVIRONMENTAL CONSULTANTS

Figure A-1
Grain-size Distribution Curves



Curve No.	Boring No.	Sample Depth, Ft	USCS Class
4	D-17	39.5	SM
5	D-24	9.0	SM
6	D-31	150.0	SM

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Figure A-2
Grain-size Distribution Curves

GEOTECHNICAL REPORTS

LIMESTONE
ELECTRIC GENERATING STATION

GEOTECHNICAL REPORTS

LIMESTONE
ELECTRIC GENERATING STATION

VOLUME III (Cont'd)

0183-0226	Geotechnical Investigation - Mine-Operation Facilities Jewett Mine
0183-0250	Geotechnical Investigation - Mine Facility Area Jewett Mine
85-342	Tank Settlement Evaluation - (McBride-Ratcliff)
0185-5017	Dynamic Soil Properties - Diesel Generator and Air Compressor Building
0185-5032	Settlement Investigation - Bus Duct Supports
8728	Field Investigation & Laboratory Test - Install Stackout Area Sprinkler System

McClelland engineers, inc. / geotechnical consultants
6100 HILLCROFT / HOUSTON, TEXAS 77081
TEL 713 / 772-3701 / TELEX 762-447

Report No. 0179-0373-2
August 13, 1980

Houston Lighting & Power Company
P. O. Box 1700
Houston, Texas 77001

Attention: Ms. Janice Gray

Field and Laboratory Test Results
Limestone Electric Generating Station
Limestone County, Texas

Gentlemen:

Submitted here is our report on soil borings and field and laboratory test results for Houston Lighting & Power Company's proposed Limestone Electric Generating Station in Limestone County, Texas. This study was requested by Mr. James Malinak during a meeting on October 18, 1979 and was authorized by your Purchase Order No. M-35994 dated March 28, 1980. This study was performed in general accordance with our proposal dated March 6, 1980.

The report presents the results of our field and laboratory investigation and includes boring logs, piezometer installation and observation data, field permeability test results, and laboratory test results. Boring logs and test results from the Reconnaissance Investigation contained in our Report No. 0179-0373-1 dated December 13, 1979, are also submitted.

We appreciate the opportunity to be of service to you on this study. Please call us if we can be of further service.

Very truly yours,

McCLELLAND ENGINEERS, INC.

Jon A. McAuliffe

Jon A. McAuliffe
Geotechnical Engineer

Michael O. Noggle

Michael O. Noggle, P.E.
Engineer Manager

JAM/MON/ps
Copies Submitted: (15)

CONTENTS

ILLUSTRATIONS

APPENDICES

INTRODUCTION

Project Description

Houston Lighting & Power Company (HL&P) is planning to construct a lignite-burning electric generating station in Limestone County, Texas. The site is located in southeast Limestone County near the intersection of the boundaries of Limestone, Freestone, and Leon Counties (see Plate 1). The facility will consist of a Plant Area, a Material Handling Area, and a Pipeline going offsite. A previous investigation was performed in the Plant Area and is contained in our Report No. 0179-0150 dated August 24, 1979.

Houston Lighting & Power has engaged Ebasco Services of New York to conduct engineering studies for the generating station.

Purpose of Study

The principal purpose of this investigation is to provide HL&P with information developed from drilling of soil borings, field testing, and laboratory testing to aid them is evaluating the general geotechnical and environmental character of the site. This objective was accomplished by:

- drilling undisturbed-sample borings to obtain soil samples,
- performing field tests for use in permeability analyses, and
- performing laboratory tests to determine pertinent physical properties of the soils.

Report Format

The report text describes the field and laboratory investigations. The text is followed by the Illustrations section and Appendices A, B, and C. Contained in the Illustrations section are an area map and the plans of borings for the three areas investigated. Appendices A, B, and C contain the plans of borings, boring logs, and field and laboratory test results for the Plant Area, the Material Handling Area, and along the Pipeline Route, respectively.

FIELD INVESTIGATION

Subsurface soil conditions at the site were explored by 124 sample borings drilled to depths ranging from 29 to 150 ft. Approximate boring locations, as provided by Ebasco, are shown on Plates 2, 3, and 4, along with the boring locations from our Report No. 0179-0150. Also shown on Plates 2, 3, and 4 are the locations of borings which could not be drilled at this time, but will be drilled at a future date. The appropriate boring coordinates and ground surface elevations were provided to us by HL&P and are shown on the individual boring logs. Boring locations are given in Texas State Plane Coordinates and ground surface elevations are referenced to mean sea level (MSL). Detailed descriptions of the soils encountered in the borings are given on the individual boring logs presented on Plates A-2 through A-37, B-2 through B-84 and C-2 through C-6 for the Plant Area, Material Handling Area, and along Pipeline Route, respectively. A key identifying most of the terms and symbols appearing on the boring logs is presented immediately after the boring logs on Plates A-38, B-85, and C-7.

The borings were drilled with rotary drilling equipment mounted on a heavy duty truck or marsh buggy vehicle. A prepared drilling fluid was used to maintain borehole integrity and facilitate drilling operations. Boring locations and depths, as well as sample types and depths, were selected by the Ebasco and HL&P site representatives. Generally, samples were obtained almost continuously to 10-ft depth, at 5-ft intervals from 10-ft depth to 100-ft depth, and at 10-ft intervals below 100-ft depth. Undisturbed samples of clays were obtained by pushing a 3-in. thin-walled tube into the soil. Samples of granular soils, and cohesive soils that were too stiff to sample with a thin-walled tube, were obtained by driving a 2-in. split-barrel sampler with a 140-lb hammer dropped 30 in. Driving resistances for the split-barrel sampler, after an initial 6-in. seating, are recorded in the "Blows Per Foot" column. Three blow count/penetration (N/ft) designations have been used, e.g. 45, 75/7", Ref/4". The first designation indicates that 45 hammer blows were required to achieve 12-in. penetration of the sampler beyond the initial 6-in. seating; the second indicates 75 hammer blows were needed to advance the sampler 7 in. beyond initial seating; the third indicates refusal (generally considered 75 hammer blows) was reached when the sampler had penetrated only 4 in. of the initial 6-in. seating.

Each sample was removed from the sampler in the field, examined, and classified by our soil technician. Representative portions of each sample were stored in appropriate containers for transportation to our Houston laboratory.

The depth to water was measured in most open boreholes at the completion of drilling and at least 24 hours later. The water depth measurements and the date of the last observation are recorded in the lower right corner of the boring logs. Piezometers were installed at several locations (see Plates 2 and 3) to monitor groundwater levels and to perform field permeability tests. Also shown on Plate 2 are the locations of piezometers which were not installed at this time. Detailed information concerning the piezometer installations is given on Plates A-39 and B-86. The piezometer observation data are listed on Plates A-40 and B-87. The results of field permeability tests are given on Plate B-88.

LABORATORY INVESTIGATION

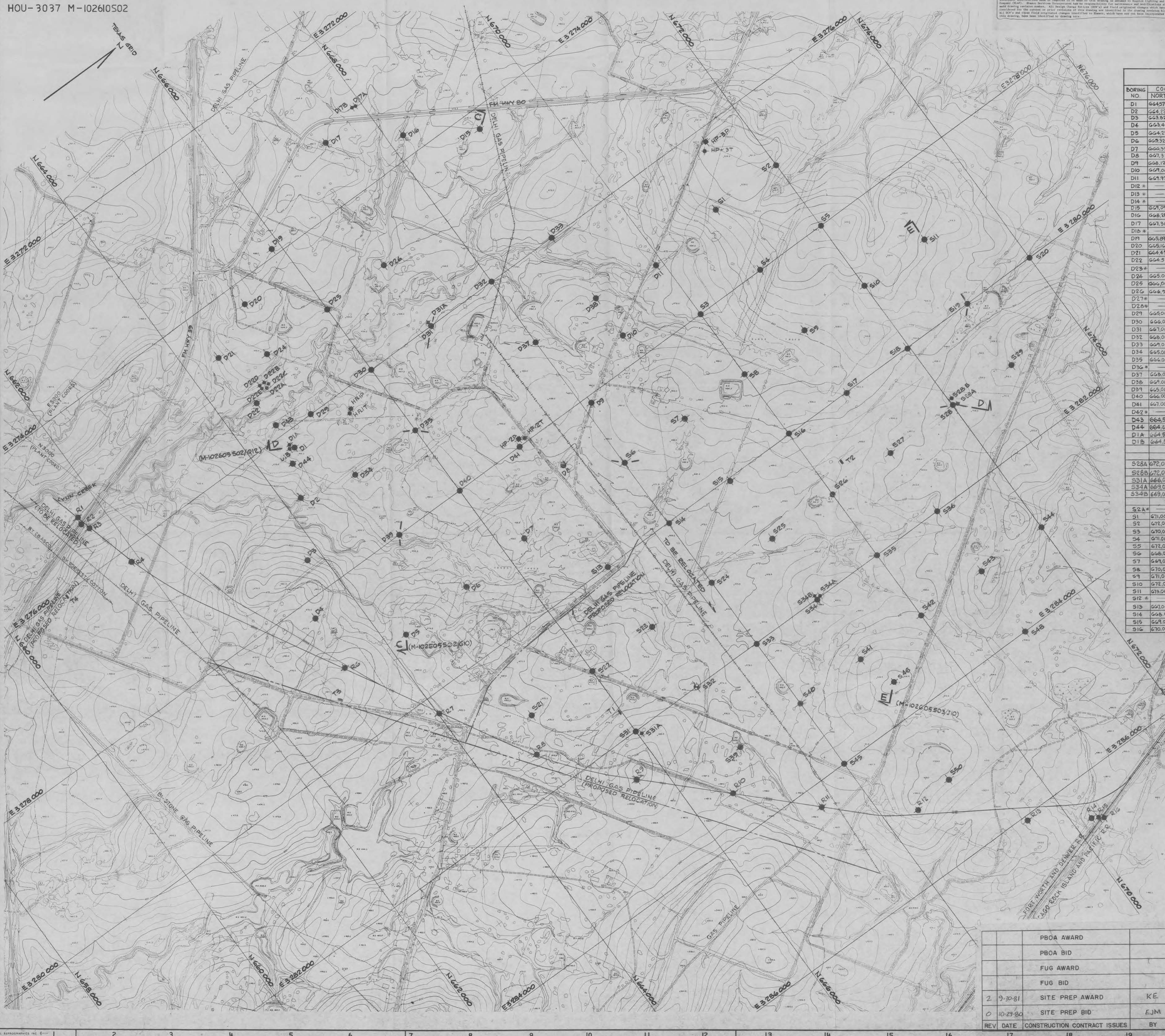
The laboratory soil tests assigned by Ebasco Services were directed primarily towards evaluating soil shear strength, compressibility, permeability, and classification. The following tabulation gives the types and total number of tests performed and identifies how the results are presented, either on the boring logs or on illustrations following the boring logs:

Type of Test	Number of Tests	Identifying Symbol or Illustration
Strength		
Triaxial Compression		
Unconsolidated-Undrained	3	△
Consolidated-Undrained with Pore Pressure Measurements	5	B-96 thru B-100
Consolidated-Drained	6	B-90 thru B-95
Consolidated-Undrained, Multiple-Stage with Pore Pressure Measurements	2	B-101 thru B-102
Penetrometer	438	⊗
Torvane	234	⌖

Type of Test	Number of Tests	Identifying Symbol or Illustration
Compressibility		
Consolidation, Incremental Loading	4	Plates B-103 thru B-106
Permeability		
Falling Head	12	Plate B-89
Constant Head	2	Plate B-89
Classification		
Water Content	196	●
Liquid and Plastic Limits	205	+----------+
Grain-Size Distribution		
Sieve Analysis thru No. 200 Sieve	6	Plate B-107
Percent Passing No. 200 Sieve	221	On "-#200,%" Column of Boring Log

Water content and unit dry weight determinations were made routinely on each triaxial compression, consolidation, and permeability test specimen.

HOU-3037 M-102610S02



After Rev 3, dated 7-6-84 to this drawing, full responsibility for the maintenance of this drawing and for subsequent modifications made or required to be made to this drawing is assumed by Houston Lighting and Power Company (HL&P). Ebasco Services Incorporated has no responsibility for maintenance and modifications after said drawing revision number. All Design Change Notices (DCN's) and field originated changes which have been considered for the current or prior revisions of this drawing are identified in the drawing revision block. All DCN's and those field originated changes identified to Ebasco, which have not yet been incorporated on this drawing, have been identified by drawing note.

NO	DATE	REVISION	BY	CH	APPROVED
1	9/28/81	REVISED (I1 TO H19) RAIL ROAD TRACKS	F.O.	SKB	CJH
2	9-30-81	SITE PREP CONTRACT ISSUE	KE	JK	CJH
3	7-6-84	ADD: (A17, O20) NOTES. TRANSFER REVISION TO HL&P	E.K	SKB	

BORING SCHEDULE

BORING NO.	COORDINATES NORTH	COORDINATES EAST	GROUND ELEV.	DEPTH (EST)
D1	664570.0	3,276,230.0	~439	100
D2	664,225.0	3,276,822.0	427	100
D3	663,820.0	3,277,540.0	~459	100
D4	663,430.0	3,278,260.0	472	50
D5	664,290.0	3,279,130.0	467	↓
D6	665,320.0	3,279,090.0	449	
D7	666,330.0	3,279,030.0	450	
D8	667,313.0	3,278,548.0	465	
D9	668,120.0	3,278,090.0	477	
D10	669,000.0	3,277,620.0	477	
D11	669,920.0	3,277,130.0	471	50
D12 *	—	—	—	—
D13 *	—	—	—	—
D14 *	—	—	—	—
D15	669,090.0	3,274,260.0	474	50
D16	668,211.0	3,273,720.0	465	50
D17	667,300.0	3,273,180.0	477	50
D18 *	—	—	—	—
D19	665,890.0	3,273,910.0	~466	50
D20	665,160.0	3,274,290.0	459	50
D21	664,450.0	3,274,660.0	~431	100
D22	664,510.0	3,275,450.0	~424	100
D23*	—	—	—	—
D24	665,000.0	3,275,000.0	~443	50
D25	666,000.0	3,275,000.0	444	50
D26	666,958.0	3,274,965.0	443	50
D27*	—	—	—	—
D28*	—	—	—	—
D29	665,000.0	3,276,000.0	~436	50
D30	666,000.0	3,276,000.0	441	50
D31	667,000.0	3,276,000.0	448	150
D32	668,000.0	3,276,001.0	452	50
D33	669,000.0	3,276,000.0	453	150
D34	665,000.0	3,277,000.0	~446	50
D35	666,000.0	3,277,000.0	~457	50
D36 *	—	—	—	—
D37	668,000.0	3,277,000.0	474	50
D38	669,000.0	3,277,000.0	466	50
D39	665,000.0	3,278,000.0	~440	150
D40	666,000.0	3,278,000.0	~459	50
D41	667,000.0	3,278,000.0	~481	150
D42 *	—	—	—	—
D43	664,540.0	3,275,840.0	~438	100
D44	664,400.0	3,276,390.0	439	50
D1A	664,566.0	3,276,222.0	438	10
D1B	664,560.0	3,276,225.0	438	63
S28A	672,024.0	3,280,973.0	504	16
S28B	672,031.0	3,280,973.0	504	36
S31A	666,000.0	3,281,990.0	487	53
S34A	669,005.0	3,281,994.0	491	78
S34B	669,002.0	3,281,990.0	491	20
S2A*	—	—	—	—
S1	671,000.0	3,277,000.0	515	50
S2	672,000.0	3,277,000.0	523	50
S3	670,000.0	3,278,000.0	478	100
S4	671,000.0	3,278,000.0	514	50
S5	672,000.0	3,278,000.0	542	↓
S6	668,003.0	3,279,003.0	478	
S7	669,003.0	3,279,003.0	489	
S8	670,000.0	3,279,000.0	490	
S9	671,000.0	3,279,000.0	500	
S10	672,000.0	3,279,000.0	521	50
S11	673,002.0	3,278,973.0	520	40
S12 *	—	—	—	—
S13	667,000.0	3,280,000.0	454	100
S14	668,003.0	3,280,003.0	467	50
S15	669,003.0	3,280,053.0	476	100
S16	670,008.0	3,279,991.0	494	50

BORING NO.	COORDINATES NORTH	COORDINATES EAST	GROUND ELEV	DEPTH (EST)
S17	670,963.0	3,280,003.0	501	100
S18	671,963.0	3,280,003.0	498	50
S19	672,963.0	3,280,003.0	498	↓
S20	674,000.0	3,280,000.0	482	
S21	665,000.0	3,281,000.0	470	
S22	666,000.0	↓	475	
S23	667,000.0		463	
S24	668,000.0	3,281,000.0	465	50
S25	669,003.0	3,281,003.0	477	90
S26	670,000.0	3,281,000.0	481	50
S27	670,963.0	3,281,003.0	495	50
S28	672,014.0	3,280,979.0	504	50
S29	672,963.0	3,281,003.0	514	50
S30*	—	—	—	—
S31	666,000.0	3,282,000.0	485	50
S32	667,000.0	3,282,000.0	471	100
S33	668,000.0	3,282,002.0	474	50
S34	669,002.0	3,282,002.0	491	100
S35	670,000.0	3,282,000.0	488	50
S36	671,000.0	3,282,000.0	497	100
S37*	—	—	—	—
S38*	—	—	—	—
S39	667,000.0	3,283,000.0	480	50
S40	668,000.0	↓	489	50
S41	669,000.0		512	100
S42	670,000.0		498	50
S43	671,000.0	3,283,000.0	518	↓
S44	672,003.0	3,283,008.0	498	
S45	668,000.0	3,284,000.0	507	50
S46	669,189.0	3,283,504.0	566	100
S47*	—	—	—	—
S48	671,000.0	3,284,000.0	504	50
S49*	—	—	—	—
S50	669,000.0	3,285,000.0	524	50
S51*	—	—	—	—
R1	661,646.0	3,275,292.0	419	
R2	661,665.0	3,275,359.0	430	
R3	661,693.0	3,275,465.0	433	
R4	661,893.0	3,276,182.0	442	
R6	663,349.0	3,279,026.0	485	
R7	664,027.0	3,280,251.0	459	
R8	664,722.0	3,281,465.0	469	
R9	665,629.0	3,282,528.0	506	
R10	666,554.0	3,283,441.0	486	
R11	667,409.0	3,284,283.0	496	
R12	668,448.0	3,285,080.0	522	
R13	669,559.0	3,286,064.0	495	
R14	670,240.0	3,286,536.0	482	
R15	670,308.0	3,286,582.0	480	
R16	670,391.0	3,286,640.0	481	
R18	671,702.0	3,286,029.0	498	
R19**	672,575.0	3,285,855.0	474	
D17A	667,911.0	3,273,019.0	~476	100
D17B	667,902.0	3,273,015.0	~476	55
D22A	665,023.0	3,276,491.0	~426	32
D22B	665,019.0	3,276,511.0	~429	70
D22C	665,017.0	3,276,509.0	~427	37
D22D	665,009.0	3,276,546.0	~429	60
D22E	665,007.0	3,276,547.0	~427	29
D31A	666,976.0	3,275,997.0	448	81
T1 E	665,988.0	3,281,668.0	474	N.R
T1 W	665,987.0	3,281,636.0		
T2	670,359.0	3,280,685.0	482	
T3 E	663,056.0	3,279,322.0	494	
T3 W	663,038.0	3,279,307.0		
T4	660,926.0	3,276,044.0	469	
HP-1P	665,473.0	3,276,253.0	~434	2
HP-1T	665,428.0	3,276,273.0	~443	2.5
HP-2P	667,032.0	3,277,925.0	~482	1.5
HP-2T	667,094.0	3,277,924.0	~482	2'
HP-3P	671,420.0	3,276,170.0	525	6'
HP-3T	later	later	later	8'

NOTES

BORING COORDINATES ARE REFERRED TO THE TEXAS STATE PLANE COORDINATE SYSTEM.
CONTOURS WERE DEVELOPED FROM TOPOGRAPHIC INFORMATION SUPPLIED BY HL & P CO WHICH CONSISTED OF TOPOGRAPHIC MAPS PREPARED FOR NORTHWESTERN RESOURCES CO. THE NORTHWESTERN MAPS WERE PHOTOGRAMMETRICALLY COMPILED FROM 1" = 1000' VERTICAL AERIAL PHOTOGRAPHY DATED JAN 14, 1979 WITH HORIZONTAL AND VERTICAL CONTROL SUPPLIED BY INTRASEARCH INC.

GEODETIC EL 450.0 CORRESPONDS TO PLANT REFERENCE EL 100.0

LEGEND

- BORING
- PIEZOMETER
- SEEPAGE TEST PIT [HP 1P]
- HEAD TEST PIT [HP 1T]
- TRENCH [T1]

* INDICATES BORING NOT DRILLED AND NOT REQUIRED
** INDICATES BORING NOT SHOWN ON DRAWING

REFERENCE DRAWINGS

BORING PLAN - SH 1 PLANT AREA M-102610 S01
FOR ADDITIONAL REFERENCE DWG SEE DWG M-102610S01.

The below listed DCN's and FCN's have not been incorporated as of the last Ebasco Revision.
NONE

WORK THIS DRAWING WITH M-102610 S01 & S03.

REV	DATE	CONSTRUCTION CONTRACT ISSUES	BY
		PBOA AWARD	
		PBOA BID	
		FUG AWARD	
		FUG BID	
2	9-30-81	SITE PREP AWARD	KE
0	10-29-80	SITE PREP BID	EJM

HOUSTON LIGHTING & POWER CO.
LIMESTONE ELECTRIC GENERATING STATION
UNIT 1, 750 MW 1985 INSTALLATION
UNIT 2, 750 MW 1986 EXTENSION

BORING PLAN - SH 2
POND AREA

FILE COPY

EBASCO SERVICES INCORPORATED

SCALE 1" = 400'
APPROVED
DATE OCT 29 1980
DIV. CIVIL
DR. E.J. MARTONE
CH E. TRINGALI
CJH MLH
HOU-3037
M-102610S02

APPENDIX B

MATERIAL HANDLING AREA

ILLUSTRATIONS

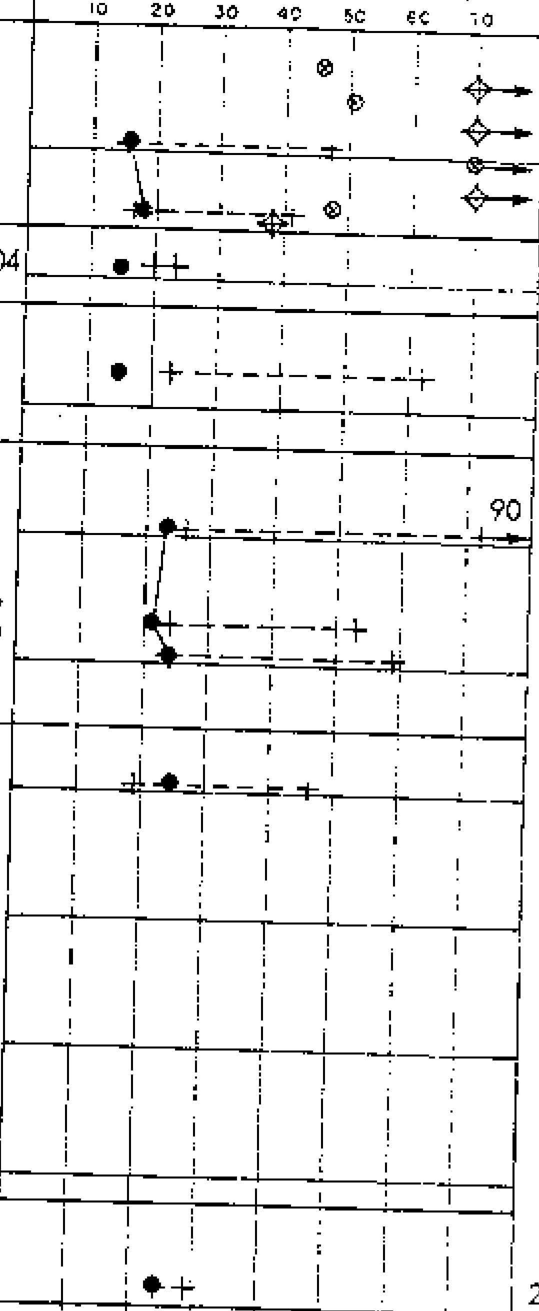
LOG OF BORING NO. D-1
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 664,570 E 3,276,230

SURF. EL: 439' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0–9	Very stiff red sandy clay -brown silty fine sand with roots to 1' -tan and light gray with clay pockets below 4' -very sandy below 6'			57 64
9–13.5	Tan and light gray clayey sand -with gravel at 11.5'		104	39
13.5–18	Light gray silty fine sand with clay pockets			36
18–27.5	Interbedded tan and light gray clay and sandy silt	34		67
	-laminated light gray and tan clay and clayey sand at 23.5'		97 99 104	[illegible] [illegible]
27.5–47.5	Light gray clayey sand -with clay seams to 42' -gray and tan below 30'	37 46		45
47.5–51	Tan silty fine sand	75/11"		22

UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4); PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70)



(Continued on Plate B-2b)

McCLELLAND ENGINEERS

LOG OF BORING NO. D-1 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS SQ FT / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT	-#200, %
	Tan silty fine sand				
55					
	-gray and tan below 57'				
60		75/10"			26
65					
	-with lignite seams at 67'				
70	-with clay seams and pockets below 68'	75/9"			
75					43
80		75/8"			
85					
90		75/7"			
95	Laminated dark gray silty clay and light gray sandy silt				63
100		75/4"			

Shear strength scale: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4

Water content scale: 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 99'
DATE: Nov. 13, 1979

DEPTH TO WATER IN BORING: 17.1'
Caved at: 18.6'
DATE: Nov. 15, 1979

McCLELLAND ENGINEERS

PLATE B-2b

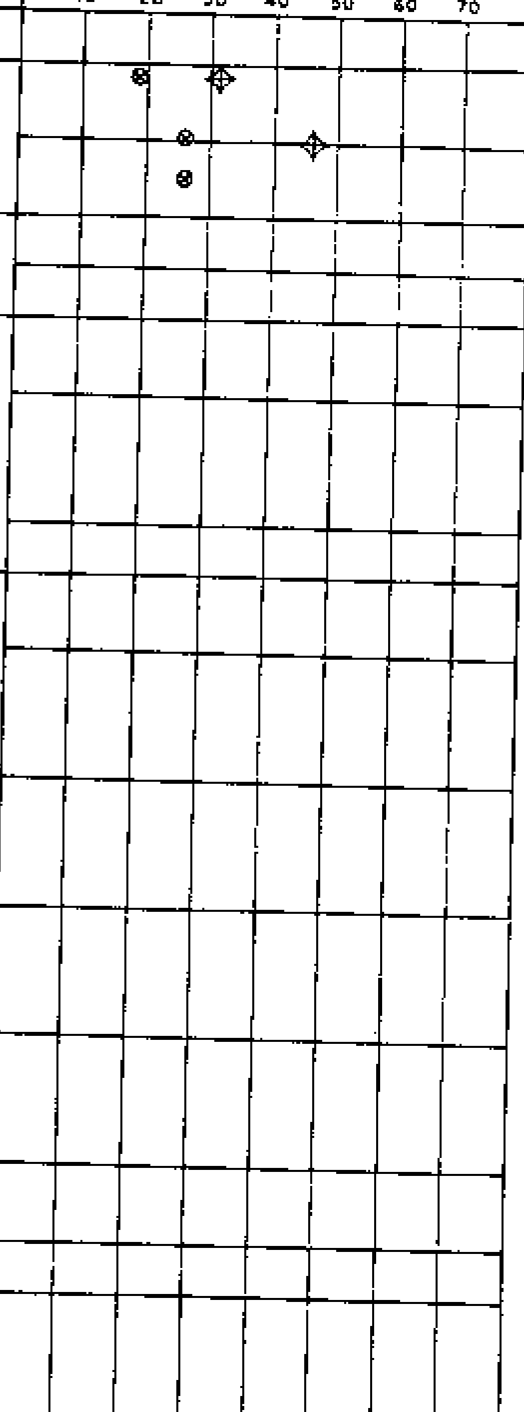
LOG OF BORING NO. D-2

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 664,225; E 3,276,822

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 426.9')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT	-#200, %
	Tan silty fine sand				
5	Firm red and light gray sandy clay -with fine sand seams below 4' -stiff with ferrous nodules below 5'				
10	Light gray and tan silty clay with silt pockets and seams	23			
15, 20	Light gray and tan silty clay -laminated with light gray and tan silt to 17.5' -laminated with light gray and tan silty fine sand below 17.5'	45			
25, 30, 35, 40, 45	Tan and gray fine sand with gray silty clay seams, pockets and nodules -brown below 32'	75/9" 75/6"			
50	Very stiff gray silty clay	75/11"			

Shear strength scale: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4
Water content scale: 10, 20, 30, 40, 50, 60, 70



(Continued on Plate B-3b)

LOG OF BORING NO. D-2 (continued)

HL&P ELECTRIC GENERATING STATION

LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10 20 30 40 50 60 70)	-# 200,%
55			Very stiff gray silty clay with silt seams and pockets -siltstone, 53.5' to 55' and at 57'	75/6"			
60–75			Interbedded tan fine sand and gray silty clay -with lignite seams, 73' to 73.5'	75/5"			
80–85			Light gray silty fine sand with silty clay pockets	75/5" Ref/6"			
90–100			Intermixed light gray silt and gray silty clay	75/6" 75/5" 75/6"			

COMPLETION DEPTH: 99.5'

DATE: Mar. 7, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. D-3
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 663, 820; E 3, 277, 540

SURF. EL: 457.4'

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT
Tan silty fine sand		
Stiff tan and light gray sandy clay -light gray and red clay, 4' to 5' -very sandy below 5'		
Light gray and tan silty fine sand with ferrous nodules and clay seams -weakly cemented at 7' -dark brown below 7'		
Very stiff gray clay with roots		
Light gray and tan sandy clay	61	
Light gray and tan sandy silt -with numerous clay seams and pockets below 18'		
Tan silty fine sand		
Intermixed gray clay and tan and red silty fine sand	59 53	
Tan silty fine sand -with clay pockets to 43' -intermixed with gray clay and light gray and tan sandy clay, 43' to 45' -with gray clay seams, 48.5' to 49'	75/11" 75 75/11" 70	

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

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

(Continued on Plate B-4b)

LOG OF BORING NO. D-3 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT
	Tan silty fine sand	
55	-with ferrous nodules at 54'	75/9"
60		75/8"
65	-tan and yellowish brown below 63'	75/6"
70		75/6"
75	Gray clay with numerous silty sand seams and pockets	75/9"
	Light gray and tan silty fine sand with light gray clay pockets	75/4"
80		
85	-light gray, 83' to 98.5'	75/5"
90		34/8"
95	-with lignite seams at 93'	Ref/5"
100	-with gray clay seams at 98.5'	Ref/6"

Column headings also printed: SYMBOL; SAMPLES; UNIT DRY WT LB/CU FT; UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70)

COMPLETION DEPTH: 99'
DATE: May 27, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. D-4

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 663,430; E 3,278,260

SURF. EL: 472.0'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT	
0	Red fine sand -brown below 2' -with clay pockets below 4'				
5	Very stiff red and tan sandy clay with sand pockets	12			46
10	Gray clay -with silty clay seams and pockets to 17.5'	21			
15	-light gray clayey fine sand at 15' -silty clay below 17.5'	25			
20	-interbedded with brown silty fine sand, 17.5' to 26'	35			
25	-interbedded with light gray silt and fine sand below 26'				
30		39			
35	-with intermixed zones below 37'				
40		48			
45			96		45
47	Brown fine sand with clay pockets -tan silty sand below 49'	75/9"			

Scale: Undrained shear strength 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4; Water content 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 49.5'
DATE: Dec. 18, 1979

DEPTH TO WATER IN BORING: Dry

Caved at: 5.1'

DATE: Dec. 20, 1979

McCLELLAND ENGINEERS

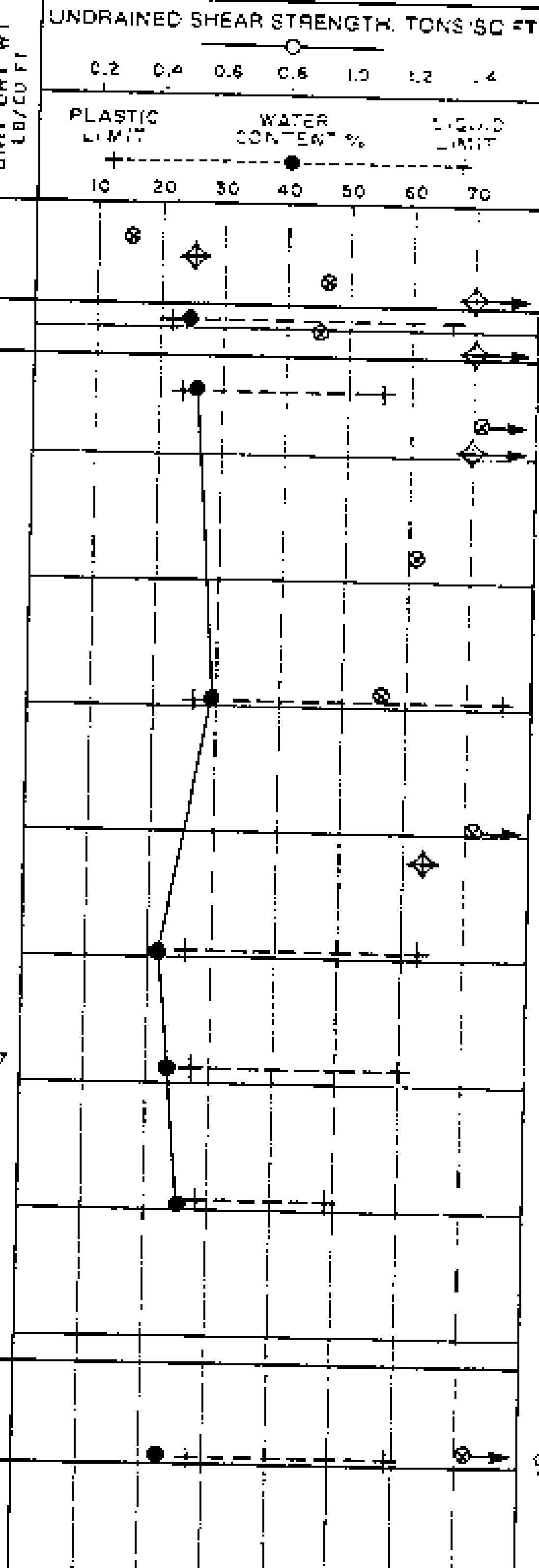
PLATE B-5

LOG OF BORING NO. D-5
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 664,290 E 3,279,130

SURF. EL: 466' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	- # 200, %
0	Firm tan sandy clay -with brown silty fine sand to 1'			
4	Stiff tan clay			88
6	Laminated very stiff light gray and tan clay, silty clay and silt			88
20		61		83
30		75		94
35			97	90
40		75/11"		89
47	Laminated very stiff dark gray clay and silt			
50		75/11"		97



COMPLETION DEPTH: 50'
DATE: Nov. 15, 1979

DEPTH TO WATER IN BORING: Dry

Caved at: 31.6'

DATE: Nov. 28, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-6

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 665,320; E 3,279,090

SURF. EL: 448.7'

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0	Stiff red sandy clay with roots -brown fine sand to .5' -very stiff below 2'			
5	Tan silty clay with sandy silt seams and pockets	40		61
10		55		
13	Intermixed tan silty fine sand and silty clay -laminated to 16'			
20		56		
24			73	
28	Tan fine sand with silty clay seams			
30		73		
40		75/9"		
42	Intermixed gray sandy clay and fine sand			
50		74		

COMPLETION DEPTH: 50'
DATE: Dec. 18, 1979

DEPTH TO WATER IN BORING: 25.1' Caved at: 29.4' DATE: Dec. 20, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-7

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 666,330; E 3,279,030

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 450.4')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 – 1.4); PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT (10 – 70)	-#200, %
0–12	Very stiff red sandy clay -stiff to 4' -tan and light gray below 4' -with ferrous nodules below 4.5' -very sandy below 8'	32			
12–33	Laminated and interbedded tan and light gray silty clay and silt -tan fine sand, 22.5' to 26.5'	51 55			
33–42	Tan and light gray fine sand with silty clay partings and seams	75/9"			
42–50	Intermixed tan silty fine sand and gray silty clay	75/10"			

COMPLETION DEPTH: 50'
DATE: Mar. 8, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. D-8

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,313; E 3,278,548

SURF. EL: 465.4'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT
	Stiff brown silty clay	
5	Very stiff tan sandy clay with ferrous nodules	54
10	Very stiff tan and light gray silty clay with silt seams and pockets -tan below 10'	36, 47
15	-with organic deposits below 13.5'	
20		65
25–30	Interbedded tan silty clay and silt	66
35	Very stiff tan and light gray shaley clay with silt partings	
40–50	Intermixed tan silty fine sand and very stiff gray silty clay -with laminated silty fine sand and silty clay layers below 42'	75/8", 75/11"

Column headings: DEPTH, FT; SYMBOL; SAMPLES; DESCRIPTION OF MATERIAL; BLOWS PER FT; UNIT DRY WT LB/CU FT; UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70); -#200, %

COMPLETION DEPTH: 50'
DATE: Feb. 27, 1980

DEPTH TO WATER IN BORING: Dry Caved at: 29.0' DATE: Feb. 26, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. D-9

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,120; E 3,278,090

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
	SURF. EL: 477.2'				
	Brown sandy silt with roots				
	Very stiff brown silty clay				
	-with roots to 2.5'				
5	-with silt pockets at 6'	32			
	-red and tan sandy silt, 6' to 8'	41			
10	-tan, 8' to 11'	41			
	-with silt partings below 8'				
	-light gray and gray, 11' to 16'				
15	-interbedded with tan silt below 16'				
20		75/9"			
	Light gray and tan silt with silty clay seams				
25					
30	Gray silty clay with silt pockets and seams	75			
	-tan, 30' to 33.5'		100		88
35	-intermixed with silty fine sand at 33.5'				
	-light gray, gray and tan below 33.5'				
40	-laminated clay and silt, 41.5' to 46'	70			
45					
50		75/11"			

COMPLETION DEPTH: 50'
DATE: Feb. 21, 1980

DEPTH TO WATER IN BORING: Dry Caved at: 37.1' DATE: Dec. 27, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-10

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,000; E 3,277,620

SURF. EL: 477.3'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT	-#200, %
0	Brown silt with roots				
5	Very stiff brown and tan sandy clay with roots and ferrous and calcareous nodules -light gray silty clay below 4'				
10	Interbedded gray silty clay and tan fine sand -with roots to 9' -with vertical organic seams at 14'		100	1.8	79
20		34			
25			94		48
30	-laminated at 29.5'	75/11"			
35	Tan silty fine sand -with silty clay pockets and ferrous stains to 34.5'	75/11"			
40		75/9"			
45		75/10"			
50		42			

COMPLETION DEPTH: 50'
DATE: Dec. 7, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-11

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,920; E 3,277,130

SURF. EL: 470.5'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-# 200, %
0–3	Gray silty fine sand -with roots to 1' -wet at 1'			
3–8	Firm tan and gray sandy clay -with gravel pockets below 5' -tan, gray and light gray below 8'	15 27		
8–12	Light gray and tan clayey sand with sandy clay pockets	30		
12–17	Intermixed light gray and tan clay and silty sand -with gravel at 13'			46
17–21	Intermixed light gray and tan silt and sandy silt	43		
21–37	Tan and gray silty fine sand with clay pockets	75/9"		
37–47	Intermixed dark gray silty clay and silt -very stiff brown clay, with lignite pockets, 43' to 44' -lignite below 44'	75/8"		100
47–49.5	Gray sandy silt	75/5"		

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 49.5'
DATE: Feb. 18, 1980

DEPTH TO WATER IN BORING: 10.5' Caved at: 40.1' DATE: Feb. 19, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. D-15
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,090 E 3,274,260

SURF. EL: 475' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2–1.4); PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT (10–70)	-#200,%
0–7	Very stiff red sandy clay with silty fine sand seams and pockets -red and light gray below 4'				59
7–11	Interbedded stiff light gray and tan clay and silty fine sand				81
11–30	Gray and tan silty fine sand -clay, 12.5' to 13'				14
		75/10"			
	-tan below 24'				
30		48			96
30–35	Laminated tan and light gray silty clay, clay and silt -with lignite seam at 32.5'	Ref/5"			
35–42	Gray silty fine sand with silty clay seams and pockets	Ref/5"		Non-Plastic	15
42–50	Laminated gray silty clay and silt	75/8"			
50		75/5"			99

COMPLETION DEPTH: 50'
DATE: Nov. 15, 1979

McCLELLAND ENGINEERS

PLATE B-13

LOG OF BORING NO. D-16
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,211; E 3,273,720

SURF. EL: 465.3'

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
Very stiff brown sandy clay -silty fine sand with roots to .5' -with ferrous nodules to 7' -tan and gray with sand pockets at 5.5' -with organic deposits at 7.5'	14	93	65
Tan and light gray silty fine sand	25		
Intermixed light gray and tan silty clay and light gray sandy silt	32		
Gray fine sand with clay pockets	75/9"		
Interbedded light gray silt and gray silty clay with organic clay seams	75/11"		
Very stiff dark gray silty clay -with silty sand pockets to 46.5' -gray with silt partings below 46.5'	75/10"	109 104	43 44

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

4.4

COMPLETION DEPTH: 50'
DATE: Dec. 14, 1979

DEPTH TO WATER IN BORING: 3.9'
Caved at: 38.3'
DATE: Dec. 20, 1979

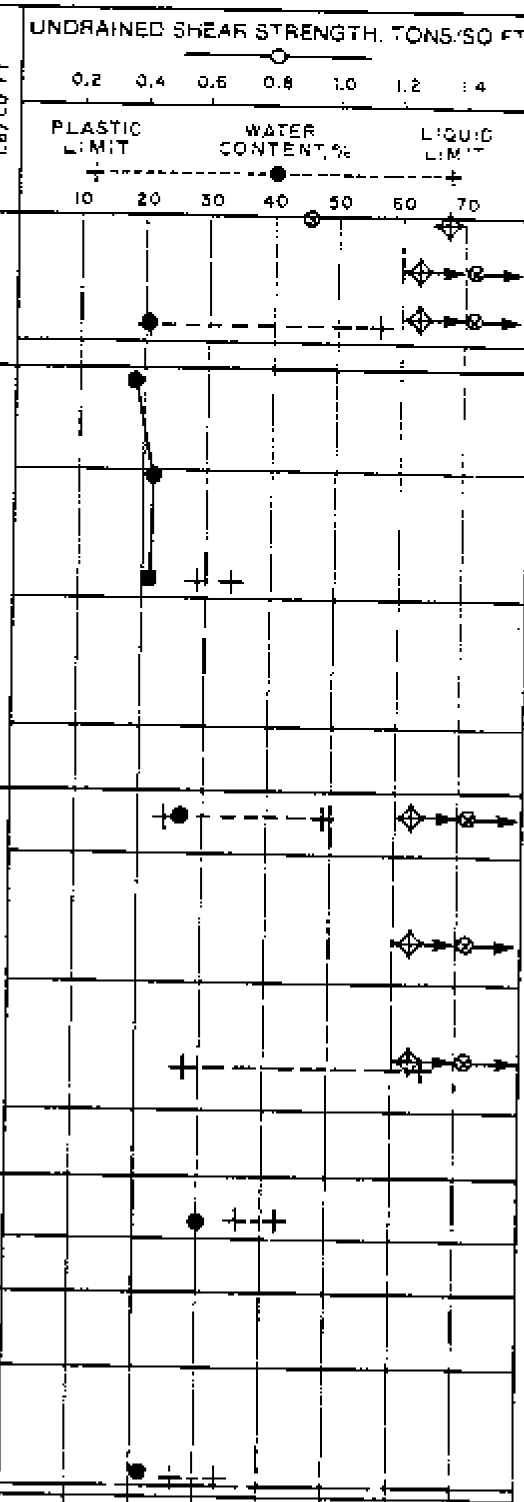
McCLELLAND ENGINEERS

PLATE B-14

LOG OF BORING NO. D-17
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,300 E 3,273,180

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 477' (approx.))	BLOWS PER FT	UNIT DRY WT LB/CU FT	-# 200, %
0–5	Very stiff tan sandy clay with roots			65
5–22	Tan clayey fine sand with clayey silt seams -with gravel to 6' -with clay seams and layers below 14.5'	39 36 49		33 33 26
22–38	Very stiff light gray clay with sand seams and layers -with tan and light gray fine sand pockets below 27.5'			55 85
38–42	Interbedded light gray clay, tan silty fine sand and gray silt -with organic seam at 39.5' -with ferrous stains, 40.5' to 41.5'	- 75/10"		29
42–49.5	Brown silty fine sand with clayey silt and silt layers	75/11"		26



COMPLETION DEPTH: 49.5'
DATE: Nov. 8, 1979

DEPTH TO WATER IN BORING: 29.0'

Caved at: 32.0'

DATE: Nov. 11, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-17-A
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,911; E 3,273,019

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 476.5'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70)	-#200, %
0–5			Very stiff red silty clay -brown and light gray with silt pockets below 3'				
5–32.5			Tan fine sand -silty sand to 22' -with silty clay pockets below 12.5' -with silty clay seams, 22' to 32.5'				
32.5–37			Intermixed tan and gray silty clay and silt				
37–48			Tan fine sand with silty clay nodules -silty sand below 43.5'				
48–50			Intermixed gray silty clay and tan and red silty fine sand				

(Continued on Plate B-16b)

McCLELLAND ENGINEERS

LOG OF BORING NO. D-17-A (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
			Intermixed gray silty clay and tan and red silty fine sand			
55			Gray fine sand			
60			Gray silty clay with silt partings			
65, 70, 75			Gray shaley clay -lignitic, 70' to 72' -with lignite partings below 72'			
80, 85, 90, 95, 100			Gray silty clay with silt pockets and seams -with lignite seams to 81' -with silt partings at 81' -laminated with silty fine sand, 83' to 87' -interbedded with silty fine sand, 87' to 94' -intermixed with gray silty fine sand below 94'			
			Note: Piezometer installed			

COMPLETION DEPTH: 101'
DATE: Mar. 8, 1980

DEPTH TO WATER
in Piezometer: 33.3'

DATE: June 6, 1980

McCLELLAND ENGINEERS

PLATE B-16b

LOG OF BORING NO. D-19

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 665, 890; E 3, 273, 910

SURF. EL: 469' (Approx.)

