THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

PERMIT AMENDMENT APPLICATION

Volume 2 of 6

City of Kingsville TEXAS

CITY OF KINGSVILLE, TEXAS

September 2018
Revision 0

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HANSON PROJECT NO. 16L0438-0003

CITY OF KINGSVILLE LANDFILL

PART III

ATTACHMENT 4

GEOLOGY REPORT

THE CITY OF KINGSVILLE LANDFILL

TCEQ PERMIT MSW 235-C

PERMIT AMENDMENT APPLICATION
PART III, ATTACHMENT 4
GEOLOGY REPORT

City of Kingsville TEXAS

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September 2018

Revision 0

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Contents

APPENDICES

ATTACHMENTS

LIST OF TABLES

1.0 INTRODUCTION

1.1 Project Information

The City of Kingsville Landfill is located approximately 1.45 miles southeast of the City of Kingsville city limits, at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130 as shown on Attachment 1- Location Map. The initial facility was permitted by the State of Texas in 1977 (Permit No. 235), and initial filling operations began in February 1977. The original 40 acre landfill is currently closed and is not Subtitle D compliant. The City of Kingsville was authorized a permit amendment for a 40-acre lateral landfill expansion of the site in 1986 (Permit No. 235-A). The approved Permit No. 235-A was developed and Sector 1 received its first load of waste material in March 1992. The City of Kingsville was again authorized a permit amendment in 1999 (Permit No. 235-B). This amendment increased the permitted acreage from 80 acres to approximately 120 acres and a maximum height of final cover of 125 feet-msl. The Kingsville Landfill is currently operating under Permit No. 235-B and subsequent permit modifications and/or authorizations.

The City of Kingsville Landfill is currently comprised of 120 acres. The City of Kingsville wishes to increase the capacity of the landfill site via a vertical and horizontal expansion through a permit amendment. The proposed permit amendment will increase the total permitted area to 176.33 acres. This will be accomplished by incorporating additional acreage to the northeast and southwest of the current permitted boundary. The existing active 108-acre waste disposal area will be expanded to a total of 121.3-acres. Other parts of this permit amendment are to; convert the current Type IV waste sector to accept Type I waste, request approval to process and dispose of liquid wastes and used tires, and to revise the floor contour and final contour plans to incorporate the vertical and horizontal expansion previously discussed.

1.2 Scope of Investiagation

The purpose of this study is to provide geological and geotechnical data for the design of the city of Kingsville Landfill. The scope of services included reviewing previous subsurface studies, summarizing the engineering properties of the subsurface materials and determining certain geotechnical design criteria such as estimated settlement and future slope stability.

1.3 Previous Subsurface Investigations

Previous subsurface investigations were conducted for the City of Kingsville Landfill to characterize subsurface conditions and assist with the development of landfill disposal cell designs. The previous testing and soils exploration work was performed by:

- Finch Energy and Environmental Services, Inc. (FEE)
- and Professional Service Industries, Inc. (PSI).

These reports are included in Appendix 1. A total of 23 soil borings were installed at this site at varying depths and testing intervals during these previous investigations.

Finch Energy and Environmental Services, Inc. conducted an investigation of subsurface materials at the Landfill location. Twelve (12) soil borings were installed and sampled. Laboratory tests were performed to determine the engineering properties of the subsurface materials. The report discussed the soils, sediments, and geologic and groundwater conditions encountered by FEE, Inc. during the hydrogeological/geotechnical investigations at the City of Kingsville Landfill. The report also discussed the characteristics of the soil samples collected and tested during the investigation.

As requested by the Texas Natural Resource Conservation Commission (TNRCC) in an NOD letter, Professional Service Industries, Inc. also conducted a subsurface investigation for FEE, Inc. and the City of Kingsville to evaluate the soil and groundwater conditions present at the site and to better define the aquiclude below the landfill site. A total of eleven (11) soil test borings were drilled and laboratory tests were performed to determine the engineering properties of the subsurface materials. This additional study discussed the types of subsurface materials encountered in the test borings and the results of the field and other laboratory tests performed for this site.

1.4 Current Subsurface Investigation

As previously identified, the proposed permit boundary for this facility will incorporate 176 acres of land with 128 acres being utilized for waste disposal. In accordance with 30 TAC 330.63 (e)(4)(B), a facility of this size requires 23-26 borings with 13-15 of these borings being installed at least 30 feet below the elevation of deepest excavation (EDE) and the remainder of the borings being installed at least 5 feet below the EDE. Before this subsurface investigation, there were fifteen (15) borings that were installed at least 5 feet below the EDE and four (4) of those borings were installed at least 30 feet below the EDE.

For this investigation, nine (9) soil borings were advanced to a minimum depth of 30 feet below the elevation of the deepest excavation of 22.5 ft and one (1) additional soil boring was advanced to 5 feet below the elevation of the deepest excavation to supplement the existing facility data. The borings were drilled in the locations identified on Attachment 2- Soil Boring Location Map. Attachment 2 also identifies the locations of the previously installed soil borings. Attachment 3 identifies groundwater elevations in addition to the existing groundwater monitoring system.

The soil borings for the current subsurface investigation were installed by Tolunay-Wong Engineers, Inc. Representative samples were collected with split-barrel sampling procedures in general accordance with the procedures for “Penetration Test and Split-Barrel Sampling of Soils” (ASTM Designation D-1586) and Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes (ASTM Designation D-1587). Borings were dry-augered using hollow stem augers to advance the boreholes until groundwater was encountered or until the boreholes became unstable and/or collapsed. Wash rotary drilling techniques were used as necessary in order to continue advancing the borings to their required completion depths. Samples were identified according to boring number and depth, protected against moisture loss, and transported to the laboratory for analysis. After obtaining all required soil samples and groundwater level readings, the soil borings were properly plugged and abandoned in accordance with 16 TAC Chapter 76, Texas Department of Licensing and Regulation (TDLR)-Water Well Drillers and Pump Installers rules. Table 1-1 below identifies specific details for both existing and newly installed soil borings. For this investigation, borings B30 through B41 were installed. These borings were advanced to depths ranging from 33.5 to 86 feet beneath the existing ground surface. Tolunay-Wong Engineers, Inc. prepared a Geotechnical Engineering Study Report that is provided in Appendix 2. Hanson Professional Services also prepared a soil boring report that has been included as Appendix 3.

Table 1-1
Soil Borings

Boring Identification	Surface Elevation (ft. AMSL)	Boring Depth (ft. bgs)	Bottom Elevation (ft. AMSL)	≥5 Feet Below E.D.E?	≥30 Feet Below E.D.E?
B-1	59.25	42	17.25	YES	NO
B-2	52.64	27	25.64	NO	NO
B-3	56.1	37	19.1	NO	NO
B-4	58.01	39	19.01	NO	NO
B-5	60.54	48	12.54	YES	NO
B-6	55.46	38	17.46	YES	NO
B-7	61.05	36	25.05	NO	NO
B-8	59.79	43	16.79	YES	NO
B-9	62.51	44	18.51	NO	NO
B-9R	41.41	17	24.41	NO	NO
B-10	49.78	29	20.78	NO	NO
B-11	60.2	33	27.2	NO	NO
B-12	52.38	48	4.38	YES	NO
B-13	59.13	50	9.13	YES	NO
B-14	49.94	42	7.94	YES	NO
B-15	48.39	37	11.39	YES	NO
B-16	55.96	47	8.96	YES	NO
B-17	41.35	33	8.35	YES	NO

Boring Identification	Surface Elevation (ft. AMSL)	Boring Depth (ft. bgs)	Bottom Elevation (ft. AMSL)	≥5 Feet Below E.D.E?	≥30 Feet Below E.D.E?
B-18	50.04	42	8.04	YES	NO
B-21	52.41	84	-31.59	YES	YES
B-23	49.5	86	-36.5	YES	YES
B-24	47.38	72	-24.62	YES	YES
B-25	61.12	88	-26.88	YES	YES
B-30	45.99	82.5	-36.51	YES	YES
B-31	58.37	68	-9.63	YES	YES
B-32	48.46	82.5	-34.04	YES	YES
B-33	64.51	86	-21.49	YES	YES
B-34	61.14	43	18.14	NO	NO
B-35	64.5	72.5	-8	YES	YES
B-36	59.13	68	-8.87	YES	YES
B-37	45.52	48	-2.48	YES	NO
B-38	41.64	58	-16.36	YES	YES
B-39	60.26	68	-7.74	YES	YES
B-40	52.31	33.5	18.81	NO	NO
B-41	50.2	62.5	-12.3	YES	YES

E.D.E.-Elevation of Deepest Excavation (22.5' Above Mean Sea Level (AMSL))

2.0 REGIONAL INFORMATION

2.1 Regional Physiography

As discussed in Finch Energy and Environmental Services' Report (Appendix 1, Section 2.0), the site of the landfill is located in the part of the Gulf Coastal Plain that has been defined as the Coastal Bend of Texas. The coastal plain is gently, but irregularly, inclined gulfward at about 5 feet or less per mile. In many areas, coastal plain slopes range from 1 to 3 feet per mile, and on the lagoonal wind-tidal flats, slopes are usually less than 1 foot per mile. Elevations within the county range from 0 feet (Gulf of Mexico) to 125 feet above Mean Seal Level (MSL) in the extreme northwestern part. It is characterized as an arid, desert like region where wind (Eolian) erosion and wind transported sediment have determined much of the area's character and distinctiveness. The surface features of the county are broad, dune covered mainland prairies and extensive coastal wind-tidal flats.

Eolian transport of silts and sands has produced the South Texas Eolian System (Sand Sheet). Extensive, hummocky prairies within the South Texas sand sheet are underlain by relic sand dunes and wind-deflated depressions which extend inland from broad wind-tidal flats along the landward margin of Laguna Madre and parts of Baffin Bay.

2.2 Regional Stratigraphy

Table 2-1 presents the geologic formations that characterize the regional stratigraphy of Kleberg County.

Table 2-1
Geologic Formations for Kleberg County

Period	Epoch	Geologic Formation	Approximate Maximum Thickness (FT)	Litholgy	Water-Bearing Properties
Quaternary		Alluvium	?	Mostly very fine to fine sand, silt, and calcareous clay	Not significant as an aquifer. Not known to be tapped by wells.
		Barrier Island Deposits	50	Tan to gray, fossiliferous, medium sand containing wood fragments; interbedded tan sand and gray clay, locally gypseous; and gray, fossiliferous sandy clay	Capable of yielding small quantities of fresh water to shallow wells on Padre Island.
	Holocene and Pleistocene (?)	South Texas Eolian Plain Deposits	60+	Tan to white, unfossiliferous, massive, fine to very fine sand, greenish gray sandy clay, highly calcareous clay or marl, and thin-bedded clayey sand.	Yields small quantities of sl ightly saline water to a few stock wells in Kenedy County. in sofne areas in Kenedy County the sand contains brine
	Pleistocene	Barrier Island and Beach Deposits	1,400	Barrier island and beach deposits mostly light gray, massive, crossbedded fine sand about 60 feet thick; contains some shell fragments.	Barrier island and beach deposits yield small quantities of fresh to probably moderately saline water to a few stock wells in eastern Kleberg County near Laguna Madre.
		Beaumont Clay and Lissie Formation, Undifferentiated		Beaumont Clay and Lissie Formation mostly very calcareous, slightly carbonaceous, blue and yellow clay and a few lenticular beds of sand.	Beaumont Clay and Lissie Formation yield small quantities of slightly to moderately saline water to a few mostly stock wells in eastern part of Kleberg and Kenedy Counties.
Tertiary	Pliocene	Goliad Sand	1,100	Fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored calcareous clay. Sand beds or sandstone compose from 40 to 60 percent of the formation.	Principal aquifer. Yields small to large quantities of fresh to slightly saline water to public supply, industrial, and irrigation wells as well as to numerous rural domestic and stock wells. Many of the wells tapping the Goliad in Kleberg and Kenedy Counties flow.
	Miocene	Lagarto Clay	1,200+	Mostly stiff, compact, gray, calcareous clay and some thin lenticular beds of gray sand.	Not known to be tapped by wells, but capable of yielding small quantities of slightly saline water in Kenedy and Jim Wells Counties.
		Oakville Sandstone	600	Very fine to coarse, brown to gray sand and sandstone interbedded with silt and a considerable amount of clay.	Yields small to moderate quantities of sl ightly saline water to industrial and stock wells in southern Jim Wells County.

*Texas Water Development Board, Report 173, Ground-Water Resources of Kleberg, Kenedy, and Southern Jim Wells Counties, Texas, July 1973. (Shafer, 1973)

2.3 Regional Hydrogeology

As discussed in Finch Energy and Environmental Services' Report (Appendix 1, Section 4.0), The Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. Also discussed in Finch Energy and Environmental Services' Report (Appendix 1, Section 3.2), the Goliad Sand of Pliocene age occurs in the subsurface of the site area. It is the principal aquifer in the site area with wells producing small to large quantities of fresh to slightly saline water to public supply, industrial, irrigation, rural-domestic, and stock wells. The aquifer is considered a large, leaky artesian aquifer. A stratigraphic column of geologic formations including a brief discussion of lithology and water-bearing properties found in the area of Kingsville is presented in Table 2-1.

The Pleistocene formations exposed in the region are the Beaumont Clay and Lissie Formation. The Beaumont Clay is recognized as lying to the east of U.S. Highway 77. The Beaumont Clay is a series of delta-plain deposits composed principally of mud with localized elongate sand and silt bodies. The Lissie Formation is composed of meanderbelt sands and muds which underlie thin loess (Eolian silt) deposits and Eolian sand deposits west of U.S. Highway 77. These two formations are generally discussed as one unit; Beaumont Clay and Lissie Formation, undifferentiated (Chicot Aquifer). Regional hydrogeology for the site is discussed further in Appendix 1.

2.4 Water Quality

As stated in Appendix 1, water quality of the Goliad is highly variable. The quality of water from wells in the Goliad Sand deteriorates at depths greater than 1,000 feet, and the salinity of the water increases eastward. Generally, water from wells in the Goliad Sand in southern Jim Wells County and about the western one-half of Kleberg County meets the quality standards of the U.S. Public Health Service. Shallow, moderately saline to very saline water overlies the fresh to slightly saline water at most places (Shafer, 1973).

The Beaumont Clay and Lissie Formation (Chicot Aquifer) yield small quantities of slightly to moderately saline water to a few shallow wells used mostly for stock needs in eastern Kleberg and Kenedy Counties. Test wells drilled for observation purposes 1.25 miles west of Riviera (approximately 15 miles south of Kingsville), show that shallow sands of the Beaumont and Lissie usually contain very saline water in this area. The casings of many wells are cemented through the Beaumont and Lissie due to highly mineralized water associated with these formations (Shafer, 1973).

A groundwater contour map has been included in Attachment 3. A monitoring well groundwater elevation table has been included as Exhibit 1 of Attachment 3 and an analytical data summary table has been included as Exhibit 2 of Attachment 3. Detailed analytical data and groundwater elevations from historic ground water monitoring of monitor wells at the site can be found in the

Groundwater Characterization Report which is included in Appendix 1. On-site groundwater monitoring well installation information has also been included in Appendix 1, and additional on-site monitor well installation information shall be provided as wells are installed.

2.5 Groundwater Recharge

As discussed in Appendix 1, Recharge within a 5 mile radius is from downward percolation of surface water, infiltration from streams, impoundments, and water retained in abandoned caliche pits. A map of the recharge area can be seen in Figure 4.14 in Appendix 1.

3.0 SITE CHARACTERIZATION

3.1 Site Topography

The natural topography in the vicinity of the landfill is relatively flat to slightly depressed. The general direction of drainage is to the east-southeast and east-northeast. The natural ground elevation at the City of Kingsville Landfill is approximately 52 feet above mean sea level (MSL). The proposed elevation of the deepest excavation at the site is approximately 22.5 feet above MSL, and the highest permitted elevation for the site is approximately 200 feet above MSL. Lines displaying site topography for the City of Kingsville Landfill have been included on Attachment 2. The site vicinity is surrounded by extensive areas of agriculture. There are also abandoned caliche mines to the west and southwest. The Santa Gertrudis Creek, located 0.7 miles to the north, trends to the east-southeast 3.25 miles to it's confluence with the San Fernando Creek which then flows southeast to the Cayo del Grullo of Baffin Bay. Jaboncillos Creek, Ebanito Creek and several small unnamed ephemeral streams, are located several miles south of the site.

3.2 Subsurface Investigation Report

3.2.1 Site Exploration

Three subsurface studies have been performed to evaluate the stratigraphy of the landfill site. A total of thirty-five (35) borings have been drilled to depths ranging from 17 to 88 feet below the natural ground surface.

Finch Energy and Environmental Services, Inc. installed twelve (12) borings ranging in depth from 17 to 48 feet below the existing ground surface. Professional Service Industries, Inc. installed eleven (11) borings ranging from 33 to 88 feet below the existing ground surface. Tolunay-Wong Engineers, Inc. installed twelve (12) borings ranging in depth from 33.5 to 86 feet below the existing ground surface.

3.2.2 Field Drilling, Sampling, and Logging

For the three investigations, the soil test borings were installed using a drilling rig capable of sampling cohesive and cohesionless materials. Samples of cohesive materials were obtained by hydraulically pushing a thin walled tube in accordance with ASTM D 1587. Non-cohesive soils were obtained by performing a standard penetration test (SPT) using a split barrel sampler in accordance with ASTM D 1586-D. The samples were extruded in the field, wrapped in foil, placed in moisture sealed containers, and protected from disturbance prior to transport to the laboratory. All samples were transported to the laboratory for testing and were identified according to boring number and depth at a minimum. Soil test borings were visually logged in the field and boring logs have been provided in Appendices 1, 2, and 3.

3.3 Site Stratigraphy

As seen on the Geologic Atlas of Texas Corpus Christi Sheet, the primary geologic formations exposed at the surface of the site are silt sheet deposits, clay dune, and clay-sand dune deposits. The topsoil consists of clay which is black, silty, and contains humic material. Sediments encountered in borings at the site are Holocene and Pleistocene in age and consist of clays, silts, sands, and caliche deposited in two (2) separate and distinct environments of deposition. The subsurface geology is presented on cross sections A – A' through B-B' included in Appendix 1.

The site is underlain by sediments that can be divided into five discontinuous units and one continuous unit. The discontinuous units are caliche bearing channel unit (I), sand filled channel unit (II), clayey sand (clay dune, III), clayey sand (clay dune IV), and sandy silty clay (V). The continuous unit consists of the light olive green to gray clay which is an aquiclude present below the site. The water bearing zone is made up of the five discontinuous units which are all in communication. The average ground water level is at approximately 35 feet below National Geodetic Vertical Datum (NGVD).

3.3.1 Body I- Caliche Bearing Channel

As stated in Appendix 1, this is the youngest, most extensive, sand containing body that can be correlated across the site. This body consists of interbeds of caliche, clays, and sands which, in themselves, are noncorrelative. The individual beds within this body appear to be of limited extent and probably represent braided deposits within a single channel approximately ½ mile in width. The base of this channel is placed at the base of the lowest caliche encountered in the borings at the site. When grouped together, it can be shown via cross section and isopach mapping that the body can obtain a maximum thickness of 40 feet and, as a whole, cuts downward into underlying beds. This body was deposited as a channel system which trends in a down dip direction, southwest to northeast, across the City of Kingsville Landfill site. Much of the caliche contained within this body has been previously removed from the site by mining operations.

3.3.2 Body II- Sand Filled Channel

As stated in Appendix 1, Body II was deposited as a channel filled with a homogeneous, well sorted, very fine grained to fine grained, clean, unconsolidated sand. The fill sediment in Body II is much simpler than the fill sediment in Body I. The preserved length and width of this channel sand is less than one half mile due to truncation and incisement by the overlying Body I channel. Body II is interpreted as being a channel due to down cutting evident on the cross sections. This channel sand is apparent in borings 10 and 17. Body II was also evident in boring 37, which was installed in the most recent geotechnical investigation by Tolunay-Wong Engineers, Inc., approximately 14.5 feet below ground elevation 45.52. Deposition of the Body II channel sand was oriented in a dip direction, southwest to northeast across the site.

3.3.3 Body III- Clayey Sand (Clay Dune)

As stated in Appendix 1, the Clayey Sand (Clay Dune) Body III lies under the eastern edge of the City of Kingsville Landfill site and is composed of a homogeneous, very fine grained, well sorted, clayey sand. Well 13 was previously the only known penetration of the sand encountering a thickness of 17'. Borings 35 and 39, installed by Tolunay-Wong Engineers, Inc., also penetrated Body III at approximately 24 feet and 36.5 feet below ground elevations of 64.5 and 60.26 feet respectively. At it's base, the sand appears to be conformable with the underlying "orange" sand which is interpreted as a near shore or beach sand. Body III is interpreted as a clay dune based on clay content, sorting, and stratigraphic position within an overall regression section.

3.3.4 Body IV- Clayey Sand (Clay Dune)

As stated in Appendix 1, the Clayey Sand (Clay Dune) Body IV is believed to be a time and stratigraphic equivalent of Body III, described above, and underlies a portion of the western edge of the City of Kingsville Landfill site. Borings 16 and 23 penetrated 18 feet and 12 feet respectively, immediately above the underlying "orange" sand. Body IV sand is similar in all respects to the homogeneous, very fine grained, well sorted, clayey sand which comprises Body III above. Cross section G-G' included in Appendix 1 (wells 16 and 23) illustrates the top of Body IV as being concave downward with a flat base, indicating deposition as a "buildup" or clay dune. Again, Body IV appears conformable with the underlying "orange" which is interpreted as a near shore or beach sand. Bodies III and IV are typical of the QCD deposits seen on the Geologic Atlas of Texas Corpus Christi Sheet. QCD is comprised of clay due and clay-sand dune deposits and possess physical properties similar to those of the sandy and silty Beaumont Formation as indicated in the Geologic Atlas of Texas.

3.3.5 Sandy Clay Bed

As stated in Appendix 1, the sandy clay bed was deposited in conjunction with Bodies I through IV and is composed of a homogeneous, tan, sandy clay containing abundant decomposed organic material. Thickness of this clay ranged from 40 to 60 feet under the City of Kingsville Landfill site with the above described Sand Bodies deposited within or adjacent to this clayey interval. The basal contact is abrupt with the underlying "orange" Sand.

3.3.6 "Orange" Sand

As stated in Appendix 1, the "orange" sand appears to have been deposited in a near shore or beach environment. The sand is extremely well sorted and clean and the grains are well rounded and composed of approximately 90% fine quartz grains and 10% fine multicolored shell fragments giving the overall sand color an orange cast. The thin (<5 feet), sheet-like nature of the sand represents a beach environment of short duration developed at the top of the Beaumont clay (Light Olive Green to Gray Clay). It is present in all wells of sufficient depth.

3.3.7 <u>Light Olive Green to Gray Clay</u>

As stated in Appendix 1, tops of the Light Olive Green to Gray Clay are necessary to make the above interpretations of shallower beds in that it is the most definitive, planar marker bed under the City of Kingsville Landfill site. This clay is pure and therefore exhibits characteristic low permeabilites with a proven thickness of at least 38 feet as seen in Boring 21 (boring log included in Appendix 1). The light olive green clay layer begins at approximately 46 feet below the ground surface elevation of 52.41 feet in boring 21, and the boring was terminated at approximately 84 feet below the surface elevation (bottom elevation of -36.5 feet). The clay layer is also evidenced in boring B-23 with an approximate thickness of 50 feet. The layer begins at approximately 36 feet below the surface elevation of 49.50 feet, and the boring terminates at approximately 86 feet below the surface elevation (bottom elevation of -36.5 feet).