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2 – 1.4); PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT (10 – 70)	-#200, %
Brown silty fine sand with roots				
Very stiff red sandy clay with ferrous nodules	19			
Red silty fine sand -with sandy clay pockets to 8' -tan below 8'	17 22 29 38			
Interbedded light gray and tan silty clay and sandy silt				
Light gray and red sandy silt	72			
Intermixed and laminated gray silty clay and fine sand				
Tan silty fine sand with silty clay pockets	75/9"			

Depth scale, ft: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

COMPLETION DEPTH: 49.5'
DATE: Dec. 14, 1979

DEPTH TO WATER IN BORING: 31.5'
Caved at: 32.0'
DATE: Dec. 20, 1979

MCCLELLAND ENGINEERS

LOG OF BORING NO. D-20
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 665,160; E 3,274,290

SURF. EL: 458.6'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	−#200, %
	Brown silty fine sand			
	Very stiff red sandy clay			
5	-with sand pockets at 5'	14		
	Red silty fine sand with sandy clay pockets and seams		88	16
10	-clayey sand to 7'	18		
	-tan with clayey silt pockets, 13' to 26'			
15	-with ferrous stains, 13' to 20' and at 49'			
20		41		
25	-light gray, 26' to 32'			
30		40		
	-intermixed tan silty fine sand and silty clay, 32' to 36'			
35				
40		47		
	-fine sand below 42'			
45				
50	-with silty clay layers at 49.5'	75/11"		

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

COMPLETION DEPTH: 50.0'
DATE: Dec. 17, 1979

DEPTH TO WATER IN BORING: 26.9' Caved at: 27.3' DATE: Dec. 20, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-21

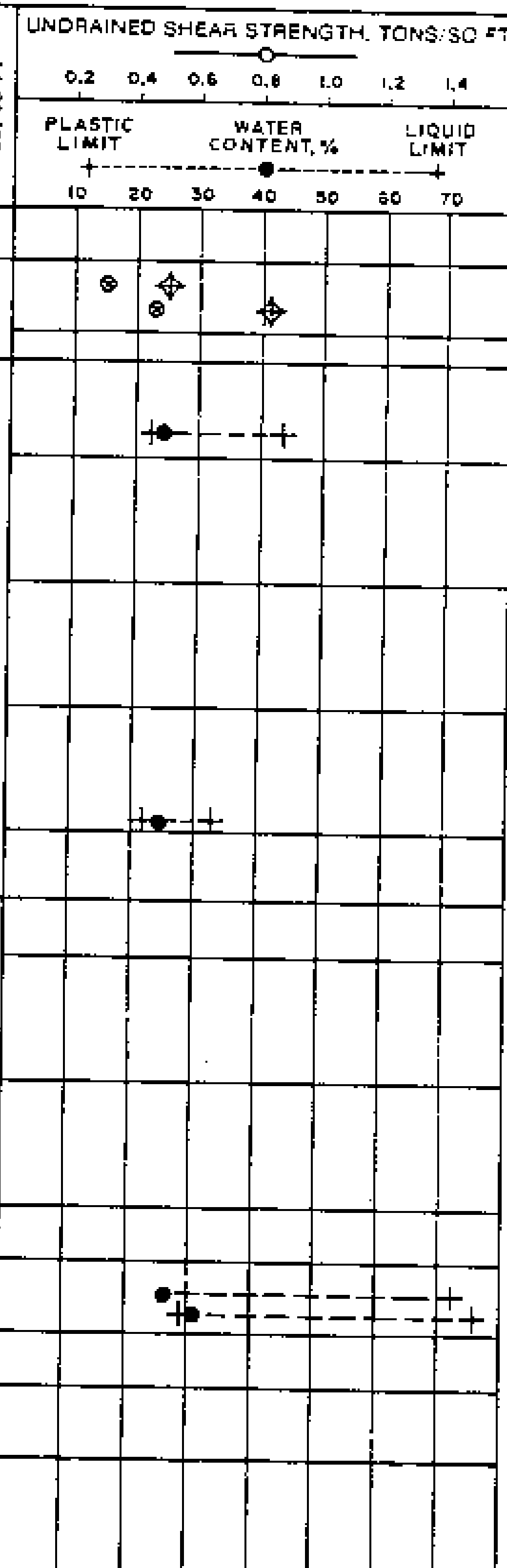
HL&P ELECTRIC GENERATING STATION

LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 664,450; E 3,274,660

SURF. EL: 433' (Approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	- # 200, %
0–2	Brown sandy silt with roots			
2–7	Firm tan and light gray sandy clay with silty fine sand seams and pockets			
7–10	Gray and light gray silty clay with silt and silty fine sand partings			69
17–20	-intermixed light gray silty clay and sandy silt, 17' to 20'	28		
24–27	-laminated gray silty clay and light gray silty sand at 24'		95	37
27–30	Tan, light gray and gray silty fine sand with silty clay seams and partings	67		
35		67		
40	-interbedded silty fine sand and silty clay at 40'	60		
42–44	Very stiff dark gray clay with traces of lignite		91	99
45			94	98
47–51.5	Light gray silty fine sand -with silty clay seams and partings to 51.5'	75/9"		



(Continued on Plate D-19b)

McCLELLAND ENGINEERS

LOG OF BORING NO. D-21 (continued)

HL&P ELECTRIC GENERATING STATION

LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10 20 30 40 50 60 70)	-#200,%
55	Light gray silty fine sand -with silty clay seams and partings to 51.5'				
60	-lignite, 59' to 61'	75/4"			
65	Laminated gray silty clay and light gray silt				
70	Light gray silty fine sand with silty clay pockets	75/4"			
75	-with silty clay seams below 74'	75/4"			
80	Gray silty clay -with silty fine sand seams and pockets to 83.5'	75/8"			
85	-laminated with light gray silty fine sand, 83.5' to 87'				
90	-light gray, 89' to 92.5'	75/6"			
95	-interbedded with light gray silt, 92.5' to 99.5'				
100	-with lignite and silt partings below 99.5'	75/9"			

COMPLETION DEPTH: 100'
DATE: Dec. 8, 1979

DEPTH TO WATER IN BORING: 36.0'   Caved at: 47.0'   DATE: Dec. 6, 1979

McCLELLAND ENGINEERS

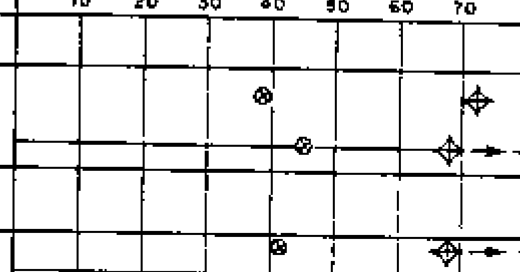
LOG OF BORING NO. D-22

HL&P ELECTRIC GENERATING STATION

LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 664, 510; E 3, 275, 450

DEPTH, FT	DESCRIPTION OF MATERIAL SURF. EL: 424' (approx.)	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
	Tan silty fine sand with roots				
5	Stiff gray sandy clay				
	Gray silty fine sand with clay pockets -tan and light gray below 6.5'				
10	Stiff light gray silty clay -with sandy clay pockets and silty fine sand seams to 12.5' -with silty fine sand pockets and seams, 12.5' to 17.5'				
20	Tan silty fine sand -wet at 19'	47			
30		49			
	-with silty clay pockets below 32'				
40	Laminated gray and tan silty clay and light gray silty fine sand -interbedded below 42'	71			
50		72			



(Continued on Plate B-20b)

MCCLELLAND ENGINEERS

LOG OF BORING NO. D-22 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT	-#200, %
	Interbedded silty clay and silty fine sand				
55	Gray silty fine sand with silty clay pockets				
60		75/11"			
65		75/9"			
70		75/7"			
	-with silty clay seams below 71'				
75		75/6"			
	Gray silty clay				
80	-with silty fine sand seams and pockets to 86'	75/6"			
	-with lignite seams, 82.5' to 86'	75/8"			
85	-lignite, 86' to 87'				
	-with silt pockets, seams, and partings below 87'				
90		75/9"			
95		75/10"			
100		75/10"			

Chart scales: Undrained shear strength 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4; Water content 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 100.0'
DATE: Dec. 10, 1979

DEPTH TO WATER IN BORING: 28.3'
Caved at: 46.0'
DATE: Dec. 6, 1979

McCLELLAND ENGINEERS

PLATE B-20b

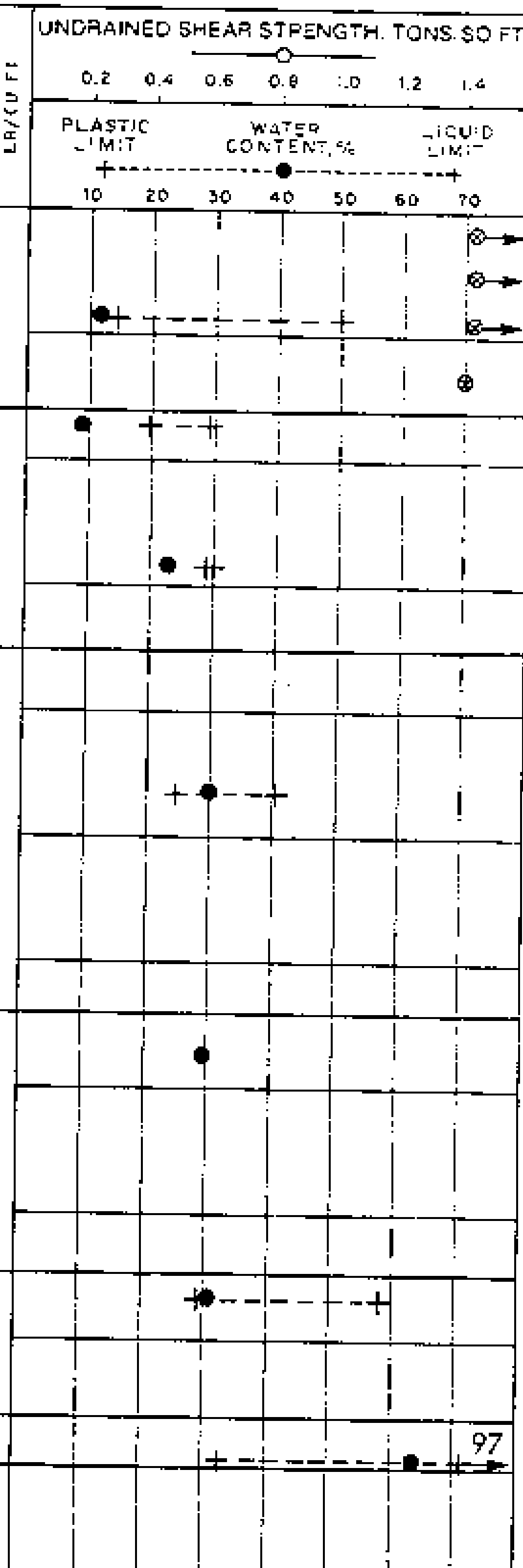
LOG OF BORING NO. D-24

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 665,000 E 3,275,000

SURF. EL: 444' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0	Very stiff red and light gray sandy clay -brown fine sand with roots to 1' -silty clay, 1' to 2' -very sandy below 6'			56
8	Tan and light gray silty fine sand -with gravel at 13'			40 27
17	Interbedded tan clay and light gray fine sand with clay and sand pockets	35 53		68 56
31	Tan silty fine sand with clay pockets	75/10"		21
41	Interbedded tan silty fine sand and red clay with gray silty clay seams			60
47	Firm gray clay with silt layers	8		83



COMPLETION DEPTH: 50'
DATE: Nov. 12, 1979

DEPTH TO WATER IN BORING: 8.3'
DATE: Nov. 15, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-26
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 666,958; E 3,274,965

SURF. EL: 443.2'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT	-# 200, %
	Brown silty fine sand with roots				
	Stiff red sandy clay				
5	Interbedded and laminated tan silty clay and silty fine sand -with ferrous stains at 8' -light gray and tan at 10'	24			
10		34			
15					88
20		25			
	-intermixed gray silty clay and tan fine sand, 22.5' to 28'				
25					
30	-with ferrous stained fine sand layers below 30'	48			
	Tan silty fine sand with silty clay partings and pockets				
35					
40		46			
	Very stiff gray silty clay with fine sand and silt partings and seams				
45					
50		75/11"			

Shear strength scale: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4
Water content scale: 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 50.0'
DATE: Dec. 15, 1979

DEPTH TO WATER IN BORING: 8.4'
Caved at: 29.1'
DATE: Dec. 20, 1979

McCLELLAND ENGINEERS

PLATE B-23

LOG OF BORING NO. D-25
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 666,000; E 3,275,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 444.2'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200,%
			Brown silty fine sand with roots				
			Very stiff red sandy clay -brown below 2'				
5			Light gray silty clay with silty fine sand pockets and seams	28			
			Tan fine sand with silty fine sand layers				
10				24			
			-intermixed tan silty fine sand and light gray silty clay, 11.5' to 16.5'				
15							
20				46			
25							
			-with tan and light gray silty clay pockets, 27' to 42.5'				
30				55			
35							
40				53			
45							
50				75/11"			

COMPLETION DEPTH: 50.0'
DATE: Dec. 18, 1979

DEPTH TO WATER IN BORING: 14.7 Caved at: 27.6' DATE: Dec. 20, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-29

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 665,000; E 3,276,000

SURF. EL: 438' (Approx.)

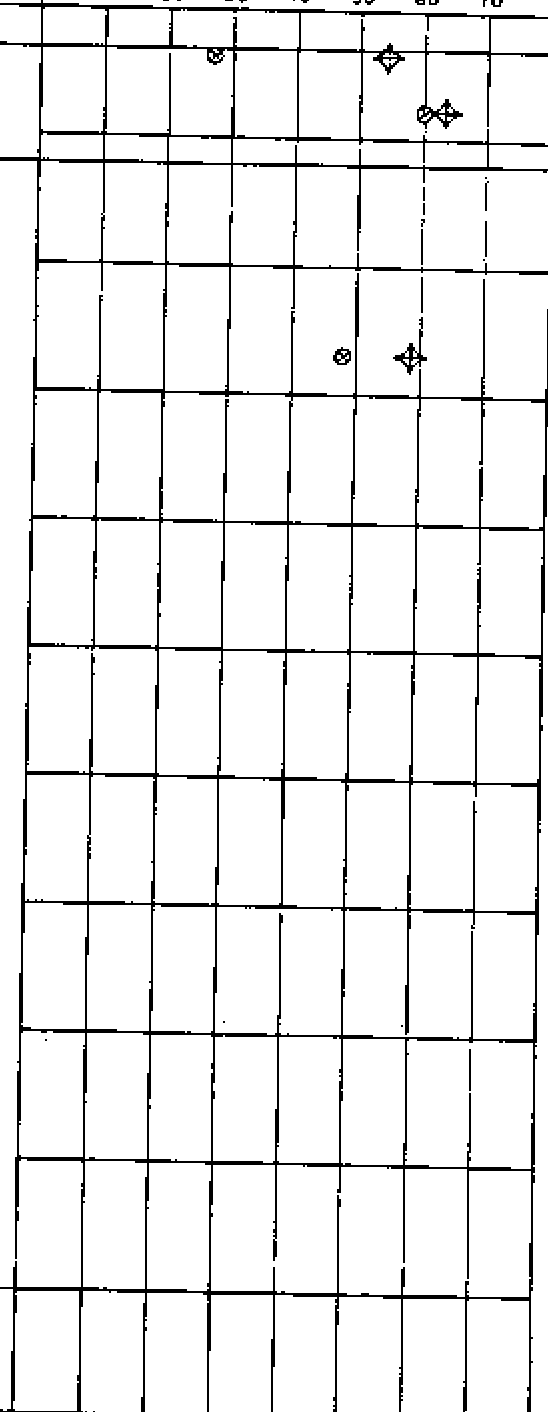
DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT
0	Brown silty fine sand with roots	
	Very stiff tan and red sandy clay	13
5–10	Tan and light gray silty fine sand -with silty clay pockets to 11.5'	
15	-stiff light gray silty clay with silt pockets, 13.5' to 17' -with silty clay pockets, 17' to 32'	
20		31
30		69
33.5	-red at 33.5'	
40		75/9"
50		75/9"

UNIT DRY WT LB/CU FT

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

-#200, %



COMPLETION DEPTH: 50.0'
DATE: Dec. 10, 1979

DEPTH TO WATER IN BORING: 16.3'

Caved at: 31.9' DATE: Dec. 14, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-30

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 666,000; E 3,276,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 440.9'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4) PLASTIC LIMIT + --- WATER CONTENT, % ● --- LIQUID LIMIT + (10, 20, 30, 40, 50, 60, 70)	-#200, %
			Stiff red, tan and light gray sandy clay -with roots to 2' -light gray and tan below 3.5' -with ferrous gravel below 5.5'				
5				27			
			Very stiff light gray silty clay with silty fine sand pockets and seams				
10			Intermixed tan silty clay and silty fine sand	28			
15							
20				43			
25							
30				36			
35			-gray, light gray and brown, 37' to 44'				
40				36			
45							
50				55			

COMPLETION DEPTH: 50.0'
DATE: Dec. 15, 1979

DEPTH TO WATER IN BORING: 16.2'

Caved at: 30.1'

DATE: Dec. 20, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-32
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,000; E 3,276,001

SURF. EL: 451.8'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2–1.4); PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT (10–70)	-#200, %
0	Firm sandy clay and silty clay with roots -brown silty fine sand to 0.5'				
5	Brown silty fine sand with silty clay seams and pockets	24			
	-light gray and tan below 8'				
10		59			
17	Interbedded gray, light gray and tan silty clay and tan and light gray silt				
20		68			
	-with siltstone seams, 23.5' to 24'				
25	Very stiff gray silty clay -with silt pockets to 31'				
30		65			
	-shaley clay, 31' to 35.5'				
35	-lignite, 35.5' to 37.5' -shaley clay, 37.5' to 40'				
40	-with silt pockets below 40'	75/8"			
43	Gray fine sand with silty clay seams and pockets	75/5"			
48		75/4"			

COMPLETION DEPTH: 49.0'
DATE: Dec. 19, 1979

DEPTH TO WATER IN BORING: 10.0'
Caved at: 22.2'
DATE: Dec. 20, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-33
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,000; E 3,276,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 452.6'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	- # 200, %
			Tan silty fine sand with roots				
5			Stiff tan and light gray sandy clay -with silt seams below 6' -with gravel below 6.5'	17 29			
10			Stiff tan and light gray silty clay, with silt seams	23			
15			-very stiff below 14'				
20				30			
			Lignite				
25							
30			Gray silty clay with interbedded and laminated layers of silty clay and silty fine sand	75/11"			
35							
40				75/8"			
			Lignite	Ref/2"			
45			Light gray silty fine sand with silty clay pockets				
50				75/5"			

(Continued on Plate B-28b)

LOG OF BORING NO. D-33 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
55			Light gray silty fine sand with silty clay pockets -with silty clay partings below 52.5'	75/5"			
60			Light gray silt with silty clay seams -with layers of intermixed and laminated silt and silty clay below 60'	Ref/6"			
65				75/5"			
70				75/8"			
75				75/8"			
80			-siltstone at 78.5'	75/7"			
85				75/5"			
90			Gray silty fine sand -silty clay with silt pockets and partings at 89.5'	75/5"			
95			-light gray with sandy clay pockets below 92.5'	75/6"			
100			Laminated and intermixed light gray silt and gray silty clay	75/7"			
			(Continued on Plate B-28c)				

LOG OF BORING NO. D-33 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT
	Laminated and intermixed light gray silt and gray silty clay	
105	Brown and gray silty clay with silt partings and pockets -with siltstone parting at 104'	75/11"
110		75/9"
115	-with vertical silt seam at 115'	75/8"
120	Gray silty fine sand with silty clay pockets and seams	75/3"
125	-interbedded gray silty fine sand and silty clay, 122' to 136'	75/5"
130		75/4"
135		
140		75/5"
145		
150		75/4"

Column headings also printed: SYMBOL; SAMPLES; UNIT DRY WT LB/CU FT; UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70); -# 200, %

COMPLETION DEPTH: 149.5'
DATE: Feb. 26, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. D-34
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 665,000; E 3,277,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 448' (Approx.)	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200,%
			Stiff red sandy clay -brown silty fine sand to 1' -with roots to 2' -tan below 4' -very sandy below 6' -very stiff below 7'				
5				26			
10				33			
			Tan silty fine sand with silty clay pockets and seams and layers of intermixed silty fine sand and silty clay				
15							
20			-brown and gray below 20'	36			
25							
30				49			
35							
40				49			
45							
50			-gray with silt pockets at 50'	54			

COMPLETION DEPTH: 50.0'
DATE: Dec. 18, 1979

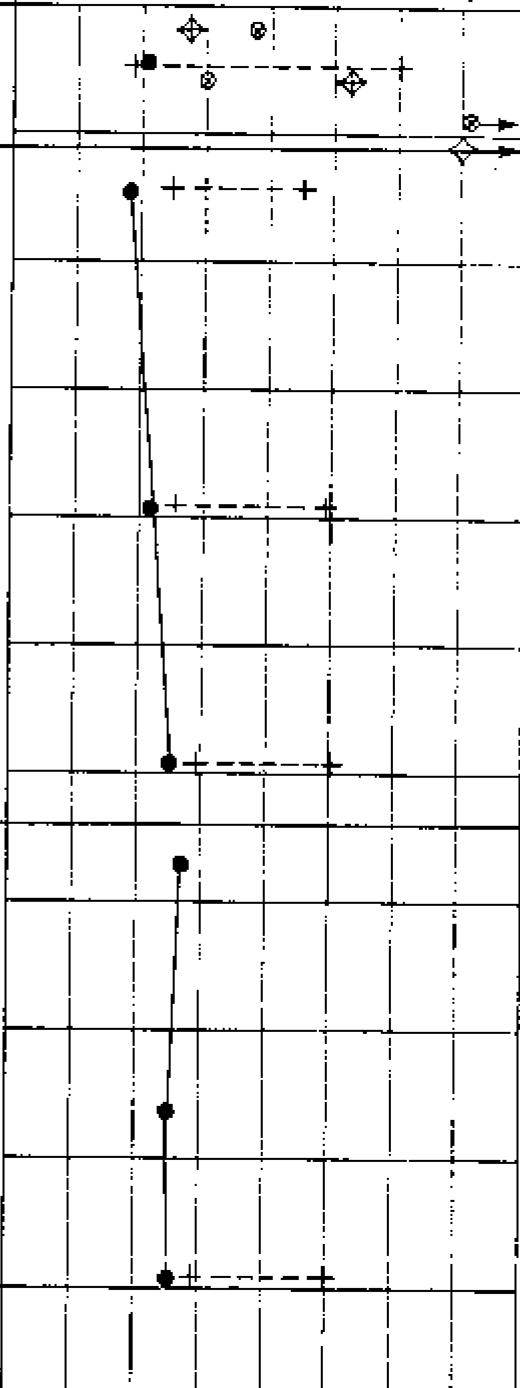
DEPTH TO WATER IN BORING: 25.8'
Caved at: 47.0'
DATE: Dec. 20, 1979

MCCLELLAND ENGINEERS

LOG OF BORING NO. D-31
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,000 E 3,276,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 448' (approx.)	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
			Stiff brown silty clay				
			-tan and light gray below 4'				77
5							
			Laminated tan and light gray silty clay and sandy silt				62
10							
15			-with sand seams at 16' -with clayey silt layers, 17.5' to 20.5'				
20				43			58
25							
30				45			59
			Interbedded gray and tan silty clay, silty fine sand and silt				37
35							
40				75/11"			
45							20
50				75/11"			62
			(Continued on Plate B-26b)				



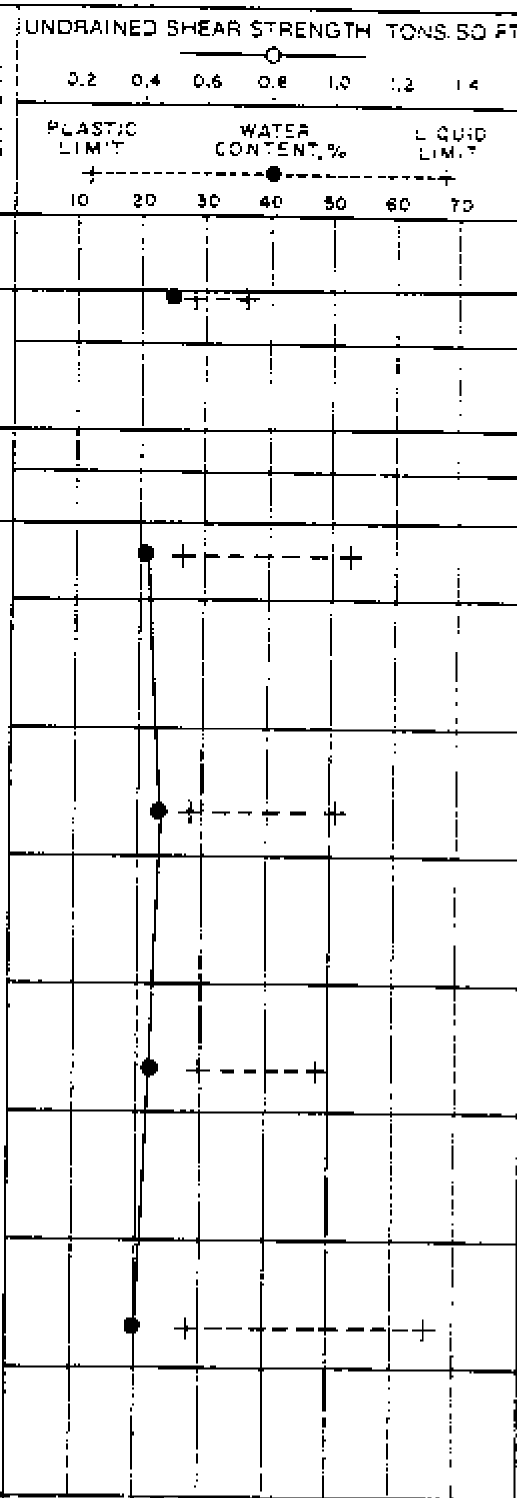
MCCLELLAND ENGINEERS

LOG OF BORING NO. D-31 (continued)

HL&P ELECTRIC GENERATING STATION

LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT; PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT	-#200,%
			Interbedded gray and tan silty clay, silty fine sand and silt				
55			Gray silty fine sand with silty clay partings				36
60			Interbedded gray silty fine sand, silty clay and silt	75/7"			
65			Laminated dark gray silty clay and gray sandy silt				75
70				75/7"			
75							63
80				75/8"			
85							81
90				75/7"			
95							94
100				80/9"			



(Continued on Plate B-26c)

LOG OF BORING NO. D-31 (continued)

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE:

LOCATION:

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL:)	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT	ELEVATION, FT
	Laminated dark gray silty clay and gray sandy silt	80/9"			
105					
	Gray silty fine sand with clay seams and partings				
110		75/5"		Non-Plastic	29
115					
120		75/5"			28
125	Laminated gray silty clay and sandy silt				
130		75/7"			68
135					
140		75/8"			72
	Gray silty fine sand with clay pockets				
145					
150		75/3"			25

Shear strength scale: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4
Water content scale: 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 150.5'
DATE: Nov. 14, 1979

LOG OF BORING NO. D-35
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 666,000 E 3,277,000

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 458' (approx.))	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200,%
0–5	Very stiff red silty clay			77
5–10	Laminated light gray silt, tan clay and light gray fine sand			71
10–33	Light gray silty fine sand with clay seams	62		32
	-brown at 22'	47		28
33–50	interbedded tan clay, light gray sandy silt and silty fine sand	75/7"		53
		75/10"		42

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

COMPLETION DEPTH: 50'
DATE: Nov. 12, 1979

DEPTH TO WATER IN BORING: 35.2'

Caved at: 43.8'

DATE: Nov. 15, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-37
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,000; E 3,277,000

SURF. EL: 474.0'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	- # 200, %
	Brown silt with silty clay pockets			
	Brown silty clay			
5	Laminated tan, brown and light gray silty clay and silt	37		
		51		
10		40		
	Laminated and interbedded gray clay and tan sandy silt			87
15				
20		49		92
	-tan and light gray below 22'			
25				85
30		42		74
	-with yellowish red fine sand partings below 32.5'			
35				
	Light gray fine sand			
40	-with gray clay pockets to 41'	75/7"		
45				
50		75/9"		

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

COMPLETION DEPTH: 49.5'
DATE: Feb. 20, 1980

DEPTH TO WATER IN BORING: Dry
Caved at: 43.3'
DATE: Feb. 26, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. D-38

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,000; E 3,277,000

SURF. EL: 465.8'

Depth, ft	Description of Material	Blows per ft	−#200, %
0–4	Stiff red sandy clay -brown silty fine sand to 0.5' -light gray and tan below 2'		
4–12	Interbedded tan and light gray silty clay and silt -laminated below 8'	13 16 29	
12–14	Intermixed tan silty fine sand and clay		54
14–23	Laminated tan and light gray silty clay and silt with sand pockets	41	90
23–29	Intermixed tan and gray silty clay and silty fine sand with ferrous partings		
29–33	Gray clay with lignite nodules	21	
33–42	Brown silty clay with lignite nodules -with silt pockets below 38'	75/11"	
42–49.5	Gray silty fine sand -with silty clay partings below 46'	75/4" 75/5"	

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

UNIT DRY WT LB/CU FT

COMPLETION DEPTH: 49.5'
DATE: Feb. 20, 1980

DEPTH TO WATER IN BORING: 9.7'
Caved at: 43.5'
DATE: Feb. 27, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. D-39
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 665,000; E 3,278,000

SURF. EL: 440' (Approx.)

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	- # 200, %
0–2	Brown silt with roots			
2–5	Very stiff red sandy clay with ferrous deposits -tan below 4'			
5–33	Light gray and tan silty clay with silty fine sand pockets -organic deposits at 8' -gray below 17'	36 (at ~20'); 33 (at ~30')		
33–48	Brown silty fine sand -with gray silty clay pockets below 37'	43 (at ~40')		
48–50	Gray and tan silty clay with silty fine sand pockets	49		

(Continued on Plate B-33b)

LOG OF BORING NO. D-39 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
			Gray and tan silty clay with silty fine sand pockets and seams				
55							
60			-gray below 60'	59			
65							
70			-interbedded silty clay and silty fine sand at 69.5'	75/10"			
75			-intermixed silty clay and silty fine sand at 73.5'				
			-with siltstone seams, 77' to 78'				
80				75/7"			
			-with silt seams, 83' to 94'				
85							
90				75/5"			
			-peaty at 93.5'				
95							
			-intermixed silty clay and silty fine sand, 99' to 100'	75/5"			
100							

(Continued on Plate B-33c)

LOG OF BORING NO. D-39 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT (10 20 30 40 50 60 70)	-# 200, %
			Gray silty clay with silty fine sand pockets and seams -intermixed silty clay and silty fine sand, 99' to 110'				
105							
				75/5"			
110							
115							
				75/3"			
120							
125							
				75/4"			
130							
135							
			Gray silty fine sand with silty clay pockets				
				Ref/6"			
140							
145							
				Ref/6"			
150							

COMPLETION DEPTH: 149.0'
DATE: Dec. 13, 1979

DEPTH TO WATER IN BORING: 18.0'
Caved at: 85.0'
DATE: Dec. 17, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-40
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 666,000; E 3,278,000

SURF. EL: 456' (Approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT	-#200, %
0–12	Red and brown silty clay -brown silty fine sand to 1' -with silt seams and pockets at 2.5' -tan and light gray, 4' to 6' -with silt pockets below 6'				
12–17	Light gray fine sand with silty clay partings				
17–47	Intermixed tan silty clay and tan and light gray silty fine sand	65			
	-very stiff tan silty clay with silty fine sand seams and pockets at 24' -laminated, 26' to 40'	67			
	-interbedded at 34'				
	-tan and light gray silty fine sand with silty clay pockets at 40'	49			
47–50	Gray silty clay with silt seams	75/11"			

UNDRAINED SHEAR STRENGTH scale: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4
WATER CONTENT scale: 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 50.0'
DATE: Dec. 10, 1979

DEPTH TO WATER IN BORING: Dry Caved at: 28.0'
DATE: Dec. 17, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-41

HL&P ELECTRIC GENERATING STATION

LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,000; E 3,278,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 478' (Approx.)	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-# 200, %
			Stiff red sandy clay -brown below 2'				
5 10 15 20 25 30 35			Intermixed very stiff light gray silty clay and tan sandy silt -brown silty clay, 4' to 6' -with vertical silt seam, 7.5' to 11' -laminated at 30' -very stiff gray clay with silt seams and partings below 32.5'	49 55			
40 45 50			Intermixed and interbedded gray silty clay and tan and light gray silty fine sand -interbedded, 42.5' to 52'	75/10" 75/11"			

(Continued on Plate D-35b)

LOG OF BORING NO. D-41 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL | BLOWS PER FT | UNIT DRY WT LB/CU FT | UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70) | -#200, %

Description of Material	Blows per ft
Interbedded gray silty clay and tan and light gray silty fine sand	
-intermixed and interbedded, 52' to 62.5'	
	72
-intermixed below 62.5'	
	75/10"
-with siltstone seams and nodules, 71' to 72'	
-siltstone, 72' to 73'	
-with laminated layers below 73'	
	75/4"
Gray silty fine sand with silty clay pockets	
	75/5"
	75/5"
	75/6"
-interbedded with silty clay at 99'	75/5"

Depth scale: 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

(Continued on Plate B-35c)

LOG OF BORING NO. D-41 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200,%
			Gray silty fine sand with silty clay pockets				
105							
		X	-with silty clay seams below 109'	75/5"			
110							
115							
		X		75/4"			
120			Gray silty clay with silty fine sand seams and pockets				
125							
		X		75/8"			
130							
135			Intermixed gray silty fine sand and silty clay				
		X		75/3"			
140							
145			-laminated below 144.5'				
		X		75/5"			
150							

COMPLETION DEPTH: 150'
DATE: Dec. 11, 1979

DEPTH TO WATER IN BORING: 56.5' Caved at: 77.0' DATE: Dec. 17, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. D-43
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 664,540; E 3,275,840

SURF. EL: 436' (Approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT
0–7	Stiff red sandy clay -red and light gray, 2' to 4' -light gray and tan below 4' -with silty fine sand layers below 6'	21	110
7–16	Very stiff light gray silty clay with silty fine sand seams -interbedded with silty fine sand at 10'	27	
16–50.5	Light gray silty fine sand -with silty clay seams, 22.5' to 27' -with silty clay pockets, 27' to 32'	34 69 65 75/10"	

Chart columns: UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70); -#200, %

(Continued on Plate B-36b)

LOG OF BORING NO. D-43 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
			Light gray silty fine sand				
55			-tan at 54.5'	72/11"			
60			-gray fine sand at 59.5' -intermixed with gray silty clay, 61.5' to 92'	75/11"			
65							
70				75/6"			
75				75/11"			
80				75/10"			
85				Ref/5"			
90				75/6"			
95			-interbedded with gray silty clay below 92'	75/3"			
100			-light gray silty clay with silty fine sand seams at 99'	75/5"			

COMPLETION DEPTH: 100.0'
DATE: Dec. 15, 1979

DEPTH TO WATER IN BORING: 13.0'   Caved at: 19.5'   DATE: Dec. 17, 1979

McCLELLAND ENGINEERS

6-16-80

LOG OF BORING NO. D-44

HL&P ELECTRIC GENERATING STATION

LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 664,400; E 3,276,390

SURF. EL: 439'

UNDRAINED SHEAR STRENGTH, TONS SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0–8	Firm red and brown sandy clay -with roots to 1.5' -brown silty fine sand to 1' -stiff, 2' to 6' -red and light gray below 3.5' -very stiff with ferrous deposits below 6'	22	112	67
8–15	Light gray silty fine sand	17 29		
15–32	Intermixed and laminated tan silty fine sand and light gray and gray silty clay -laminated, 22.5' to 30' -gray silty clay with silty fine sand seams and pockets below 30'	45 45		
32–49.5	Light gray fine sand -with silty clay pockets below 42' -tan silty sand below 49'	75/6" 75/8"		

COMPLETION DEPTH: 49.5'
DATE: Dec. 17, 1979

DEPTH TO WATER IN BORING: 18.9' Caved at: 25.9' DATE: Dec. 20, 1979

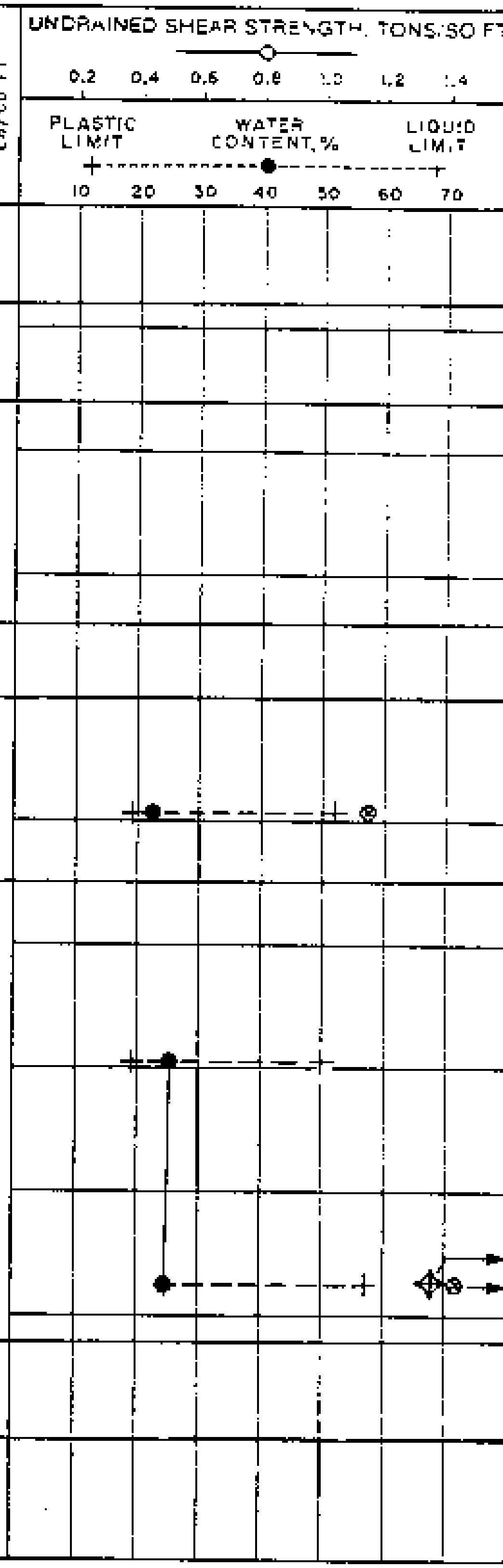
McCLELLAND ENGINEERS

LOG OF BORING NO. S-1
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 671,000; E 3,277,000

SURF. EL: 515.2'

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200,%
Tan fine sand -with roots to 1'			
Tan and light gray sandy clay -tan and light gray clayey sand below 7'	26 34		
Tan and light gray silty fine sand with silty clay pockets	40		
Light gray and tan sandy clay	25		
Interbedded tan, light gray and gray clay and silt			95
Interbedded light gray and gray clay and light gray silty fine sand -very stiff with ferrous seams at 43.5'	48 48		56 67
Laminated dark gray silty clay and light gray silt	75		



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

COMPLETION DEPTH: 50'
DATE: February 19, 1980

DEPTH TO WATER IN BORING: 4.6' Caved at: 19.9' DATE: Feb. 27, 1980

McCLELLAND ENGINEERS

PLATE B-38

LOG OF BORING NO. S-2
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 672,000; E 3,277,000

SURF. EL: 523.4'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT
0–12	Tan fine sand -silty sand below 2'	7 13 17		
12–16	Very stiff light gray and red sandy clay with sand seams and pockets			
16–22.5	Very stiff gray clay with silty fine sand seams and partings and ferrous seams			⊗→
22.5–25.5	Laminated light gray clay and light gray sandy silt -sand below 24.5'			
25.5–48.5	Very stiff light gray clay with numerous sand, sandy silt and silty sand seams and partings			⊗→ ⊗→ ⊗→ ⊗→ ⊗→

Plot scales: Undrained shear strength, tons/sq ft: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4. Plastic limit — Water content, % — Liquid limit: 10, 20, 30, 40, 50, 60, 70.

COMPLETION DEPTH: 48.5'
DATE: May 27, 1980

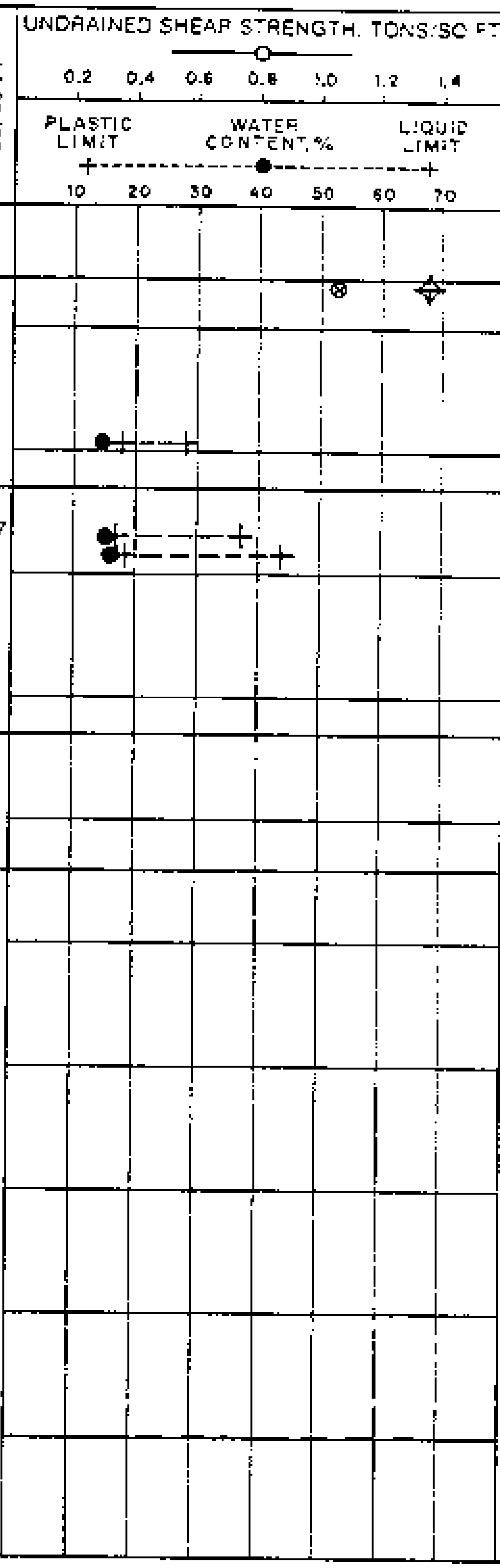
McCLELLAND ENGINEERS

LOG OF BORING NO. S-3
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,000; E 3,278,000

SURF. EL: 478.2'

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
Brown and tan silty fine sand			
Very stiff light gray and tan sandy clay -light gray below 8' -with silty fine sand seams below 9'	26 32 35		47
Intermixed light gray and brown sandy clay and sandy silt -with sandy clay layer at 14'	65	107	60 63
Tan sandy silt with silty clay partings			
Light gray and tan fine sand -with silty clay partings below 32' -with gravel, 36.5' to 38' -with silty clay pockets and seams below 42' -intermixed gray silty clay and silt, 44' to 47' -interbedded tan and light gray fine sand and silty clay, 47' to 52.5'	75/9" 75/8" 75/5"		



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

(Continued on Plate B-40b)

LOG OF BORING NO. S-3 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
	Light gray and tan fine sand				
	-interbedded sand and silty clay, 47' to 52.5'				
55	-laminated dark gray silty clay and light gray silt, 52.5' to 57'				
60	-light gray below 57'	75/9"			
	-with laminated silty clay and silt seams, 59.5' to 62'				
65		75/3"			
	-with clayey silt partings, 65.5' to 67'				
70		75/4"			
	-with silty clay pockets below 71'				
75		75/3"			
80		75/5"			
85		Ref/5"			
90	-laminated dark gray silty clay and light gray silt, 89' to 92.5'	75/4"			
95		Ref/4"			
	-gray with clayey silt partings below 96'				
100		Ref/4"			

COMPLETION DEPTH: 99'
DATE: Feb. 20, 1980

DEPTH TO WATER IN BORING: 22'

Caved at: 28.0'

DATE: Feb. 27, 1980

MCCLELLAND ENGINEERS

LOG OF BORING NO. S-4
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 671,000; E 3,278,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 513.5'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
0–17			Brown fine sand -light gray, 2' to 4' -wet at 4' -tan, 4' to 7' -stiff sandy clay, 7' to 8' -red, light gray and tan below 8' -silty fine sand, 8' to 12' -clayey sand below 12'	13 25 46			29
17–22			Laminated light gray and brown silty clay and silt	22			
22–41			Interbedded light gray and tan silty fine sand and clay -clayey sand with clay seams and pockets at 40'	48 64			47 40
41–49.5			Light gray and tan silty fine sand with silty clay partings	75/6"			

COMPLETION DEPTH: 49.5'
DATE: Feb. 19, 1980

DEPTH TO WATER IN BORING: 5.2'

Caved at: 7.6' DATE: Feb. 26, 1980

LOG OF BORING NO. S-5
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 672,000; E 3,276,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 542.4	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT (10 20 30 40 50 60 70)
			Tan silty fine sand			
5 10			Stiff tan and red very sandy clay with ferrous nodules -with clayey sand and clay pockets, 4' to 6' -light gray and tan below 6' -very stiff below 8'			
15 20 25 30 35 40 45 50			Light gray and tan silty fine sand -cemented at 13' -with clay pockets below 18' -with clay seams, 18' to 23', 33' to 43.5' and below 48.5' -slightly clayey to 28' and 38' to 43.5' -white and very silty below 38'	75/6" 75/4" 62 57		

COMPLETION DEPTH: 50'
DATE: May 25, 1980

McCLELLAND ENGINEERS

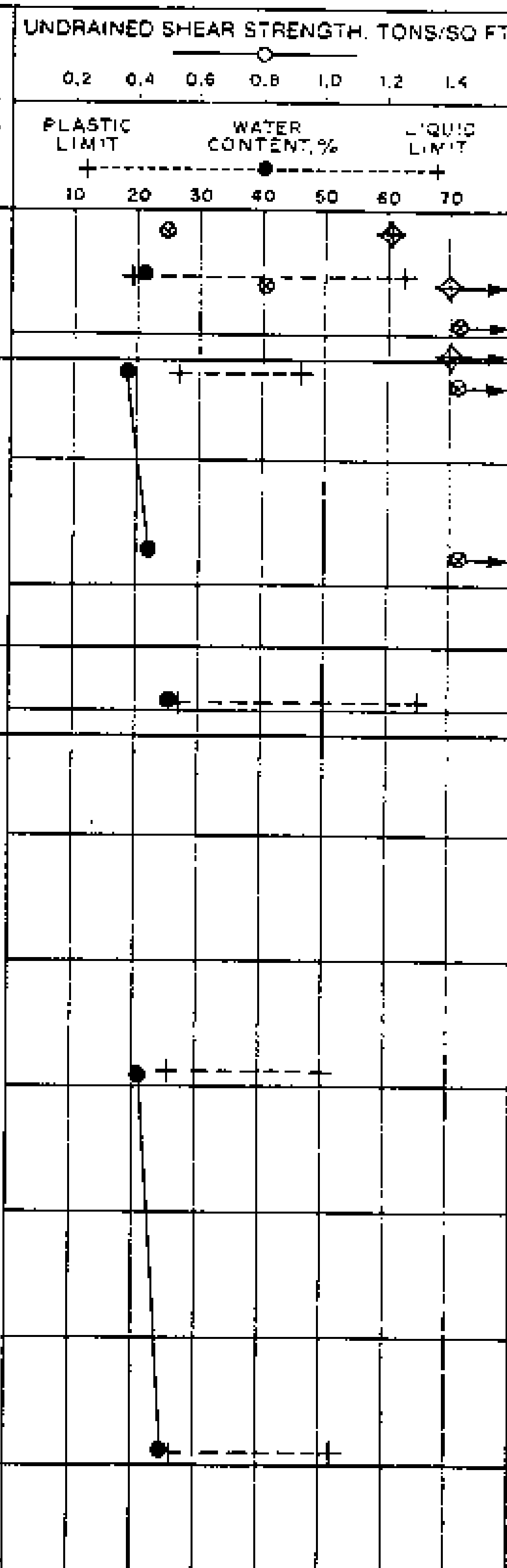
LOG OF BORING NO. S-6

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,000 E 3,279,000

SURF. EL: 479' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0–5.5	Stiff brown clay with silt seams and pockets -tan below 3.5'			82
5.5–17	Laminated tan and light gray silt, very stiff silty clay and clay -brown below 8'			87 72
17–20.5	Very stiff brown clay with silt partings	37		91
20.5–50	Laminated brown clay and silt	33 64		
	-with sandy silt partings below 32'	75/11" 75/7" 75/11" 75/9"		90 78



COMPLETION DEPTH: 50'
DATE: Nov. 10, 1979

DEPTH TO WATER IN BORING: Dry

Caved at: 36.5'

DATE: Nov. 15, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-7

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,003; E 3,279,003

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (SURF. EL: 488.7')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT (10 20 30 40 50 60 70)	- # 200, %
			Brown silty fine sand with roots				
5			Very stiff gray and brown sandy clay with roots and gravel pockets				
10			Laminated tan and light gray silty clay and silt				
			-with silty clay pockets to 8.5'				
			-with ferrous nodules and stains to 24'				
15			-with silt layers below 14'				
20				31			
25			-with seams of laminated gray clay and organic matter below 24'				
30				45			
35			-with silty sand partings below 34'				
40				48			
45			-with reddish brown fine sand layer at 43.5'				
50				47			

COMPLETION DEPTH: 50'
DATE: Nov. 16, 1979

DEPTH TO WATER IN BORING: Dry Caved at: 4'
DATE: Nov. 28, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-8
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split barrel   LOCATION: N 670,000; E 3,279,000

SURF. EL: 489.8'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT (10 20 30 40 50 60 70)	−#200,%
0–1	Brown silty fine sand with roots				
1–13	Very stiff red, brown and light gray sandy clay -with roots to 7' -with light gray silty sand pockets at 8.5'				61
13–26	Light gray and tan silty fine sand with cemented sand seams -with brown sandy clay seams to 22' -with silty clay layer at 20'	59			
26–32	Laminated light gray and gray silty clay and silt with silty fine sand partings	37			
32–50	Tan silty fine sand with clay seams and partings -light gray and brown, 39' to 42.5' -fine sand below 39' -light gray below 42.5'	7 75/9" 75/8"			29

COMPLETION DEPTH: 50'
DATE: Nov. 16, 1979

DEPTH TO WATER IN BORING: 32.8'   Caved at: 33.8'   DATE: Nov. 28, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-9

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 671,000; E 3,279,000

SURF. EL: 500.3'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70)
0	Tan silty fine sand			
4	-fine sand below 4'			
5		14		
6	Light gray, tan and red sandy clay	25		
8.5	Light gray and tan clayey sand with vertical sand seams			
11.5	Very stiff light gray, tan and red sandy clay with sand seams and pockets	64		
21	White silty fine sand with light gray clay seams			
28	-numerous clay seams, 28' to 33'	41		
33	-tan and light gray below 33'	61		
39		54		
43	-tan, 43' to 48.5' and below 49'	75/10"		
48.5	light gray, 48.5' to 49'	75/10"		

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

COMPLETION DEPTH: 49.5'
DATE: May 26, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. S-10
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 672,000; E 3,279,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 521.1'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)
			Light gray fine sand			
5			Very stiff red and light gray sandy clay with clayey sand pockets and ferrous nodules	10		
10			Tan and red silty fine sand with silty clay pockets -tan and light gray below 11'	27		
15				28		
20			Laminated and interbedded tan silty fine sand, brown clay and silty clay	47		
25						
30			Laminated and interbedded gray clay, light gray silt and silty fine sand with ferrous stains	49		
35						
40				58		
45						
50			Tan and gray silty fine sand with clay seams and pockets	75/7"		

COMPLETION DEPTH: 49.5'
DATE: Dec. 19, 1979

DEPTH TO WATER IN BORING: 33.0' Caved at: 47.3' DATE: Dec. 20, 1979

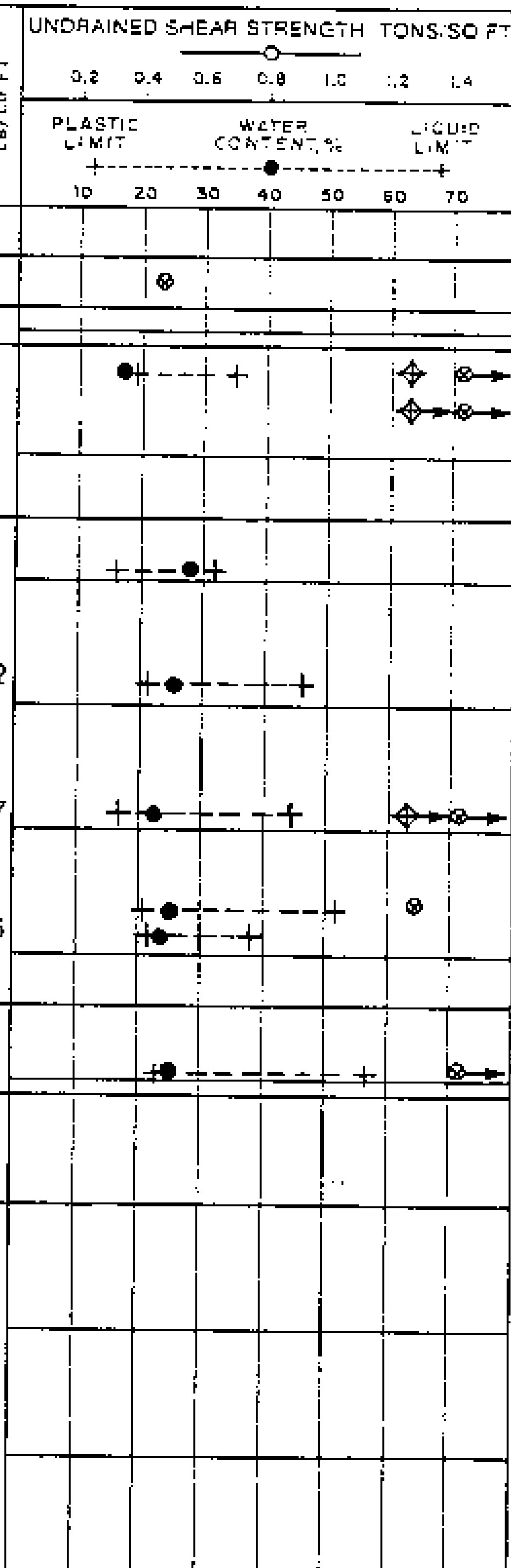
McCLELLAND ENGINEERS

LOG OF BORING NO. S-11
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 673,000 E 3,279,000

SURF. EL: 520' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0	Light gray fine sand -with roots to 1'			
	Red and gray sandy clay			
5	Red and light gray fine sand			
	Very stiff red and gray sandy clay			36
10	-with ferrous stains below 10.5'			
15	Interbedded red and light gray fine sand and light gray clay			47
20	-with layers of laminated sandy clay, clay and fine sand below 18'		92	70
25	-gray below 23'		97	56
30			95	78
				75
35	Very stiff brown clay with fine sand partings	50		89
40	Interbedded light gray clay and tan silty fine sand -with siltstone partings below 39'	49		



COMPLETION DEPTH: 40'
DATE: Nov. 9, 1979

DEPTH TO WATER IN BORING: 4.2'
Caved at: 29.0'
DATE: Nov. 11, 1979

LOG OF BORING NO. S-13
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,000; E 3,280,000

SURF. EL: 453.8'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2–1.4); PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT (10–70)	-#200,%
	Brown clayey silt with roots				
5, 10	Very stiff red and gray sandy clay -with roots to 7' -damp at 4' -stiff at 5' -with clayey sand pockets below 7' -with ferrous deposits at 8'				
15	Interbedded brown silty clay and light gray silt				
20	-brown silt layer at 20'	39			
	-with gray clay pockets below 22'				
25	-with ferrous seams below 23'	57			
	-laminated gray silty clay and brown silt, 27' to 35'				
30		64			
35	-brown and light gray at 35'				
40	-interbedded gray clay, brown silt and brown silty clay at 40'	62			
45	-with layers of laminated silty clay and silt, 43.5' to 50'				
50		46			

(Continued on Plate B-49b)

LOG OF BORING NO. S-13 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70)	-#200, %
55	Interbedded brown silty clay and light gray silt -interbedded brown silty fine sand, gray silty clay and brown silt at 54'				
60 65	Gray silt -with siltstone nodules to 61.5' -with dark gray silty clay partings below 61.5'	75/8"			
70	Very stiff dark gray silty clay with silt partings	75/9"			
75	Interbedded dark gray silty clay and gray sandy silt				
80 85 90 95	Gray silty fine sand with dark gray silty clay layers, seams and pockets -intermixed with dark gray silty clay, 89' to 99'	75/5" 75/5" 75/7" 75/6"			
100					

COMPLETION DEPTH: 99.5'
DATE: Dec. 7, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-14
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,003; E 3, 280,003

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 466.9')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70)	-#200, %
	Brown sandy silt with clay pockets, roots and gravel				
5	Stiff brown and red sandy clay with roots -very stiff brown and tan below 4'				
10	Laminated brown and light gray silty clay and silt with fine sand partings				
15					
20	-tan below 21'	48			
25					
30	Gray silt	75/10"			
35	Laminated gray and brown clay, silt, and silty fine sand				
40					
45	-with clay layer at 44'		100		48
50	Gray sandy silt, with silty clay pockets	75/9"			

COMPLETION DEPTH: 49.5'
DATE: Nov. 16, 1979

DEPTH TO WATER IN BORING: 6.5'

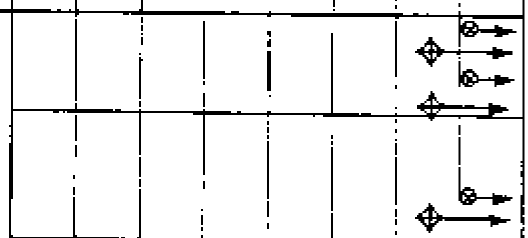
Caved at: 49'

DATE: Nov. 16, 1979

LOG OF BORING NO. S-15
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,0003; E 3,280,053

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 476.5')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
	Tan silty fine sand with roots				
5	Very stiff tan and red sandy clay with silt pockets -with ferrous nodules and siltstone pockets, 6' to 8.5' -brown and gray below 7'				
10					
15	Laminated light gray, tan and gray clay, silty clay and silt				
20		38			
25					
	-gray and brown below 28'				
30		66			
35					
40		65			
45	~with clay, silty clay and silt layers, 44' to 50'				
50		58			



(Continued on Plate B-51b)

LOG OF BORING NO. S-15(continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
55			Laminated light gray, tan and gray clay, silty clay and silt -brown fine sand layer at 53.5'				
60			Laminated and interbedded brown and tan fine sand, silt and silty clay	75/9"			
65			-gray and tan, 62.5' to 66.5'				
70			-gray, brown and dark gray below 69'	75/6"			
75			Gray silty fine sand				
80			Gray clay with light gray silt partings	75/9"			
85			Gray silty fine sand with silty clay partings	75/8"			
90				75/7"			
95			-gray clay with light gray silt partings at 94.5'	75/10"			
100				75/9"			

COMPLETION DEPTH: 100'
DATE: Nov. 17, 1979

DEPTH TO WATER IN BORING: 24'
Caved at: 35.4'
DATE: Nov. 18, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-16
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

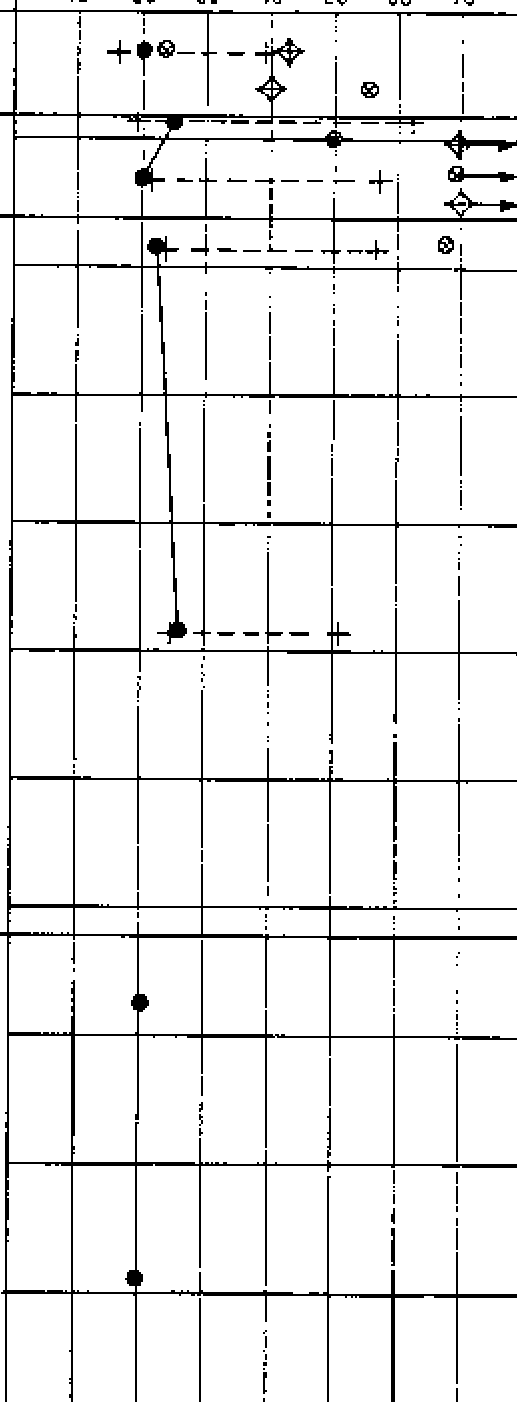
TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,000 E 3,280,000

SURF. EL: 496' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0–4	Stiff tan silty clay -brown fine sand to 1'			54
4–8	Very stiff tan and gray clay with silt partings			83 78
8–36	Very stiff light gray and brown clay with numerous silty clay and fine sand partings and seams -fine sand, 32' to 33'	35 74		82 73
36–50	Light gray fine sand with clay seams and partings	75/5" 35 75/8"		17 17

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70



COMPLETION DEPTH: 50'
DATE: Nov. 10, 1979

DEPTH TO WATER IN BORING: 35.5' Caved at: 45.0' DATE: Nov. 11, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-17
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,963; E 3,280,003

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 500.6'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2–1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10–70)	-#200, %
0–2			Brown silty fine sand with roots				
2–8			Very stiff red and light gray sandy clay -silty fine sand layer at 7.5'				
8–27			Interbedded and laminated light gray silty clay, silt and silty fine sand	33			
27–48			Light gray silty fine sand, with silty clay partings and pockets	75/6" 74			
48–50			Laminated gray, light gray, and red clay, silty clay, and silt	75/10"			

(Continued on Plate B-53b)

McCLELLAND ENGINEERS

LOG OF BORING NO. S-17 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT
	Laminated gray, light gray, and red clay, silty clay, and silt	
55	Tan fine sand with silty fine sand layers -with clay pockets to 71.5'	
60		75/9"
65		
70		75
75		75/5"
80		75/9"
85		17
90	-with organic matter and traces of lignite below 89.5'	46
95	-intermixed very stiff brown silty clay and clay at 93'	75/8"
100	-with silty clay partings and ferrous stains at 99'	75/5"

Column headings: DEPTH, FT; SYMBOL; SAMPLES; DESCRIPTION OF MATERIAL; BLOWS PER FT; UNIT DRY WT LB/CU FT; UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70); -#200, %

COMPLETION DEPTH: 100'
DATE: Nov. 20, 1979

DEPTH TO WATER IN BORING: Surface Caved at: 53' Read upon completion
DATE: Nov. 20, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-18
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE 3" thin-walled tube & 2" split-barrel LOCATION: N 671,963; E 3,280,003

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 497.6'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200,%
			Brown silty fine sand with roots				
5			Very stiff red and light gray sandy clay				
10			Light gray and tan silty fine sand				
15			-with silty clay and silt seams and ferrous stains below 14'				
20				62			
25			-brown below 24'				
30				75/6"			
35			-with layers of laminated silty clay and fine sand, 33.5' to 36.5' and below 48'				
40				75/10"			
45			-fine sand below 44'				
50				55			

COMPLETION DEPTH: 50'
DATE: Nov. 20, 1979

DEPTH TO WATER IN BORING: 37.8' Caved at: 38.8'
DATE: Nov. 28, 1979

LOG OF BORING NO. S-19

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split barrel LOCATION: N 672,963; E 3,280,003

SURF. EL: 498.5'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 – 1.4); PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT (10 – 70)	-#200, %
0–2	Brown silty fine sand with roots				
2–6	Stiff red and light gray sandy clay with roots				
6–22	Very stiff brown silty clay with light gray silt partings -with numerous silt partings and seams below 14' -with dark brown clay seams at 18'				
22–42	Laminated very stiff dark gray silty clay and light gray silt -with clay and silt layers below 35'	75/8" (at ~30) 75/10" (at ~40)			
42–50	Tan silty fine sand with silty clay and silt seams and pockets	75/5" (at ~44) 75/6" (at ~49)			

(Continued on Plate B-55b)

LOG OF BORING NO. S-19(continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200,%
			Tan silty fine sand with silty clay and silt seams and pockets				
			-interbedded light gray and brown silty fine sand and dark gray silty clay at 53'				
55							
			-brown and gray below 59'	75/10"			
60							
				75/7"			
65							
				75/8"			
70							
			-with dark gray silty clay seams and partings at 74'	75/5"			
75							
				75/5"			
80							
			-with lignite seams at 84' and 94'	75/6"			
85			-with fine sand layers below 84'				
				75/4"			
90							
				75/3"			
95							
				Ref/3"			
100							

COMPLETION DEPTH: 99'
DATE: Nov. 26, 1979

DEPTH TO WATER IN BORING: 38.6' Caved at: 51.6' DATE: Nov. 28, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-20
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 674,000; E 3,280,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 482.2'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)
			Tan silty fine sand with roots			
5			Very stiff light gray sandy clay with ferrous stains			
			Tan silty fine sand -with ferrous nodules, 6' to 8.5' -with clay pockets below 8.5'	20		
10						
15			Very stiff light gray and tan clay -with ferrous nodules to 23' -with sandy silt partings, 15' to 18' -with sandy silt seams below 15' -with sandy silt pockets below 18' -dark brown, 18' to 23' -laminated black clay and light gray silty sand, 23' to 28' and 43' to 44' -black below 28' -with numerous silty sand seams, 33' to 34'			
20						
25						
30						
35						
40						
45			-with some pyrite crystals, 43' to 44'			
50						

COMPLETION DEPTH: 49.0'
DATE: May 23, 1980

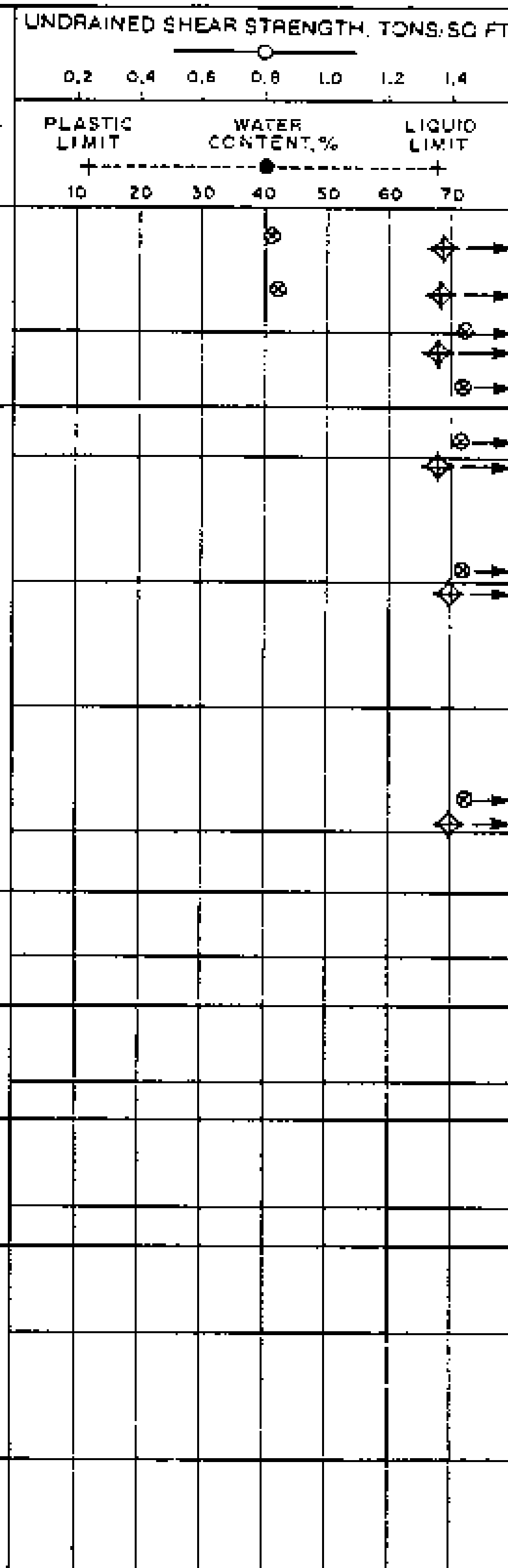
McCLELLAND ENGINEERS

LOG OF BORING NO. S-21
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 665,000; E 3,281,000

SURF. EL: 470.1'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT
0–8	Very stiff brown silty clay with ferrous nodules -brown silty fine sand with roots to 0.5'		
8–27	Interbedded very stiff gray clay, light gray silty clay and silt with ferrous stains	75/11"	
27–32	Light gray silt with silty clay seams	75/11"	
32–36	Laminated gray silty clay and light gray silty fine sand		
36–41	Light gray and tan silty fine sand with silty clay seams	75/11"	
41–50	Interbedded and laminated gray clay and silty clay -slickensided clay at 43.5' -black and gray with clayey silt seams at 50'	75/11"	



COMPLETION DEPTH: 50'
DATE: Dec. 5, 1979

DEPTH TO WATER IN BORING: 36'
Caved at: 47'
DATE: Dec. 6, 1979

LOG OF BORING NO. S-22
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split barrel LOCATION: N 666,000; E 3,281,000

SURF. EL: 475.5'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2–1.4); PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT (10–70)	-#200, %
0–1.5	Red clayey sand with silty fine sand seams and roots				
1.5–8	Very stiff tan silty clay with sandy clay and silt pockets, ferrous nodules, and gravel pockets and seams				
8–19	Interbedded tan and gray silty clay and silt				
19–27.5	Brown silt with silty clay seams and partings	64			
27.5–31.5	Intermixed light gray and gray clay and sandy silt	53			
31.5–37	Interbedded gray clay and red silt with siltstone seams and partings				
37–50	Brown silt -intermixed brown silt and gray clay below 42'	74 70			

COMPLETION DEPTH: 50'
DATE: Dec. 5, 1979

DEPTH TO WATER IN BORING: 28.3' Caved at: 46'
DATE: Dec. 6, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-23
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,000; E 3,281,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (SURF. EL: 463.2')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)
			Firm tan sandy clay with ferrous nodules -silty fine sand to 0.5'			
5			Tan silty fine sand -with numerous light gray clay pockets to 6' -laminated sandy silt and light gray clay, 6' to 8' -with numerous light gray clay seams, 8' to 18' -with numerous clay pockets, 13' to 18' -with numerous tan clay seams below 18'			
10						
15						
20						
25			Very stiff light gray clay -with numerous tan silty sand seams and partings to 28.5' -with ferrous stained seams and deposits below 28.5'			
30						
35			Tan silty fine sand with light gray clay pockets -very stiff gray clay, 36.5' to 38.5' -with light gray clay seams and pockets, 43' to 48' -with numerous gray clay seams below 48'	75/10"		
40						
45						
50						

COMPLETION DEPTH: 49'
DATE: May 24, 1980

LOG OF BORING NO. S-24
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split barrel LOCATION: N 668,000; E 3,281,000

SURF. EL: 464.6'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT	-#200, %
	Brown silt with roots				
5	Firm red sandy clay -with roots to 2.5' -red and light gray with ferrous nodules below 3' -very stiff below 5'				
10	Interbedded tan silt and gray silty clay				
	Brown silty fine sand				
15	Interbedded brown silt and gray silty clay				
20	-brown sandy silt layer at 20'	41			
25	-with clay seams at 24'				
30	Brown silt with silty clay pockets and seams	71			
35	-with ferrous layer at 34'				
	-with clay pockets, 37' to 39'				
40		63			
	-sandy below 42.5'				
45					
50		75/7"			

Scale: shear strength 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4; water content 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 49.5'
DATE: Nov. 28, 1979

LOG OF BORING NO. S-25
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

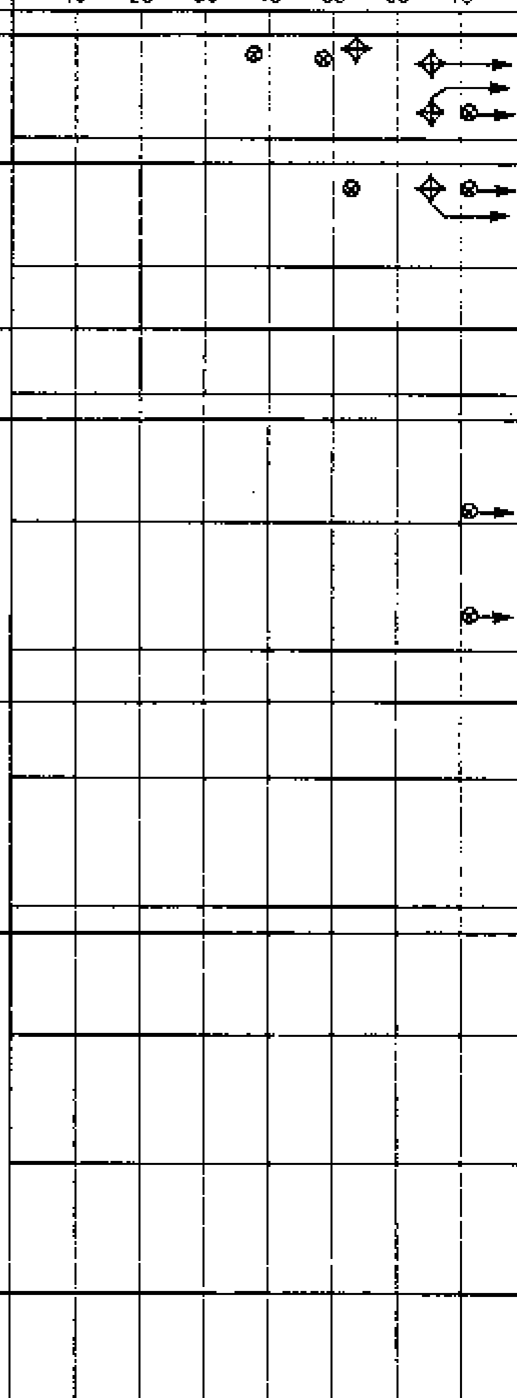
TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,003; E 3,281,003

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 477.3')	BLOWS PER FT	UNIT DRY WT LB/CU FT
0–1	Brown silty fine sand		
1–5.5	Stiff brown and red sandy clay with silty clay pockets and roots -with gravel pockets, 4' to 5'		
5.5–12.5	Very stiff tan and gray silty clay with silt partings and layers of laminated silty clay and silt		
12.5–16	Brown silt		
16–27	Very stiff brown and gray silty clay with silt partings and pockets	30	
27–36	Brown silt with gray siltstone seams -with silty clay seams and pockets to 32.5' -slightly sandy below 32.5'	75/10"	
36–50	Intermixed brown, gray and tan silt and silty clay -laminated silt and silty clay layer at 40'	66, 49	
	Note: Washed boring from 50' to 90'		

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70

-#200, %



COMPLETION DEPTH: 50'
DATE: Nov. 27, 1979

DEPTH TO WATER IN BORING: 12.6' Caved at: 54.5' DATE: Nov. 28, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-26
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,000; E 3,281,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (SURF. EL: 481.4')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT (10 20 30 40 50 60 70)	-# 200,%
0–4			Tan silty fine sand				
4–10			Very stiff brown and dark gray sandy clay with ferrous nodules and roots -with light gray sand and silt pockets at 7'				
10–22			Laminated and interbedded tan and brown silt and gray silty clay	45			
22–26			Brown and red silt with clayey silt seams				
26–33			Interbedded gray clay, brown silt, and silty fine sand	50			
33–49.5			Gray silt with clayey silt and sandy silt seams	75/9"			
			-with silty clay pockets below 47'	75/11"			

COMPLETION DEPTH: 49.5'
DATE: Nov. 27, 1979

DEPTH TO WATER IN BORING: 1.2'
Caved at: 2.3'
DATE: Nov. 28, 1979

McCLELLAND ENGINEERS

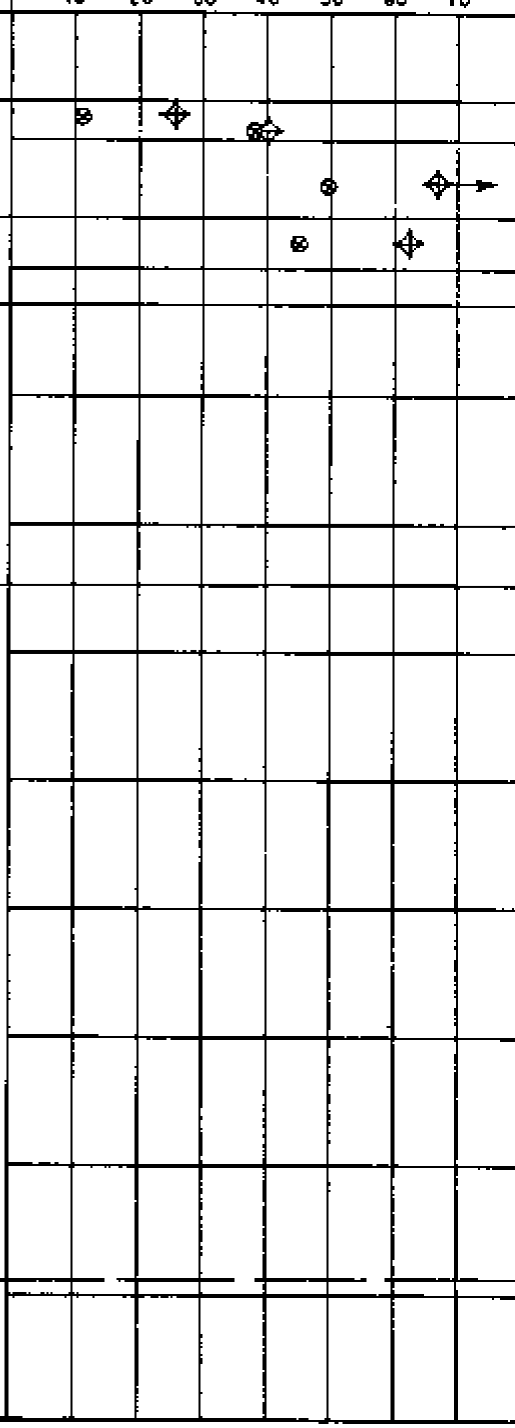
LOG OF BORING NO. S-27
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,963; E 3,281,003

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 494.9')	BLOWS PER FT	UNIT DRY WT LB/CU FT	-# 200, %
0–3	Tan silty fine sand with roots			
3–11	Stiff light gray and red sandy clay -soft, 3.5' to 4' -with siltstone and claystone seams at 7'			
11–17	Interbedded stiff tan and light gray silty clay and sandy clay with silt partings and ferrous stains			
17–22	Laminated and interbedded tan and light gray silty clay and silt with black vertical stains	47		
22–49.5	Light gray and tan silty fine sand with sandy silt and fine sand layers -with silty clay partings and seams below 29'	71 65 75/8"		

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

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4
PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70



COMPLETION DEPTH: 49.5'
DATE: Nov. 26, 1979

DEPTH TO WATER IN BORING: 34.4' Caved at: 44.2' DATE: Nov. 28, 1979

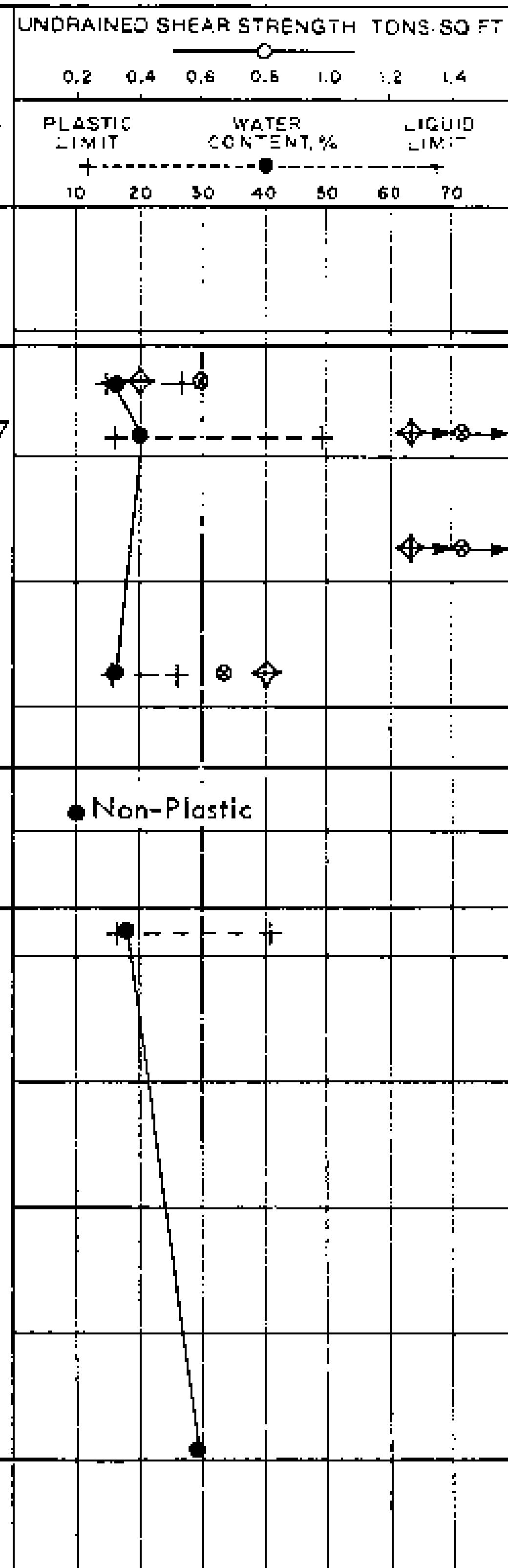
McCLELLAND ENGINEERS

LOG OF BORING NO. S-28
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 672,000 E 3,281,000

SURF. EL: 504' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0–5	Tan fine sand with roots	18		
5–22	Stiff light gray and tan sandy clay with clay layers -very stiff below 7' -brown and gray, 8' to 17.5' -with vertical sand seams, 12.5' to 15.5' -tan and gray with clayey sand layers below 17.5'		107	58 70 37
22–27.5	Light gray fine sand with silty clay seams			10
27.5–50	Interbedded light gray silty fine sand and silty clay	40 72 59		37 31



COMPLETION DEPTH: 50'
DATE: Nov. 8, 1979

DEPTH TO WATER IN BORING: 4.4'
Caved at: 19.5'
DATE: Nov. 14, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-29
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 672,963; E 3,281,003

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 513.7'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4) PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70)	– # 200, %
			Tan silty fine sand with roots				
5			Very stiff red and light gray sandy clay with sand pockets and roots -blocky below 4'				
10			Intermixed and interbedded brown and light gray sandy clay, silt, and silty fine sand				
15			Interbedded light gray and tan silt and sandy silt -intermixed silt and sandy silt to 17'				
20				60			
			-with weakly cemented siltstone, 23' to 24'	70/7"			
25							
30			-with silty clay partings below 29.5'	75/10"			
35							
40			-with layers of laminated silt, sandy silt and silty clay below 40'	72			
45							
50				69			

COMPLETION DEPTH: 50'
DATE: Nov. 26, 1979

DEPTH TO WATER IN BORING: 19.4' Caved at: 34.4' DATE: Nov. 28, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. 5-30

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube

LOCATION: N 674,000; E 3,281,000

SURF. EL: 521.7'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / WATER CONTENT, %
0–4	Tan silty fine sand with roots			
4–8	Intermixed tan sandy clay, sand and silt with roots and ferrous stains			
8–22	Red and tan silty fine sand with sandy clay pockets			
22–25	Hard tan clay with silt pockets			⊗→
25–50	Laminated tan clay and silt -with ferrous stains at 40' -laminated black clay and light gray silt below 43'			

Shear strength scale: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4. Water content scale (Plastic Limit, Water Content, Liquid Limit): 10, 20, 30, 40, 50, 60, 70.