3.4 Geologic Fault and Seismicity Assessment

A geologic fault and seismicity assessment was performed by FEE. Sections 3.3.1 and 3.3.4 in Appendix 1 discusses faults and faulting, and seismic impact zones at the City of Kingsville Landfill. Conclusions from FEE are as follows:

"An evaluation of potential faults or fault zones does not indicate the presence of *active* faults. Topographic Maps, literature searches, aerial photographs, Petroleum Industry maps and a field survey were used in this evaluation. The field survey combined with topographic maps did not *reveal* structural damage to buildings, ground scarps, or unusual surface depressions. Changes in drainage or vegetation patterns which are also associated with faulting were not present. Data presented by Algermissen, et al, 1990 suggests a low probability of major seismic activity in the vicinity of the site."

A Seismic Impact Zone Map from the USGS from 1990 has been provided by FEE in Figure 4.9 of Appendix 1. A Seismic-Hazard Map for the Conterminous United States from 2014 from the USGS has also been included as Attachment 4. Both maps show the City of Kingsville Landfill site to be clear of any potential seismic impact zones.

3.5 Geologic Processes

Active Geologic Processes are discussed in Section 3.3 of Appendix 1. The primary geologic process occurring in this area of Texas is erosion. Based on soil types and character, and topography, erosion does not appear to be a significant factor under "normal conditions" or if design criteria are met and maintained. The construction of silt fences, wind screens, diversion berms, and routine maintenance should keep erosion at the City of Kingsville Landfill manageable.

4.0 GEOTECHNICAL REPORT

4.1 Laboratory Results

Laboratory tests were performed by Finch Energy and Environmental Services, Inc., Professional Service Industries, Inc., and Tolunay-Wong Engineers, Inc. on recovered soil samples to determine the engineering properties of the strata during the previous and most recent geotechnical engineering studies. Laboratory tests were performed in general accordance with ASTM International standards to measure physical and engineering properties of the recovered samples. Laboratory testing descriptions and methods used in the most recent Tolunay-Wong Engineers, Inc. study can be viewed in table 4-1. Laboratory results gathered from previous subsurface investigations performed by FEE and PSI are located in section 8.0 of Appendix 1. A summary of Tolunay-Wong's laboratory results has been included below.

Table 4-1
Laboratory Testing Program

Test Description	Test Method
Amount of Material in Soils Finer than No. 200 Sieve	ASTM D 1140
Unconfined Compressive Strength of Cohesive Soil (UC)	ASTM D 2166
Water (Moisture) Content of Soil	ASTM D 2216
Liquid Limit, Plastic Limit and Plasticity Index of Soils	ASTM D 4318
Density (Unit Weight) of Soil Specimens	ASTM D 2937
One-Dimensional, Incremental Loading Consolidation	ASTM D 2435
Consolidated-Undrained Triaxial Compression w/ Pore Water Pressure	ASTM D 4767

Standard geotechnical laboratory test results and soil properties encountered in the project borings are presented on the logs of borings in Appendix B of Appendix 2. Results of completed one-dimensional consolidation and consolidated-undrained triaixial compression tests performed on the selected cohesive soil samples obtained for this study are included in Appendix C of Appendix 2.

In-situ moisture contents of selected cohesive clay samples ranged from 18% to 34%. Results of Atterberg Limits tests on selected clay samples indicated liquid limits (LL) ranging from 31 to 81 with plasticity indices (PI) ranging from 18 to 58. The amount of materials finer than the No. 200 sieve on the selected samples ranged from 55% to 100%. In-situ moisture contents of selected silty sand samples ranged from 23% to 24%. The amount of materials finer than the No. 200 sieve on the selected samples tested for grain size distribution ranged from 14% to 38%.

Undrained shear strengths derived from field pocket penetrometer readings ranged from 0.25-tsf to 4.50-tsf. Undrained shear strengths derived from laboratory unconfined compressive (UC) strength testing ranged from 0.16-tsf to 3.41-tsf with corresponding total unit weights of 86-pcf to 105-pcf. Shear strength of cohesive soils inferred from SPT blow counts generally were similar. Based on this undrained shear strength data, the consistency of the cohesive soils encountered in the project borings is considered to be very soft to very stiff. Tabulated laboratory test results at the recovered sample depths are presented on the boring logs in Appendix B of Appendix 2.

4.2 Geotechnical Analysis

4.2.1 <u>Settlement Analysis</u>
One-dimensional consolidation tests were performed by Tolunay-Wong Engineers, Inc. using select samples from the soil borings to evaluate the compressibility characteristics of the foundation soils. The results of the consolidation tests are presented in Appendix D of Appendix 2. The predicted settlements resulting from consolidation settlement of the foundation soils due to the weight of the overlying landfill material are on the order of 1 foot.

Mr. Ralph N. Lewis of PSI also performed a settlement analysis during PSI's previous geotechnical analysis, and his calculations are shown in Appendix H.2 of Appendix 1. His calculations show that conservatively the final landfill cover will settle 3.0 inches at the center and 1.5 inches at the edges of the landfill. These calculations were based on previous landfill designs and capacities.

4.2.2 <u>Slope Stability</u>
A slope stability analysis was conducted by FEE. The objective of the analysis was to determine the local sliding stability of the liner system and cover as well as the overall stability of the embankment slope. The proposed embankments have a 4 (horizontal) to 1 (vertical) slope. FEE determined that a maximum allowable landfill height to satisfy a minimum factor of safety of 2.0 under static loading conditions was approximately 125 NGVD. Further discussion of the results from these analyses can be seen in Appendix 1 Section 8.3- Engineering Analysis. Tolunay-Wong Engineers, Inc. also performed a waste mass stability analysis during their geotechnical engineering study. Tolunay determined that the calculated factor of safety for peak shear strength conditions exceeded 1.5 for their assumed strength and unit weight parameters, the analyzed cross sections, and assumed failure geometry. The calculated factor of safety for large displacement condition exceeds 1.5, which in their judgement, and based on published information, is acceptable. Further discussion of the results of this study have been included in Appendix 2 Section 7- Waste Mass Stability.

5.0 CONCLUSIONS

As discussed in Finch Energy and Environmental Services, Professional Service Industries, Inc., and Tolunay-Wong Engineers Inc. reports and based upon the results of field and laboratory investigations performed during these studies, the following conclusions have been developed:

The site is located in the Gulf Coastal Plain of Texas with the Beaumont Clay and Lissie Formation undifferentiated near the surface. This formation underlies silt sheet deposits, clay dune, and clay-sand dune deposits on the surface at the site.

The site is underlain by sediments that can be divided into five discontinuous units [Caliche Bearing Channel Unit (I), Sand Filled Channel Unit (II), Clayey Sand (Clay Dune)(III), Clayey Sand (Clay Dune)(IV), Sandy (Silty) Clay] and one continuous unit [Light Olive Green to Gray Clay Aquiclude]. The water bearing zone is made up of the five discontinuous units which are all in communication. The normal ground water level is at approximately 35 ft NGVD.

The uppermost aquifer beneath the base grade of the existing site can be defined as a discontinuous fluvial-deltaic environment in which all units are in hydraulic communication with each other and bounded by the 38 foot thick plus Light Olive Green to Gray Clay aquiclude at depths of 5 ft to 17 ft above mean sea level. Groundwater movement is to all sides of the landfill except to the northwest.

The Landfill site has a Light Olive Green to Gray Clay layer of more than 38 feet thickness which forms an aquiclude between the uppermost local aquifer and the Chicot aquifer which is the uppermost regional aquifer. The Chicot aquifer is located between 200 and 300 feet below mean seal level (MSL) and generally contains slightly-saline to saline water in Kleberg County.

Tolunay determined that the calculated factor of safety for peak shear strength conditions exceeded 1.5 for their assumed strength and unit weight parameters, the analyzed cross sections, and assumed failure geometry. The calculated factor of safety for large displacement condition exceeds 1.5, which based on published information, is acceptable. Based on Tolunay-Wong's Geotechnical Engineering Study results, and in their opinion, it is anticipated that the planned landfill configuration should be stable, provided excess pore pressures are not generated within the waste mass or that there is no increase in piezometric head above 1 foot within the underlying liner cover material or leachate collection system. The generation of pore pressures and increase in piezometric head within the materials could substantially reduce the factor of safety and increase the risk for stability problems. Also, the predicted settlements resulting from consolidation settlement of the foundation soils due to the weight of the overlying landfill material are on the order of 1 foot.

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3. Finch, R.N, P.E., Geology Report, Permit Amendment Application-City of Kingsville Landfill, City of Kingsville, Kleberg County, Texas, Permit Amendment No. MSW 235-B: Finch Energy and Environmental Services, Inc, (1998).

4. O'Connor, M.J., P.E., and Rein, A.R., E.I.T., Subsurface Exploration and Laboratory Analysis for the Proposed Landfill Expansion, Kingsville, Texas: Professional Service Industries, Inc, (1997).

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CITY OF KINGSVILLE LANDFILL

PART III, ATTACHMENT 4

APPENDIX 1

GEOLOGY REPORT DATED MAY 29, 1998 AND JUNE 29, 1998, AND REVISED SEPTEMBER 30, 1998, WITH APPENDICES.

ATTACHMENT 4

Geology Report

Finch Energy & Environmental Services, Inc.
P.O. Box 73/1204 W. King, Kingsville, TX 78364
Phone: (512) 592-9810 Fax: (512) 592-5552

ATTACHMENT 4 - GEOLOGY REPORT
PERMIT AMENDMENT APPLICATION-CITY OF KINGSVILLE LANDFILL
CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

Permit Amendment No. MSW 235-B

Prepared for: City of Kingsville
P.O. Box 1458
Kingsville, Tx 78364

Prepared by: F.E.E., Inc.
P.O. Box 73
Kingsville, Tx 78364
(512)592-9810

TABLE OF CONTENTS

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STATE OF TEXAS
RAY N. FINCH
30926
REGISTERED PROFESSIONAL ENGINEER
9-30-98

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RAY N. FINCH
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PROFESSIONAL ENGINEER
9-30-98

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RAY N. FINCH
30926
REGISTERED
PROFESSIONAL ENGINEER
6-26-98

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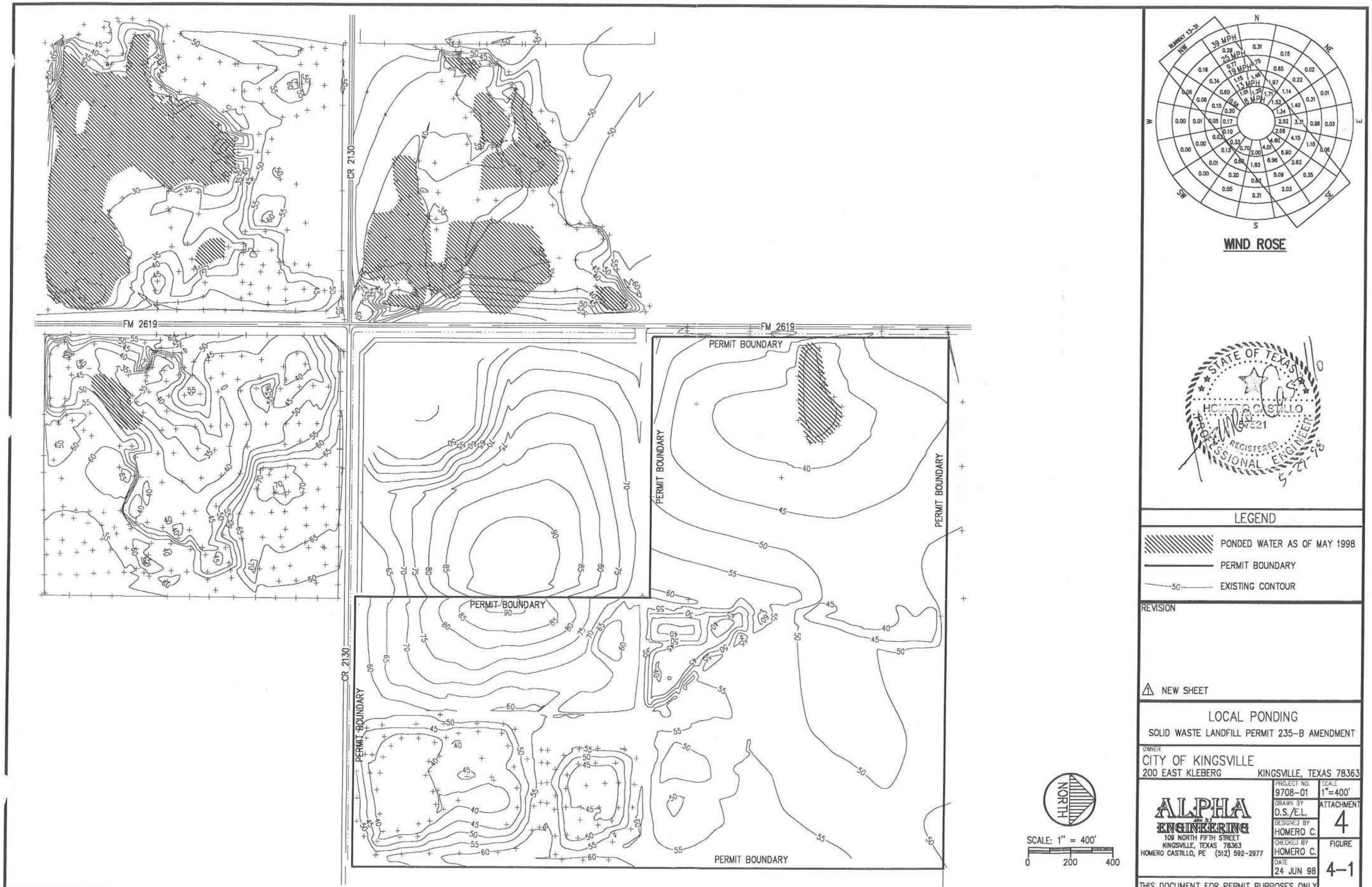
1.0 FACILITY LOCATION AND SETTING