COMPLETION DEPTH: 50'
DATE: July 2, 1980

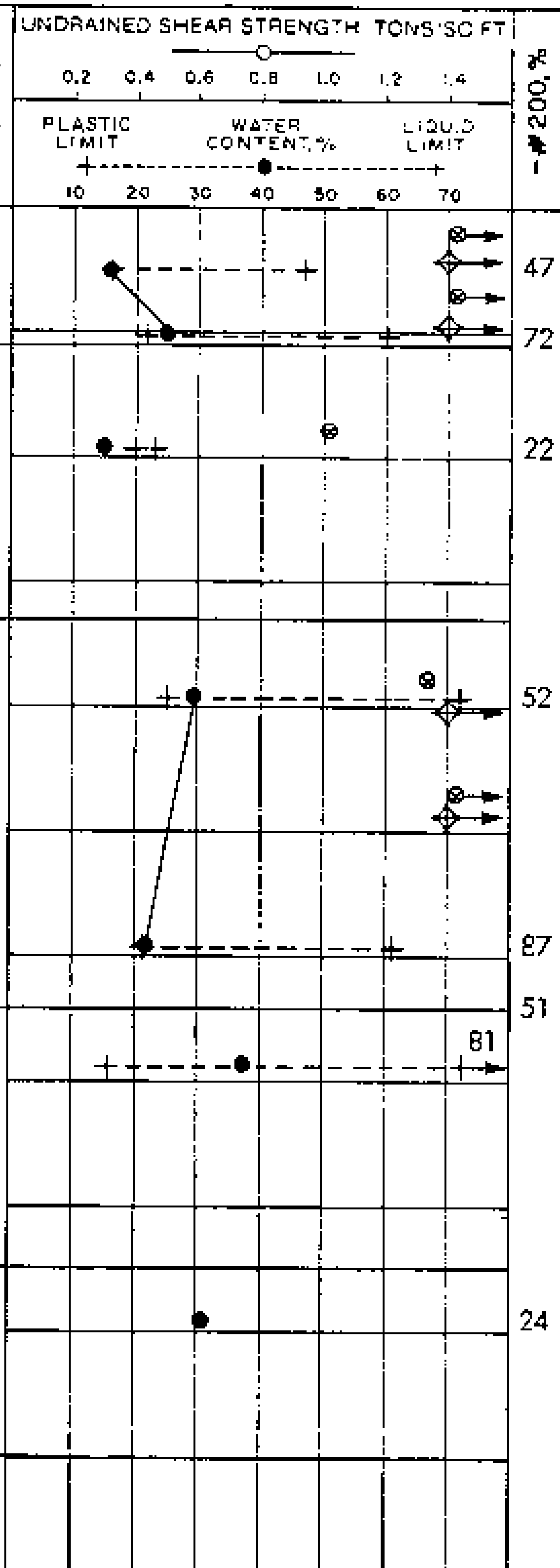
McCLELLAND ENGINEERS

LOG OF BORING NO. S-31
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 666,000 E 3,282,000

SURF. EL: 483' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0–5	Very stiff red sandy clay -gray fine sand to 1'			47 72
5–16	Interbedded light gray clay and red sand -with silt seams below 12.5'	30		22
16–32	Very stiff dark gray and tan clay with sandy silt seams	24		52 87
32–42	Hard dark gray shaley clay -with sand layers to 37' -with silt layers below 37'	51		51
42–50	Light gray and tan silty fine sand -lost circulation at 42.5'	75/10"		24



COMPLETION DEPTH: 50'
DATE: Nov. 12, 1979

DEPTH TO WATER IN BORING: 11.7'

DATE: Nov. 14, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-32
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,000; E 3,282,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 471.4'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)
			Tan silty fine sand			
5			Stiff light gray and red sandy clay with ferrous nodules -very stiff below 5' -with tan silty fine sand seams at 6' -tan and light gray below 6'			
10			Laminated light gray clay and light gray and tan silty fine sand			
15 20			Light gray silty fine sand -with clay seams to 17' -tan and light gray with silt seams below 18'	75/11"		
25			Very stiff light gray clay with numerous light gray and tan silty sand seams and partings			
30			Tan silty fine sand with light gray clay pockets			
35			Intermixed light gray clay and tan silty fine sand	75/10"		
40 45			Tan silty fine sand -with gray clay seams to 48' and 53.5' to 54' -light gray below 48'	75/11" 59		
50						

(Continued on Plate B-68b)

LOG OF BORING NO. S-32 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT
Light gray silty fine sand -with clayey sand seams, 53' to 53.5'	45	
Intermixed light gray clayey sand and silty clay with gray clay pockets	55	
Tan and light gray silty fine sand -slightly clayey to 88'	53	
	53	
-light gray and red with clay seams and soft black lignite seams, 73' to 75'	75/10"	
	75	
-light gray below 83'	49	
	56	
-with light gray clay pockets, 93' to 98'	75/11"	
	75/3"	

DEPTH, FT: 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

COMPLETION DEPTH: 98.5'
DATE: May 25, 1980

McCLELLAND ENGINEERS

PLATE B-68b

LOG OF BORING NO. S-33

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,000; E 3,282,002

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT
	SURF. EL: 473.6'	
0	Firm red silty clay -brown silty fine sand to 0.2' -very stiff below 2' -with silt seams below 6'	
12.5	Brown silt with sandy silt seams -with silty clay partings and pockets below 16.5'	
18.5		75/11"
29.5		50
31.5	Interbedded light gray, tan and brown clay, silty clay and silt	
39.5	-intermixed clay, silty clay, and silt at 40'	42
42	Brown silt with gray clay pockets	
49.5		75/10"

Column headings: DEPTH, FT; SYMBOL; SAMPLES; DESCRIPTION OF MATERIAL; BLOWS PER FT; UNIT DRY WT LB/CU FT; UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70); -#200, %

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

COMPLETION DEPTH: 49.5'
DATE: Nov. 29, 1979

MCCLELLAND ENGINEERS

LOG OF BORING NO. S-34
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,000 E 3,282,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 494' (approx.)	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
0–8			Very stiff reddish brown and light gray clay -brown fine sand to 1' -red clay, 2' to 4'				85
8–41			Very stiff brown and light gray clay with fine sand and silt partings				70
							93
				55			
			-with silty fine sand partings, 30' to 36' -gray and tan below 30'	75/10"			90
			-with silt layers at 37'				
				75/10"			
41–50			Laminated dark gray and light gray clay and silty fine sand -gray and tan below 44' -with brownish yellow silty clay layer at 44.5'				67 87
				75/8"			

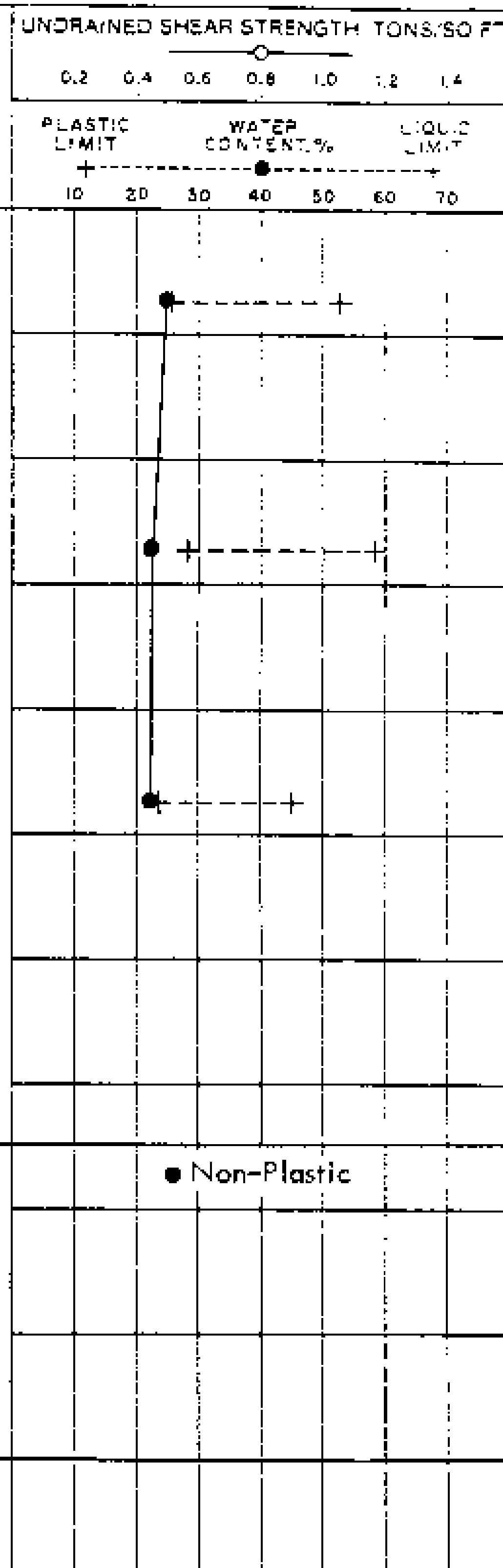
(Continued on Plate B-70b)

LOG OF BORING NO. S-34 (continued)

HL&P ELECTRIC GENERATING STATION

LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
	Laminated dark gray and light gray clay and silty fine sand			66
55				
60		75/9"		
65				89
70		75/7"		
	-very hard shaley clay, 72.5' to 76'			82
75	-silty fine sand, 77' to 80'			
80		75/4"		
85				
	Interbedded gray silty fine sand and gray clay	75/2"		20
90				
95		75/3"		
100		75/2"		



COMPLETION DEPTH: 100'
DATE: Nov. 11, 1979

DEPTH TO WATER IN BORING: 35.0'
Caved at: 41'
DATE: Nov. 13, 1979

LOG OF BORING NO. S-35

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,000; E 3,282,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL: 487.8'	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4) PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70)	-#200, %
0–8			Very stiff red silty clay -with vertical silt partings, 2' to 2.5' -with tan and light gray silt seams below 4'				
8–50			Interbedded and laminated light gray and brown silt and silty clay				
20			-very stiff tan and light gray silty clay with silt partings at 20'	48			
30				66			
40				68			
50				64			

COMPLETION DEPTH: 50'
DATE: Nov. 29, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-36
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 671,000; E 3,282,000

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 496.6')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT (10 20 30 40 50 60 70)	-#200, %
	Brown sandy silt with roots				
5	Very stiff light gray and red sandy clay -with clayey sand pockets to 5'				
10	Very stiff tan and light gray silty clay -with vertical silty fine sand seams below 8'				
15	Light gray silt with silty clay pockets				
20	Interbedded light gray and tan silt and silty clay	48			
30		51			
40	-with gray clay pockets below 37.5'	55			
45	Interbedded very stiff gray clay, silty clay and silt -laminated silty clay and silt at 49'	75/9"			

(Continued on Plate B-72b)

LOG OF BORING NO. S-36 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT	-#200, %
52–57	Interbedded very stiff gray clay, silty clay and silt				
57–62	Brown silt with silty clay seams	75/10"			
62–72	Gray sandy silt -with silty clay pockets below 67'	75/7"			
72–82	Gray silty fine sand with silty clay pockets	75/9" 75/6"			
82–92	Interbedded dark gray clay, silt, and sandy silt -with silty fine sand layer at 89'	75/7" 75/7"			
92–99.5	Gray silty fine sand with silty clay seams and pockets	75/8" 75/9"			

Chart scale: UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4; WATER CONTENT, %: 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 99.5'
DATE: Nov. 29, 1979

DEPTH TO WATER IN BORING: 36.7'
Caved at: 69'
DATE: Dec. 3, 1979

LOG OF BORING NO. S-39
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 667,000; E 3,283,000

SURF. EL: 479.7'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT
0–2	Brown silty fine sand with roots		
2–7	Very stiff light gray and tan sandy clay with silt pockets and ferrous stains with roots		
7–13	Very stiff brown and gray silty clay with vertical sand seams		
13–31	Tan and gray fine to medium sand with sandy clay pockets	36 75/9" 75/8"	
31–37	Gray silty clay with fine sand and silt partings		
37–43	Laminated gray and brown clay and silt	75/10"	
43–48	Laminated gray silty clay and tan silt		
48–50	Tan silt with silty clay pockets	56	

UNDRAINED SHEAR STRENGTH TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

COMPLETION DEPTH: 50'
DATE: Dec. 5, 1979

DEPTH TO WATER IN BORING: Dry
Caved at: 28.0'
DATE: Dec. 6, 1979

McCLELLAND ENGINEERS

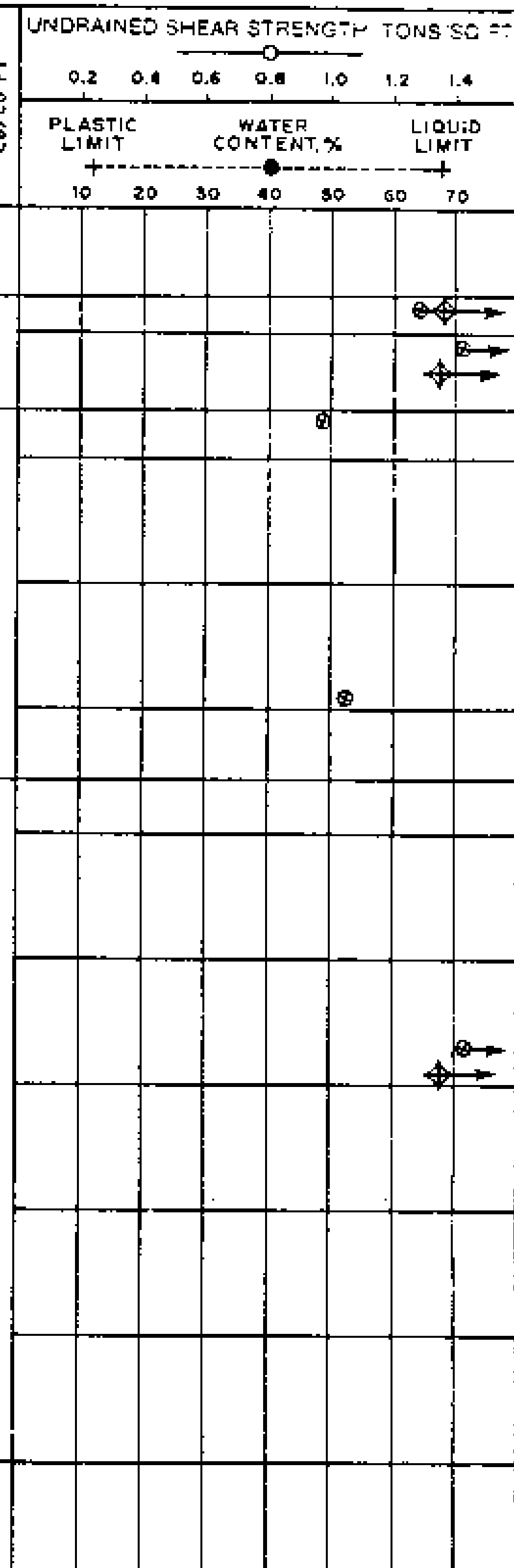
LOG OF BORING NO. S-40

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,000; E 3,283,000

SURF. EL: 489'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0–4	Brown silt with roots			
4–8.5	Very stiff tan and light gray silty clay -light gray and red at 7'			
8.5–23	Interbedded light gray silt and brown stiff clay -very stiff below 18' -with fine sand seams at 20'	16		
23–50	Gray and light gray silt with silty clay partings and pockets, with layers of interbedded silt and very stiff silty clay	29		
	-gray and brown below 40'	30		
50		43		



COMPLETION DEPTH: 50'
DATE: Dec. 3, 1979

DEPTH TO WATER IN BORING: 32.8' Caved at: 45' DATE: Dec. 6, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-41
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,000; E 3,283,000

SURF. EL: 512.4'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT; PLASTIC LIMIT / WATER CONTENT, % / LIQUID LIMIT	-#200, %
0–6	Very stiff red and light gray silty clay with silt pockets -tan silt to 0.5' -brown and light gray below 2'				
6–9	Very stiff gray clay with silty clay and silt pockets				
9–17.5	Tan silt with clay and silty clay pockets and seams				
17.5–42	Interbedded tan silt, gray clay and silty clay -tan and light gray below 22.5'	75			
	-light gray silt, 30' to 33'	71			
		75/11"			
42–46	Very stiff dark gray clay with light gray silty clay and silt seams and partings				
46–50	Brown silt with silty clay seams	56			

(Continued on Plate B-75b)

LOG OF BORING NO. S-41(continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200,%
			Brown silt with silty clay seams				
55							
60			-with clayey silt pockets, 60' to 67'				
65			-sandy, 67' to 71'				
70							
75			-with siltstone seams, 76' to 77.5'				
80							
85							
90				75/8"			
95							
100			-silty fine sand at 99'	75/9"			

COMPLETION DEPTH: 99.5'
DATE: Dec. 1, 1979

DEPTH TO WATER IN BORING: 56.9' Caved at: 57.4' DATE: Dec. 3, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-42
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,000; E 3,283,000

DEPTH, FT | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL | BLOWS PER FT | UNIT DRY WT LB/CU FT | UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) | PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70) | -#200, %

SURF. EL: 498.4'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT
0	Brown silty fine sand with sandy clay pockets and roots	
	Very stiff red and brown sandy clay with sand pockets & roots	
5	Very stiff light gray and tan silty clay with sand-filled root voids	
10	Light gray and tan silt with silty clay partings and seams	
20		49
24	-tan below 24'	
30		75/11"
40		75/11"
50	-with ferrous seams at 50'	75/10"

COMPLETION DEPTH: 50'
DATE: Nov. 30, 1979

DEPTH TO WATER IN BORING: 37.7'
Caved at: 43.4'
DATE: Dec. 5, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-43

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 671,000; E 3,282,999

SURF. EL: 518.1'

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT
0	Brown silty fine sand with roots		
	Stiff red sandy clay -light gray and red below 6' -clayey sand, 5' to 7' -firm at 9'		
9.5	Stiff light gray and tan clay, blocky -gray and tan below 12.5' -with silt partings below 14'		
18	Interbedded and laminated light gray and tan clay, silty clay and silt	35 (at ~20') 56 (at ~30')	
38	Brown silt	75/11" (at ~40') 73 (at ~50')	

UNDRAINED SHEAR STRENGTH, TONS/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70

-#200, %

COMPLETION DEPTH: 50'
DATE: Dec. 4, 1979

DEPTH TO WATER IN BORING: 7.0' Caved at: 11.0' DATE: Dec. 6, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. 5-44

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 672,003; E 3,283,008

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 497.9')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2–1.4) / PLASTIC LIMIT, WATER CONTENT %, LIQUID LIMIT (10–70)	-#200,%
0	Intermixed brown silt, silty clay and sandy clay				
1.5	Stiff brown and gray clay with silt partings -very stiff below 3' -brown silt layer at 5.5'				
8	Interbedded and laminated light gray and gray clay, silty clay and silt				
20		32			
30	-laminated gray silty clay and light gray silt at 30'	66			
31.5	Gray silt -with dark gray clay and silty clay seams to 41'				
39		75/6"			
49	-brown at 49'	75/7"			

COMPLETION DEPTH: 49.5'
DATE: Dec. 4, 1979

DEPTH TO WATER IN BORING: 15.8' Caved at: 46.0'
DATE: Dec. 6, 1979

LOG OF BORING NO. S-45

HL&F ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 668,000; E 3,284,000

SURF. EL: 506.6'

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT
Brown silty fine sand with roots		
Tan fine sand		
Stiff light gray and red sandy clay -with sand pockets below 6'		
Tan and light gray silty fine sand	24	
Intermixed light gray and red fine sand and gray clay -with cemented sand seams below 22.5'	34	
Very stiff light gray clay with silt partings and cemented sand nodules	15	
Intermixed very stiff gray clay and gray and tan fine sand -with silt partings below 42.5'		
Laminated light gray and tan silty clay and silt	19	

Column headings: DEPTH, FT; SYMBOL; SAMPLES; UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4); PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (10, 20, 30, 40, 50, 60, 70); -#200, %

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

COMPLETION DEPTH: 50'
DATE: Dec. 3, 1979

DEPTH TO WATER IN BORING: 39.0' Caved at: 45.8' DATE: Dec. 6, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. 5-46

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669, 189; E 3, 283, 504

SURF. EL: 566.4'

UNDRAINED SHEAR STRENGTH TONS/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
0–5	Very stiff brown clay with silty sand pockets and seams -silt to 0.5' -with roots to 2'		105 (106)	44
5–8	Interbedded brown silt, gray clay and silty clay			
8–18	Laminated tan silt and very stiff light gray clay			
18–50	Light gray and tan silt with siltstone seams	52		
	-with silty sand seams, 27' to 41'			
	-laminated silt and clay at 30'	69		
	-with ferrous seams, 37' to 47'			
	-with clay partings and seams below 40'	75/11"		
	-interbedded silt and silty clay at 43'			
	-tan at 47'			
50		75/9"		

(Continued on Plate B-80b)

LOG OF BORING NO. S-46 (continued)
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4); PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	-#200,%
55, 60			Light gray and tan silt with siltstone seams -with clay pockets, 51' to 56'	75/10"			
65			Light gray silty fine sand				
70, 75, 80			Light gray silt with silty clay pockets and seams -clayey silt, 73' to 77' -tan below 77'	68 67			
85, 90, 95			Tan and light gray silty fine sand with sandy clay pockets and seams	64			
100			Laminated dark gray clay and light gray silt	70			

COMPLETION DEPTH: 100'
DATE: Nov. 30, 1979

DEPTH TO WATER IN BORING: 70.6' Caved at: 71.4' DATE: Dec. 3, 1979

McCLELLAND ENGINEERS

LOG OF BORING NO. S-47

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,000; E 3,284,000

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (SURF. EL: 505.1')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT (10 20 30 40 50 60 70)
			Tan silty sand with roots			
5, 10			Very stiff red and tan sandy clay -with silty sand pockets to 3' -stiff to 5' and below 8'			
15, 20			Red silty fine sand with sandy clay pockets -clay seams at 18.5'			
25			Very stiff tan silty clay with silt pockets			
30			Laminated tan very stiff clay and silty sand			
35, 40, 45, 50			Tan silty fine sand with clay pockets	49 41		

COMPLETION DEPTH: 50'
DATE: July 1, 1980

McCLELLAND ENGINEERS

LOG OF BORING NO. S-48

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 671,000; E 3,284,000

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 504.5')	BLOWS PER FT	UNIT DRY WT LB/CU FT	UNDRAINED SHEAR STRENGTH, TONS/SQ FT / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT	-#200, %
0–5.5	Brown silty fine sand -fine sand, 3' to 5' -clayey sand below 5'				
5.5–11	Very stiff light gray and red sandy clay with ferrous deposits				
11–43	Light gray and tan fine sand -interbedded fine sand, clay and silt, 13' to 15' -with light gray clay seams, 15' to 31.5'				
20		31			
30		7			
	-circulation lost, 33' to 42'				
35		39			
39		75/9"			
43–50	Tan and light gray silty fine sand with clay seams				
45		69			
50		63			

COMPLETION DEPTH: 50'
DATE: Dec. 4, 1979

DEPTH TO WATER IN BORING: Dry Caved at: 41.0'
DATE: Dec. 6, 1979

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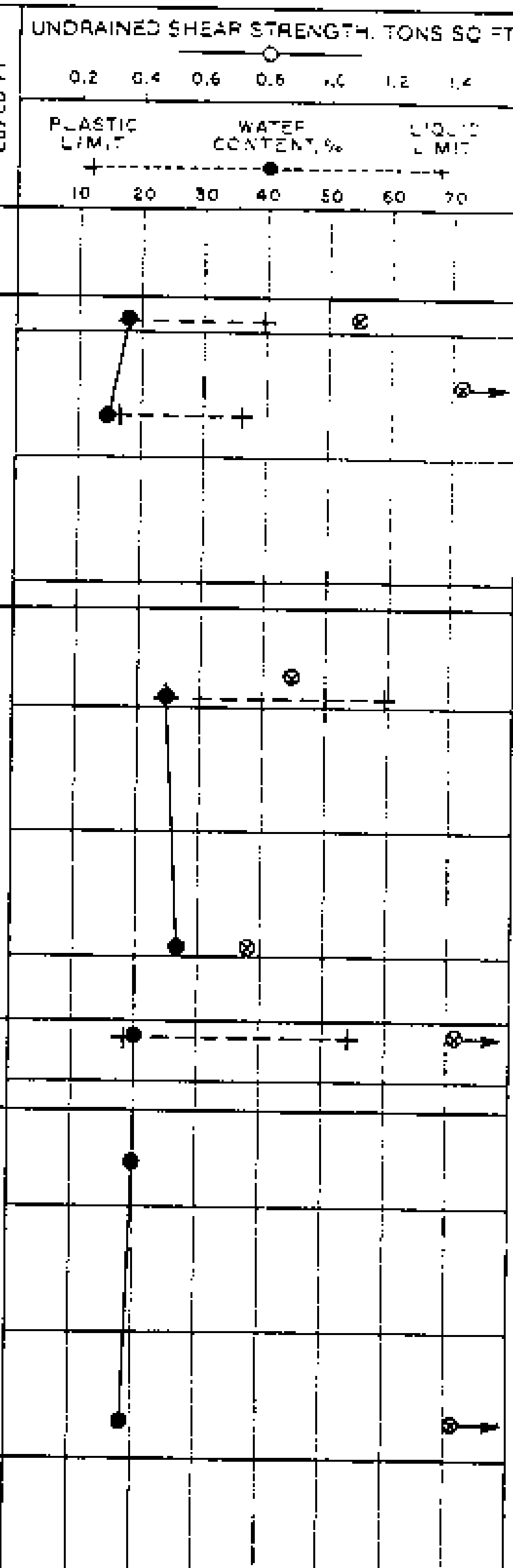
LOG OF BORING NO. S-50
HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 669,000 E 3,285,000

SURF. EL: 521' (approx.)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	-#200, %
	Light gray fine sand			
	-with roots to 1.5'			
5	Very stiff red and light gray sandy clay			54
	-very sandy below 8'			31
10	-with fine sand layers below 10.5'			
15		45		
	Interbedded stiff gray clay and red fine sand			
20		44		32
	-with clay pockets and fine sand layers below 21'			
25				
30	-with siltstone partings below 29.5'	38		58
	Very stiff gray clay			94
35				
	Interbedded very stiff gray and tan silty clay and fine sand			87
40				
45				
	-dark brown clay layer at 49'			44
50				



COMPLETION DEPTH: 50'
DATE: Nov. 10, 1979

DEPTH TO WATER IN BORING: 23.1'
Caved at: 26.0'
DATE: Nov. 14, 1979

LOG OF BORING NO. S-51

HL&P ELECTRIC GENERATING STATION
LIMESTONE COUNTY, TEXAS

TYPE: 3" thin-walled tube & 2" split-barrel LOCATION: N 670,000; E 3,285,000

UNDRAINED SHEAR STRENGTH TONS/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT: 10 20 30 40 50 60 70

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL: 505')	BLOWS PER FT	UNIT DRY WT LB/CU FT
0	Tan silty fine sand with roots		
2	Firm tan and red sandy clay -with clayey sand pockets to 4' -very stiff below 6'		
12	Very stiff gray clay with silty sand pockets		
15	Intermixed tan stiff clay and silty sand		
40		44	
43	Light gray silty sand with clay pockets		
50		50/10"	

COMPLETION DEPTH: 50'
DATE: July 1, 1980

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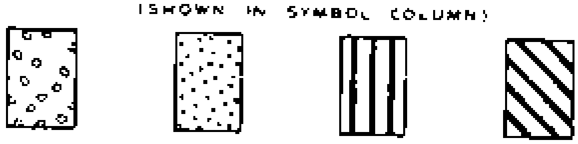
SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES

(SHOWN IN SYMBOL COLUMN)

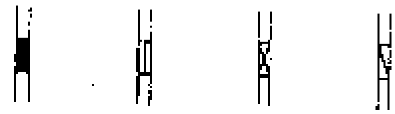


Gravel Sand Silt Clay

Predominant type shown heavy

SAMPLER TYPES

(SHOWN IN SAMPLES COLUMN)



Shelby Tube Piston Split Spoon No Recovery

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

DESCRIPTIVE TERM	RELATIVE DENSITY
Loose	0 to 40%
Medium dense	40 to 70%
Dense	70 to 100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TON/SQ FT
Very soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very stiff	2.00 to 4.00
Hard	4.00 and higher

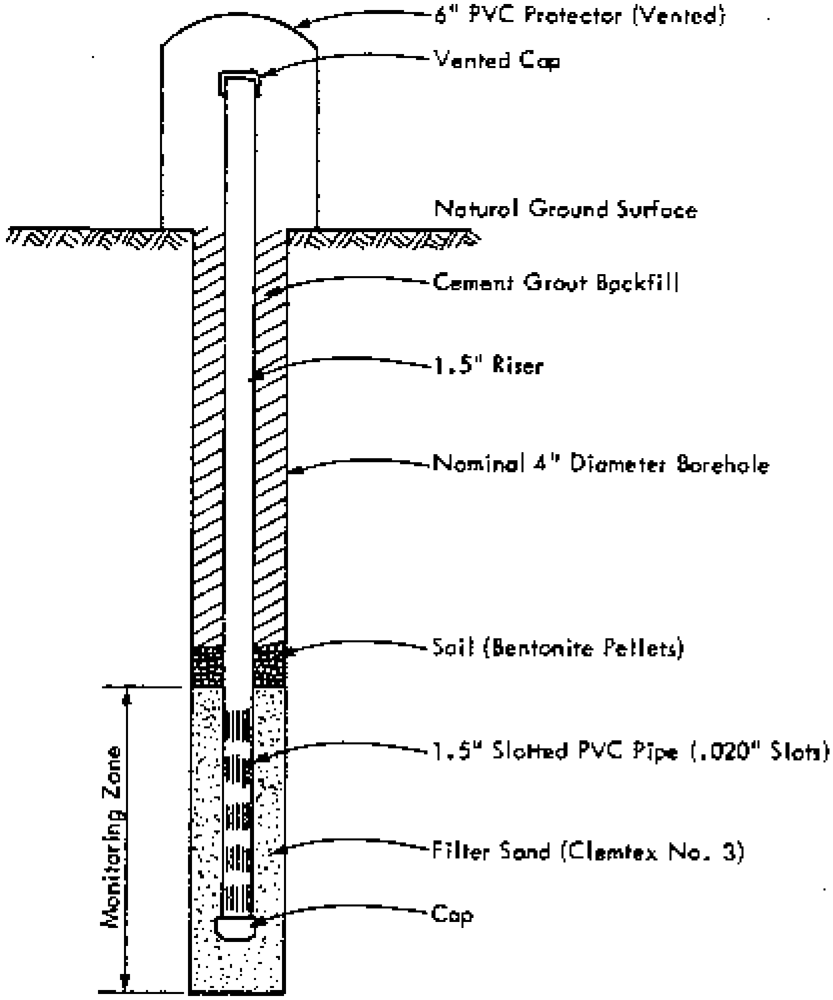
Note. Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	– having inclined planes of weakness that are slick and glossy in appearance.
Fissured	– containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	– composed of thin layers of varying color and texture.
Interbedded	– composed of alternate layers of different soil types.
Calcareous	– containing appreciable quantities of calcium carbonate.
Well graded	– having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly graded	– predominantly of one grain size, or having a range of sizes with some intermediate size missing.

Terms used in this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No 3-357, Waterways Experiment Station, March 1953

McCLELLAND ENGINEERS



Piezometer No.	Location Coordinates, Ft		Ground Elevation, Ft (Approx.)	Monitoring Zone Elevation, Ft (Approx.)
D1A	N 664, 575	E 3, 276, 230	440	437 to 432
D1B	N 664, 565	E 3, 276, 230	440	385 to 377
D17A	N 667, 911	E 3, 273, 019	476.5	383.5 to 375.5
D17B	N 667, 901	E 3, 273, 015	476.5	426.5 to 410.5
D22A	N 665, 022	E 3, 276, 490	426	406 to 393
D22B	N 665, 017	E 3 276, 510	426	363 to 385
D22C	N 665, 017	E 3, 276, 508	426	393 to 385
D22D	N 665, 009	E 3, 276, 546	426	373 to 365
D22E	N 665, 007	E 3, 276, 547	426	403 to 395
D31A	N 667, 005	E 3, 276, 000	448	367 to 357
S28A	N 672, 005	E 3, 281, 000	506	500 to 490
S28B	N 671, 995	E 3, 281, 000	506	452 to 470
S31A	N 666, 005	E 3, 282, 000	483	440 to 432
S34A	N 668, 995	E 3, 282, 000	494	423 to 415
S34B	N 669, 005	E 3, 282, 000	494	484.5 to 476

Note:
Ground Elevations for D17A and D17B were surveyed; all other ground elevations were estimated

PIEZOMETER INSTALLATION DATA
Material Handling Area

Piezometer No.	Predominant Soil Type In M–	June 1980 Ft	June 1980 Elevation (Approx.)(3)	July 1980 Depth, Ft	July 1980 Elevation (Approx.)(3)
D-1A	Sandy clay		(2)	(2)	(2)
D-1B	Silty fine sand		(2)	(2)	(2)
D-17A	Intermixed silty clay and s	.3	443.2	32.8	443.7
D-17B	Intermixed silty clay and f	.9	458.6	18.3	458.2
D-22A	Silty fine sand	)	(2)	(2)	(2)
D-22B	Silty fine sand with silty c	)	(2)	(2)	(2)
D-22C	Silty fine sand and lamina and silty fine sand	)	(2)	(2)	(2)
D-22D	Silty fine sand with silty c	)	(2)	(2)	(2)
D-22E	Silty fine sand	)	(2)	(2)	(2)
D-31A	Laminated silty clay and s	.3	436	12.6	435
S-28A	Sandy clay	.0	498	8.3	498
S-28B	Interbedded silty fine sand	y	Dry	30.0	476
S-31A	Silty fine sand	.5	445	38.2	445
S-34A	Laminated clay and silty f	)	(2)	(2)	(2)
S-34B	Clay with silt partings	)	(2)	(2)	(2)

Notes:
(1) Piezometer not installed yet
(2) No reading was taken
(3) Ground elevations for D-17A and I
All other elevations are approxima
countour map.

R OBSERVATIONS

ant Area

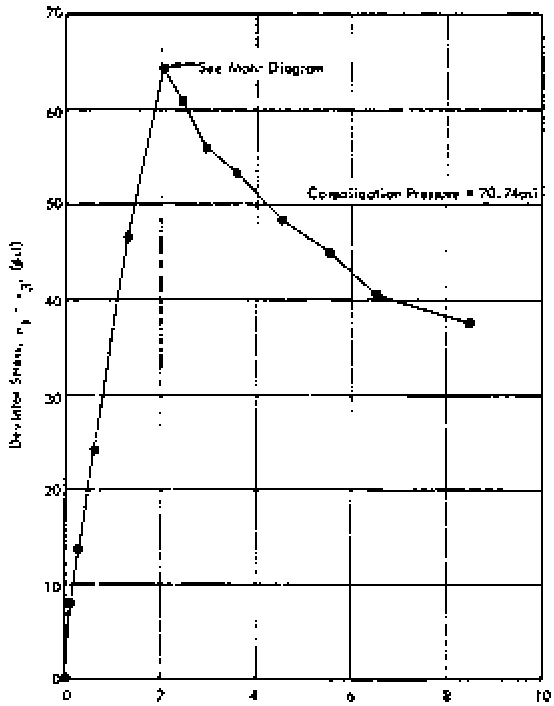
Piezometer No.	Predominant Soil Type In Monitoring Zone	Groundwater			Field Permeability, k, cm/sec from	
		Depth, Ft	Elevation	Date	Time Lag Test	Falling Head Test
D-18	Silty fine sand	18.0	422	11/17/79	-	7.6×10^{-6}
D-31A	Laminated silty clay and gray silt	21.0	427	11/20/79	4.3×10^{-5}	-
S-31A	Silty fine sand	40.0	443	11/19/79	2.7×10^{-4}	6.4×10^{-6}
S-34A	Laminated silty clay and silty fine sand	34.7	459	11/16/79	1.5×10^{-4}	2.1×10^{-5}

FIELD PERMEABILITY TEST RESULTS
Material Handling Area

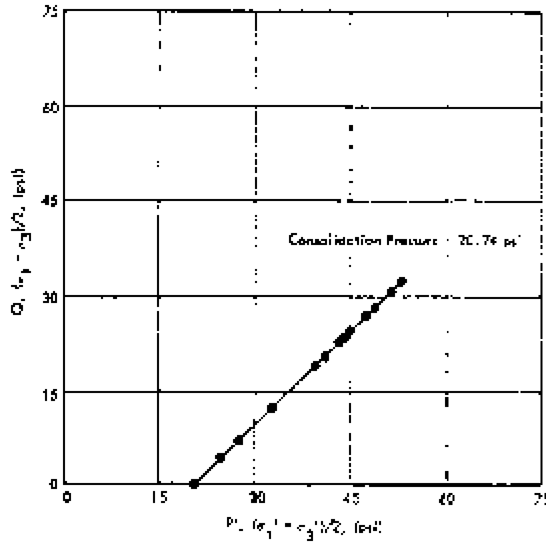
Boring No.	Sample No.	Depth, Ft	Soil Type	Laboratory Permeability at 20° C (K_v) cm/sec
D-1	8	7.5	Tan and light gray very sandy clay	3.8×10^{-7}
D-1	13	23.5	Laminated light gray and tan clay and clayey sand	2.1×10^{-8}
D-4	6	7.0	Very stiff red and tan sandy clay	7.3×10^{-7}
D-6	6	7.0	Tan silty clay with sandy silt seams and pockets	2.0×10^{-7}
D-21	7	8.0	Gray and light gray silty clay with silty fine sand partings	4.0×10^{-7}
D-21	13	24.5	Tan silty fine sand	2.1×10^{-2}
D-26	8	14.0	Interbedded tan silty clay and silty fine sand	1.0×10^{-6}
S-3	7	14.0	Light gray and brown sandy clay	1.1×10^{-5}
S-8	4	5.5	Very stiff, red, brown, and light gray sandy clay	5.9×10^{-9}
S-8	15	34.5	Tan silty fine sand	1.9×10^{-4}
S-28	6	9.5	Very stiff brown and gray sandy clay	1.6×10^{-8}
S-34	10	15.0	Very stiff brown and light gray clay	1.7×10^{-6}
S-34	21	44.5	Very stiff brownish yellow silty clay with sand partings	4.9×10^{-4}
S-46	3	2.5	Very stiff brown clay with silt pockets	4.1×10^{-9}

LABORATORY PERMEABILITY TEST RESULTS

Material Handling Area



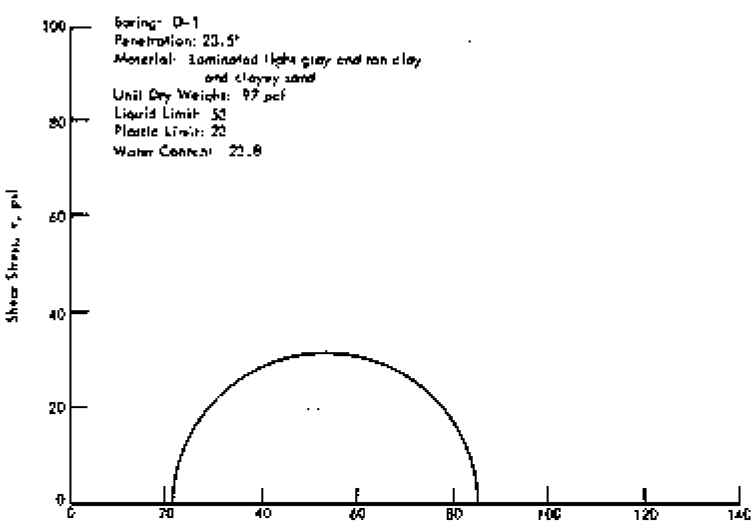
STRESS-STRAIN CURVE



P'Q DIAGRAM

LEGEND

Total Stress

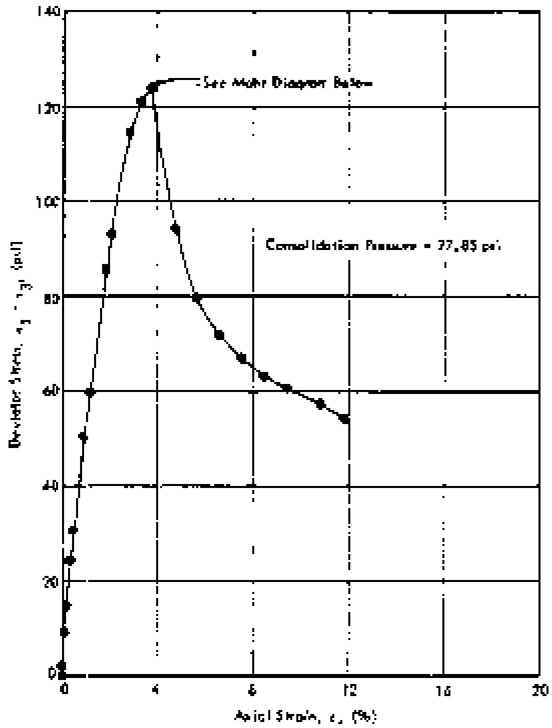


MOHR DIAGRAM

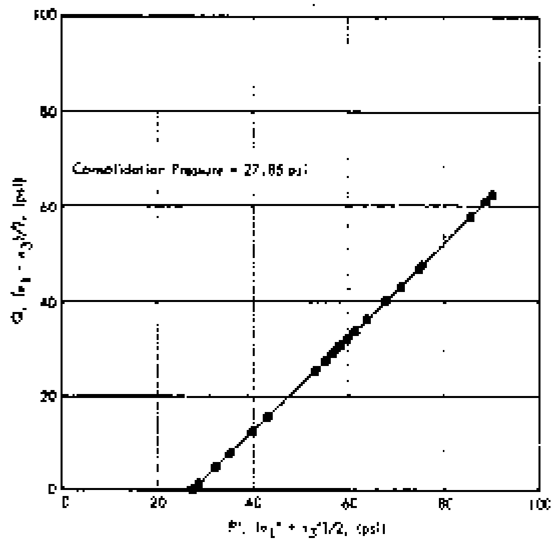
TRIAXIAL COMPRESSION TEST RESULTS

Consolidated - Drained

FORM DFT-1.3 (1978) Job No.



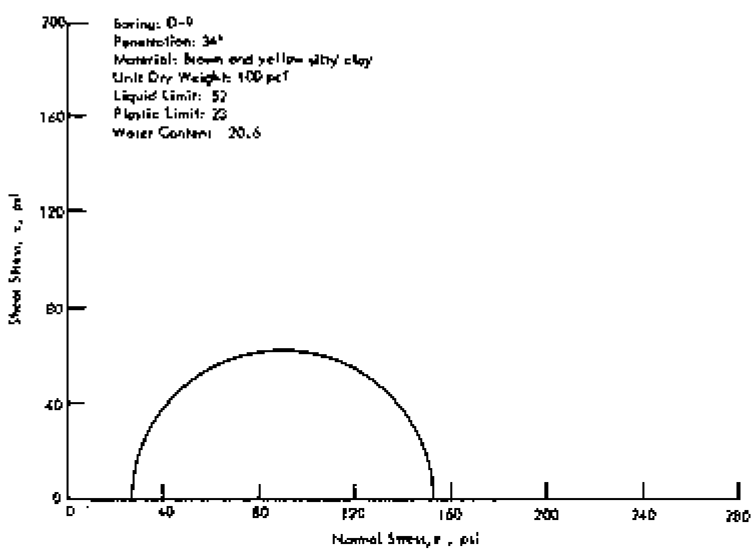
STRESS-STRAIN CURVE



P-Q DIAGRAM

LEGEND

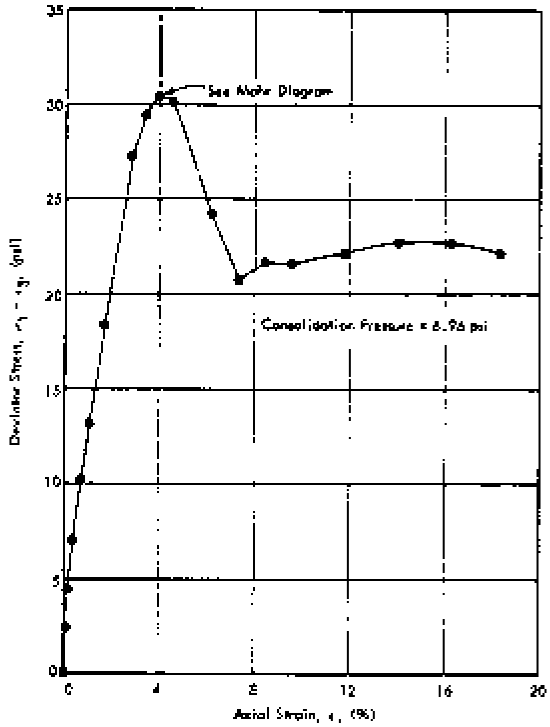
Total Stress ———



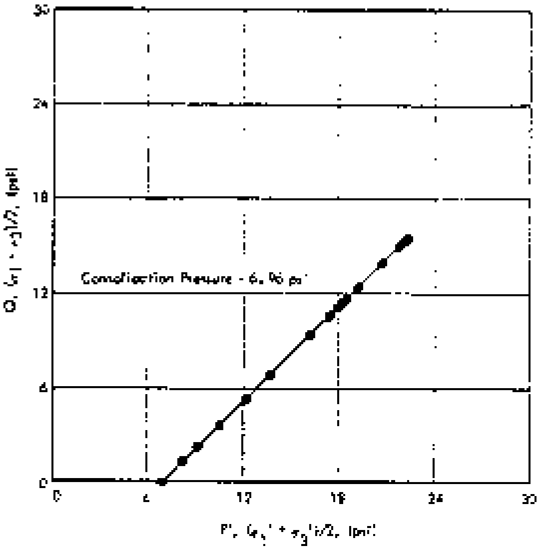
MOHR DIAGRAM

TRIAXIAL COMPRESSION TEST RESULTS

Consolidated - Drained

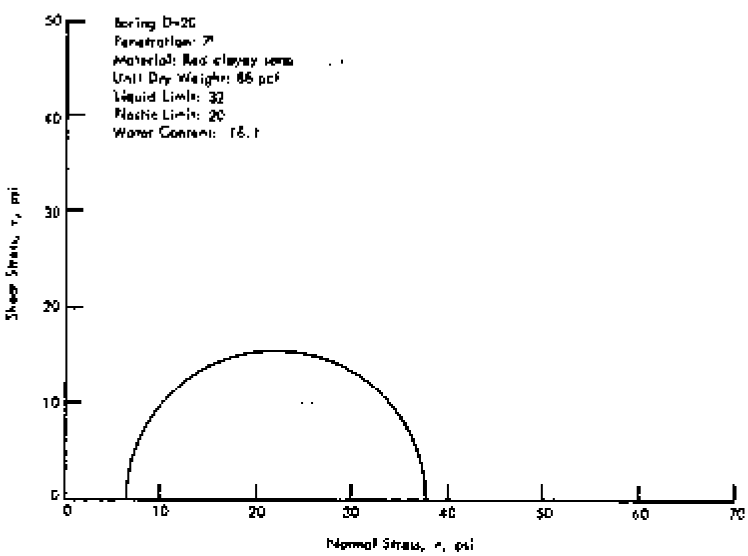


STRESS-STRAIN CURVE



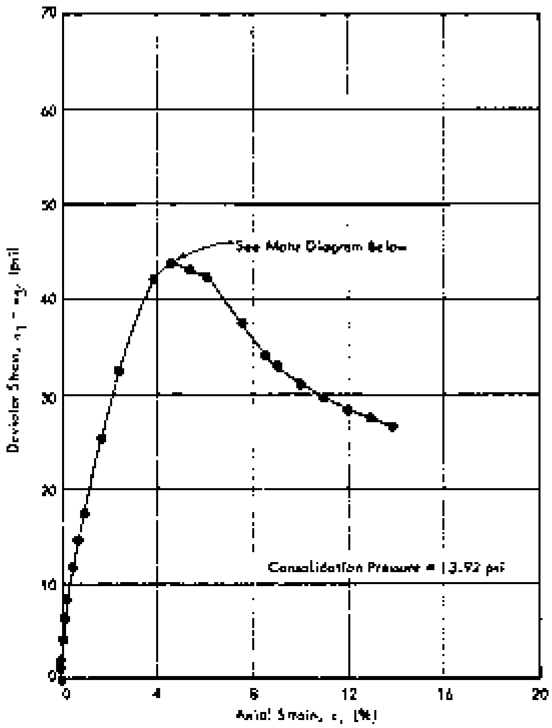
P-Q DIAGRAM

LEGEND
Total Stress

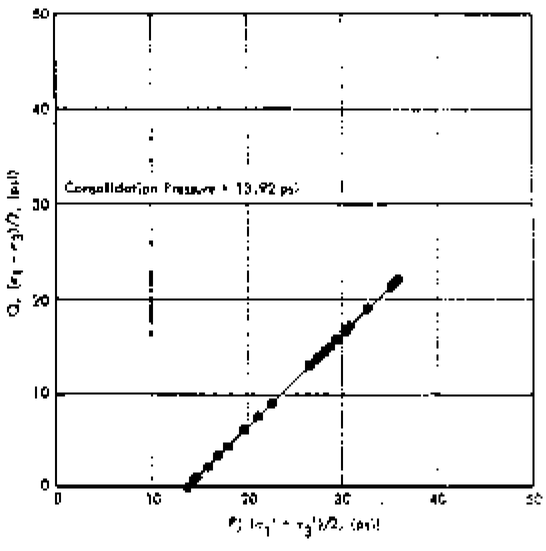


MOHR DIAGRAM

TRIAXIAL COMPRESSION TEST RESULTS
Consolidated- Drained



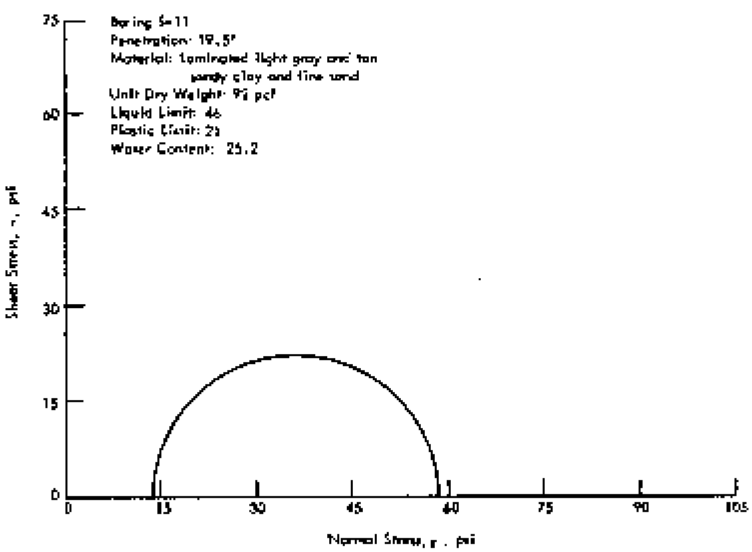
STRESS-STRAIN CURVE



P-Q DIAGRAM

LEGEND

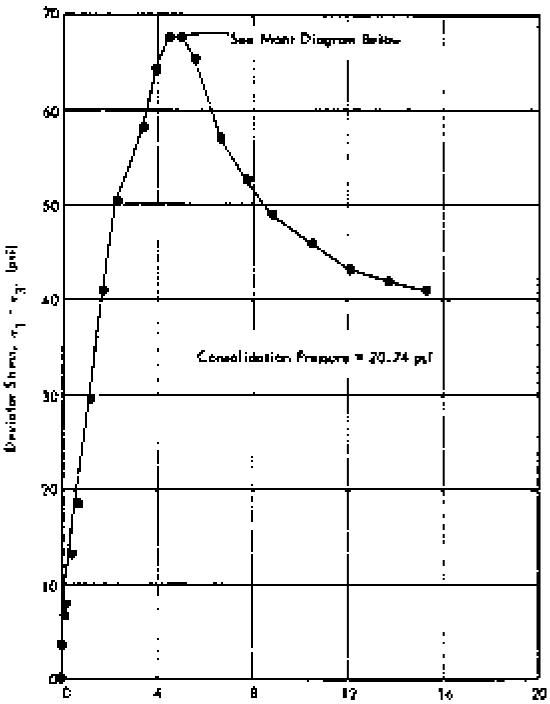
Total Stress ———



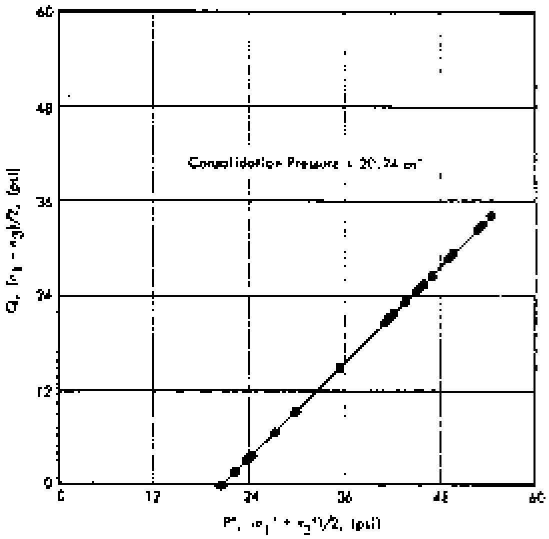
MOHR DIAGRAM

TRIAXIAL COMPRESSION TEST RESULTS
Consolidated-Drained

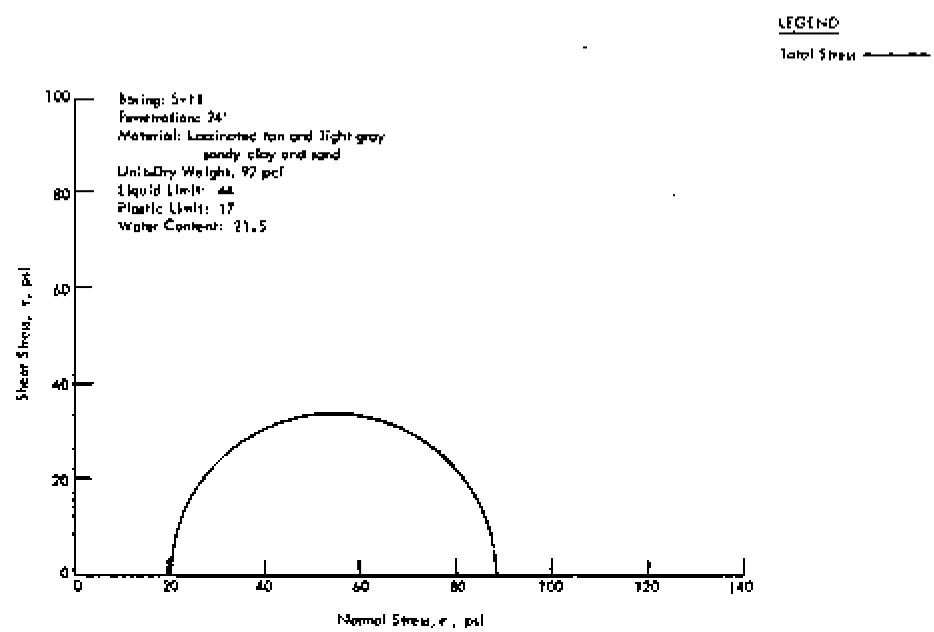
FORM OFT-13 (1978) Job No.



STRESS-STRAIN CURVE



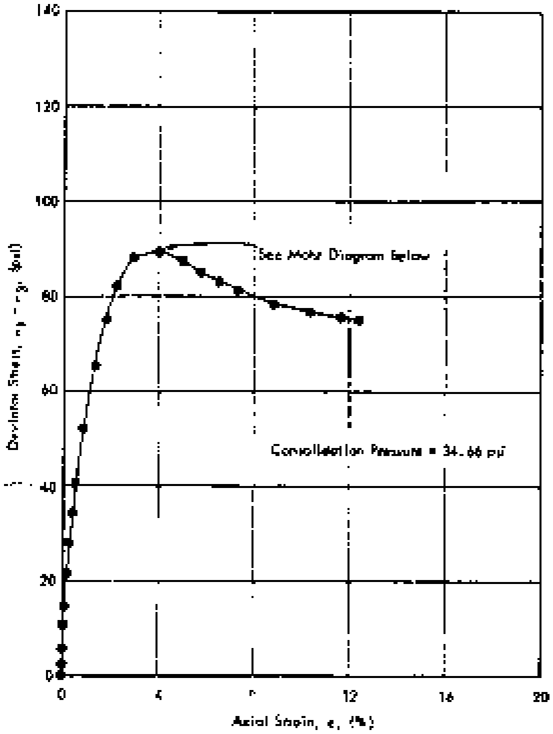
P'Q DIAGRAM



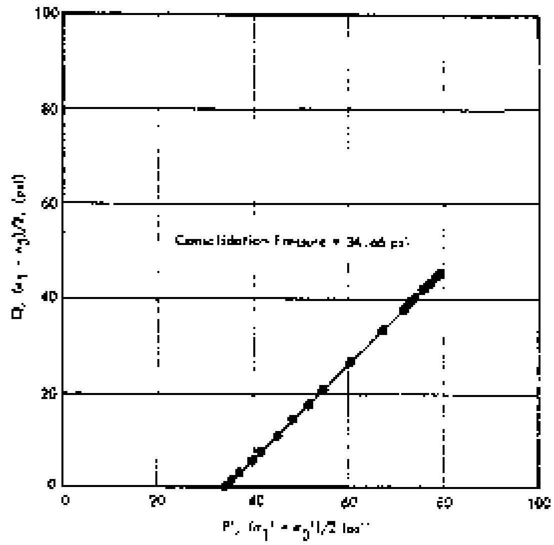
MOHR DIAGRAM

TRIAXIAL COMPRESSION TEST RESULTS

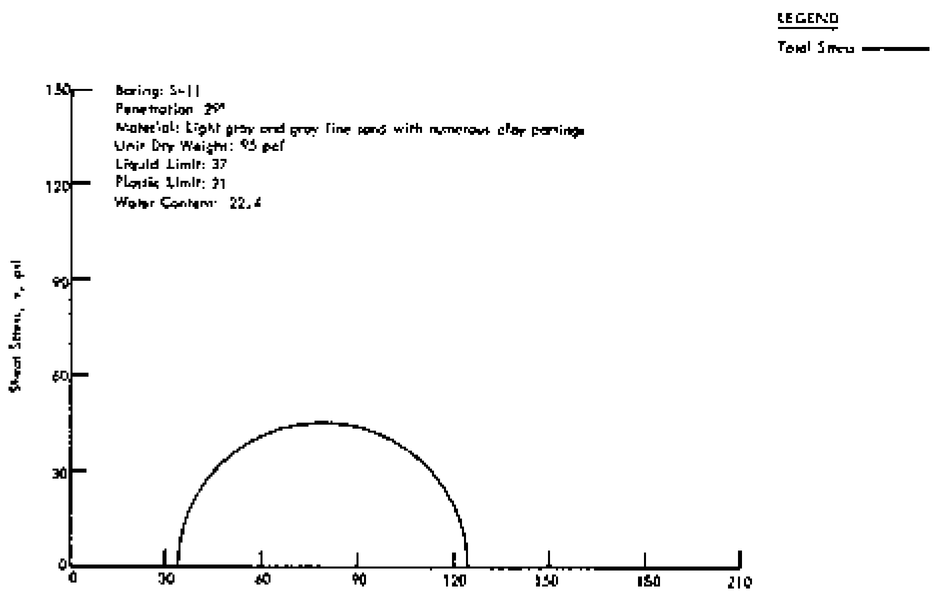
Consolidated - Drained



STRESS-STRAIN CURVE

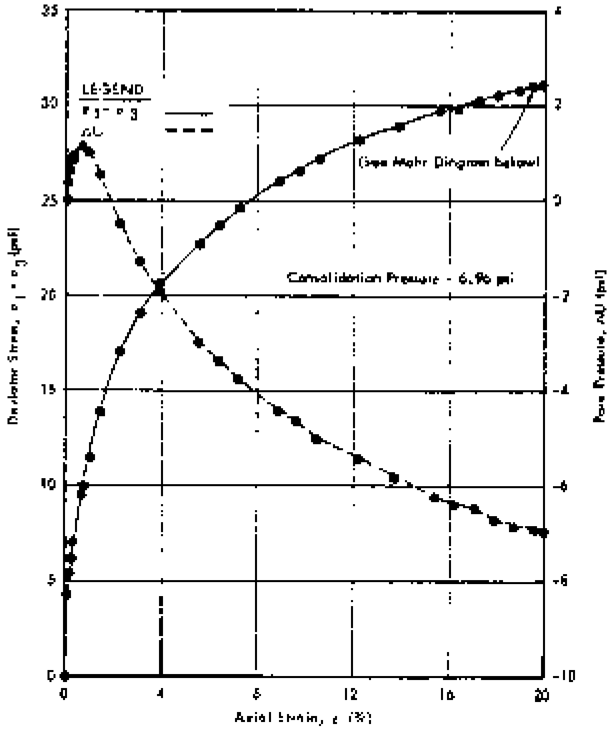


P-Q DIAGRAM

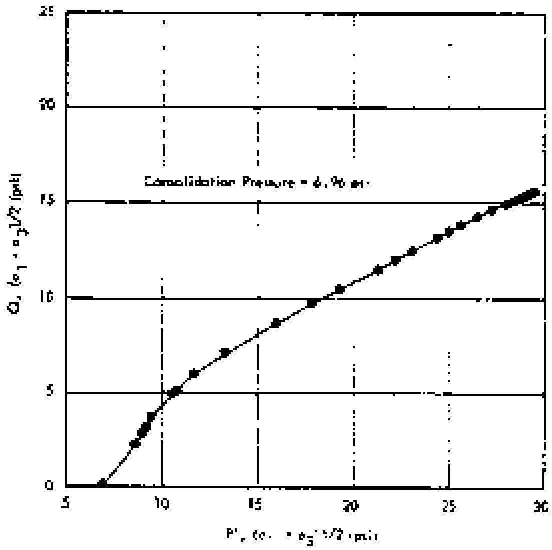


MOHR DIAGRAM

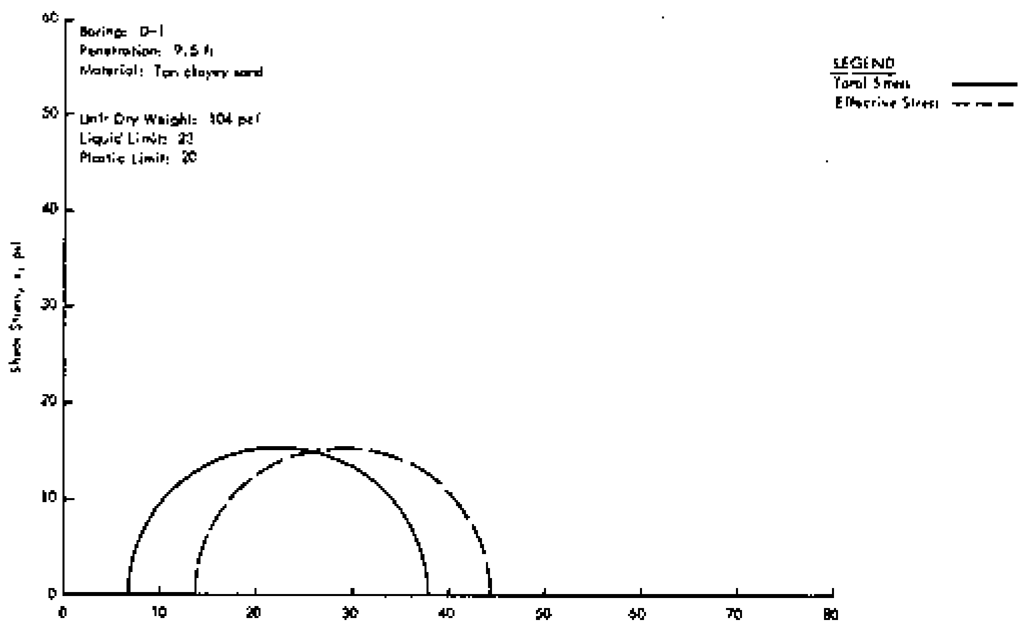
TRIAXIAL COMPRESSION TEST RESULTS
Consolidated - Drained



STRESS-STRAIN AND PORE PRESSURE-STRAIN CURVES

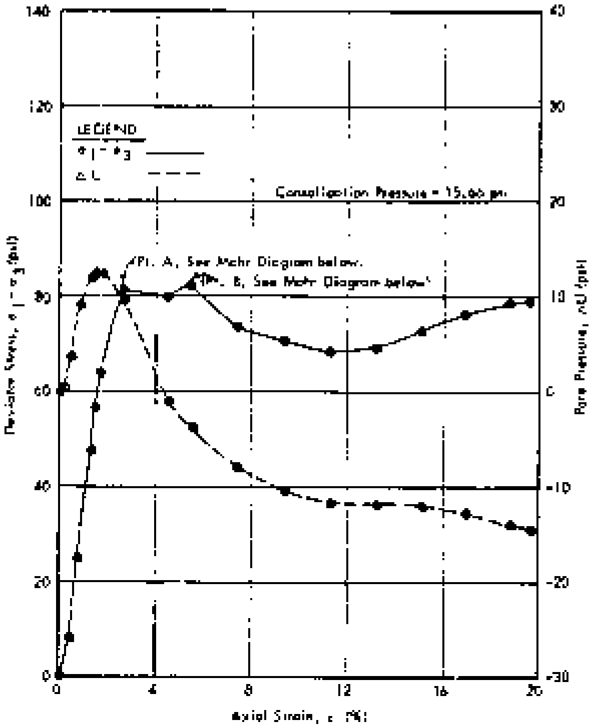


P-Q DIAGRAM

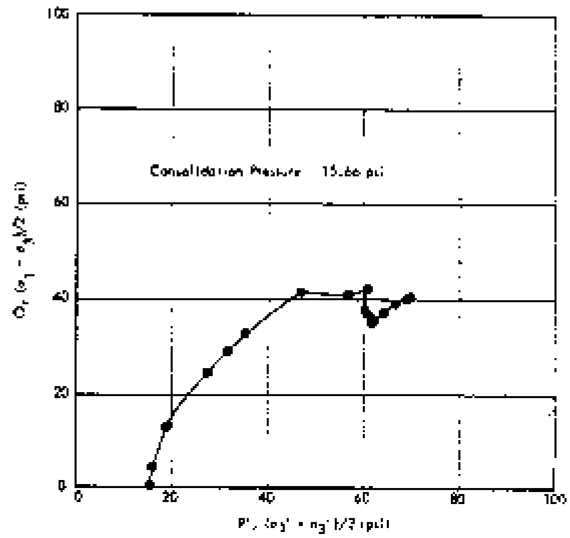


MOHR DIAGRAM

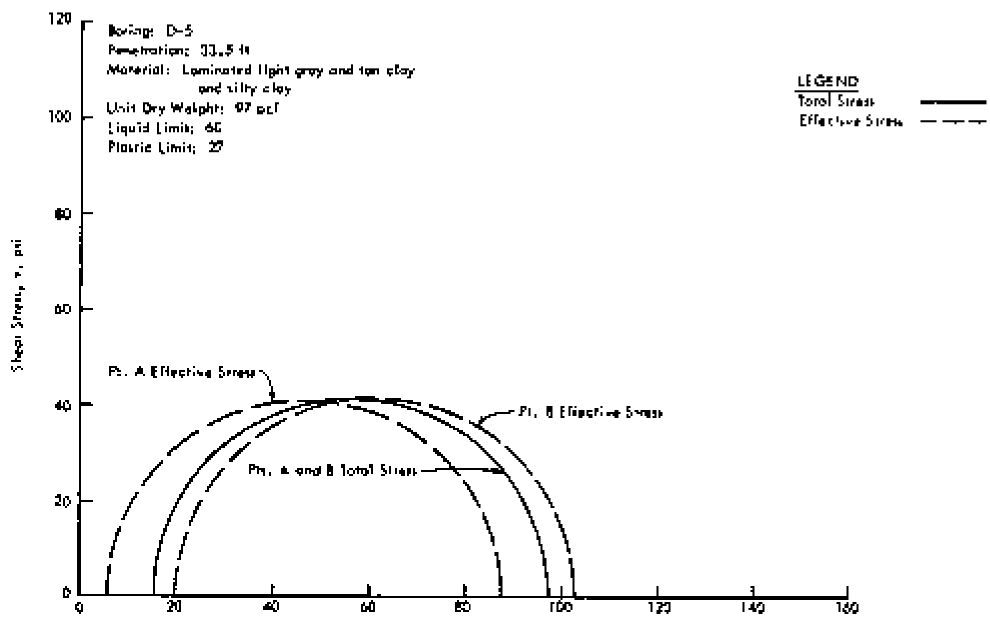
TRIAXIAL COMPRESSION TEST RESULTS
Consolidated-Undrained with
Pore Pressure Measurements



STRESS-STRAIN AND PORE PRESSURE-STRAIN CURVES

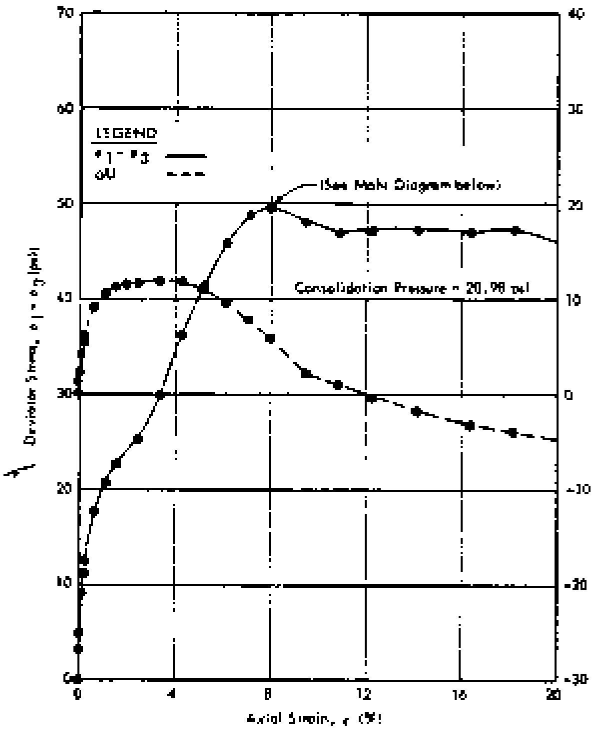


P-Q DIAGRAM

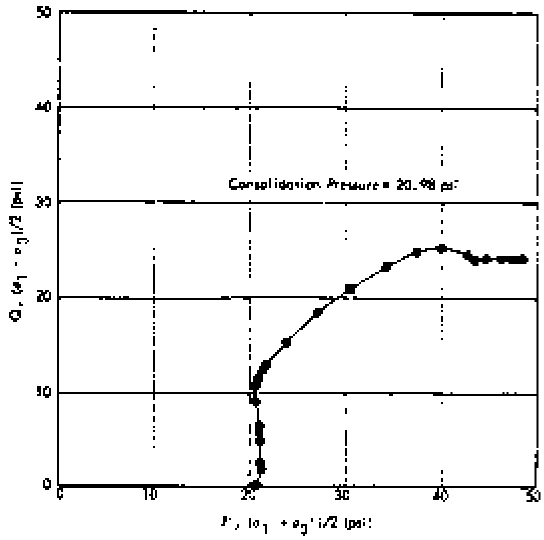


MOHR DIAGRAM

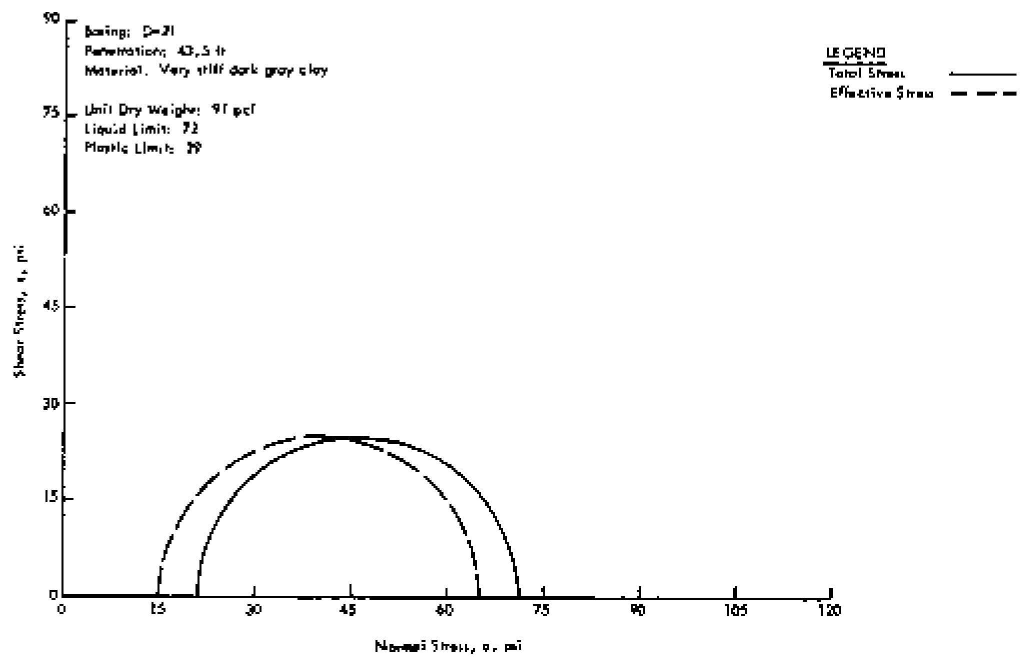
TRIAXIAL COMPRESSION TEST RESULTS
Consolidated-Undrained with
Pore Pressure Measurements



STRESS-STRAIN AND PORE PRESSURE-STRAIN CURVES



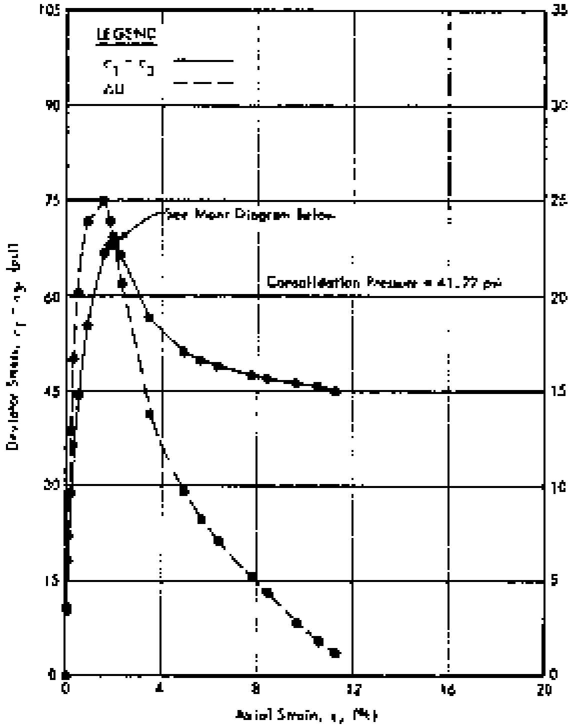
P-Q DIAGRAM



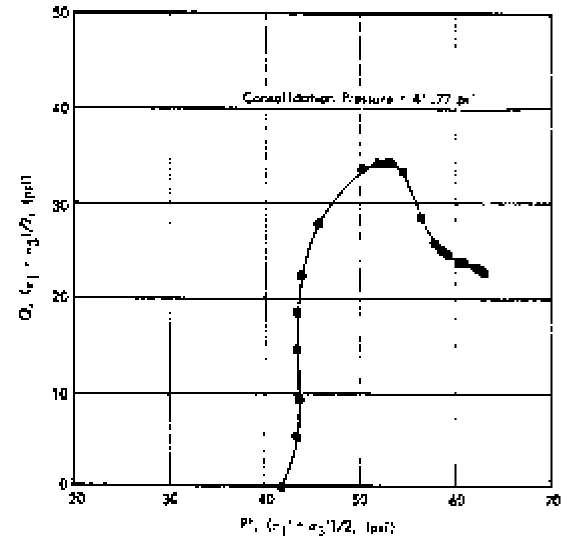
MOHR DIAGRAM

TRIAXIAL COMPRESSION TEST RESULTS

Consolidated-Undrained with Pore Pressure Measurements



STRESS-STRAIN AND PORE PRESSURE-STRAIN CURVES



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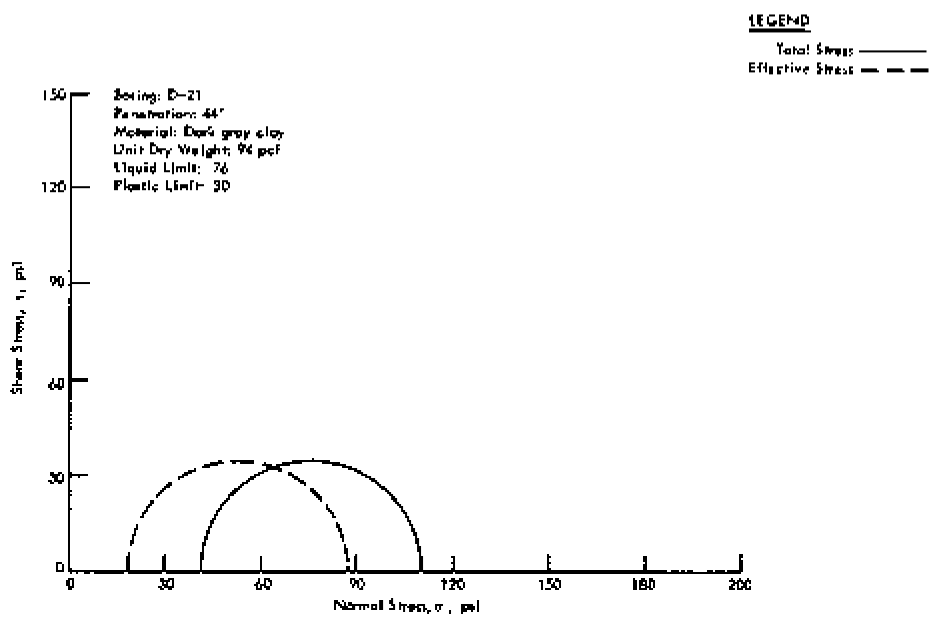
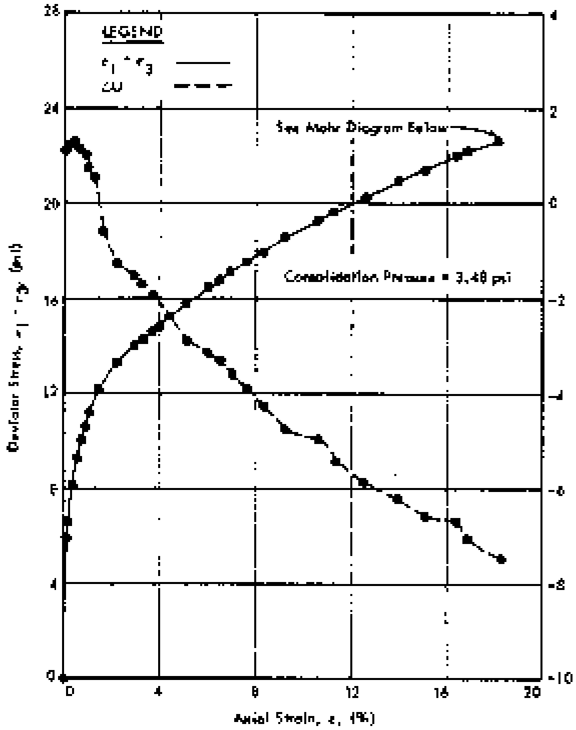