1.0 FACILITY LOCATION AND SETTING

The Kingsville Municipal Solid Waste Landfill (MSWLF) is located in north central Kleberg county, approximately five (5) miles southeast of the center of the city of Kingsville, Tx. The site is specifically located on the northwest corner of the intersection of Farm-to-Market Road #2619 and Kleberg County Road #2130 (See Figure 4.1). The site is geologically located at the northern boundary of the South Texas Eolian System. The current permitted area in Farm Lot (FL) 13 and West 1/2 FL 14, Section 36, Kleberg Town and Improvement Subdivision is 55.87 acres more or less (26.34 closed, 12.23 unused, 17.30 active) in size. The proposed expansion into East 1/2 FL 14, FL11, and FL12 will increase the total landfill area to 160 acres, more or less. This 160 acres will be composed of approximately 40 acres closed and unused, and approximately 120 acres of permitted area (active plus unused), assuming TNRCC approval of this permit application.

Additionally, the site is located within an area historically used for the surface mining of caliche. The site is an abandoned mine and abandoned mines are adjacent to the site on the North, West and Southwest. The area of abandoned mines is approximately one (1) square mile in size.


FM 2619
CR 2130
PERMIT BOUNDARY
WIND ROSE
STATE OF TEXAS
HOMERO CASTILLO
REGISTERED
PROFESSIONAL ENGINEER
LEGEND
PONDED WATER AS OF MAY 1998
PERMIT BOUNDARY
EXISTING CONTOUR
REVISION
NEW SHEET
LOCAL PONDING
SOLID WASTE LANDFILL PERMIT 235-B AMENDMENT
OWNER
CITY OF KINGSVILLE
200 EAST KLEBERG
KINGSVILLE, TEXAS 78363
PROJECT NO. 9708-01
SCALE 1"=400'
DRAWN BY D.S./E.L.
DESIGNED BY HOMERO C.
CHECKED BY HOMERO C.
DATE 24 JUN 98
ATTACHMENT 4
FIGURE 4-1
ALPHA ENGINEERING
109 NORTH FIFTH STREET
KINGSVILLE, TEXAS 78363
HOMERO CASTILLO, PE (512) 592-2977
SCALE: 1" = 400'
0 200 400
NORTH
THIS DOCUMENT FOR PERMIT PURPOSES ONLY

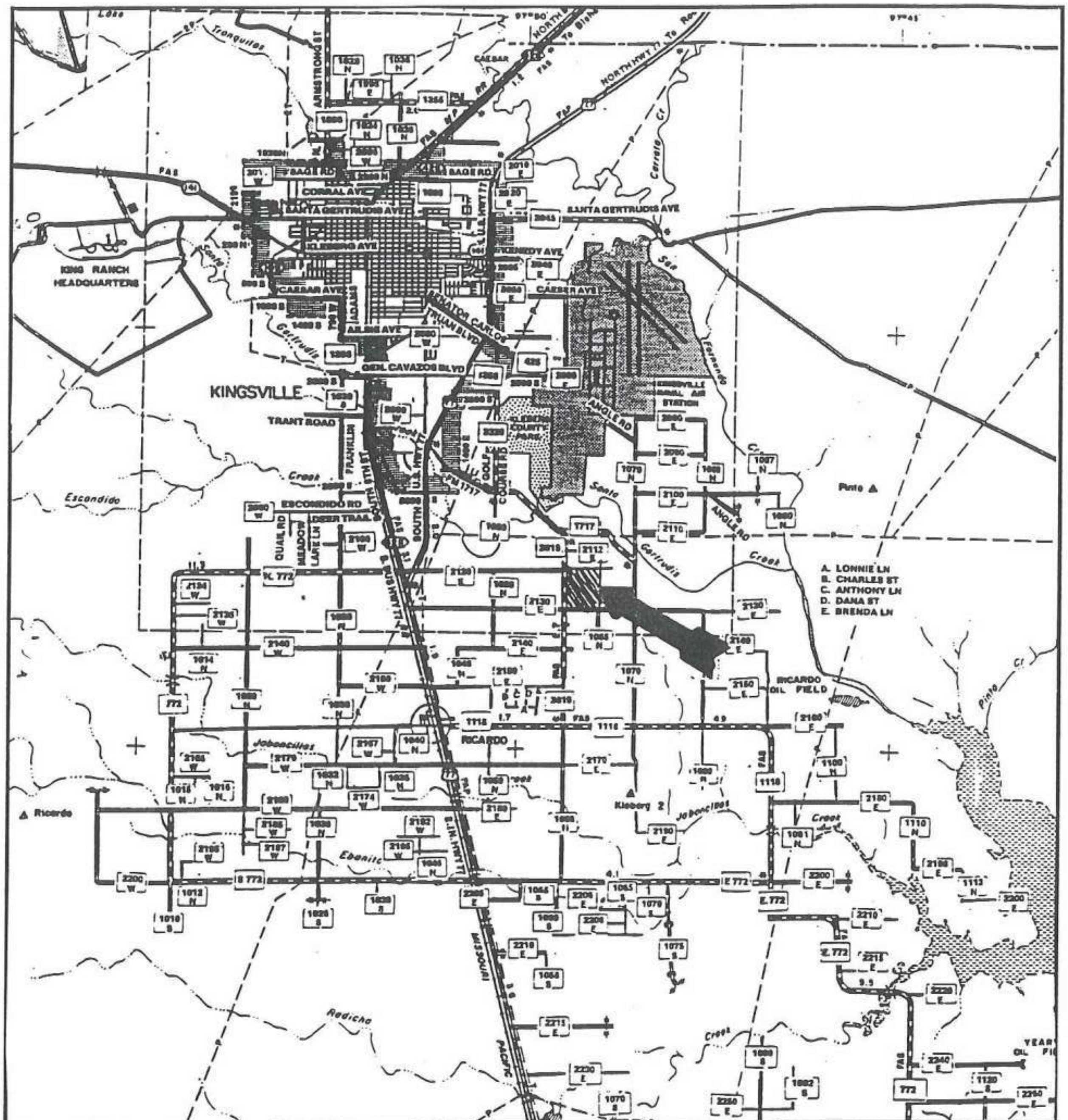


Figure 4.1
Site Location Map
(no scale)

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2

2.0 REGIONAL PHYSIOGRAPHY AND TOPOGRAPHY

2.0 REGIONAL PHYSIOGRAPHY AND TOPOGRAPHY

The Kingsville MSWLF is located within the part of the Gulf Coastal Plain that has been defined as the Coastal Bend of Texas. (See Figure 4.2) The coastal plain is gently, but irregularly, inclined gulfward at about 5 feet or less per mile. In many areas, coastal plain slopes range from 1 to 3 feet per mile, and on the lagoonal wind-tidal flats, slopes are usually less than 1 foot per mile. Elevations within the county range from 0 feet (Gulf of Mexico) to 125 feet above Mean Seal Level (MSL) in the extreme northwestern part. It is characterized as an arid, desert like region where wind (Eolian) erosion and wind-transported sediment have determined much of the area's character and distinctiveness. The surface features of the county are broad, dune covered mainland prairies and extensive coastal wind-tidal flats. The climate is one of low rainfall, high evaporation, and persistent onshore winds.

Eolian transport of silts and sands has produced the South Texas Eolian system (sand sheet). Extensive, hummocky prairies within the South Texas sand sheet are underlain by relic sand dunes and wind-deflated depressions which extend inland from broad wind-tidal flats along the landward margin of Laguna Madre and parts of Baffin Bay.

Live-oak mottes, stands of brushland, and active sand dunes break the widespread sandy prairies of the Kingsville area into many local, discontinuous patches of rangeland. A few small ephemeral streams, that extend coastward across the northern and northwestern parts of the area, discharge into Baffin Bay.

In a broad area southwest of Santa Gertrudis Creek and Cayo del Grullo, mud and sand substrates are veneered by relatively thin airborne silt (loess) deposits that have settled out downwind from the large dune fields southeast of Sarita. The silt, or loess, sheet overlies muddy sediments between U.S. Highway 77 and Cayo del Grullo and sandy and silty deposits west of U.S. Highway 77. (Brown, 1977)

The Santa Gertrudis Creek, located 0.7 miles to the north, trends to the east-southeast 3.25 miles to it's confluence with the San Fernando Creek which then flows southeast to the Cayo del Grullo of Baffin Bay. Jaboncillos Creek, Ebanito Creek and several small unnamed ephemeral streams, are located several miles south of the site. (See Figure 4.3)

Standing water several feet deep is present on the floor of the abandoned caliche mines to the west and southwest. These mines were excavated to a depth of approximately forty feet. This would place the mine floor in proximity to ground water level. The standing water has continued to be present throughout the extended drought period of the past 2-3 years. The USGS topographic map of the area indicates that these pits are considered permanent water bodies. A more complete discussion of the impacts of these local depressions on groundwater is given in section 6.2.3.

The land surface surrounding the site is flat to slightly depressed. The general direction of drainage is to the east-southeast and east-northeast. The minimum depth of the site is approximately 40 feet above MSL (excavated depth). The current elevation of the MSWLF is 90 feet above MSL, and the planned elevation is 125 feet MSL (top of capped section). Extensive areas of agriculture surround the site.

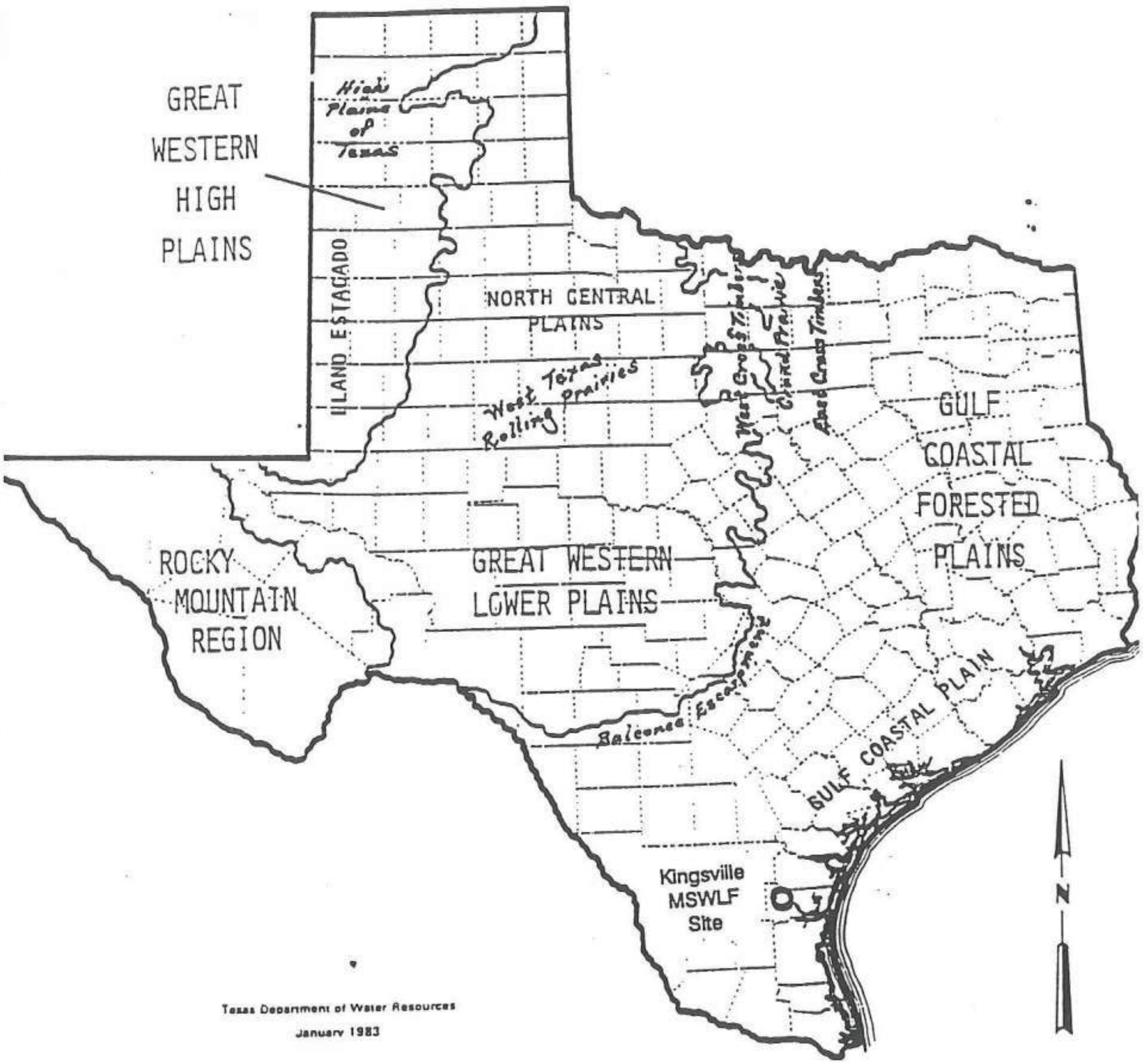

Figure 4.2
Physiographic Map
of Texas
Texas Dept of Water
Resources - 1983

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5

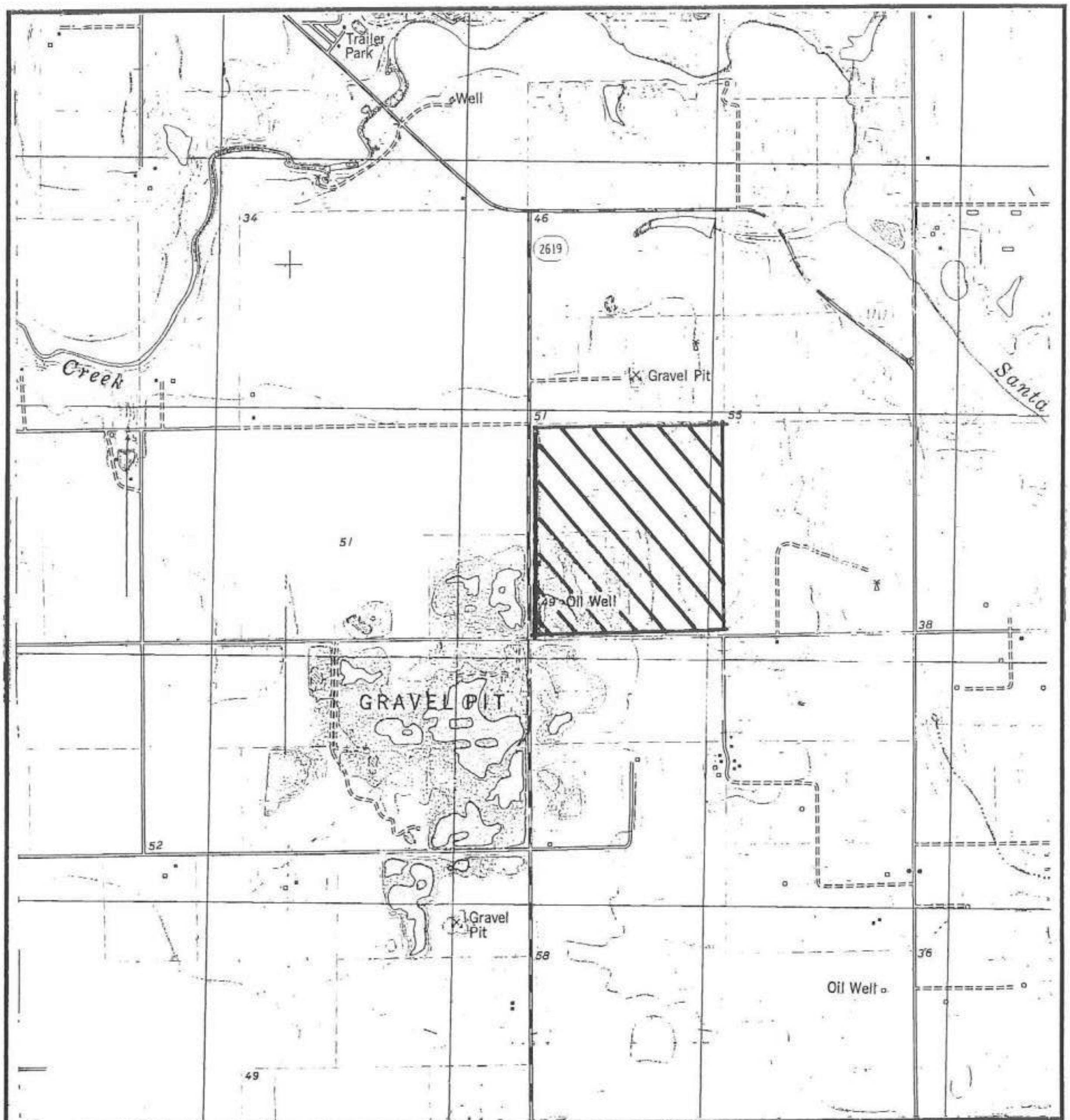

Figure 4.3
US Geological Society
Topographic Map of
the MSWLF area

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6

3.0 REGIONAL GEOLOGY AND HYDROLOGY

3.0 REGIONAL GEOLOGY AND HYDROGEOLOGY

3.1 Regional Geology

The Texas Coastal Zone is composed of several active, natural systems of environments: fluvial-deltaic, barrier-strandplain-chenier, and bay-estuary-lagoon systems, as well as an Eolian (wind) system in South Texas and marsh-swamp systems in more humid middle and upper coastal regions. (See Figure 4.4) The Coastal Zone is also underlain by sedimentary deposits that originated in ancient, but similar, coastal systems. (Brown, 1977) The clastic sediments composing the geologic formations grade from fluviatile and deltaic sand, silt, and clay in inland areas to predominantly finer sediments that interfinger with brackish and marine sediments near the Gulf Coast and offshore. Geologic structure in the area is relatively simple. The water bearing formations underlying the report area form a monocline which dips gently toward the coast. Although faults are fairly common in many of the deeply buried formations, none of the geologic formations within the scope of this report are known to be displaced by significant faults (Shafer, 1973).

3.2 Regional Hydrogeology

A stratigraphic column of geologic formations including a brief discussion of lithology and water-bearing properties found in the area of Kingsville is presented as Figure 4.5.

The Goliad Sand of Pliocene age occurs in the subsurface of the site area. It is the principal aquifer in the site area with wells producing small to large quantities of fresh to slightly saline water to public supply, industrial, irrigation, rural-domestic, and stock wells. The aquifer is considered a large, leaky artesian aquifer. The lithology is fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored calcareous clay. The formation outcrops in Duval County where it is under water table conditions. (See Figure 4.6) The Goliad Sand dips to the east from 20 to 40 feet per mile. It reaches a maximum thickness of about 1,100 feet and it's top lies 1,400 feet below the surface in the vicinity of Padre Island. In the Kingsville area, the Goliad is about 500 feet below the land surface. (Shafer, 1973)

The Pleistocene formations exposed in the region are the Beaumont Clay and Lissie Formation. The Beaumont Clay is recognized as lying to the east of U.S. Highway 77. The Beaumont Clay is a series of delta-plain deposits composed principally of mud with localized elongate sand and silt bodies. The Lissie Formation is composed of meanderbelt sands and muds which underlie thin loess (Eolian silt) deposits and Eolian sand deposits west of U.S. Highway 77. These two formations are generally discussed as one unit; Beaumont Clay and Lissie Formation, undifferentiated.

During Pleistocene time, large streams eroded large amounts of sand, gravel, clay, and silt from the upland areas. These clastic sediments were deposited by streams meandering across the nearly featureless coastal plain. Sand beds are lenticular grading rapidly both horizontally and vertically into clay or silt within short distances. These deposits slope to the east at about 25 feet per mile. The thickness of the unit ranges from 100 feet in parts of Jim Wells County where the base of the unit is nearest land surface to approximately 1,400 feet in far eastern Kleberg and Kenedy Counties. The formations consist mostly of very calcareous, slightly carbonaceous, blue and yellow clay, and a few lenticular beds of sand. Many of the sand beds, especially those near the surface, are fine to very fine grained. Calcareous nodules and disseminated caliche are common in the shallow part of the section. The group yields small quantities of slightly to moderately saline water to a few shallow wells used mostly for stock needs in eastern Kleberg and Kenedy Counties. (Shafer, 1973)

The South Texas Eolian system is of Modern, Holocene, and Pleistocene age according to the Environmental Geologic Atlas of the Texas Coastal Zone - Kingsville Area. The landfill site is situated within the Riviera loess sheet to the east of U.S. Highway 77 and southeast of Kingsville. The Riviera loess sheet is characterized as a thin, discontinuous loess sheet composed of airborne silt derived from upwind areas of wind deflation. East of U.S. Highway 77, the loess overlies flat Pleistocene delta-plain deposits composed principally of mud with localized elongate sand and silt bodies (Beaumont Clay). The Riviera loess sheet varies in thickness from a few inches to several feet; locally the loess is absent and Pleistocene deposits are exposed at the surface. The loess and underlying Pleistocene deposits, especially the sands, are extensively calichified. This formation is of minor importance in the site area (Brown, 1977). (See Figure 4.7)

3.2.1 Regional Soils

The Environmental Geologic Atlas - Kingsville Area indicates that the soils in the area of the landfill site are of two types: Type II and Type IX. (See Figure 4.7) The predominant soil group is Group IX which is described as clay -sand dunes and dune complexes, active and inactive, sparsely and heavily vegetated respectively. Older vegetated dune complexes have a higher sand and caliche content. Currently active dunes are high in clay content. Type II soil group is defined as dominantly sand, high to very high permeability and drainage, moderate water-holding capacity, low to moderate compressibility and shrink-swell potential. The Atlas also points out in Table 6 that these types of soils may have problems as solid waste disposal areas. However, the use of geosynthetic clay liner as replacement for higher permeability soils addresses this problem.

The Texas Coastal Basins Cooperative River Basin Survey Plate 4-5 indicates that the soils at the landfill site are type 3-V described as Victoria-Orelia- Clareville group. These are described as cracking clayey soils; soils with loamy surface layers underlain by cracking clayey layers and soils loamy throughout, some of which are compact beneath the surface layer.