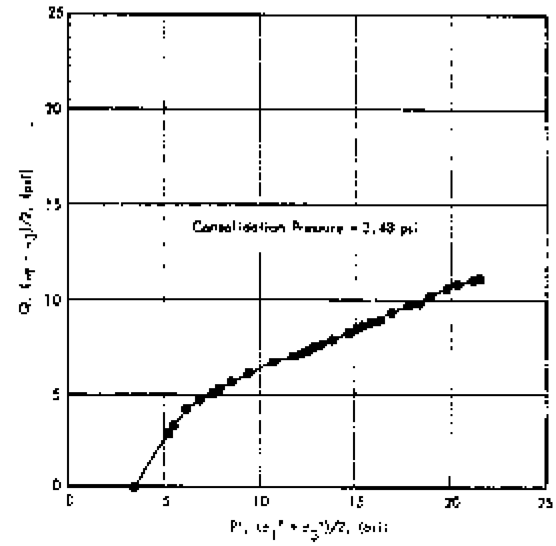
MOHR DIAGRAM

TRIAXIAL COMPRESSION TEST RESULTS

Consolidated-Undrained with
Pore Pressure Measurements



STRESS-STRAIN AND PORE PRESSURE-STRAIN CURVES



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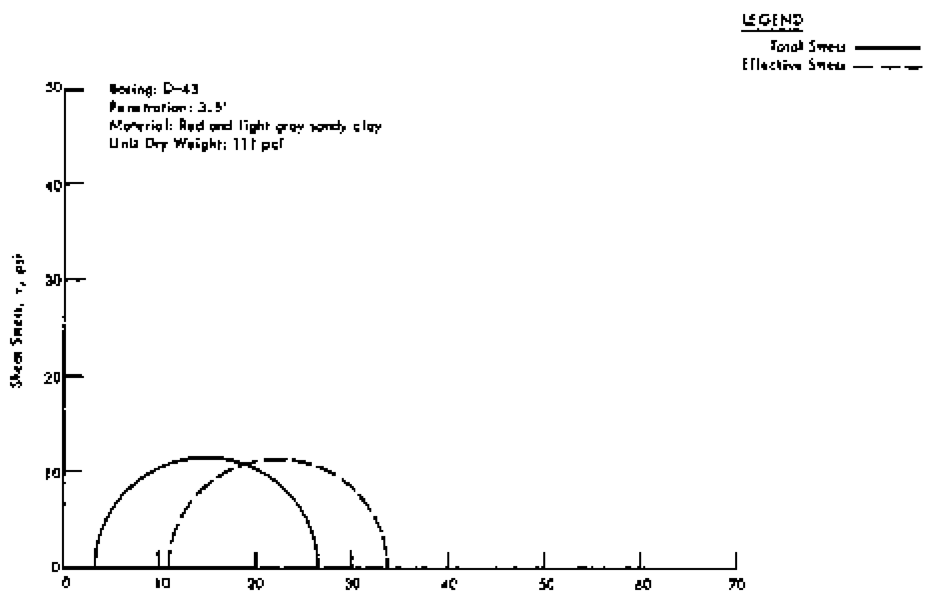
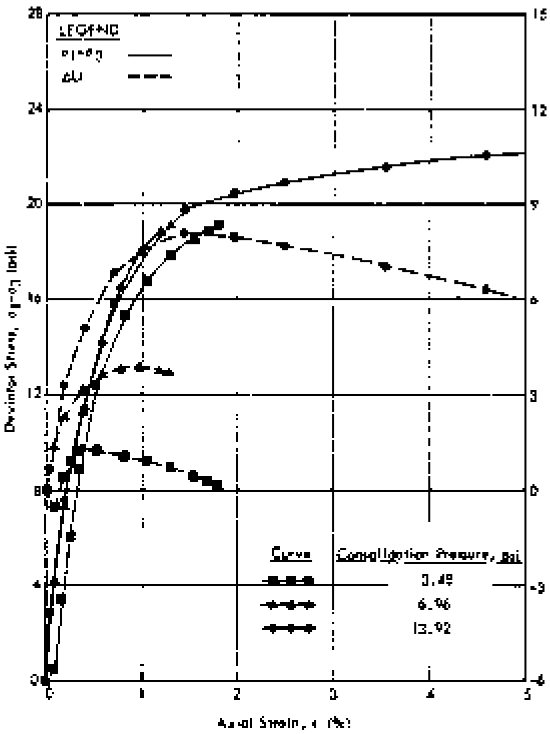
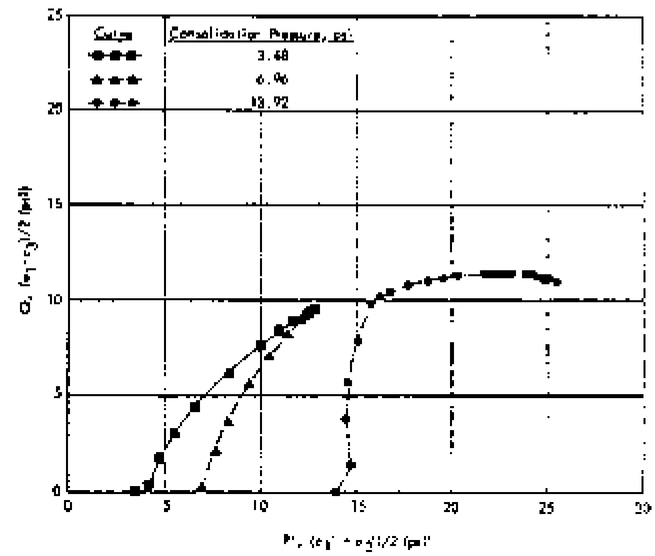


MOHR DIAGRAM

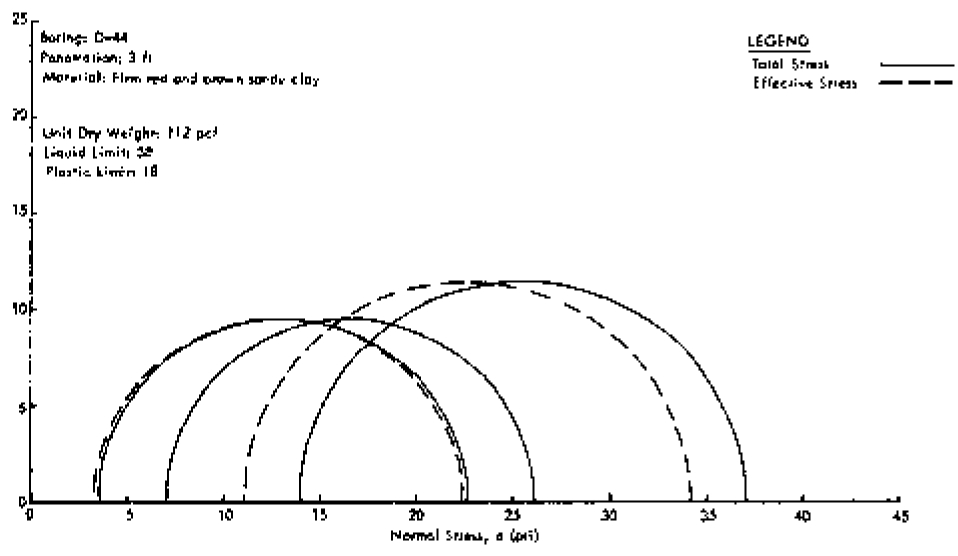
TRIAXIAL COMPRESSION TEST RESULTS
Consolidated-Undrained with
Pore Pressure Measurements



STRESS-STRAIN AND PORE PRESSURE-STRAIN CURVES

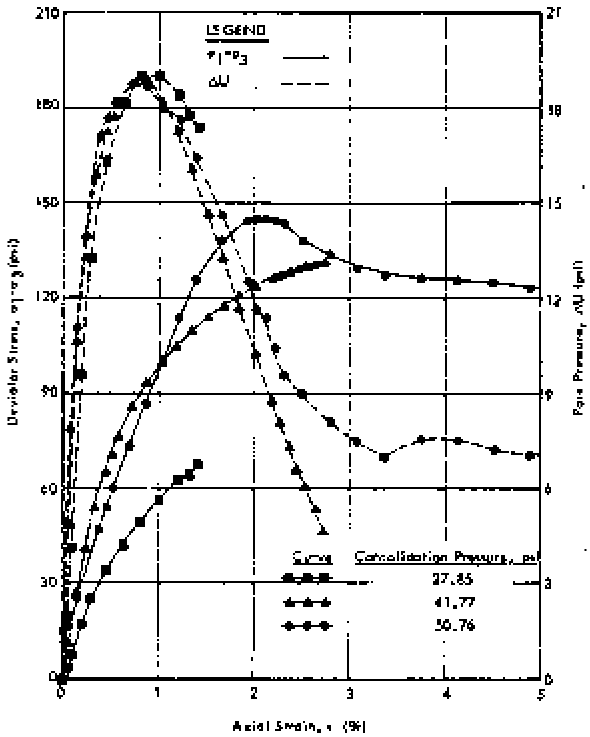


P-Q DIAGRAM

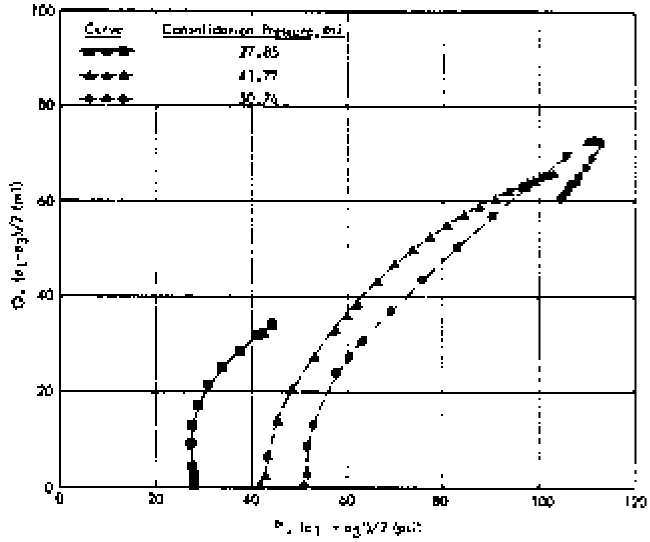


MOHR DIAGRAM

TRIAXIAL COMPRESSION TEST RESULTS
Consolidated-Undrained, Multi-Stage with
Pore Pressure Measurements



STRESS-STRAIN AND PORE PRESSURE-STRAIN CURVES



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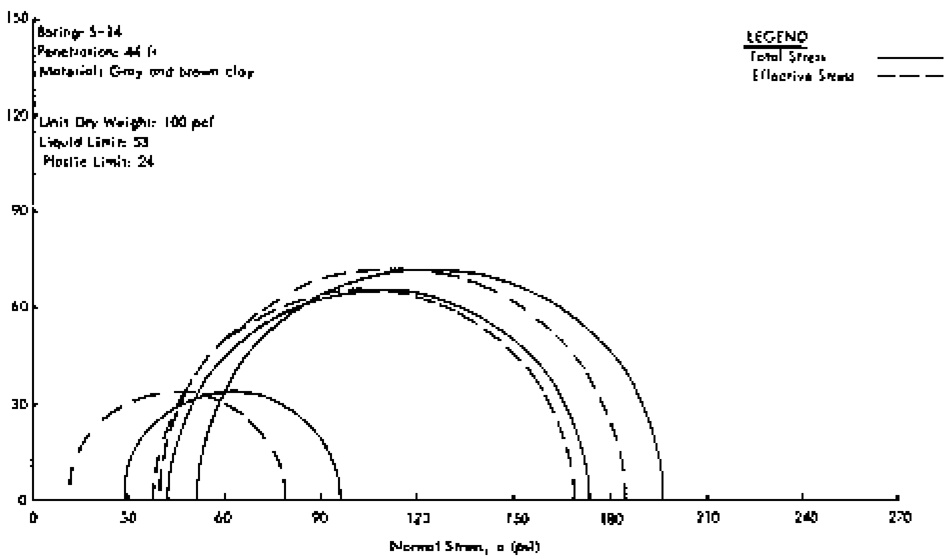


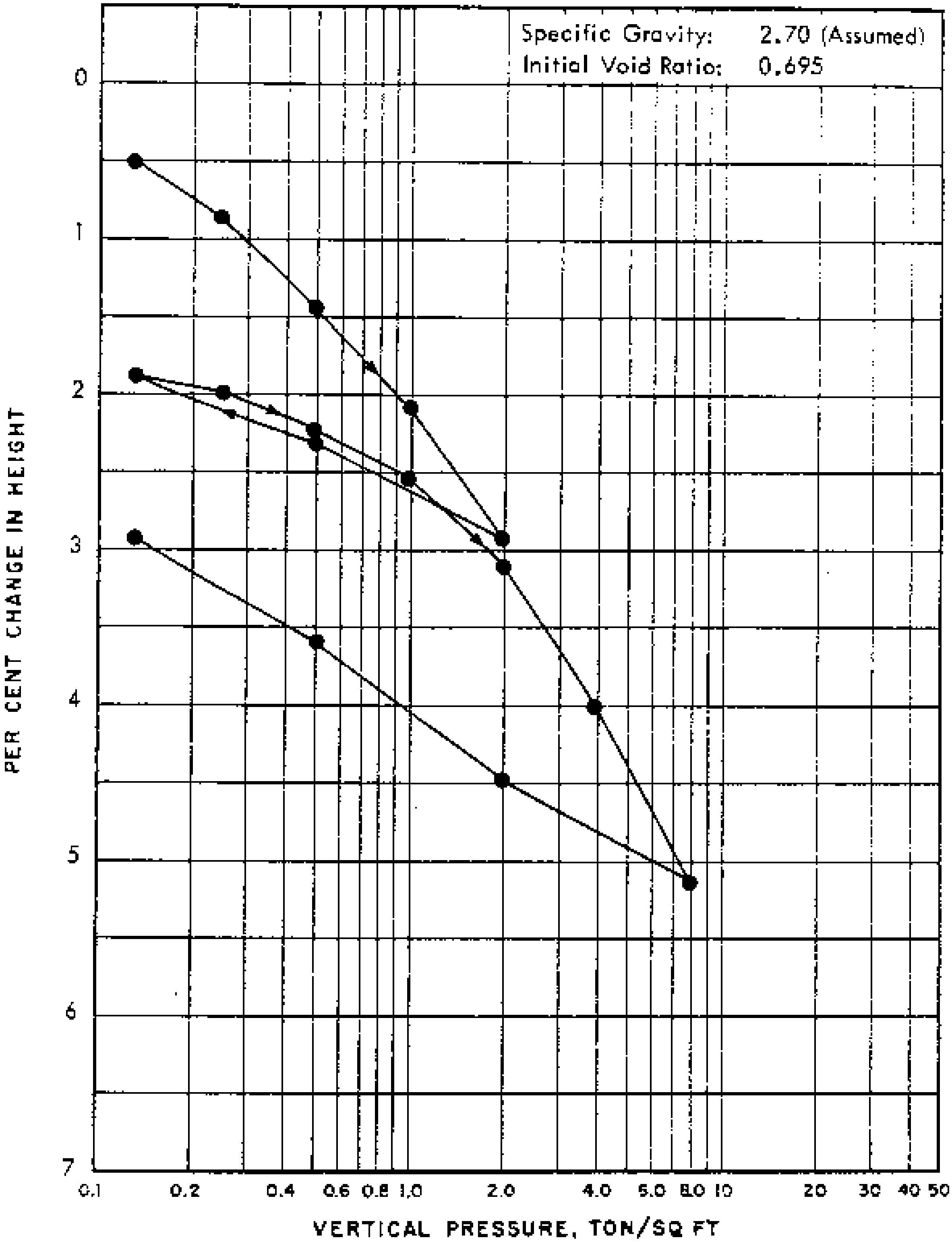
MOHR DIAGRAM

TRIAXIAL COMPRESSION TEST RESULTS

Consolidated-Undrained, Multi-Stage with Pore Pressure Measurements

BORING: D-1 DEPTH: 24.5 Ft.
MATERIAL: Tan and light gray clay with sandy silt seams

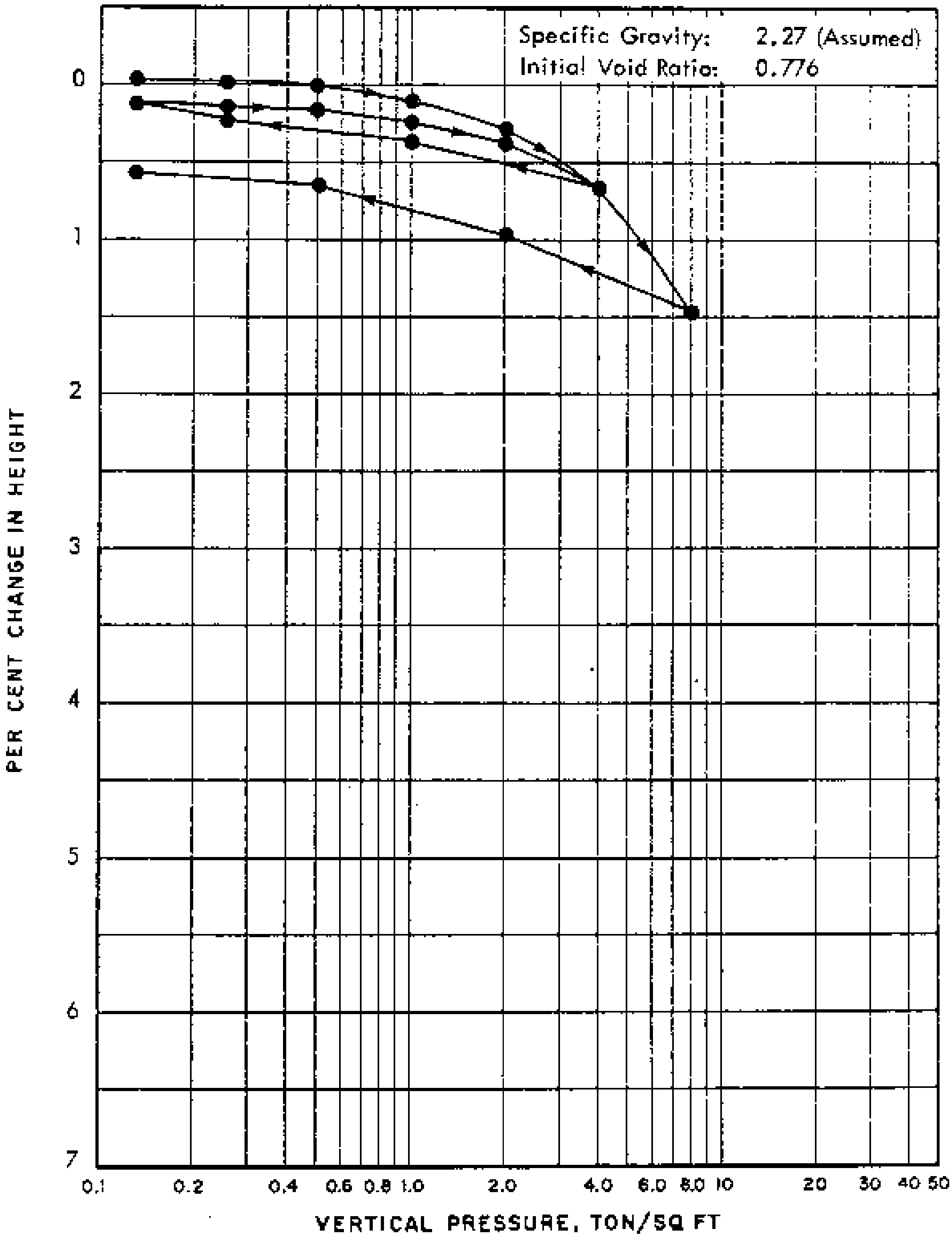
UNIT DRY WEIGHT: 99 LB/CU FT
WATER CONTENT: 23 %
LIQUID LIMIT: 54
PLASTIC LIMIT: 23



CONSOLIDATION TEST RESULTS

BORING: D-4 DEPTH: 44.0 Ft.
MATERIAL: Gray clay with fine sand pockets

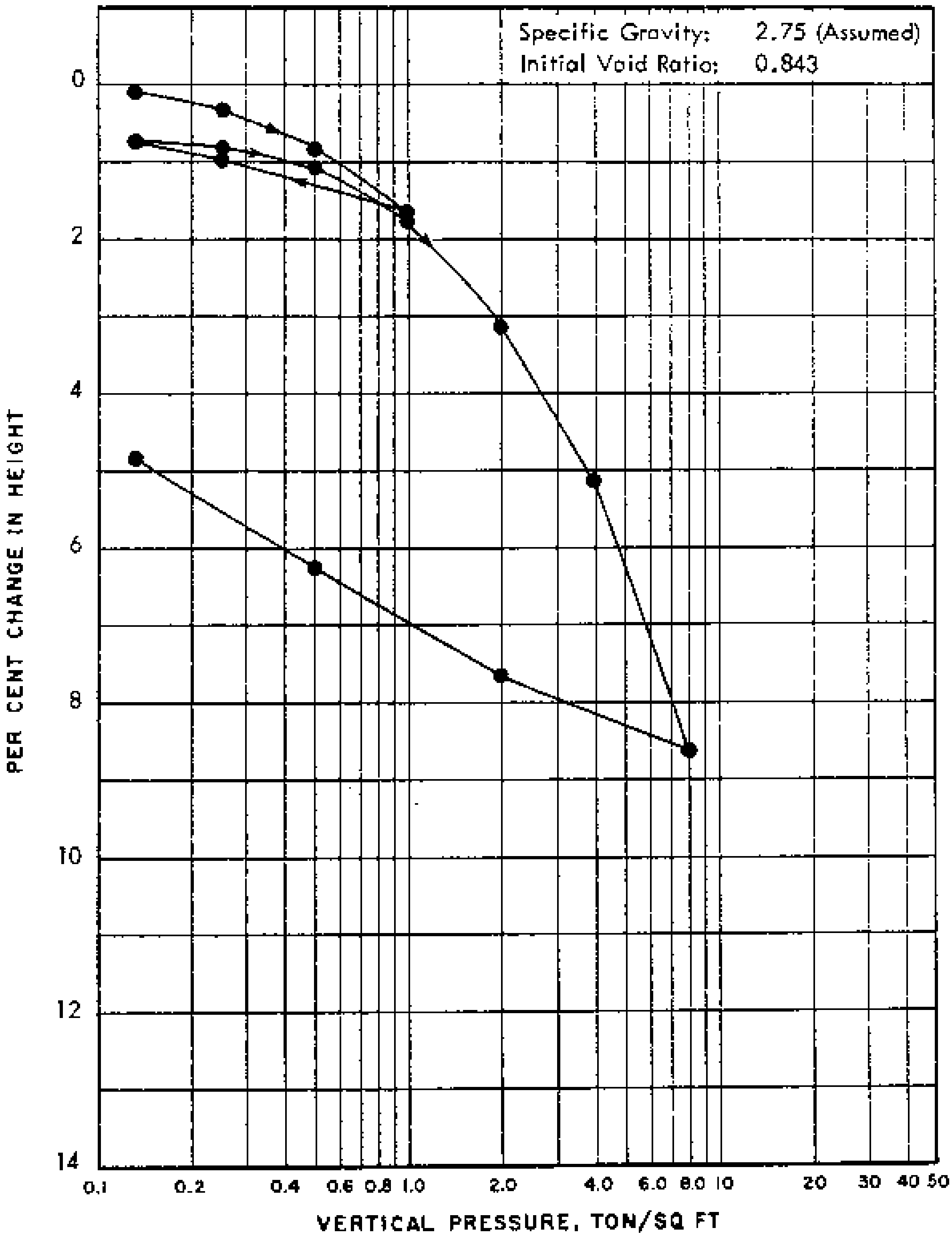
UNIT DRY WEIGHT: 96 LB/CU FT
WATER CONTENT: 29 %
LIQUID LIMIT: 57
PLASTIC LIMIT: 26



CONSOLIDATION TEST RESULTS

BORING: D-16 DEPTH: 6.5 Ft.
MATERIAL: Very stiff brown sandy clay with ferrous nodules

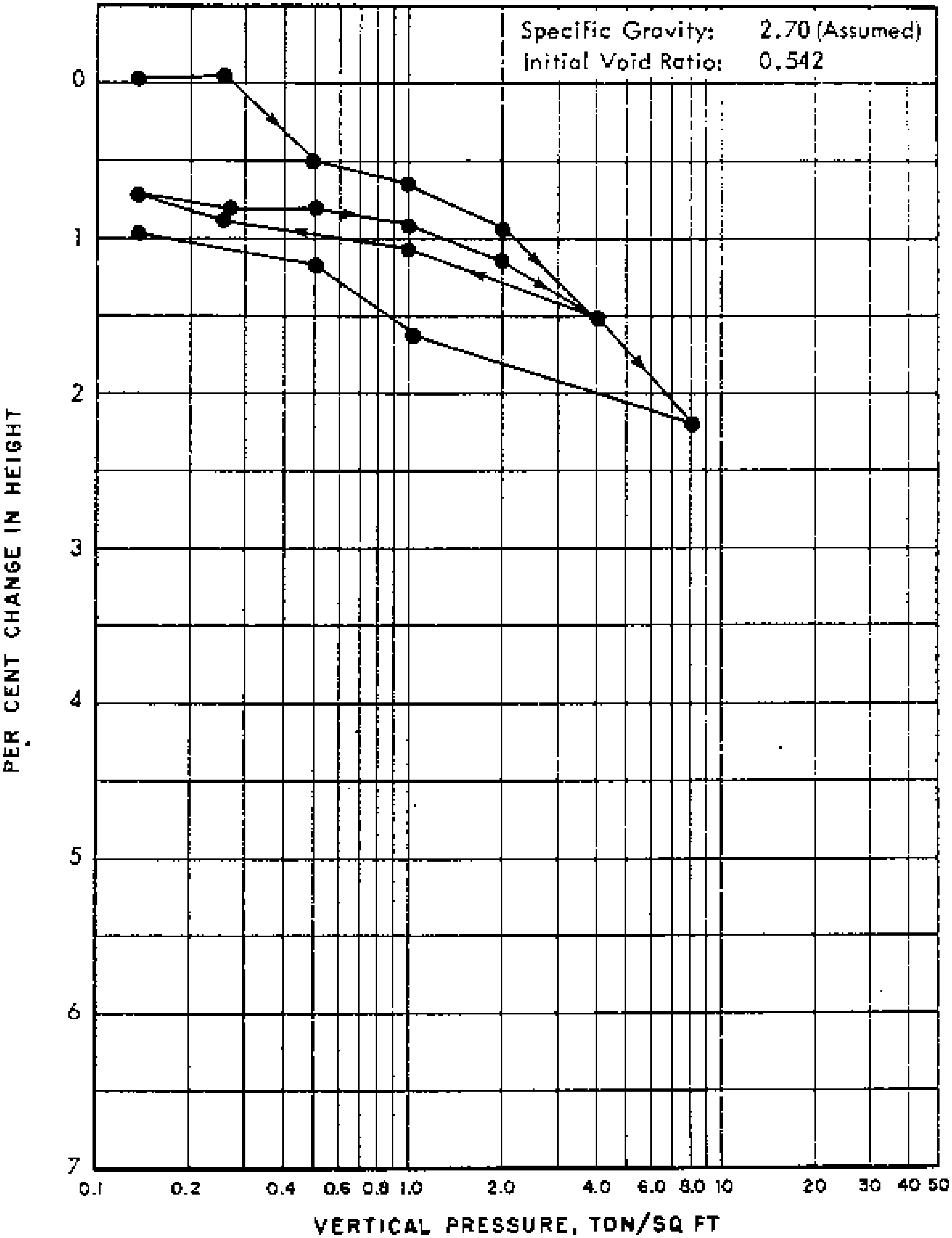
UNIT DRY WEIGHT: 93 LB/CU FT
WATER CONTENT: 31 %
LIQUID LIMIT: 53
PLASTIC LIMIT: 21



CONSOLIDATION TEST RESULTS

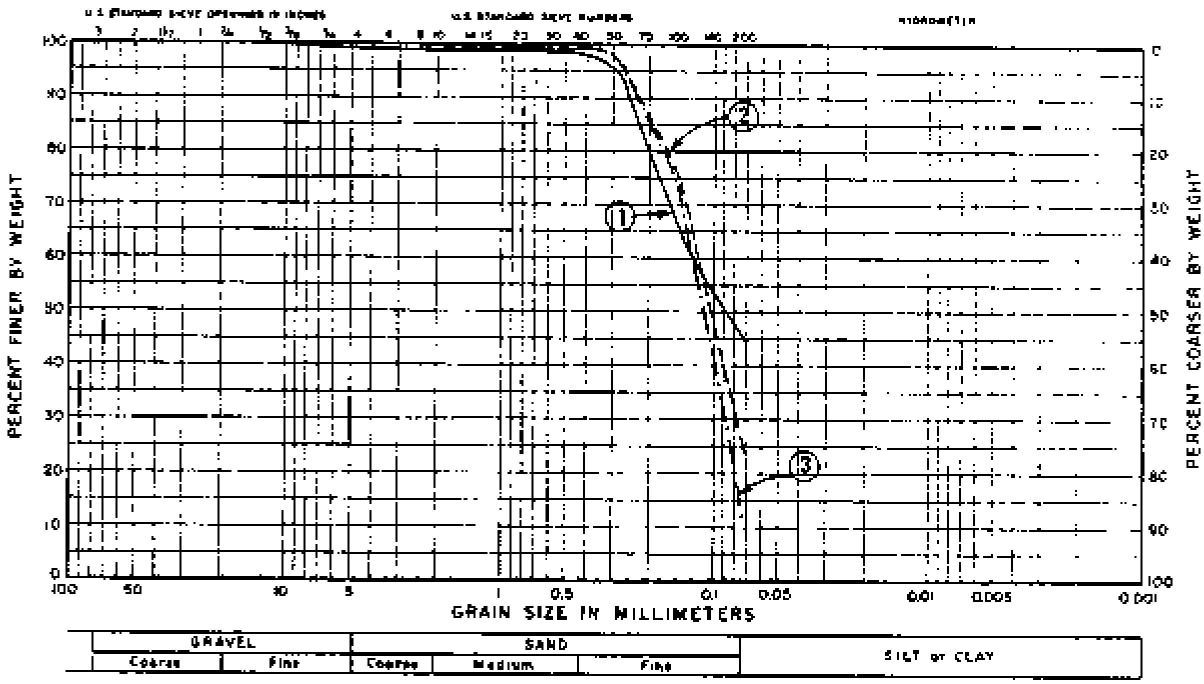
BORING: D-16 DEPTH: 44.0 Ft.
MATERIAL: Very stiff dark gray silty clay with silty sand pockets

UNIT DRY WEIGHT: 109 LB/CU FT
WATER CONTENT: 19 %
LIQUID LIMIT: 47
PLASTIC LIMIT: 22



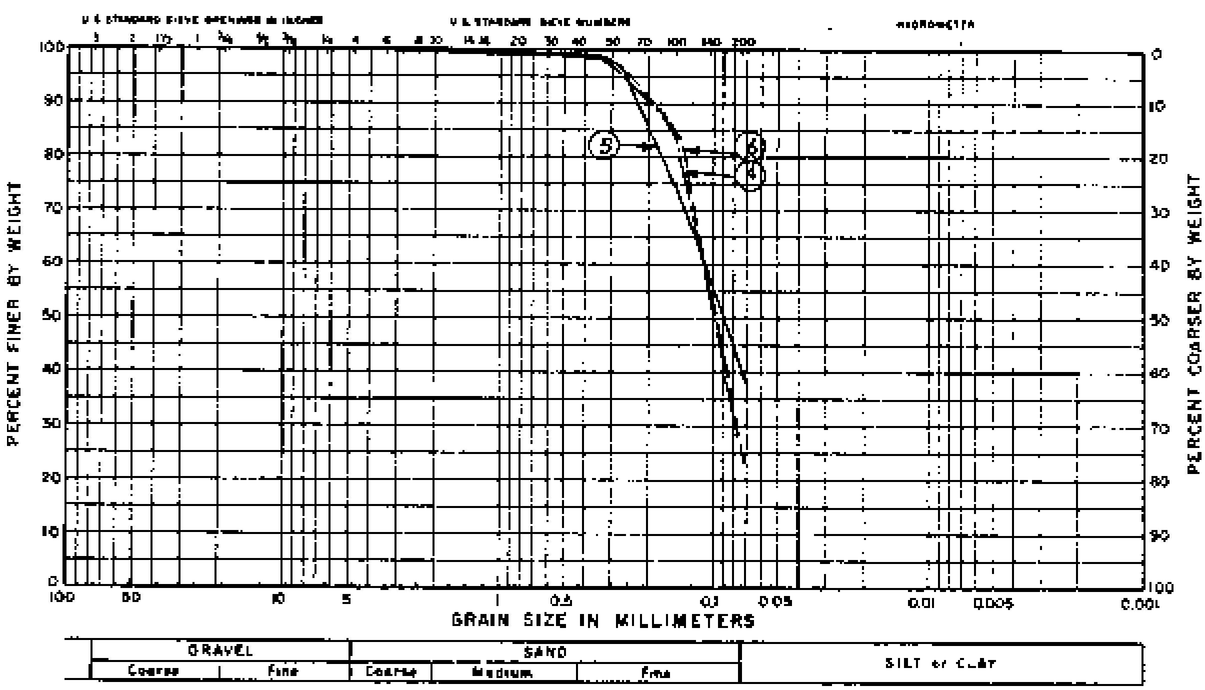
CONSOLIDATION TEST RESULTS

GRAIN SIZE CURVES



Curve No.	Boring No.	Penetration, Ft	Material
1	D-1	30.0	Light gray clayey sand
2	D-1	59.5	Gray and tan silty fine sand
3	D-15	15.0	Gray and tan silty fine sand

GRAIN SIZE CURVES



Curve No.	Boring No.	Penetration, Ft	Material
4	D-17	39.5	Tan silty fine sand
5	D-24	9.0	Tan and light gray silty fine sand
6	D-31	150.0	Gray silty fine sand

Monitoring Well Locations

Limestone Power Plant

NRG Energy


MW-5
MW-4

7.a) Observation Well

- The groundwater monitoring program at Limestone is designed to monitor potential impacts of the Solid Waste Disposal Area (SWDA) on groundwater resources beneath the site and in the vicinity of Lynn Creek down-gradient of the DSDA. Groundwater monitoring has been conducted at the Limestone Plant since 1988. During each semi-annual sampling event, static water level measurements are taken and a set of groundwater samples are collected at each of the eleven monitoring wells. Historical water level measurements from MW-5 located immediately down gradient from the DSDA reported no significant increase in the water elevation.
- Historical water level measurements from MW-4 located immediately down gradient from the ST-18 reported no significant increase in the water elevation.

Pro. . . Identification
No. HOU-3037-101200

HOUSTON LIGHTING & POWER COMPANY
LIMESTONE ELECTRIC GENERATING STATION
UNIT 1, 750 MW 1985 INSTALLATION
UNIT 2, 750 MW 1986 EXTENSION

CIVIL DESIGN CRITERIA

CDC-1

SITE IMPROVEMENTS

Status	Date	Prepared By	Reviewed By	Pages Affected
Original	1/23/80	W Broderick WB	A A Toth AAT	
R1	4/5/85	R Sullivan RS	R Kapadia RK	
R2				
R3				
R4				

EBASCO SERVICES INCORPORATED

NEW YORK, NEW YORK

CONTENTS

1.0 SITE IMPROVEMENTS

1.1 General Plant Description

The plant site is located in Limestone County, Texas, approximately 130 miles NNW of Houston. It is a two unit installation for the Limestone Electric Generating Station of the Houston Lighting & Power Company.

The plant grade for this site is established at 450.0 feet above sea level. The ground level and contours in the vicinity of the plant site are shown on U.S. Geological Survey Map (Farrar, Texas Quad Sheet) with the scale of 1:24000. The site is underlain by the Calvert Bluff Formation of the Wilcox Group. This formation consists primarily of fine grained alluvial sediments ranging from medium sand to clay.

A well water system provides cycle makeup and supply for the potable water system. Wells are provided by HL&P. Cooling tower makeup is pumped with Lake Limestone, located approximately seven miles away by pipeline to the plant.

Lignite fuel is delivered to the plant from the mine area by overland conveyor. Provisions will also be designed for future truck delivery.

On site storage of bottom ash and scrubber slugde is provided. Ash pond and stabilized sludge areas are designed for a 35 year ultimate storage capacity including dikes and staged development per the requirements of CDC-13. R1

1.2 Site Plan

a) Site Plan drawing M-101609 is developed by Civil in concert with Project's development of the Enlarged Site and Plot Plans described below. This Site Plan drawing shows the overall site including the following at a scale of 1"=800':

- Property acquisition line
- Contour lines (topography)
- Location of make-up (M-U) Water Intake at Lake Limestone
- Routing of the M-U water pipe line from Lake Limestone to plant
- Transmission Line Routing
- Location of Northerly limits of lignite deposits
- Routing and interface point between plant and mainline for railroad

1.0 SITE IMPROVEMENTS (Cont'd)

1.2 Site Plan (Cont'd)

b) Enlarged Site Plan - Plant area drawing M-001600 developed by Projects covers the main arrangement features for areas of proximity to the main plant and includes the following at a scale of 1"=600':

- Property limits
- Wind Rose
- Overall plant arrangement
- True North & Texas Grid North
- Coordinates of Plant Reference Lines & Base Lines
- General location of plant buildings, liquid storage areas, cooling towers, lignite storage piles and waste disposal areas.

1.3 Plot Plan

The plot plan drawing M-001601 developed by Projects shows the plant layout within the confines of the property lines to a larger scale and in greater detail than the site plan drawings. The plot drawing includes:

- A scale of 1"-100', showing a more prominent plan of the plan complex including all components and buildings and their relation to each other R1
- Space to be allocated for future use in the vicinity of the new plant
- Access roads and railroads in the vicinity of the plant
- Grid coordinates of the steam generator and turbine
- Tie-in to column line locations of the main structures with the site coordinates
- Circulating water and make-up water piping in the cooling tower and main plant vicinity
- Lignite storage and handling facilities
- Limestone unloading, storage and handling facilities
- Solid waste handling and disposal facilities

1.0 SITE IMPROVEMENTS (Cont'd)

1.4 General Improvements

General improvements to the plant site include the work of clearing, grubbing, excavation, backfilling, grading, drainage, and erosion and sediment control. Also included are the construction of access roads, railroads, walks, parking facilities, dams, dikes, embankments, and foundation preparation. The site plan and plot plan drawings described above, provide the basis for developing the requirements and extent of the site improvement work. R1

2.0 DESIGN BASIS

2.1 Clearing and Grubbing

"Clearing" includes the cutting of all trees to within one (1) foot of the groundline and the disposal of the trees, limbs, branches, slash, deadfalls, wood fencing, wood structures and other debris or encumberences present in the areas to be cleared that are free to float. "Clearing and grubbing" includes the complete removal and disposal of all standing trees including their root systems, all brush, bushes, shrubs, stumps, vines, and their root systems, logs, trees cut by others, wood fencing, wood structures, debris rubbish or encumberences that are free to float.

The clearing and grubbing drawing shows the exact limits for "clearing", and "clearing and grubbing", based on the site and plot plans and on construction requirements.

Clearing and grubbing must comply with all Federal and State laws and local ordinances including those concerning disposal of materials. Erosion and sediment control is provided.

2.2 Excavation and Backfill

The work of excavation, backfill, filling and grading includes:

a) the removal and storage or disposal of all earth, sand, gravel, rock, boulders, debris and other materials at stockpile locations or in spoil areas;

b) erecting and maintaining substantial barricades around excavations where required for safety;

c) backfilling of all unauthorized overexcavations

d) care and removal of all surface water, rainwater and groundwater seeping or flowing into the excavations by means of ditching, damming, pumping or other suitable means;

2.0 DESIGN BASIS (Cont'd)

2.2 Excavation and Backfill (Cont'd)

e) the foundation preparation in advance of concrete placement under the plant structures.

Equipment and services shall comply with all Federal and State laws, EPA requirements, and local ordinances. In addition, requirements are established for meeting or adhering to specified "Standard Specification" or "Tentative Specifications" of the American Society for Testing and Materials (ASTM). These include standards for the classification of soils as well in-place and laboratory density testing of soils.

The location and extent of the work to be done is illustrated on the appropriate excavation and backfill drawings.

2.3 Dewatering

The operation and maintenance of a temporary dewatering system is the contractor's responsibility if dewatering is required by the excavation and backfill requirements for this site. The general purpose of a dewatering system is to lower and control ground water levels and hydrostatic pressures to permit all excavation and construction to be performed in the dry.

2.4 Erosion and Sediment Control

Erosion and sediment control will be provided to limit the quantity and rate of discharge of turbid water into the streams and waterways at the site.

Permanent erosion control features are incorporated into the project at the start of construction. Temporary control measures are used to control erosion and sediment discharges that develop during normal construction practices but are not associated with permanent control features of the project.

2.5 Embankments, Dams, Dikes & Channels

The design of embankments, dams, dikes and channels for this plant is a function of site topography and soil characteristics. Stripping and preparation of embankment foundations and the placement of embankment material are described in the specifications and on the drawings.

2.0 DESIGN BASIS (Cont'd)

2.5 Embankments, Dams, Dikes, & Channels (Cont'd)

Fill material and placement techniques are established based on site conditions and structural requirements. Cut-off trenches are provided if applicable. Backfilling of impervious material is provided for if required.

Slope protection is provided on faces of all embankments, dams, dikes, and channels for protection of slopes against the action of wind, wave and erosion.

2.6 Plant Roads, Bridges, Walks, Parking

Roads are provided for plant access and construction access. A plant loop system of roads is provided around the main plant buildings. Access roads are provided to the major outlying structures such as the coal handling system, bottom ash pond, stabilized sludge area, circulating water system structures and other facilities. Walks adjacent to buildings are provided to serve the outside equipment.

Bridges or culverts are provided as necessary for access roads where the roads cross water or drainage facilities.

Adequate parking facilities for the operating staff, visitors, and other employees are provided, as required, in such areas as adjacent to the gate house, the service building, the coal crusher house, the coal unloading station as well as the control building.

The access roads and all loop roads for the plant are designed for H-20 truck loading in accordance with AASHTO standards and Ebasco design guides. Grades are limited to 6% maximum. Length of vertical curves are limited to 50 feet minimum. Horizontal curves are limited to centerline radii to 40 feet minimum.

2.7 Railroads

Permanent railroad tracks are provided from the existing main rail line to the plant area for delivery of lignite, limestone, materials, and equipment. Within the plant area, sidings are provided for lignite and limestone delivery stabilized sludge removal, maintenance and equipment delivery, service to light oil tanks and liquid chlorination tanks with the necessary by-pass and cross-over tracks. Refer to Plot Plan Drawing No. HOU-3037-M-001601.

2.0 DESIGN BASIS (Cont'd)

2.7 Railroads (Cont'd)

Railroad lines are designed in accordance with AREA standards and Ebasco design guides. Grades are limited to 1% entering and 1.5% exiting the plant and curves are limited to a minimum radii of 410 feet unless local railroad criteria stipulate otherwise.

2.8 Drainage

The plant area is provided with two isolated drainage systems to handle contaminated and uncontaminated water. The contaminated drainage system handles liquid discharges from equipment and storage areas which might be contaminated with oil and/or chemicals. The uncontaminated drainage system provides for safe discharge of uncontaminated storm water.

Diversion ditches are provided around the bottom ash pond, the stabilized sludge area, and the main plant area to provide for safe dissipation of storm water from surrounding areas. The main plant area is also provided with a storm drainage system. No provision will be made to spill any water from the bottom ash impoundment during the operational life of the plant. Prior to abandonment of the bottom ash pond, after 35 years of operation, the bottom ash will be covered with top soil and seeded, and a spillway structure constructed to accommodate runoff after the recycling of water ceases. However, during the operational life of the pond an emergency overflow device will be provided to ensure structural stability of the embankment. This emergency overflow provision is designed to prevent overtopping due to a more severe rainfall intensity event than called for by operational design requirements.

The rainfall intensity for the plant area is based on a 25 year, 24 hour storm as defined in Weather Bureau Technical Paper No. 40. Emergency spillways for structures other than the bottom ash pond are designed for a more severe rainfall, 50 year, 24 hour storm. The "rational method" as outlined in Ebasco design guide is used for estimating runoff.

The storm drain lines are designed to run 75 percent full. The flow velocity in the storm drain lines is set for a maximum of 8 feet per second and a minimum of 3 feet per second. Catch basins or manholes are provided at changes in alignment or grade, at drain line junctions, and located so as not to exceed 300 feet.

Drainage ditches have a minimum slope of 0.002.