The soil in the area of the landfill site is defined to be Czar-Delfina-Orelia according to the General Soil Map of Kleberg County, Texas prepared by the Soil Conservation Service. This soil group is described as "somewhat poorly to well drained loamy fine sands, fine sandy loams and sandy clay loams that have moderately to very slowly permeable lower layers with low and moderate shrink-swell potentials. This unit consists of about 35 percent Czar soils, 30 percent Delfina soils, 20 percent Orelia soils, and 15 percent other soils. The detailed description of these soils is given in Appendix O. This same source states that the Czar soils have slight limitations for area type sanitary landfills but are so minor they are easily overcome. The Czar soil is good for daily landfill cover. The Delfina soil has the same rating (slight) for area type sanitary landfills as Czar soils. The use of Delfina soil for landfill cover varies from good to fair. The Orelia soil has a moderate rating for area type sanitary landfills which means that limitations can be overcome or modified. The Orelia soil has fair use as landfill cover.

Consultation with the local USDA Soil Conservation Office produced a specific aerial photograph soils map of the area. This map defines the caliche pits as just that. The soils surrounding the remainder of the site are of four types: Hidlago fine sandy loam, Racombes sandy clay loam, Runge fine sandy loam, and Willacy fine sandy loam. The description of these soils from the National Soils database at Iowa State University are attached in Appendix O.

The geologic description of the site surface and subsurface described in sections 6 and 8 confirm that the site has a major caliche bearing channel, a discontinuous sand filled channel, and two clay dunes. Thus, the soils description from the Environmental Geologic Atlas, the Kleberg County Soils Map and the local SCS describe the site soils best.

Figure 4.4
Regional Geology Map
EGA-Texas Coastal Zone
Kingsville Area - 1977

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10

EXPLANATION

QUATERNARY

Recent or Late (?) Pleistocene

Pleistocene

F S

Fill and Spoil

Fill, F, material dredged for raising land surface above alluvium and barrier island deposits and for creating land. Spoil, S, dredged material forming islands along waterways. Properties highly variable, mixed mud, silt, sand, and shell; mud and silt winnowed when reworked

Qal

Alluvium

Clay, silt, sand, and gravel, organic material abundant locally; includes point bar, natural levee, stream channel, backswamp, coastal marsh, mud flat, clay dune, sand dune, and oyster reef deposits. Includes some terrace deposits along streams other than the Nueces

Qbi

Barrier island deposit

Sand, silt, and clay; mostly sand, well sorted, fine grained, abundant shells and shell fragments; interfingers with silt and clay in landward direction; includes beach ridge, spit, tidal channel, tidal delta, washover fan, and sand dune deposits; "high to very high permeability, low water-holding capacity, low compressibility, low shrink-swell potential, good drainage, high shear strength, low plasticity"

Qcd | Qsd | Qds | Qs | Qsi

Windblown deposits

Includes clay dune and clay-sand dune deposits, Qcd; active dunes and dune complexes; Qsd; stabilized sand dune deposits, Qds; sand sheet deposits, Qs; and silt sheet deposits, Qsi. Small areas of Pleistocene deposits within these various units not separately mapped

Clay dune and clay-sand dune deposits, Qcd, clay, silt, and sand ranging from mostly clay and silt in coastal areas to a mixture of clay, silt, and sand inland; light gray, calcareous; forms elongate deposits mostly on downwind side of intermittently wet basins, relief 5-30 feet; physical properties similar to those of the sandy and silty Beaumont

Active dunes and dune complexes on mainland, Qsd, banner dunes common, local barchan dunes; relief up to 30 feet; "very high permeability, low water-holding capacity, low compressibility, low shrink-swell potential, good drainage, high shear strength, low plasticity, unstable because of migration"

Stabilized sand dune deposits, Qds, strong relict eolian grain, sparse grass; includes active blowout areas with depressed relief, hummocky, locally becomes fresh-water marsh in wet season, and well-stabilized sand dunes with dense live-oak mottes and scrub; "moderate to very high permeability, low to moderate water-holding capacity, low compressibility, low shrink-swell potential, good to fair drainage, high shear strength, low plasticity, shallow water table"

Sand sheet deposits, Qs, no relict grain, sparse grass; physical properties similar to those of "Stabilized sand dune deposits," Qds

Silt sheet deposits, Qsi, silt and fine sand in thin, locally discontinuous sheet winnowed from other "Windblown deposits," brush and grass covered, rests on various Pleistocene deposits; has physical properties similar to those of other "Windblown deposits," but because of its thinness engineering plans should consider the nature of the underlying materials

Qd

Deweyville Formation

Sand, silt, clay, and gravel, includes point bar, natural levee, and stream channel deposits, surface characterized by relict meanders of much larger radius of curvature than those of present streams; occurs along Nueces River at three levels: 5-20, 20-30, and 40-55 feet above level of Recent floodplain

Qbb Qb Qb

Beaumont Formation

Beaumont Formation, Qb, with barrier island and beach deposits, Qbb, mapped separately. Beaumont Formation, Qb, mostly clay, silt, sand, and gravel; includes mainly stream channel, point bar, natural levee, and backswamp deposits, and to a lesser extent coastal marsh, mud flat, lagoonal, Recent and older lake, clay dune, and sand dune deposits; concretions and massive accumulations of calcium carbonate (caliche) and concretions of iron oxide and iron-manganese oxides in zone of weathering; surface pitted by shallow lakes or dry lake beds with associated clay dunes which in places align along meanderbelt ridges; pimple mounds only in vicinity of Qbb unit; thickness 100± feet

The stippled overprint (source shown in Index to Geologic Mapping) shows areas that are "Dominantly clay and mud of low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, level to depressed relief, low shear strength, and high plasticity; geologic units include interdistributary muds, abandoned channel-fill muds, and fluvial overbank muds." The nonstippled areas are "Dominantly clayey sand and silt of low-moderate permeability, moderate drainage, level relief with local mounds and ridges, and high shear strength; geologic units include meanderbelt, levee, crevasse splay, and distributary sands"

Barrier island and beach deposits, Qbb, mostly fine-grained sand, shells scarce; surface slightly higher than that of surrounding deposits, characterized by numerous pimple mounds and poorly defined relict beach ridges; includes many Recent, locally active sand dunes; probably part of "Ingleside" barrier island system; thickness less than 60 feet

Ql

Lissie Formation undivided

Sand, silt, clay, and minor amount of gravel; iron oxide and iron-manganese nodules common in zone of weathering, in upper part locally calcareous, some concretions of calcium carbonate; surface fairly flat and featureless except for numerous rounded shallow depressions and pimple mounds, lower part very gently rolling; characterized by "moderate permeability, moderate drainage, and high shear strength; geologic units include meanderbelt, levee, crevasse splay, and distributary sands and floodbasin mud over meanderbelt sand;" thickness 200± feet

Fault

U
D

U, *upthrown side;* D, *downthrown side; dashed where inferred*

Figure 4.4a Geology Map Explanation

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11

SYSTEM	SERIES	GEOLOGIC FORMATION	APPROXIMATE MAXIMUM THICKNESS (FT)	LITHOLOGY	WATER-BEARING PROPERTIES
Quaternary		Alluvium	?	Mostly very fine to fine sand, silt, and calcareous clay.	Not significant as an aquifer. Not known to be tapped by wells.
		Barrier Island deposits	50	Tan to gray, fossiliferous, medium sand containing wood fragments; interbedded tan sand and gray clay, locally gypseous; and gray, fossiliferous sandy clay.	Capable of yielding small quantities of fresh water to shallow wells on Padre Island.
	Holocene and Pleistocene (?)	South Texas eolian plain deposits	60 +	Tan to white, unfossiliferous, massive, fine to very fine sand, greenish gray sandy clay, highly calcareous clay or marl, and thin-bedded clayey sand.	Yields small quantities of slightly saline water to a few stock wells in Kenedy County. In some areas in Kenedy County the sand contains brine.
	Pleistocene	Barrier island and beach deposits		Barrier island and beach deposits mostly light gray, massive, cross-bedded fine sand about 60 feet thick; contains some shell fragments.	Barrier island and beach deposits yield small quantities of fresh to probably moderately saline water to a few stock wells in eastern Kleberg County near Laguna Madre.
		Beaumont Clay and Lissie Formation, undifferentiated	1,400	Beaumont Clay and Lissie Formation mostly very calcareous, slightly carbonaceous, blue and yellow clay and a few lenticular beds of sand.	Beaumont Clay and Lissie Formation yield small quantities of slightly to moderately saline water to a few mostly stock wells in eastern part of Kleberg and Kenedy Counties.
Tertiary	Pliocene	Goliad Sand	1,100	Fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored calcareous clay. Sand beds or sandstone compose from 40 to 60 percent of the formation.	Principal aquifer. Yields small to large quantities of fresh to slightly saline water to public supply, industrial, and irrigation wells as well as to numerous rural domestic and stock wells. Many of the wells tapping the Goliad in Kleberg and Kenedy Counties flow.
	Miocene	Lagarto Clay	1,200 +	Mostly stiff, compact, gray, calcareous clay and some thin lenticular beds of gray sand.	Not known to be tapped by wells, but capable of yielding small quantities of slightly saline water in Kenedy and Jim Wells Counties.
		Oakville Sandstone	600	Very fine to coarse, brown to gray sand and sandstone interbedded with silt and a considerable amount of clay.	Yields small to moderate quantities of slightly saline water to industrial and stock wells in southern Jim Wells County.

Figure 4.5
Stratigraphic Column

Texas Water Development Board
1987

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Figure 4.6
Regional Cross-Section
Texas Water Development Board
1987

REVISION 1
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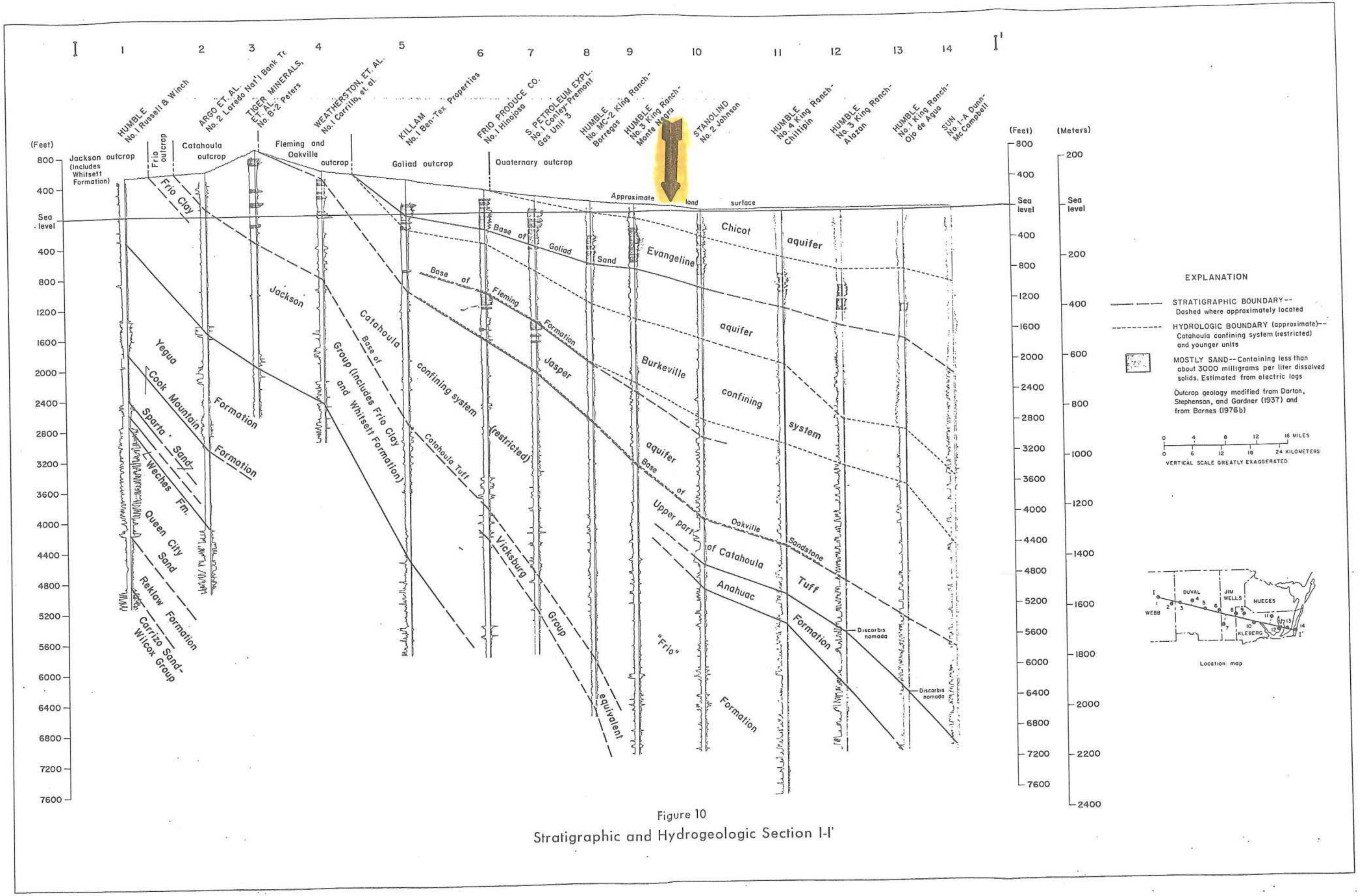