2.9 Fencing

Security fencing is provided around the main plant area and substation as shown on the Plot Plan. The perimeters of the plant area, the electrical substation, the ash pond, and stabilized sludge areas are provided with an 8 foot high chain link security fence with barbed wire arms. Gates for access are provided at roads, railroads, and walkways.

3.0 CONSTRUCTION FEATURES

3.1 Clearing and Grubbing

All "clearing", and "clearing and grubbing", and handling of debris proceeds in a manner that avoids interference with other work in progress. Extreme care is taken to preserve and avoid damage to trees, shrubs and other vegetative cover in areas outside the limits defined on the drawings. Any practical means for performing the work may be employed including such equipment as tractors and chains, bulldozers with brush hooks or rakes or ax and chain saw. Products of the "clearing", and "clearing and grubbing" work are completely and immediately disposed of. Adequate equipment and personnel for fire prevention and control are provided. All grubbing holes and depressions are backfilled, compacted and graded to conform to the surrounding ground contours.

3.2 Excavation and Backfill

All excavation is made in the order of progress required by the construction program. During the course of all excavation work, extreme care is exercised to preserve and avoid damage to trees, shrubs and all other vegetation which does not directly hamper work progress. Only approved access roads are used. The discharge into natural streams or ponds of gasoline, oil or any other waste material is prohibited.

Insofar as it is practiciable, all suitable materials resulting from open-cut excavations shall be used for permanent construction. All waste or excess material is disposed of in a manner which will avoid the necessity of rehandling or the interference with other work.

The bottom excavations will be proof rolled prior to the initiation of backfill operations. The placement and compaction procedure of the various types of fill will be established to yield the required in-place densities. The backfill is compacted to a minimum of 95 percent of the maximum density obtained in the Modified Proctor Compaction Test (ASTM D-1557, Method C).

Control tests of densities and moisture contents will be made as the work progresses to assure that required densities and moisture content are being achieved. The soils control program assures that all controlled backfills comply with design requirements and specifications.

The soils control activities are performed primarily in four areas of the project. These four major areas are the borrow areas, stockpile area, the construction area and the soils in laboratory. The activities performed in each of these areas are integrated in accordance with the specifications. Records are maintained to provide quality assurance for the complete soils control program.

3.0 CONSTRUCTION FEATURES (Cont'd)

3.3 Dewatering

The dewatering system, if required for construction, shall achieve the following:

a) minimize the disturbance to the foundation soils in the vicinity of the wells;

b) the wells, screens, filters and pumps are surged and developed such that fines or sands being removed for the entire system are minimized; and

c) upon completion of the dewatering requirements, the wells shall be completely grouted.

Observation wells (piezometers) are provided to monitor the elevation of the ground water and piezometric water levels continuously during operations. Provision for emergency flooding of excavations is required.

3.4 Erosion and Sediment Control

Every effort is made to minimize erosion from excavation and embankment construction operation by:

a) the construction of temporary berms, dikes and diversion ditches;

b) limiting the disturbance of natural areas to the absolute minimum required;

c) implementing measures of erosion control described in the EPA publications EPA-R2-72-015 and EPA-62513-76-003 (See References); and

d) sequencing of excavation and embankment construction to maintain natural traps on eroded material.

All slopes freshly excavated and shaped are raked along the contour lines. Slopes not shaped to final grade are also raked across the slopes if they are to be exposed for more than 24 hours. Slopes shaped to the final grade, as well as all disturbed areas to remain exposed during a period of critical erosion, are immediately protected by seeding and mulching.

3.5 Embankments, Dams, Dikes & Channels

Protection against flooding from storms and large flows in washes is provided for.

3.0 CONSTRUCTION FEATURES (Cont'd)

3.5 Embankments, Dams, Dikes & Channels

All soft or unstable material shall be excavated to establish a stable foundation. Upon completion of excavation and initial preparation the foundations will be inspected and mapped.

Operations affecting the materials and installation of the embankment dikes will be subject to quality assurance surveillance.

3.6 Plant Roads, Bridges, Walks, Parking

The main access roads are 24 feet wide with 6 foot wide shoulders. The plant loop roads and other access roads are 20 feet wide with 4 foot wide shoulders. The roads are built of reinforced concrete on a base of stabilized local soil. The base consists of a 6 inch base coarse of crushed aggregate on compacted and rolled subgrade. The roads are crowned approximately 2 inches for drainage.

Concrete and/or crushed stone walks 5 feet wide are provided in the vicinity of the building and equipment outside the main plant. The parking areas are surfaced with reinforced concrete.

3.7 Railroads

The railroads is constructed of crushed stone ballast 10 inches thick placed beneath the ties on the well compacted and rolled subgrade. The ties for the railroad track support are 6 inch x 8 inch x 8 feet - 6 inch wood treated by creosote petroleum solution. Track for all railroads are 115 pound AREA rail.

3.8 Drainage

All storm water runoff from within the coal storage and reclaimer area is drained to the contaminated waste water basin.

Concrete pits with grating are provided at the main and auxiliary transformers of sufficient capacity to retain all transformer oil. All storm water runoff collected in these pits is conveyed to the contaminated drainage system.

Concrete pipe is used for all storm drain lines. Unreinforced concrete pipe is used for drain lines up to 10 inches in diameter. Reinforced concrete pipe is used for drain lines 12 inches and over.

3.0 CONSTRUCTION FEATURES (Cont'd)

3.9 Fencing

Fabric and framing are of galvanized steel and are installed in accordance with industry standards. Line posts are spaced a maximum of 10 feet on centers. Pull posts and gate posts are installed as required.

4.0 REFERENCES

4.1 Codes and Standards

Equipment, services, material fabrication and testing will conform strictly to codes, specifications and standards as indicated. In general, the latest revision of the following codes and standards apply:

a) Occupational Safety and Health Standards, OSHA Regulation 29 CFR Part 1910 (November 7, 1978);

b) American Society for Testing Materials - ASTM

c) American Concrete Institute (ACI) 318 "Building Code Requirements for Reinforced Concrete."

4.2 Guides and Criteria

Weather Bureau Technical Paper No. 40.

Ebasco Concrete - Hydraulic Design Guide.

Ebasco CDC-2, "Site Investigation, Excavation and Foundation Design Parameters", Project Identification No. HOU-3037-102200.

EPA-R2-72-015, "Guideline for Erosion and Sediment Control Planning and Implementation", August 1972.

EPA-62513-76-003, "Erosion and Sediment Control Surface Mining in the Eastern U.S., Volume 1 and 2", October 1976.

4.3 Ebasco Specifications

"Clearing and Grubbing", Project Identification No. HOU-3037-101400

"Subsurface Investigation & Drilling", Project Identification No. HOU-3037-102400

"Excavation & Backfill", Project Identification No. HOU-3037-102401

"Embankments, Dams, Dikes & Channels", Project Identification No. HOU-3037-102408

4.0 REFERENCES (Cont'd)

4.4 Reference Drawings

Enlarged Site Plan - Plant Area	HOU-3037-001600	R1
Plot Plan	HOU-3037-001601	
Grading	HOU-3037-101600	
Drainage	HOU-3037-101602	
Paving Plan	HOU-3037-101603	
Plant Roads	HOU-3037-101604	
Railroads & Unloading Areas	HOU-3037-101605	
Erosion & Sediment Control, Plans & Sect.	HOU-3037-101606	
Erosion & Sediment Control, Settling Pond	HOU-3037-101607	
Erosion & Sediment Control, Inlet & Discharge	HOU-3037-101608	
Site Plan	HOU-3037-101609	R1
Holding Basin Area Roads, Grading & Drainage	HOU-3037-101610	
Holding Basin Infl. & Distrib. Struc. M & R	HOU-3037-101611	
Holding Basin Area Excavation Plan	HOU-3037-101612	
Coal Pile Seepage Control	HOU-3037-101620	
Foundation Investigation - Profiles	HOU-3037-102605	
Boring Plan	HOU-3037-102610	
Excavation & Backfill	HOU-3037-102620	
Manholes & Trenches	HOU-3037-102625	

T.H.

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

ATLANTA, GEORGIA ZIP CODE 30306 600 VIRGINIA AVE., N.E. PHONE (404) 872 0795	MONROE, LA ZIP CODE 71201 315 N. SECOND ST. PHONE (318) 387-2327	NEW ORLEANS, LA ZIP CODE 70112 814 CONTI ST. PHONE (504) 524 8395	AUSTIN, TEXAS ZIP CODE 78723 1916 TILLERY ST. PHONE (512) 477-3738	BEAUMONT, TEXAS ZIP CODE 77705 2480 W. CARDINAL DR. #Z PHONE (713) 842-1020	CORPUS CHRISTI, TEXAS ZIP CODE 78416 810 S. PADRE ISLAND DR. PHONE (512) 854-4801	
EAGLE PASS, TEXAS ZIP CODE 78852 RT. 2 BOX 4917 PHONE (512) 773 3717	FREEPORT, TEXAS ZIP CODE 77541 415 NORTH AVENUE F PHONE (713) 233 6366	HARLINGEN, TEXAS ZIP CODE 78550 210 N. "T" STREET PHONE (512) 423-6826	HOUSTON, TEXAS ZIP CODE 77007 1714 MEMORIAL DR. PHONE (713) 224-2047	LAREDO, TEXAS ZIP CODE 78041 2908 SAN BERNARDO PHONE (512) 727-3702	SAN ANTONIO, TEXAS ZIP CODE 78216 8430 WESTERN BLVD. PHONE (512) 342 9377	VICTORIA, TEXAS ZIP CODE 77901 402 E. STEPHENSON DR. PHONE (512) 575 0281

REPORT OF FIELD COMPACTION TESTS

TESTED FOR: Houston Lighting & Power Company
Attn: L.D. Wilson

PROJECT: Limestone Electric Generating Statio
Limestone County, Texas
Units 1 & 2

DATE: 9-7-83 S.W.D.A

OUR REPORT NO.: B-100-2000

	TEST NO.	*	**	LOCATION	DEPTH / ELEV	PERCENT MOISTURE	PERCENT COMPACTION	COMMENTS
1	9411	2-C	A	Hazardous Waste Area West Bank	6"	12.1	85.4	A
6	8446	2-C	A	" " " " "	6"	16.8	85.2	A

METHOD OF TEST:

* G - GRANULAR C - COHESIVE 1 - EMBANKMENT 2 - BACKFILL 3 - BASE COURSE 4 - SUBGRADE

** A MAXIMUM DENSITY 123.2 B-101-46 #/CU. FT. OPTIMUM MOISTURE 10.0 % AASHTO T-____

B MAXIMUM DENSITY ____ #/CU. FT. OPTIMUM MOISTURE ____ % AASHTO T-____

BALLOON ☐ SAND CONE ☐ NUCLEAR DENSOMETER ☑

COMMENTS: A. TEST RESULTS COMPLY WITH SPECIFICATIONS B. RECOMPACTION REQUIRED C. TEST IS AFTER RECOMPACTION

REMARKS: Gauge #8489, Funnel #___, Inspector: Murray Wall

Following Page 1 of 7 Total tests = 18

Respectfully Submitted,

Hunter B. Atkins

Report No.: B-103-46

HOUSTON LIGHTING & POWER

SIEVE ANALYSIS
ASTM D422, D1140

PROJECT Limestone

SAMPLE IDENTIFICATION red/brown clayey silty sand P-46

SOURCE OF SAMPLE RR E of 39

DATE SAMPLED 12-4-81 DATE TESTED 12-11-81

SHOW WEIGHT TO NEAREST TENTH. 206.3

SHOW %s TO NEAREST WHOLE NO.

SPECIFICATION							
		SAND	SIEVE	WEIGHT RETAINED	CUMULATIVE WT. RETAINED	CUMULATIVE % WT. RETAINED	CUMULATIVE % WT. PASSING
			4	-0-	-0-	-0-	100.0
			40	6.4	6.4	3.2	96.8
			200	137.2	143.6	62.7	37.3
			PAN				

SAND FINENESS MODULUS	

REVIEWED BY ____________

INSPECTOR H. Atkins

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

ATLANTA, GEORGIA ZIP CODE 30308 600 VIRGINIA AVE., N E PHONE (404) 872 0795	MONROE, LA ZIP CODE 71201 315 N. SECOND ST. PHONE (318) 387 2327	NEW ORLEANS, LA ZIP CODE 70112 814 CONTI ST. PHONE (504) 524-8395	AUSTIN, TEXAS ZIP CODE 78723 1916 TILLERY ST. PHONE (512) 477-3738	BEAUMONT, TEXAS ZIP CODE 77705 2480 W CARDINAL DR. #Z PHONE (713) 842-1020	CORPUS CHRISTI, TEXAS ZIP CODE 78416 810 S. PADRE ISLAND DR. PHONE (512) 854 4801	
EAGLE PASS, TEXAS ZIP CODE 78852 RT. 2 BOX 4917 PHONE (512) 773-3717	FREEPORT, TEXAS ZIP CODE 77541 415 NORTH AVENUE F PHONE (713) 233 6366	HARLINGEN, TEXAS ZIP CODE 78550 210 N. "T" STREET PHONE (512) 423-6826	HOUSTON, TEXAS ZIP CODE 77007 1714 MEMORIAL DR. PHONE (713) 224-2047	LAREDO, TEXAS ZIP CODE 78041 2908 SAN BERNARDO PHONE (512) 727-3702	SAN ANTONIO, TEXAS ZIP CODE 78216 8430 WESTERN BLVD. PHONE (512) 342-9377	VICTORIA, TEXAS ZIP CODE 77901 402 E. STEPHENSON DR. PHONE (512) 575 0281

REPORT OF FIELD COMPACTION TESTS

TESTED FOR: Houston Lighting & Power Company
Attn: L.D. Wilson

PROJECT: Limestone Electric Generating Statio
Limestone County, Texas
Units 1 & 2

DATE: 6-23-83 Solid Waste Disp. area

OUR REPORT NO.: B-100-1649

TEST NO.	*	**	LOCATION	DEPTH / ELEV	PERCENT MOISTURE	PER CENT COMPACTION	COMMENTS
7620	2-C	A	S. East Bank of Pond @ Solid Waste Disposal area	6"	17.1	100+	A
7621	2-C	A	East Bank of Pond at Solid Waste Disposal area	6"	19.7	100+	A
7622	2-C	A	N. Eastside of Bank of Solid Waste Disposal area Pond	6"	21.7	100+	A

METHOD OF TEST:

* G - GRANULAR C - COHESIVE 1 - EMBANKMENT 2 - BACKFILL 3 - BASE COURSE 4 - SUBGRADE

** A MAXIMUM DENSITY 94.6 P-51 #/CU. FT. OPTIMUM MOISTURE 25.6 % AASHTO T.____

B MAXIMUM DENSITY ____ #/CU. FT. OPTIMUM MOISTURE ____ % AASHTO T.____

BALLOON ☐ SAND CONE ☐ NUCLEAR DENSOMETER ☒

COMMENTS: A. TEST RESULTS COMPLY WITH SPECIFICATIONS B. RECOMPACTION REQUIRED C. TEST IS AFTER RECOMPACTION

REMARKS: Gauge #4437, Funnel #___, Inspector: K. Bowen

.olloway

PAGE 1 OF 2

Respectfully Submitted,

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

ATLANTA, GEORGIA ZIP CODE 30306 600 VIRGINIA AVE., N.E. PHONE (404) 872-0795	MONROE, LA ZIP CODE 71201 315 N. SECOND ST. PHONE (318) 387-2327	NEW ORLEANS, LA ZIP CODE 70112 814 CONTI ST. PHONE (504) 524-8395	AUSTIN, TEXAS ZIP CODE 78723 1916 TILLERY ST. PHONE (512) 477-3738	BEAUMONT, TEXAS ZIP CODE 77705 2480 W. CARDINAL DR. #Z PHONE (713) 842-1020	CORPUS CHRISTI, TEXAS ZIP CODE 78416 810 S. PADRE ISLAND DR. PHONE (512) 854-4801	
EAGLE PASS, TEXAS ZIP CODE 78852 RT. 2 BOX 4917 PHONE (512) 773-3717	FREEPORT, TEXAS ZIP CODE 77541 415 NORTH AVENUE F PHONE (713) 233-5366	HARLINGEN, TEXAS ZIP CODE 78550 210 N. "T" STREET PHONE (512) 423-6826	HOUSTON, TEXAS ZIP CODE 77007 1714 MEMORIAL DR. PHONE (713) 224-2047	LAREDO, TEXAS ZIP CODE 78041 2908 SAN BERNARDO PHONE (512) 727-3702	SAN ANTONIO, TEXAS ZIP CODE 78216 8430 WESTERN BLVD. PHONE (512) 342-9377	VICTORIA, TEXAS ZIP CODE 77901 402 E. STEPHENSON DR. PHONE (512) 575-0281

REPORT OF FIELD COMPACTION TESTS

TESTED FOR: Houston Lighting & Power Company
Attn: L.D. Wilson

PROJECT: Limestone Electric Generating Statio
Limestone County, Texas
Units 1 & 2

DATE: 6-23-83 S.W.D.A.

OUR REPORT NO.: B-100-1052

	TEST NO.	*	**	LOCATION	DEPTH / ELEV	PERCENT MOISTURE	PERCENT COMPACTION	COMMENTS
4	7640	2-C	A	South West Bank of Solid Waste Disp. area Pond	6"	21.8	100+	A
5	7641	2-C	A	South East Bank of Solid Waste Disposal area Pond	6"	20.3	100+	A

METHOD OF TEST:

* G - GRANULAR C - COHESIVE 1 - EMBANKMENT 2 - BACKFILL 3 - BASE COURSE 4 - SUBGRADE

** A MAXIMUM DENSITY 94.6 / B-101-51 #/CU. FT. OPTIMUM MOISTURE 25.6 % AASHTO T-___

B MAXIMUM DENSITY ____ #/CU. FT. OPTIMUM MOISTURE ____ % AASHTO T-___

BALLOON ☐ SAND CONE ☐ NUCLEAR DENSOMETER ☐

COMMENTS: A. TEST RESULTS COMPLY WITH SPECIFICATIONS B. RECOMPACTION REQUIRED C. TEST IS AFTER RECOMPACTION

REMARKS: Gauge #4437, Funnel #___, Inspector: K Bowen

BSchultz

Holloway

Page 4 of 8

Respectfully Submitted,

Hamilton

SHILSTONE ENGINEERING TESTING LABORATORY, INC.
R. R. #1
Jewett, Texas 75846

REPORT OF MOISTURE DENSITY RELATIONSHIP OF SOIL

TESTED FOR: Houston Lighting & Power Company
Attn: L. D. Wilson

PROJECT: Limestone Electric Generating Station
Limestone County, Texas
Units 1 & 2

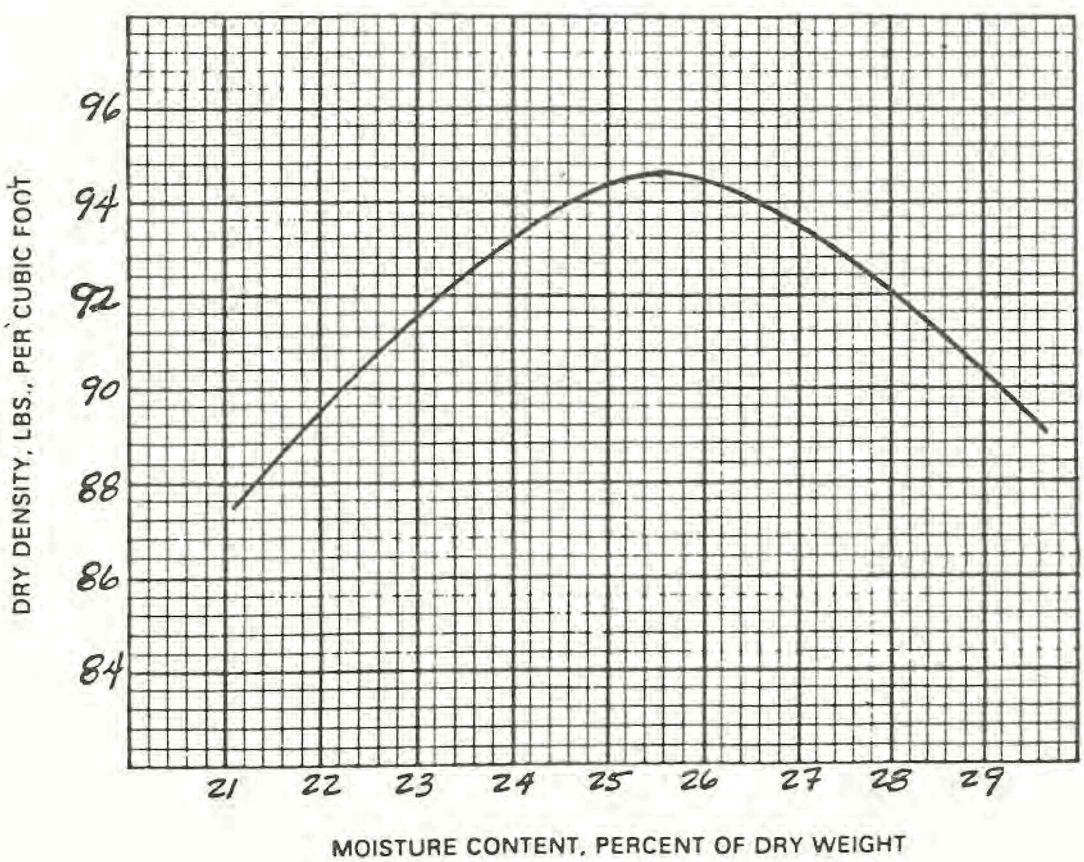
DATE: December 12, 1981

OUR REPORT NO.: B-101-51

TEST DATA

Visual Classification: Brownish red clay
Sample Source: Railway east of 39

Method of Test: ASTM D698 Method A
Test Results: Maximum Dry Density 94.6 lbs/ft³
Optimum Moisture Content 25.6 %



Respectfully Submitted,

Shilstone Engineering Testing Laboratory, Inc.

Report ~~Lab.~~ No. 8-102-47

ATTERBERG LIMITS TEST

Date 12-10-81

Project Limestone

Location RR E of 39 Vcty of R-12

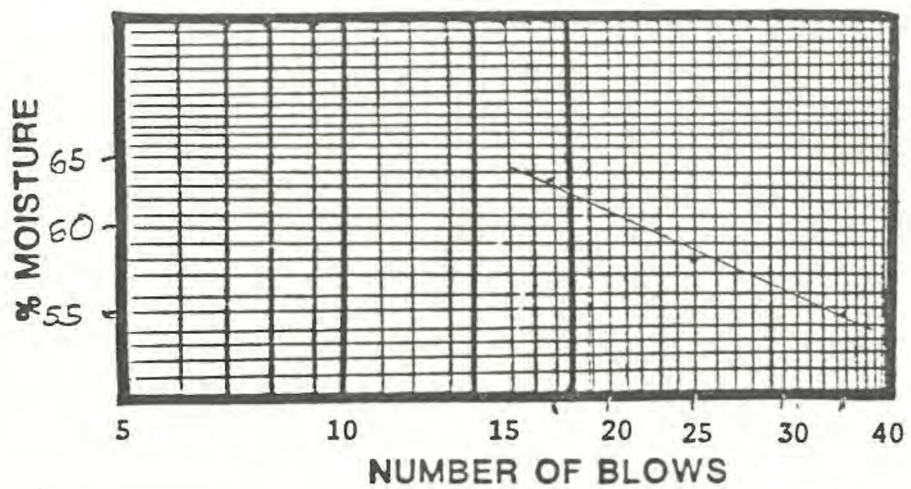
Sample No. P-51

Liquid Limit ASTM D 423					
Run Number		1	2	3	4
Dish No.		70	48	60	
Wt. in Gr.	Wt. Wet Soil + Dish	28.59	30.13	34.19	
	Wt. Dry Soil + Dish	23.55	24.[illegible]	26.57	
	Wt. Water	5.04	5.91	7.62	
	Wt. Dish	14.31	14.03	14.52	
	Wt. Dry Soil	9.24	10.19	12.05	
Moisture Content		54.5	57.9	63.[illegible]	
No. Blows		35	25	17	

L. L. 58

P. L. 29

P. I. 29



Plastic Limit ASTM D 424					
Run Number		1	2	3	4
Dish No.		29			
Wt. in Gr	Wt. Wet Soil + Dish	19.81			
	Wt. Dry Soil + Dish	[illegible]			
	Wt. Water	[illegible]			
	Wt. Dish	[illegible]			
	Wt. Dry Soil	[illegible]			
Moisture Content		28.5			
Plastic Limit		29			

Description of Sample Brownish red clay

Report No.: B-103-54

HOUSTON LIGHTING & POWER

N

SIEVE ANALYSIS
ASTM D422, D1140

PROJECT Limestone

SPECIFICATION			SAMPLE IDENTIFICATION Brownish red clay				
			SOURCE OF SAMPLE Vcty of R-12, P-51				
		SAND	DATE SAMPLED 12-10-81 DATE TESTED 12-11-81				
			SHOW WEIGHT TO NEAREST TENTH. 176.9				
			SHOW %s TO NEAREST WHOLE NO.				
			SIEVE	WEIGHT RETAINED	CUMULATIVE WT. RETAINED	CUMULATIVE % WT. RETAINED	CUMULATIVE % WT. PASSING
			4	-0-	-0-	-0-	100.0
			40	.1	.1	0.1	99.9
			200	69.9	70.0	39.6	60.4
			PAN				

SAND FINENESS MODULUS	

REVIEWED BY ____________________

INSPECTOR H. Atkins

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

ATLANTA, GEORGIA ZIP CODE 30306 600 VIRGINIA AVE., N.E. PHONE (404) 872-0795	MONROE, LA ZIP CODE 71201 315 N. SECOND ST. PHONE (318) 387-2327	NEW ORLEANS, LA ZIP CODE 70112 814 CONTI ST. PHONE (504) 524-8395	AUSTIN, TEXAS ZIP CODE 78723 1916 TILLERY ST. PHONE (512) 477-3738	BEAUMONT, TEXAS ZIP CODE 77705 2480 W. CARDINAL DR. #2 PHONE (713) 842-1020	CORPUS CHRISTI, TEXAS ZIP CODE 78416 810 S. PADRE ISLAND DR. PHONE (512) 854-4801	
EAGLE PASS, TEXAS ZIP CODE 78852 RT. 2 BOX 4917 PHONE (512) 773-3717	FREEPORT, TEXAS ZIP CODE 77541 415 NORTH AVENUE F PHONE (713) 233-6366	HARLINGEN, TEXAS ZIP CODE 78550 210 N. "T" STREET PHONE (512) 423-6825	HOUSTON, TEXAS ZIP CODE 77007 1714 MEMORIAL DR. PHONE (713) 224-2047	LAREDO, TEXAS ZIP CODE 78041 2908 SAN BERNARDO PHONE (512) 727-3702	SAN ANTONIO, TEXAS ZIP CODE 78216 8430 WESTERN BLVD. PHONE (512) 342-9377	VICTORIA, TEXAS ZIP CODE 77901 402 E. STEPHENSON DR. PHONE (512) 575-0281

REPORT OF FIELD COMPACTION TESTS

TESTED FOR: Houston Lighting & Power Company
Attn: L.D. Wilson

PROJECT: Limestone Electric Generating Station
Limestone County, Texas
Units 1 & 2

DATE: S.W.D.A 8-29-83 OUR REPORT NO.: B-100-1158

	TEST NO	*	**	LOCATION	DEPTH / ELEV	PERCENT MOISTURE	PERCENT COMPACTION	COMMENTS
2	8321	2-C	A	S.W.D.A Hazardous Waste N-E	6"	20.3	100+	A
3	8322	2-C	A	" " " N-W	6"	28.7	100+	A
4	323	2-C	A	" " " W	6"	20.0	100+	A
5	8324	2-C	A	" " " S-W	6"	25.8	100+	A
6	8325	2-C	A	" " " S-E	6"	18.0	100+	A
7	8326	2-C	A	" " " E	6"	20.0	100+	A

METHOD OF TEST:

* G - GRANULAR C - COHESIVE 1 - EMBANKMENT 2 - BACKFILL 3 - BASE COURSE 4 - SUBGRADE

** A MAXIMUM DENSITY 88.3 B-101-69 #/CU. FT. OPTIMUM MOISTURE 27.3 % AASHTO T.____

B MAXIMUM DENSITY ________ #/CU. FT. OPTIMUM MOISTURE ________ % AASHTO T.____

BALLOON ☐ SAND CONE ☐ NUCLEAR DENSOMETER ☑

COMMENTS: A. TEST RESULTS COMPLY WITH SPECIFICATIONS B. RECOMPACTION REQUIRED C. TEST IS AFTER RECOMPACTION

REMARKS: Gauge # 8490 Funnel #___, Inspector: Murray Wall

M. Wall

Page 2 of 6

Respectfully Submitted,

B. Shilstone

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

R. R. #1
Jewett, Texas 75846

ATLANTA, GEORGIA ZIP CODE 30306 600 VIRGINIA AVE., N.E. PHONE (404) 872 0795	MONROE, LA ZIP CODE 71201 315 N. SECOND ST. PHONE (318) 387 2327	NEW ORLEANS, LA ZIP CODE 70112 814 CONTI ST. PHONE (504) 524 8395	AUSTIN, TEXAS ZIP CODE 78723 1916 TILLERY ST PHONE (512) 477 3738	BEAUMONT, TEXAS ZIP CODE 77705 2480 W. CARDINAL DR. #2 PHONE (713) 842 1020	CORPUS CHRISTI, TEXAS ZIP CODE 78416 810 S. PADRE ISLAND DR PHONE (512) 854 4801	
EAGLE PASS, TEXAS ZIP CODE 78852 RT. 2 BOX 4917 PHONE (512) 773 3717	FREEPORT, TEXAS ZIP CODE 77541 415 NORTH AVENUE F PHONE (713) 233 6366	HARLINGEN, TEXAS ZIP CODE 78550 210 N. "T" STREET PHONE (512) 423 6826	HOUSTON, TEXAS ZIP CODE 77007 1714 MEMORIAL DR. PHONE (713) 224 2047	LAREDO, TEXAS ZIP CODE 78041 2908 SAN BERNARDO PHONE (512) 727 3702	SAN ANTONIO, TEXAS ZIP CODE 78216 8430 WESTERN BLVD PHONE (512) 342 9377	VICTORIA, TEXAS ZIP CODE 77901 402 E. STEPHENSON DR PHONE (512) 575 0281

REPORT OF MOISTURE DENSITY RELATIONSHIP OF SOIL

TESTED FOR: Houston Lighting & Power Company
Attn: L. D. Wilson

PROJECT: Limestone Electric Generating Station
Limestone County, Texas
Units 1 & 2

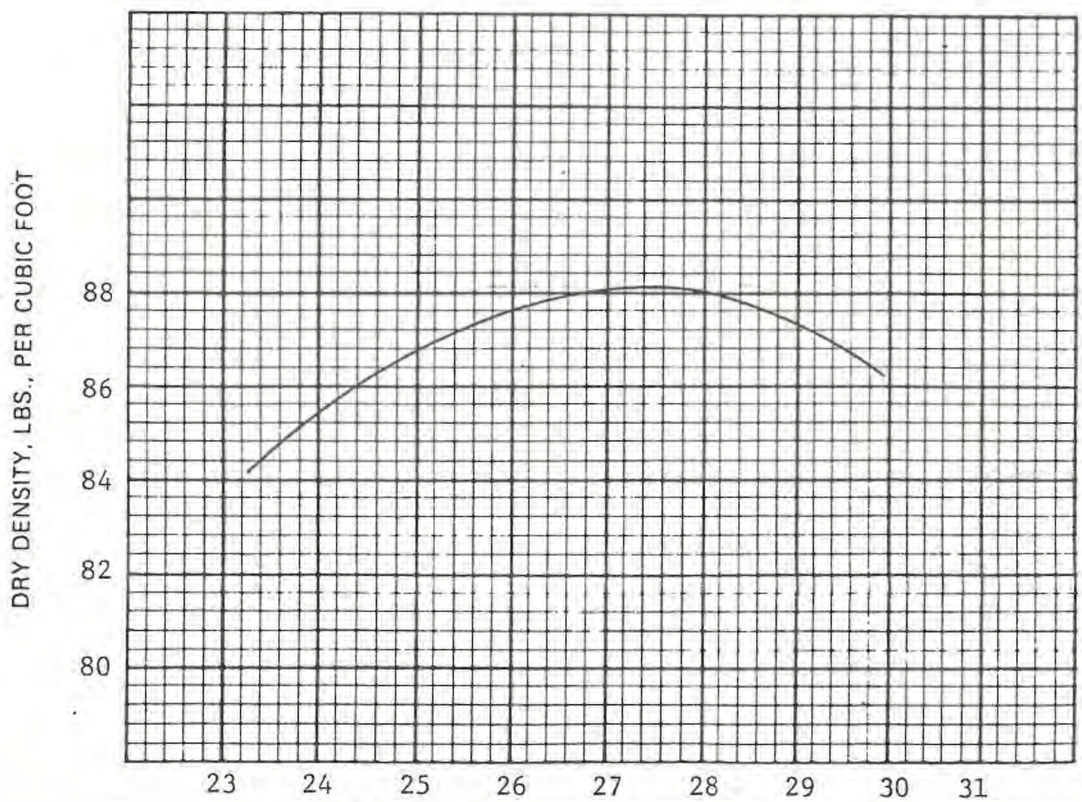
DATE: March 10, 1982

OUR REPORT NO.: B-101-069a

TEST DATA

Visual Classification: Red Clay
Sample Source: Area 3

Method of Test: ASTM D-698 Method A
Test Results: Maximum Dry Density 88.3 lbs/ft³
Optimum Moisture Content 27.3 %



Respectfully Submitted,
Shilstone Engineering Testing Laboratory, Inc.

OFFICES OF AFFILIATED CORPORATIONS:
ALBANY, AUGUSTA, COLUMBUS, GA; CARBONDALE, CHAMPAIGN, DOWNERS GROVE (CHICAGO), EAST PEORIA, SPRINGFIELD, IL; FT. WAYNE, TERRE HAUTE, WEST LAFAYETTE, IN; ANN ARBOR, DETROIT, FLINT, LANSING, MI; CHARLOTTE, NC; COLUMBUS, LIMA, OH; COLUMBIA, FLORENCE, SC
5805M

REPORT NO. ~~XXXXXXX~~. B-102-082

ATTERBERG LIMITS TEST

Date 8-1-82

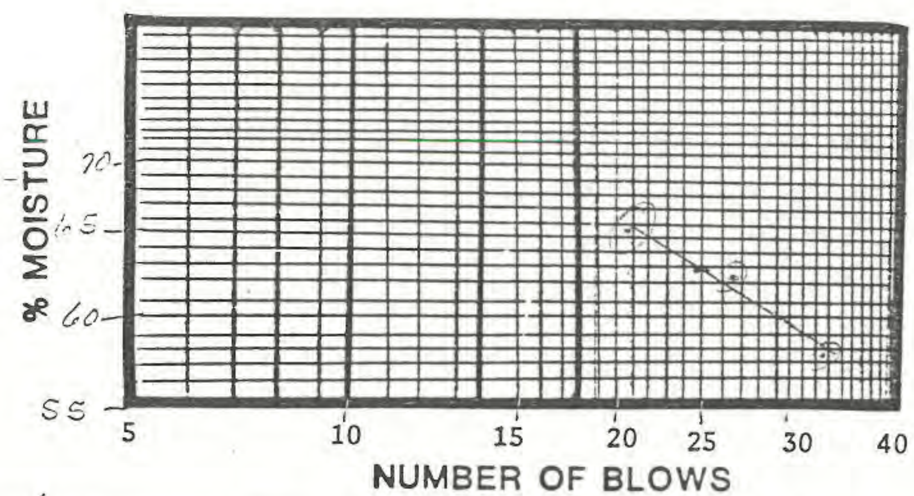
Project [illegible]

Location [illegible]

Sample No. P-29

Liquid Limit ASTM D 423					
Run Number		1	2	3	4
Dish No.		24	7	48	
Wt. in Gr.	Wt. Wet Soil + Dish	28.82	26.05	28.47	
	Wt. Dry Soil + Dish	23.44	21.79	22.87	
	Wt. Water	5.38	4.76	5.60	
	Wt. Dish	14.15	14.13	14.27	
	Wt. Dry Soil	9.29	7.66	8.60	
Moisture Content		57.9	63.4	65.1	
No. Blows		33	27	21	

L. L.	63
P. L.	31
P. I.	32



Plastic Limit ASTM D 424					
Run Number		1	2	3	4
Dish No.		22			
Wt. in Gr.	Wt. Wet Soil + Dish	[illegible]			
	Wt. Dry Soil + Dish	20.00			
	Wt. Water	1.83			
	Wt. Dish	[illegible]			
	Wt. Dry Soil	5.87			
Moisture Content		31.2			
Plastic Limit		31			

Description of Sample Red Silty Clay

Technician [illegible] Reviewed By [illegible]

HOUSTON LIGHTING & POWER

SIEVE ANALYSIS
ASTM D1140 - 0422

REPORT NO. B-103-116

PROJECT Limestone SAMPLED BY RP1/7/3

SAMPLE IDENTIFICATION P-19V
SOURCE OF SAMPLE AREA 3
DATE SAMPLED 2-9-85 DATE TESTED
SHOW WEIGHT TO NEAREST TENTH. 174.8
SHOW %s TO NEAREST WHOLE NO.

SPECIFICATION							
	COARSE AGGREGATE	SAND	SIEVE	WEIGHT RETAINED	CUMULATIVE WT. RETAINED	CUMULATIVE % WT. RETAINED	CUMULATIVE % WT. PASSING
			4	-0-	-0-	-0-	100%
			40	1.5	1.5	-0-	100%
			200	53.4	54.9	31.4	68.6%
			PAN				

SAND FINENESS MODULUS	

REVIEWED BY Arlind Cheela

INSPECTOR

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

ATLANTA, GEORGIA ZIP CODE 30306 600 VIRGINIA AVE., N.E. PHONE (404) 872-0795	MONROE, LA ZIP CODE 71201 315 N. SECOND ST PHONE (318) 387-2327	NEW ORLEANS, LA ZIP CODE 70112 814 CONTI ST. PHONE (504) 524-8395	AUSTIN, TEXAS ZIP CODE 78723 1916 TILLERY ST. PHONE (512) 477-3738	BEAUMONT, TEXAS ZIP CODE 77705 2450 W. CARDINAL DR. #2 PHONE (713) 842-1020	CORPUS CHRISTI, TEXAS ZIP CODE 78418 810 S. PADRE ISLAND DR. PHONE (512) 854-4601

EAGLE PASS, TEXAS ZIP CODE 78852 RT. 2 BOX 4917 PHONE (512) 773-3717	FREEPORT, TEXAS ZIP CODE 77541 415 NORTH AVENUE F PHONE (713) 233-6366	HARLINGEN, TEXAS ZIP CODE 78550 210 N. "T" STREET PHONE (512) 423-6826	HOUSTON, TEXAS ZIP CODE 77007 1714 MEMORIAL DR PHONE (713) 224-2047	LAREDO, TEXAS ZIP CODE 78041 2508 SAN BERNARDO PHONE (512) 727-3702	SAN ANTONIO, TEXAS ZIP CODE 78216 8430 WESTERN BLVD. PHONE (512) 342-5377	VICTORIA, TEXAS ZIP CODE 77901 402 E. STEPHENSON DR. PHONE (512) 575-0281

REPORT OF FIELD COMPACTION TESTS

TESTED FOR: Houston Lighting & Power Company
Attn: L.D. Wilson

PROJECT: Limestone Electric Generating Station
Limestone County, Texas
Units 1 & 2

DATE: 8-16-83 S.W.D.A. HAZARDOUS WASTE POND   OUR REPORT NO.: B-100-1163

TEST NO.	*	**	LOCATION	DEPTH / ELEV	PERCENT MOISTURE	PERCENT COMPACTION	COMMENTS
2230	1C	A	67' N. OF S. END OF POND	6"	19.3	100.0+	A

METHOD OF TEST:

* G - GRANULAR   C - COHESIVE   1 - EMBANKMENT   2 - BACKFILL   3 - BASE COURSE   4 - SUBGRADE

** A MAXIMUM DENSITY 98.3 B-101-15 #/CU. FT. OPTIMUM MOISTURE 22.4 % AASHTO T-____

B MAXIMUM DENSITY ________ #/CU. FT. OPTIMUM MOISTURE ________ % AASHTO T-____

BALLOON ☐   SAND CONE ☐   NUCLEAR DENSOMETER ☒

COMMENTS: A. TEST RESULTS COMPLY WITH SPECIFICATIONS B. RECOMPACTION REQUIRED C. TEST IS AFTER RECOMPACTION

REMARKS: 8490   C. HAINES

HOLLOWAY   PAGE 1 OF 2

Respectfully Submitted,

OFFICES OF AFFILIATED CORPORATIONS:
ALBANY, ATLANTA, AUGUSTA, COLUMBUS, GA; CARBONDALE, CHAMPAIGN, DOWNERS GROVE (CHICAGO), EAST PEORIA, SPRINGFIELD, IL; TERRE HAUTE, WEST LAFAYETTE, IN; BATON ROUGE, MONROE, NEW ORLEANS, LA; COLUMBUS, OH; COLUMBIA, FLORENCE, SC; AUSTIN, BEAUMONT, CORPUS CHRISTI, EAGLE PASS, FREEPORT, HARKER HEIGHTS, HARLINGEN, HOUSTON, LAREDO, SAN ANTONIO, VICTORIA, TX

12602.5M

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

ATLANTA, GEORGIA ZIP CODE 30306 600 VIRGINIA AVE., N.E. PHONE (404) 872-0795	MONROE, LA ZIP CODE 71201 315 N. SECOND ST. PHONE (318) 387-2327	NEW ORLEANS, LA ZIP CODE 70112 814 CONTI ST. PHONE (504) 524-8395	AUSTIN, TEXAS ZIP CODE 78723 1916 TILLERY ST. PHONE (512) 477-3738	BEAUMONT, TEXAS ZIP CODE 77705 2480 W. CARDINAL DR. #2 PHONE (713) 842-1020	CORPUS CHRISTI, TEXAS ZIP CODE 78418 810 S. PADRE ISLAND DR. PHONE (512) 854-4801

EAGLE PASS, TEXAS ZIP CODE 78852 RT. 2 BOX 4917 PHONE (512) 773-3717	FREEPORT, TEXAS ZIP CODE 77541 415 NORTH AVENUE F PHONE (713) 233-6366	HARLINGEN, TEXAS ZIP CODE 78550 210 N. "T" STREET PHONE (512) 423-6826	HOUSTON, TEXAS ZIP CODE 77007 1714 MEMORIAL DR. PHONE (713) 224-2047	LAREDO, TEXAS ZIP CODE 78041 2908 SAN BERNARDO PHONE (512) 727-3702	SAN ANTONIO, TEXAS ZIP CODE 78216 8430 WESTERN BLVD. PHONE (512) 342-5377	VICTORIA, TEXAS ZIP CODE 77901 402 E. STEPHENSON DR. PHONE (512) 575-0281

REPORT OF FIELD COMPACTION TESTS

TESTED FOR: Houston Lighting & Power Company
Attn: L.D. Wilson

PROJECT: Limestone Electric Generating Statio
Limestone County, Texas
Units 1 & 2

DATE: 8-16-83 S.W.D.A. HAZARDOUS WASTE POND

OUR REPORT NO.: B-100-1163

TEST NO.	*	**	LOCATION	DEPTH / ELEV	PERCENT MOISTURE	PERCENT COMPACTION	COMMENTS
8230	C	A	67' N. OF S. END OF POND	6"	19.3	100.0+	A

METHOD OF TEST:

* G - GRANULAR C - COHESIVE 1 - EMBANKMENT 2 - BACKFILL 3 - BASE COURSE 4 - SUBGRADE

** A MAXIMUM DENSITY 98.3 B-101-15 #/CU. FT. OPTIMUM MOISTURE 22.4 % AASHTO T-

B MAXIMUM DENSITY #/CU. FT. OPTIMUM MOISTURE % AASHTO T-

BALLOON ☐ SAND CONE ☐ NUCLEAR DENSOMETER ☑

COMMENTS: A. TEST RESULTS COMPLY WITH SPECIFICATIONS B. RECOMPACTION REQUIRED C. TEST IS AFTER RECOMPACTION

REMARKS: 8490 C. HAINES

HOLLOWAY PAGE 1 OF 2

Respectfully Submitted,

SHILSTONE ENGINEERING TESTING LABORATORY, INC.