Figure 10

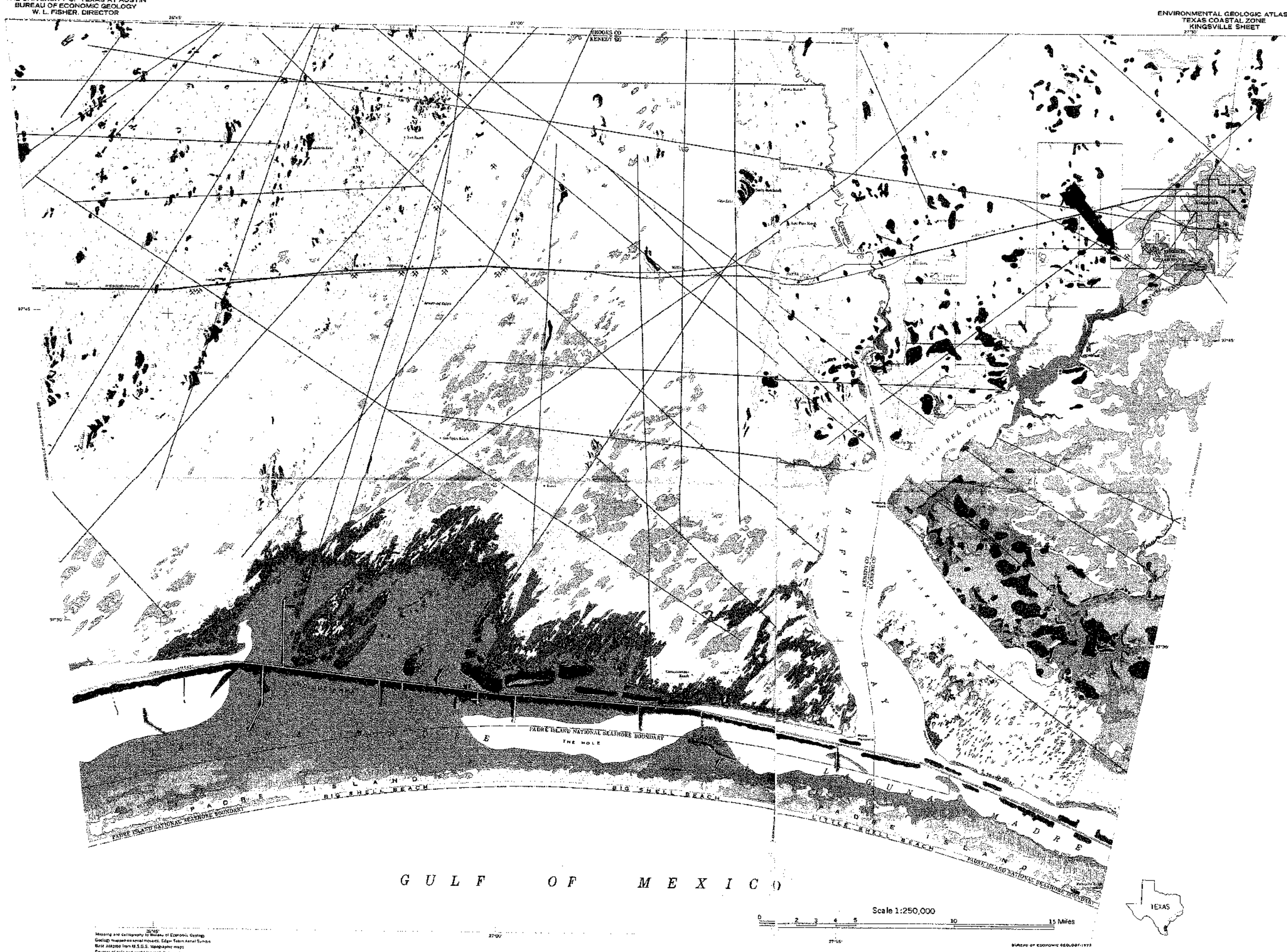
Stratigraphic and Hydrogeologic Section I-I'

Figure 4.7
Physical Properties Map
Bureau of Economic Geology
EGA-Texas Coastal Zone
Kingsville Area 1977

REVISION 1
14

THE UNIVERSITY OF TEXAS AT AUSTIN
BUREAU OF ECONOMIC GEOLOGY
W. L. FISHER, DIRECTOR

ENVIRONMENTAL GEOLOGIC ATLAS,
TEXAS COASTAL ZONE
KINGSVILLE SHEET



PHYSICAL PROPERTIES

EXPLANATION

CATEGORIES

GROUP I.

Dominantly clay and mud, low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, level to depressed relief, low shear strength, high plasticity
Geologic units include interdistributary muds, channel-fill muds, mud-filled coastal lakes

GROUP II.

Dominantly sand, high to very high permeability, low water-holding capacity, low compressibility, low shrink-swell potential, good drainage, low ridge and depressed relief, high shear strength, low plasticity
Geologic units include Modern barrier island sands (beach, foredunes, stabilized eolian blowouts, vegetated barrier flats, wind-deflation troughs and storm runnels, washover channels), and Pleistocene barrier - strandplain sands

GROUP III.

Dominantly clayey sand and silt, moderate permeability and drainage, moderate water-holding capacity, low to moderate compressibility and shrink-swell potential, level relief with local mounds and ridges, high shear strength
Geologic units include Pleistocene fluvial-distributary (includes levee and crevasse splay) and delta front sands, silt and local undifferentiated clay, delta front facies may be covered by loess or mud veneer

GROUP IV.

Coastal marsh, fresh to brackish, not mapped because of scale, narrow band along mainland shore

GROUP V.

Inland marsh, fresh-water, ephemeral, alternately wet and dry, variable substrate, commonly mud, low to moderate permeability, moderate water-holding capacity, poor drainage, poor to moderate load-bearing strength, moderately high organic content, subject to flooding, locally thin mud may veneer sand substrate
Geologic units include fresh-water marsh and fresh-water marsh-filled wind deflation areas; local ephemeral fresh-water marsh in eolian blowout areas not mapped

GROUP VI.

Wind-tidal flat, salt marsh rare or absent, sand with minor amounts of mud and algal mat laminations, alternatively submergent (0 - 2 feet) and emergent, unvegetated, subject to intense eolian transport of sand, local depressed areas with soft substrate, properties similar to Group II
Geologic units include several wind-tidal flat facies

GROUP VII.

Madeland and spoil, properties highly variable, mixed mud, silt, sand, and shell, reworked spoil commonly sandy and shelly with moderate sorting similar to Group III
Geologic units include subaerial spoil heaps or mounds, subaerial reworked spoil, subaqueous spoil, made land

GROUP VIII.

Transitional wind-tidal flat and eolian sand sheet, brief periods of tidal inundation alternating with longer sustained periods of wind deflation and clay-dune accretion, numerous clay dunes with properties similar to Group I, wind-tidal flat properties similar to Group VI, essentially an area of wind destruction of eolian sand sheet

GROUP IX.

Clay-sand dunes and dune complexes, active and inactive, sparsely and heavily vegetated respectively, see Geologic map to differentiate dunes, mixed sand, silt, and clay with variable properties similar to Group III, older vegetated dune complexes have higher sand and caliche content, currently active dunes high in clay content
Geologic units include inactive, brush-covered clay-sand dune complex, active, grass-covered clay-sand dunes, and eolian accretionary bars and ridges (rincons, potreros)

GROUP X.

Eolian sand sheet, poorly to well stabilized with grass, brush, and live oaks, see Geologic map to differentiate vegetation cover, moderate to very high permeability, low to moderate water-holding capacity, low compressibility, low shrink-swell potential, good to fair drainage, high shear strength, low plasticity, shallow water table, flat to hummocky or ridge-like topography
Geologic units include active dune blowout area, sand sheet with strong relict grain, sand sheet with no relict grain, sand sheet deflation area, moderately stabilized dune and sand sheet, and well-stabilized dune and sand sheet

GROUP XI.

Active dune complex, sand, friable, very high permeability, low water-holding capacity, low compressibility, low shrink-swell potential, good drainage, high shear strength, low plasticity, unstable due to migration, local relief up to 30 feet
Geologic units include active dune complex in sand sheet area, backisland dune field, fore-island blowout dune, and coppice dune and sand flats

GROUP XII.

Loess sheet, silt and fine sand, thin and locally discontinuous, overlying fluvial or deltaic-bay sand and mud, locally sandy near underlying Pleistocene channel bodies, loess variable thickness, properties similar to Group X, underlying non-eolian sediments resemble Groups I and III, engineering plans should involve consideration of depth of silt and sand and nature of subadjacent Pleistocene sediment
Geologic units include sand sheet overlying deltaic facies and sand sheet overlying fluvial facies

Refer to tables in text for land-use evaluation such as engineering, solid waste disposal, and other functional categories based on physical properties and other parameters

⚒ Pit or quarry, commonly caliche-cemented fluvial and deltaic deposits

● Solid waste disposal site, sanitary landfills, and open dumps

Active or potentially active fault, based on lineament or grain displayed on aerial photographs

Sources of data given in text

3.3 Active Geologic Processes

3.3.1 Faults and Faulting

The site is located on the west flank, southwest quadrant, of the Kingsville Dome, an area of post Late Miocene (<8 m.y.b.p.) uplift which is the largest isolated, positive structure in Kleberg County. The uplift influences an area of approximately 50 square miles. Although origin of the uplift is unknown it is attributed to deep seated diapiric shale or salt movement. The overall paucity of oil and gas production on the Dome is due to late uplift and resulting late trap formation. Possible destruction of any pre Miocene hydrocarbon traps could have also occurred. Past and current oil and gas production has been obtained from sands within the Oligocene age Frio and Miocene age Oakville formations. Productive reservoirs are highly compartmentalized by faulting. Two primary fault zones divide the Dome into quadrants.

> a.) Northeast striking regional Frio, down to the coast, growth fault buried below the Oakville formation, and
> b.) West-Northwest striking post Miocene Santa Gertrudis Fault zone, down to the South-Southwest with associated, up to the north northeast, relief faults.

An updip projection of the regional Frio growth fault passes below the landfill site at approximate depths of 6,000 to 7,000 feet, but the fault is buried below the Miocene age Oakville formation and therefore does not influence shallower beds. Updip projections of the Santa Gertrudis fault system are located north of and not in the vicinity of the landfill site. Beds as recent as the Goliad sand are influenced by the uplift but it is unknown as to whether Santa Gertrudis faulting penetrates this high in the section. It is believed that the Late Miocene uplift and associated Santa Gertrudis faults predate deposition of the Pleistocene Beaumont and Lissie formations. The Pleistocene beds exhibit northeast dip in the landfill site vicinity (Structure Map, Top Lt. Olive Green Clay) whereas deeper Miocene and Oligocene beds exhibit west to southwest dips due to uplift.