HOUSTON, TEXAS ZIP CODE 77007 1714 MEMORIAL DRIVE PHONE (713) 224-2047

FREEPORT, TEXAS ZIP CODE 77541 415 NORTH AVENUE F PHONE (713) 233-6366

AUSTIN, TEXAS ZIP CODE 78704 2024 SOUTH LAMAR PHONE (512) 447-7751

ATLANTA, GEORGIA ZIP CODE 30306 600 VIRGINIA AVENUE, N.E. PHONE (404) 872-0795

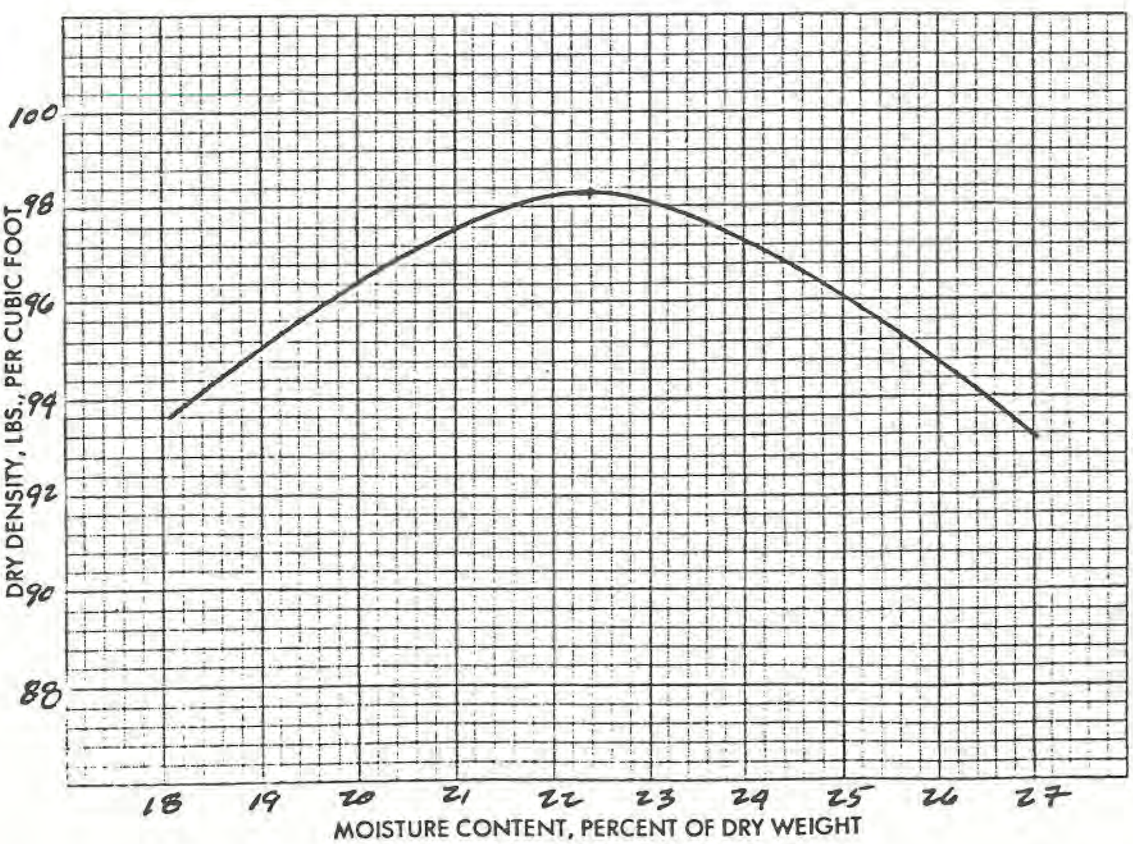
REPORT OF MOISTURE DENSITY RELATIONSHIP OF SOIL

TESTED FOR: Houston Lighting and Power PROJECT: Limestone Project

DATE: October 19, 1981 OUR REPORT NO: B-101-15

TEST DATA

Visual Classification: Reddish Brown Clay
Sample Identification Number: P-15
Method of Test: ASTM D698 Method C
Sample Source: on-site (Area 1)
Test Results: Maximum Dry Density 98.3 lbs/ft³
Optimum Moisture Content 22.4 %



Technician: H. Atkins

Respectfully Submitted,

Shilstone Engineering Testing Laboratory, Inc.

Report ~~Lab~~. No. B-102-17 (revised)

Date 10-21-91

ATTERBERG LIMITS TEST

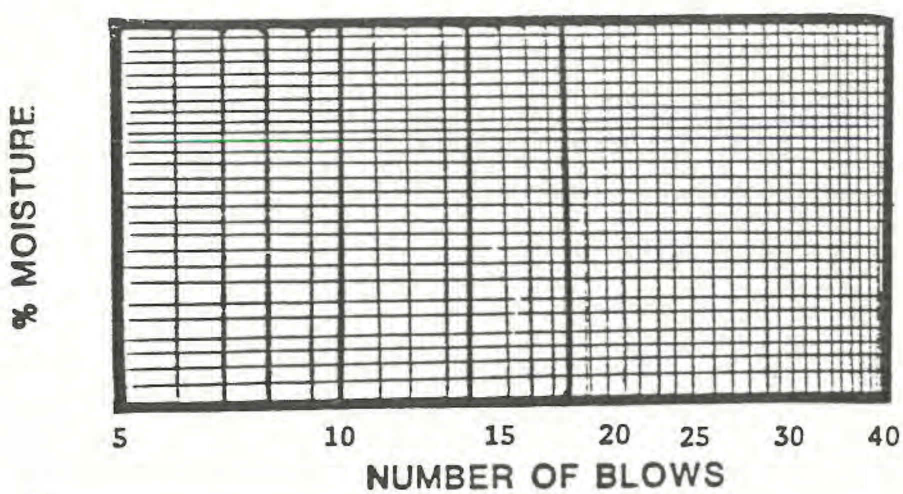
Project Limestone

Location on site Area 1

Sample No. P-15

Liquid Limit ASTM D 423					
Run Number		1	2	3	4
Dish No.		62			
Wt.in Gr.	Wt.Wet Soil + Dish	47.19			
	Wt.Dry Soil + Dish	36.39			
	Wt. Water	10.80			
	Wt. Dish	14.41			
	Wt. Dry Soil	21.98			
Moisture Content		49.1			
No. Blows		27			

L. L.	50
P. L.	[illegible]
P. I.	27



Plastic Limit ASTM D 424					
Run Number		1	2	3	4
Dish No.		14			
Wt.in Gr.	Wt.Wet Soil + Dish	[illegible]			
	Wt.Dry Soil + Dish	[illegible]			
	Wt. Water	[illegible]			
	Wt. Dish	[illegible]			
	Wt. Dry Soil	[illegible]			
Moisture Content		[illegible]			
Plastic Limit		[illegible]			

Description of Sample [illegible]

Technician [illegible] Reviewed By:

PARTICLE SIZE ANALYSES OF MATERIALS

ASTM D-422, ASTM D-1140

Name of Project: Limestone Electric Generating Station
Material: P-15 reddish brwn clay
Time of Soaking (Min. 2 Hr.): overnight
Wt. of Oven-Dry Pan and Sample: 706.5

Report Number: B-103-9
Technician: H. Atkins
Wt. of Pan: 206.5
Wt. of Washed and Dried Sample and Pan: 303.2

WASHED SIEVE ANALYSIS

Sieve Designation	Pan & Sample Wt. Retained (gms.)	Pan Wt. (gms.)	Sample Wt. Retained (gms.)	Total % Retained	Total % Passing
No. 40	153.5	110.0	43.5	8.7	91.3
No. 200	259.7	206.5	53.2	10.64	80.66

DRY SIEVE ANALYSIS

Sieve Designation	Pan & Sample Wt. Retained (gms.)	Pan Wt. (gms.)	Sample Wt. Retained (gms.)	Total % Retained	Total % Passing
3"					
2"					
1½"					
1"					
3/4"					
1/2"					
3/8"					
No. 4					
No. 16					
No. 40					
No. 50					
No. 200					

Above Ground Impoundment Surveillance procedure

Subject: **DSDA/ST-18 Impoundments**

SURVEILLANCE PROCEDURES

The ST-18 & DSDA slopes and pond infrastructure is visually inspected after periods of rainfall greater than half an inch and/or at a minimum of once a week for the signs of wind or water erosion. This inspection includes, but is not limited too, the visual inspection of the ground cover, signs of erosion, condition of the road and fullness of the pond. Issues identified during there routine investigations are related to the Operations Supervisor on duty and to contract coordinators for prompt attention.

TO : David Burton
FROM: Bob Eyeington

Limestone Electric Generating Station
ENVIRONMENTAL SYSTEM STATUS

Date 12/15/10

SYSTEM	Comments
MAIN PLANT AREA	
MH F-7 CONTAINMENT	Valve closed - H_2O Present
SEWAGE TREATMENT PLANT (006)	3271779 - Surge Pit & Settlers - OK
STORM WATER TREATMENT	5.58' Level - Lowed up to LWC - #1 MCC P/D
API SEPERATOR	Tank level indicator o/s - Tank Full
CT-2	Valve closed - empty
CT-1	Valve closed - empty
ORGANIC BASIN	8.5' Freeboard
INORGANIC BASIN	7.1' FT Freeboard
CHEMICAL EQUALIZATION BASIN	10' Freeboard
EMERGENCY COOLING POND	OK
LP-1	Valve closed - empty
LYNN CREEK	OK
YD-1	Valve open - OK
LIGNITE RUNOFF POND	8.10' Level
SWDA	
PR-2	Valve closed - empty
PR-1	Valve closed - empty
THICKENER CONTAINMENT	#1 Thickener o/s
BA PUMP SUMP	A/B pump sump o/s - Diesel E/P
EMERGENCY POND	9.1' Freeboard - Diesel I/S to DSDA
API SEPERATOR & OW SUMP	pumps in Auto - empty
HC-1	Valve closed - empty
ST-18	17.0' Freeboard
002 POND	1.13' Level

There have been 0 excedences this month for a total of 0 excedences for the year.

c: Distribution

CBT - pumps in Auto - o/s

K pond 10.13 @ 1243

DSDA @ 1254 - 2 trucks - I/s to South side

Revised 7-07-03
Revised 4-27-04
File #. 6.3002

ST 18 Pond Operations

Table of Contents:

1.0 Purpose and Scope

1.1 To provide a safe and environmentally compliant method of operating the ST18 pond.

2.0 Definitions

2.1 Automatic Level Control: Level will be controlled by a pair of floats, which, when the local controls are in the “on” position, the floats will dictate whether a start/stop signal is sent to the sump pumps according to CWD L13868.

2.2 Manual Level Control: Level will be controlled by operator manually starting/stopping pump at a local control station.

3.0 Responsibilities

3.1 It is the responsibility of the SWDA Yard Operator to check the pond level twice (minimum) during a 12 hour shift, whether the sump pumps are operating in manual or auto.
3.2 It is the responsibility of the SWDA Yard Operator to check the ST 18 sump pumps and associated equipment for proper starting parameters.
3.3 It is the responsibility of the SWDA Yard Operator to safely start & run the ST 18 sump pumps.

4.0 Location

4.1 North of SWDA Control Building & West of the hydrobins.

5.0 Prerequisites

5.1 Must have a minimum level of 2 ft to start.
5.2 Discharge valve must be open for manual/auto operation.
5.3 Check that pumps are lined up to thickener that is in service.
5.4 Check breakers to make sure equipment is not tagged and breaker is ready.

6.0 Materials Required

6.1 All required PPE.

7.0 Procedures

7.1 Manual Operation

7.1.1 Make sure that pond level is at least 2 ft from bottom of pond.
7.1.2 Start either “A” or “B” sump pump from local station.

7.1.3 Check level periodically (as frequent as every two hours, when levels are either within the 2 ft freeboard or 3 ft from bottom of pond) to determine if another pump needs to be put in service. *If level is above 10 ft (from bottom of pond), both pumps should be in service.*

7.1.4 Shut pump(s) off when pond level is 1 ft from bottom of pond.

7.2 Automatic Operation

7.2.1 Make sure both pumps are in the "on" position at the local control panel.

7.2.2 Pump "B" will start at ~7 ft and stop at ~4 ft.

7.2.3 Pump "A" will start at ~4 ft and stop at ~1 ft.

8.0 Review and Training

9.1 This procedure shall be reviewed annually.

9.0 References

9.1 CWD – L13868

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

April 29, 1994

Mr. Richard Bye
Houston Lighting & Power Company
P.O. Box 1700
Houston, Texas 77251

RE: Houston Lighting & Power, Route 1, Jewett, TWC #32490, Compliance Evaluation Inspection Conducted on April 29, 1994

Dear Mr. Bye:

On April 29, 1994 Mr. Don Naylor of the Region 9 Field Office conducted an Industrial Solid Waste Compliance Evaluation Inspection at the above referenced facility. A complete investigation of facility records and a physical inspection of the facility waste management areas indicated no apparent violations of the Texas Natural Resource Conservation Commission Regulations pertaining to Hazardous and Solid Waste Management.

At this time no further actions are required by your facility. If you have any questions or need further assistance please call Mr. Don Naylor at (817) 751-0335.

Sincerely,

Jim Edwards

Jim Edwards
Waste Program Manager

DN

Reply To: Region 9 • 6801 Sanger Ave., Suite 2500 • Waco, Texas 76710-7807 • Area Code 817/751-0335

P.O. Box 13087 • Austin, Texas 78711-3087 • 512/908-1000

HL&P 1008A (3-90)

Hous Lighting & Power Co any

LWK-file

OFFICE MEMORANDUM

JMD Plc. Sk
So. Limestone

To R.W. Lawhn May 11, 1994

From R.T. Bye RTB

Subject Industrial Solid Waste Compliance Evaluation Inspection
Limestone Electric Generating Station

An Industrial Solid Waste Compliance Evaluation Inspection was conducted by Mr. Don Naylor of the Texas Natural Resource Conservation Commission (TNRCC) Region 9 Field Office on April 29, 1994. The primary objective of the inspection was to review the facility records and to visually examine the facility's waste management areas. As stated in the attached April 29, 1994 letter from the TNRCC, no apparent violations pertaining to Hazardous and Solid Waste Management were noted at the facility.

JMD\ENV002QN.WPM

cc: E.A. Feith
T.E. Gish
P.R. King
J.L. Ryan

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

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At this time no further actions are required by your facility. If you have any questions or need further assistance please call Mr. Don Naylor at (817) 751-0335.

Sincerely,

Jim R. Edwards

Jim Edwards
Waste Program Manager

DN

TCEQ EXIT INTERVIEW FORM: Potential Violations and/or Records Requested

Regulated Entity/Site Name	Limestone Steam Electric Station			**TCEQ Add. ID No. RN No. (optional)**	TXR05V737
Investigation Type	CCI	**Contact Made In-House (Y/N)** Y	**Purpose of Investigation**	Compliance Investigation	
Regulated Entity Contact	William Odom		**Telephone No.**	903-626-9762	**Date Contacted**
Title	Lead Environmental Specialist		**Fax No.**		**Date Faxed**

NOTICE: The information provided in this form is intended to provide clarity to issues that have arisen during the investigation process between the TCEQ and the regulated entity named above and *does not represent final TCEQ findings related to violations*. Any potential or alleged violations discovered after the date on this form will be communicated by telephone to the regulated entity representative prior to the issuance of a notice of violation or enforcement. Conclusions drawn from this investigation, including additional violations or potential violations discovered (if any) during the course of this investigation, will be documented in a final investigation report.

Issue		For Records Request: identify the necessary records, the company contact and date due to the agency. For Alleged and Potential Violation issues: include the rule in question with the clearly described potential problem. Other type of issues: fully describe.	
No.	**Type[1]**	**Rule Citation (if known)**	**Description of Issue**
1	AV	Permit, Part III E3(g)	SWP3 certification not signed - resolved during investigation

[1]Issue Type Can Be One or More of: AV (Alleged Violation), PV (Potential Violation), O (Other), or RR (Records Request)

Did the TCEQ document the regulated entity named above operating without proper authorization?	☐ Yes	☒ No
Did the investigator advise the regulated entity representative that continued operation is not authorized?	☐ Yes	☒ No

Document Acknowledgment. Signature on this document establishes only that the regulated entity (company) representative received a copy of this document and associated continuation pages on the date noted. If contact was made by telephone, document will be faxed to regulated entity; therefore, signature not required.

Matthew Vaughn	12-7-10	Robert Eyewagh	12-7-10
Investigator Name (Signed & Printed)	**Date**	**Regulated Entity Representative Name (Signed & Printed)**	**Date**

If you have questions about any information on this form, please contact your local TCEQ Regional Office.
Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, call 512-239-3282.

White Copy: Regulated Entity Representative Yellow Copy: TCEQ
TCEQ-20085 (Rev. 6/07)

Emergency Action Plan

Subject: **DSDA/ST-18 Impoundments**

Extended Rainfall Events

During periods of extended or intense rainfall, personnel that may be in the vicinity of the DSDA pond or ST-18 will observe the conditions of the slopes of the ponds. Should there be any visible indications that a potential for slope failure exists, the operations supervisor will be notified via plant radio, Channel 2. The operations supervisor will inform plant personnel and contractors to avoid the areas.

Impoundment Failure

In the event of a potential catastrophic dam failure, plant staff will contact the operations supervisor on shift. The operations supervisor will initiate the Internal Notification procedure outlined in the Spill Prevention, Control, and Countermeasure Plan for the Limestone Electric Generating Station, page 2.2.


4 miles
Donie, Texas
Pop. 249
3 miles
First Baptist Church
2 miles
1 miles
NRG
DSDA Pond
Texas Westmoreland Coal Company
Jewett Mine
Little Flock Baptist Church
Little Rock Church


4 miles
Donie, Texas
Pop. 249
3 miles
First Baptist Church
2 miles
1 miles
NRG
ST-18 Pond
Texas Westmoreland Coal Company
Jewett Mine
Little Flock Baptist Church
Little Rock Church

Site Name:	Limestone Generating Station	**Date:**	February 22, 2011
Unit Name:	ST 18	**Operator's Name:**	NRG Texas LLC.
Unit I.D.:	N/A	**Hazard Potential Classification:**	High ☐ Significant ☐ Low ☒
	Inspector's Name:	Kyle Shepard & Andy Cueto	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	X		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	X		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	X		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A	N/A	Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	X		Is water exiting outlet, but not entering inlet?		X
6. If instrumentation is present, are readings recorded (operator records)?	N/A	N/A	Is water exiting outlet flowing clear?	N/A	N/A
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	N/A	N/A	From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)	X		At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	N/A	N/A	From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?	N/A	N/A	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?	N/A	N/A	23. Water against downstream toe?	X	
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Issue #	Comments
1.	LARGEST DIAMETER OF TREE GROWING IS APPROXIMATELY 2 INCHES.

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit TX0082651 **INSPECTOR**

Date

Impoundment Name ST 18

Impoundment Company NRG Texas LLC.

EPA Region REGION 6

State Agency (Field Office) Address 1445 Ross Ave. Dallas, TX 75202-2750

Name of Impoundment ST 18

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☐ **Update** ☒

	Yes	No
Is impoundment currently under construction?	☐	☒
Is water or ccw currently being pumped into the impoundment?	☒	☐

IMPOUNDMENT FUNCTION: STORM WATER STORAGE

Nearest Downstream Town Name: NO TOWN WITHIN A 5 MILE RADIUS

Distance from the impoundment: N/A

Location:

Latitude	Degrees	Minutes	Seconds	**N**
Longitude	Degrees	Minutes	Seconds	**W**

State **County**

	Yes	No
Does a state agency regulate this impoundment?	☐	☒

If So Which State Agency?

HAZARD POTENTIAL *(In the event the impoundment should fail, the following would occur):*

☐ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

☒ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

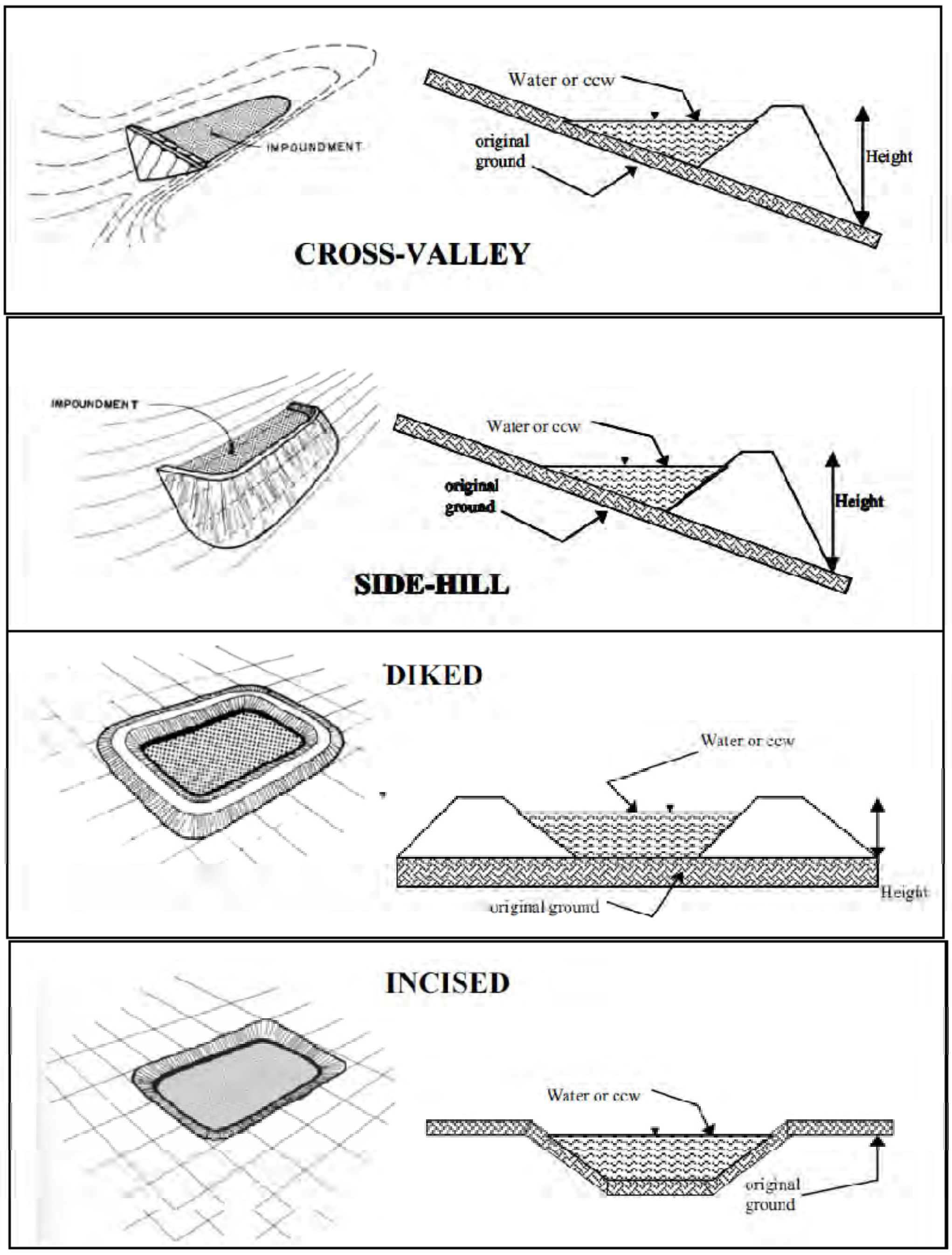
☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

UPON VISUAL INSPECTION, THERE WAS NO SIGHT OF ANY POSSIBLE BREACHING OR OVERTOPPING OF THIS IMPOUNDMENT.

CONFIGURATION:



☐ Cross-Valley ☒ Side-Hill ☐ Diked

☐ Incised (form completion optional) ☐ Combination Incised/Diked

Embankment Height (ft)		**Embankment Material**	IN-SITU SOIL
Pool Area (ac)		**Liner**	CLAY ±3 FEET THICK
Current Freeboard (ft)		**Liner Permeability**	$\pm 10^{-7}$

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

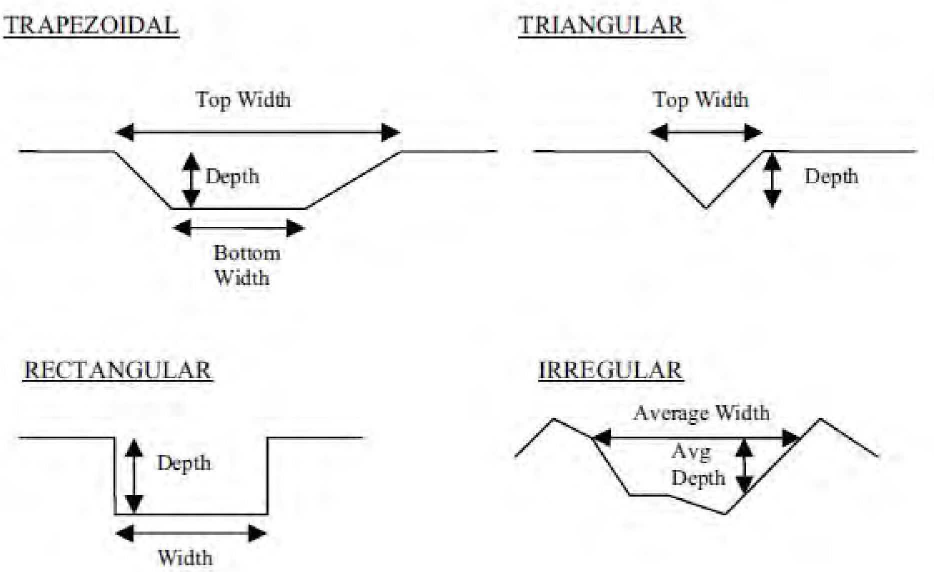
☐ Rectangular

☐ Irregular

depth (ft)

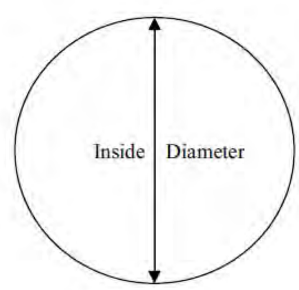
average bottom width (ft)

top width (ft)



☒ **Outlet**

18” inside diameter
(SDR 17 – smooth lined – 19.5” OD)



Material

☐ corrugated metal

☐ welded steel

☐ concrete

☐ plastic (hdpe, pvc, etc.)

☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☐	☒

☐ **No Outlet**

☒ **Other Type of Outlet** (specify): PUMP SYSTEM

The Impoundment was Designed By **EBASCO**

	Yes	No
Has there ever been a failure at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been significant seepages at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? If there is no information just note that.

NO

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?

YES

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?

NO

Site Name:	Limestone Generating Station	**Date:**	February 22, 2011
Unit Name:	DSDA	**Operator's Name:**	NRG Texas LLC.
Unit I.D.:	003	**Hazard Potential Classification:**	High ☐ Significant ☐ Low ☒
	Inspector's Name:	Kyle Shepard & Andy Cueto	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	X		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	X		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	X		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	N/A	N/A	Is water entering inlet, but not exiting outlet?	N/A	N/A
5. Lowest dam crest elevation (operator records)?	X		Is water exiting outlet, but not entering inlet?	N/A	N/A
6. If instrumentation is present, are readings recorded (operator records)?	X		Is water exiting outlet flowing clear?	N/A	N/A
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	N/A	N/A	From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trashracks clear and in place?	N/A	N/A	From downstream foundation area?		X
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X	"Boils" beneath stream or ponded water?		X
14. Clogged spillways, groin or diversion ditches?	N/A	N/A	Around the outside of the decant pipe?		X
15. Are spillway or ditch linings deteriorated?		X	22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?	N/A	N/A	23. Water against downstream toe?	X	
17. Cracks or scarps on slopes?		X	24. Were Photos taken during the dam inspection?	X	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Issue #	Comments

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit TX0082651 **INSPECTOR**

Date

Impoundment Name DSDA UNIT NO. 003

Impoundment Company NRG Texas LLC.

EPA Region REGION 6

State Agency (Field Office) Address 1445 Ross Ave.
Dallas, TX 75202-2750

Name of Impoundment DSDA UNIT NO. 003

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ☐ **Update** ☒

	Yes	No
Is impoundment currently under construction?	☐	☒
Is water or ccw currently being pumped into the impoundment?	☐	☒

IMPOUNDMENT FUNCTION: PROCESS POND

Nearest Downstream Town Name: NO TOWN WITHIN A 5 MILE RADIUS

Distance from the impoundment: N/A

Location:

Latitude	Degrees	Minutes	Seconds	**N**
Longitude	Degrees	Minutes	Seconds	**W**

State **County**

	Yes	No
Does a state agency regulate this impoundment?	☐	☒

If So Which State Agency?

HAVAZARD POTENTIAL *(In the event the impoundment should fail, the following would occur):*

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☒ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

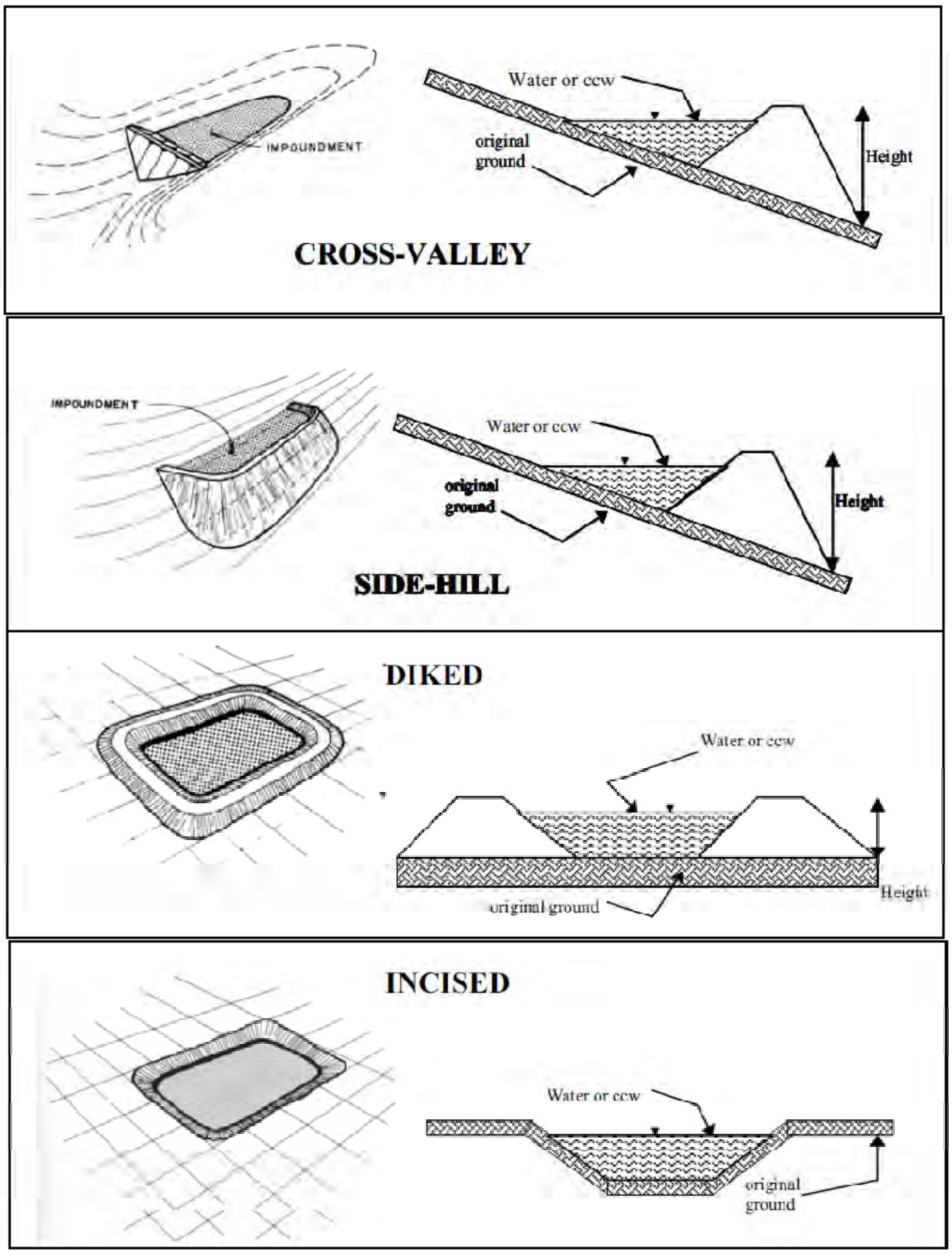
☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

UPON VISUAL INSPECTION, THERE WAS NO SIGHT OF ANY POSSIBLE BREACHING OR OVERTOPPING OF THIS IMPOUNDMENT.

Impoundment is used as a process unit to absorb and bind high chloride wastewaters produced in the plant process. The resulting stable sludge is trucked to onsite landfill.

CONFIGURATION:



- [ ] Cross-Valley
- [ ] Side-Hill
- [x] Diked
- [ ] Incised (form completion optional)
- [ ] Combination Incised/Diked

Embankment Height (ft)	24	**Embankment Material**	IN-SITU SOIL
Pool Area (ac)	20.84	**Liner**	CLAY ±3 FEET THICK
Current Freeboard (ft)	2	**Liner Permeability**	$\pm 10^{-7}$

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway**

☐ Trapezoidal

☐ Triangular

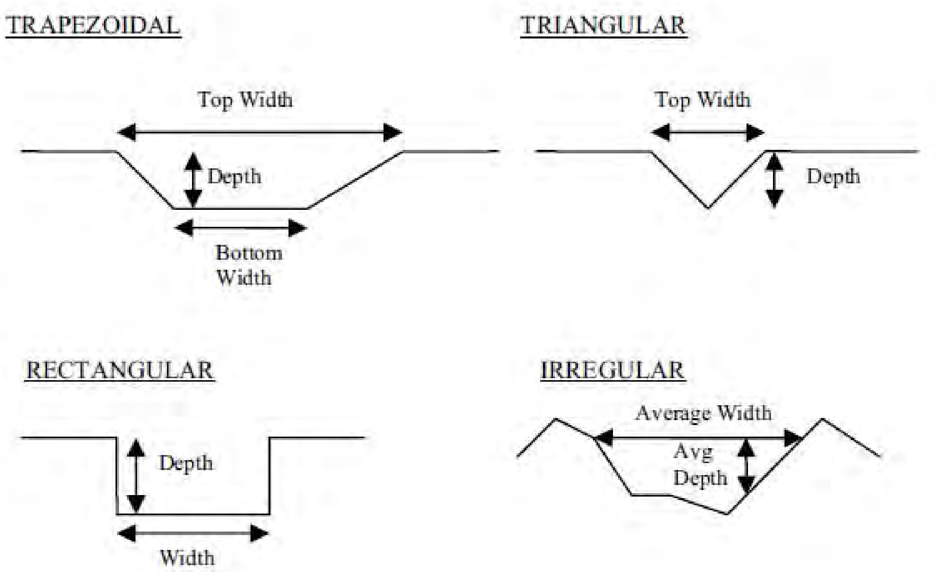
☐ Rectangular

☐ Irregular

depth (ft)

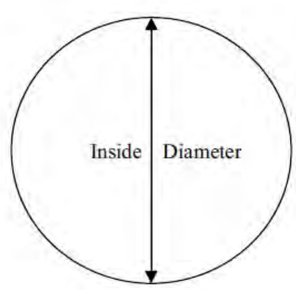
average bottom width (ft)

top width (ft)



☐ **Outlet**

18” inside diameter
(SDR 17 – smooth lined – 19.5” OD)



Material

☐ corrugated metal

☐ welded steel

☐ concrete

☐ plastic (hdpe, pvc, etc.)

☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☐	☒

☒ **No Outlet**

☐ **Other Type of Outlet** (specify):

The Impoundment was Designed By EBASCO

	Yes	No
Has there ever been a failure at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been significant seepages at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? If there is no information just note that.

NO

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?

YES

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?

NO

NRG Limestone

Available Information Checklist

Coal Combustion Residuals Impoundment (CCRI) Dam

ITEM DESCRIPTION	PROVIDED BY UTILITY		
	YES	NO	N/A
1. Descriptive Information:			
a) Impoundment Capacity (Normal & Max)	X		
b) Impoundment Surface Area	X		
c) Hazard Classification	X		
d) Freeboard (Normal & Min)	X		
e) Maximum Dam Height	X		
f) Dam Crest Elevation	X		
g) Crest Width	X		
h) Upstream Slope Inclination	X		
i) Downstream Slope Inclination	X		
j) Spillway Type, Size, & Crest Elevation	X		
k) Outlet Condit Type, Size, & Max Flow Capacity	X		
l) Historical Maximum Pond Elevation	X		
m) Year Built	X		
n) Design Life			X
o) Specific Wastes Permitted in Impoundment	X		
p) Other (describe)			
2. Regional Map showing CCWI & schools, hospitals, etc. w/i 5 mi downgradient	X		
3. Management Unit Dwgs:			
a) Plans	X		
b) Sections	X		
c) Elevations	X		
d) Other (describe) (assumptions & specs)	X		
4. Design Information:			
a) Name of Designer of Record (EBASCO)	X		
b) Design Assumptions	X		
c) Design Analyses (Including Hydrologic/Hydraulic & Slope Stability Analyses		X	

Available Information Checklist (Continued)

Coal Combustion Residuals Impoundment (CCRI) Dam

ITEM DESCRIPTION	PROVIDED BY UTILITY		
	YES	NO	N/A
d) Spillway Design Flood or Design Basis			X
e) Slope Stability Factors of Safety		X	
f) Design Soil Properties and Parameters	X		
g) Other (describe)			
5. Permits:			
a) NPDES? Number? TX0082651	X		
b) Dam Safety - Operating Permit? Number? n/a			X
c) Other (describe) (Stormwater SWDA TXR05V737)	x		
6. Subsurface Information:			
a) Geology	X		
b) Geotechnical Report	X		
c) Test Boring Logs	X		
d) Subsurface Profiles	X		
f) Other (describe)			
7. Monitoring Information:			
a) Observation Wells/Piezometer Readings	X		
b) Seepage Readings	X		
c) Settlement Readings			X
d) Alignment Readings			X
e) Inclinometer Readings			X
f) Time vs Reading Graphs			X
g) Other (describe)			
8. Instrumentation Dwgs:			
a) Location Plan	X		
b) Section Views	X		
c) Other (describe)			

Available Information Checklist (Continued) Coal Combustion Residuals Impoundment (CCRI) Dam			
ITEM DESCRIPTION	PROVIDED BY UTILITY		
	YES	NO	N/A
9. Operation, Maintenance, & Surveillance:			
a) Operating Procedures	X		
b) Maintenance Procedures	X		
c) Inspection Procedures	X		
d) Third Party Inspection Reports (TCEQ)	X		
e) Other (describe)			
10. Miscellaneous:			
a) Construction Documentation/Foundation Prep	X		
b) Spills or Releases			X
c) Repairs			X
d) Inundation Map		X	
e) Other (describe)			
f) Emergency Action Plan	X		

NOTE:
All data is to be furnished on CD to Dewberry by the end of 15 March 2011.

Available Information Checklist - Addendum

Coal Combustion Residuals Impoundment (CCRI) Dam

ITEM DESCRIPTION	PROVIDED BY UTILITY		
	YES	NO	N/A
11. Coal Combustion Residuals Handling Equipment Train:			
a) Fly Ash			
• **Generation & Collection Methods; Equipment**	X		
• **Transport to Storage Methods; Equipment; Containment Methods**	X		
• **Storage Methods; Equipment; Containment Methods**	X		
• **Transport to Disposition Methods; Equipment; Containment Methods**	X		
b) Bottom Ash			
• **Generation & Collection Methods; Equipment**	X		
• **Transport to Storage Methods; Equipment; Containment Methods**	X		
• **Storage Methods; Equipment; Containment Methods**	X		
• **Transport to Disposition Methods; Equipment; Containment Methods**	X		
c) Boiler Slag			
• **Generation & Collection Methods; Equipment**	X		
• **Transport to Storage Methods; Equipment; Containment Methods**	X		
• **Storage Methods; Equipment; Containment Methods**	X		
• **Transport to Disposition Methods; Equipment; Containment Methods**	X		
d) Flue Gas Desulfurization Sludge			
• **Generation & Collection Methods; Equipment**	X		
• **Transport to Storage Methods; Equipment; Containment Methods**	X		
• **Storage Methods; Equipment; Containment Methods**	X		
• **Transport to Disposition Methods; Equipment; Containment Methods**	X		

Fly Ash, Bottom Ash, Boiler Slag and FGDS are all commercially sold for beneficial reuse.
1. Fly Ash is pneumatically conveyed to hard stand then picked up via truck by 3rd party.
2. Bottom Ash and Boiler Slag are wet conveyed via conduit to conic dewaterers and then for the most part sold to 3rd party who trucks the residue out. Remainder is is conveyed via truck to onsite landfill.
3. FGD Sludge is wet conveyed to dewatering units (belt presses, and centrifuges) then sold as gypsum. Remainder is is conveyed via truck to onsite landfill.