An evaluation of potential faults or fault zones does not indicate the presence of active faults. Topographic Maps, literature searches, aerial photographs, Petroleum Industry maps and a field survey were used in this evaluation. The field survey combined with topographic maps did not reveal structural damage to buildings, ground scarps, or unusual surface depressions. Changes in drainage or vegetation patterns which are also associated with faulting were not present.

A surface lineament passing through the site was noted on the Physical Properties map in the Kingsville Volume of the Environmental Geologic Atlas of the Texas coastal Zone. (See Figure 4.7, Lineament Labeled A) No surface expression of faulting as related to this lineament is noted. Improved copies of Figures 4.8 &4.9 could not be located.

Electric logs of the oil and gas wells drilled in the immediate area are not recorded to ground surface. Electric logs of two uranium wells were located and obtained from URI, Inc.'s Kingsville office. The location of these wells are noted on the Cross section map and subsurface maps submitted with this revised report.

3.3.2 Subsidence and Unstable Areas

Site specific soil conditions which might result in differential compaction are not evident. A 2' to 2.5' topsoil and loess cover is present in the current agricultural area and the unmined areas. Below, the topsoil, is a firm to very hard clay. This clay is described as silty, calcified, with caliche, and is uniform in character throughout the site.

A field investigation did not reveal any geologic or geomorphologic features which might affect the soil stability. On site are an office and scale house, and maintenance facilities. Off site (within a one (1) mile radius) are 41 residences and agricultural buildings. All buildings are one-story in design.

An off-site field investigation of the petroleum producing areas did not reveal any major storage, processing or secondary recover facilities which could affect site stability at the surface or at depth.

Subsidence at the site does not appear to be a problem. The settlement analysis in Appendix H indicates a maximum settling of 3.0 inches at the center of the landfill and 1.5 inches at the edges. The maximum stress when the landfill is completely filled is between 1.25 to 1.50 tons per square foot. Unconfined compressive strength is typically 3.0 to 5.0 tons per square foot. Typical strain of less than 1% is encountered when compressive stress is 1.5 tons per square foot . Therefore, subsidence does not appear to be a problem. Some localized sand channels will have to be replaced during construction.

3.3.3 Erosion

Based on soil types and character, and topography, erosion does not appear to be significant factor under "normal conditions" or if design criteria are met and maintained. The soils data found in the references given in Section 3.2.1 above say very little about erosion potential. However, it is obvious that sandy soils will tend to become airborne with sufficient velocity. It is therefore important that the cap for the landfill be immediately covered, compacted and vegetated. The length of rainfall run-off on slopes has been addressed by breaking up the long runs on the cap with diversionary berms. Thus, active cap cover and maintenance will minimize erosion from the site. However, in a situation of torrential rains associated with tropical storms or hurricanes erosion may be significant in local areas and for a limited time frame.

Although cultivated agricultural lands may tend to undergo some erosion with sandy types of soils, pasture lands or other vegetated soils greatly reduce the potential to erode. The land fill soils for capping will be compacted and/or vegetated or both to minimize erosion. The final cover for the landfill will be well capped and diversionary berms for water flow control on long slopes will be used.

3.3.4 Seismic Impact Zones

Data presented by Algermissen, et al, 1990 suggests a low probability of major seismic activity in the vicinity of the site. (See Figure 4.9)

3.4 Wetlands

A representative from the U.S. Army Corps of Engineers has visited the site. The U.S. Army Corps of Engineers has concluded that there are no wetlands on the COK MSWLF site. (See Figure 4.10)

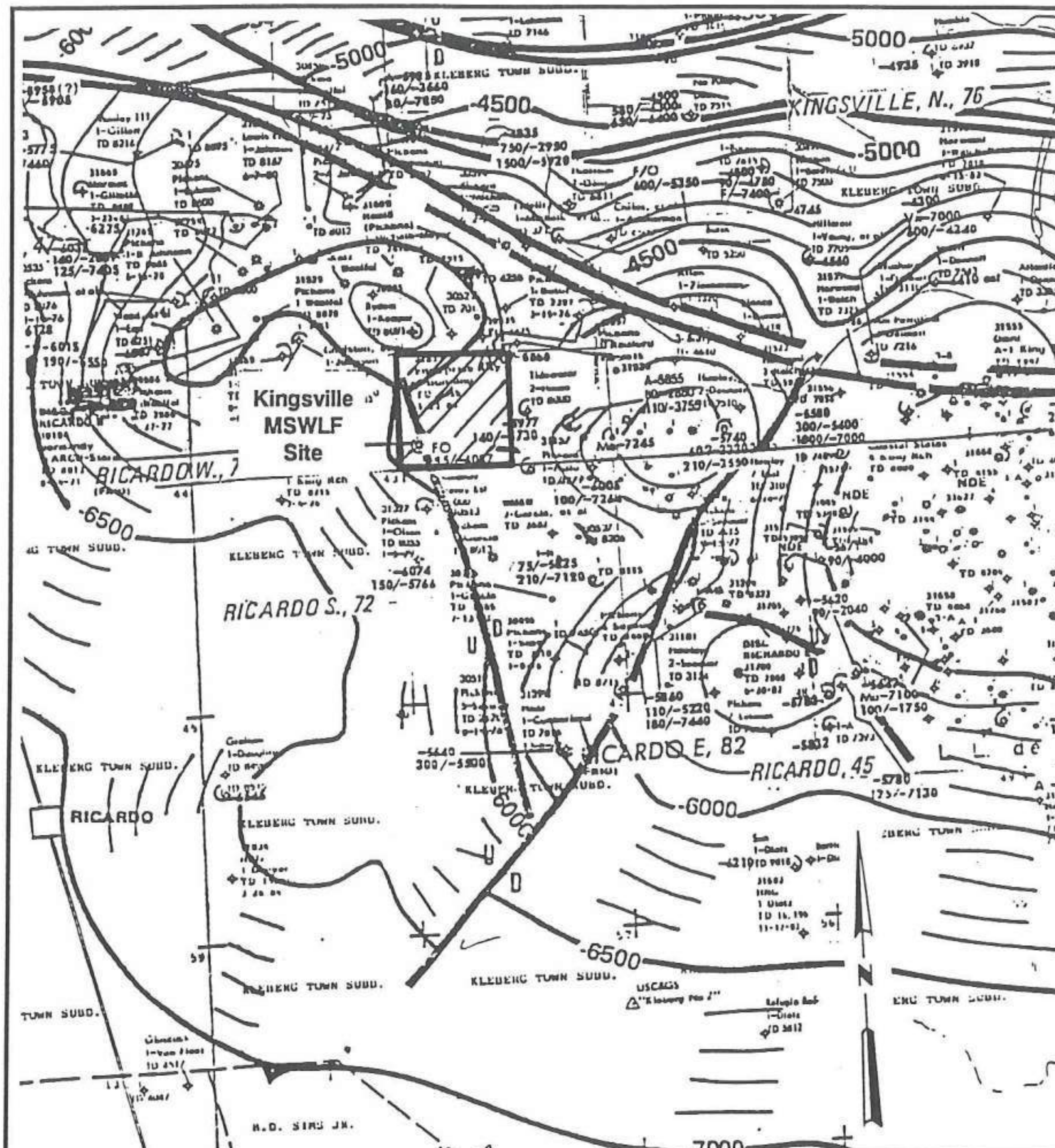


Figure 4.8
Fault Map of
the MSWLF area
USGS OFR
#82-1033

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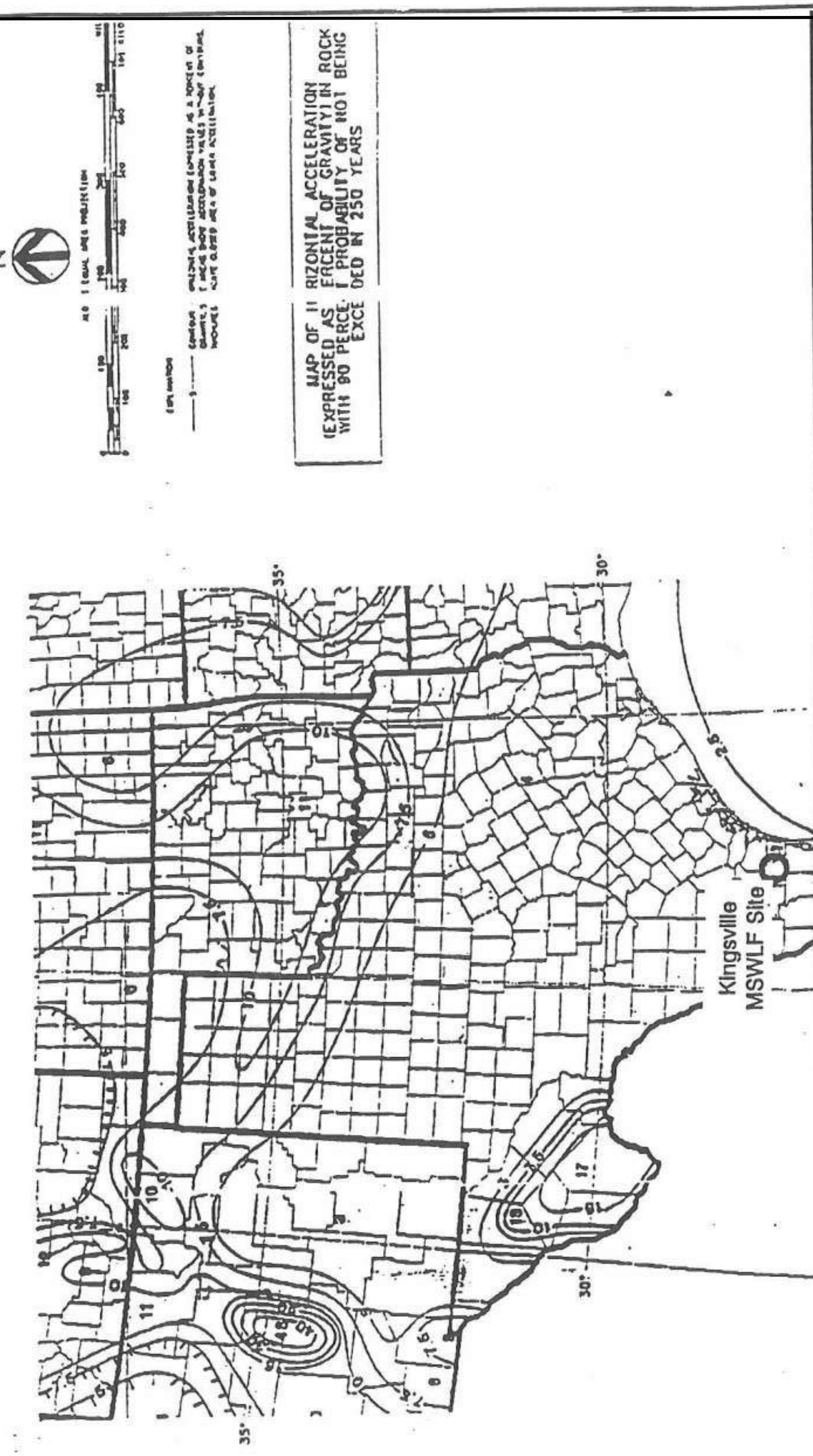

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Figure 4.9
Seismic Impact Zone Map
USGS OFR #82-1033

FIGURE 4.10

U.S. Army Corps of Engineers

Letter Dated November 7, 1997

DEPARTMENT OF THE ARMY
SOUTHERN AREA OFFICE, CORPS OF ENGINEERS
P.O. BOX 2946
CORPUS CHRISTI, TEXAS 78403-2946

REPLY TO
ATTENTION OF

November 7, 1997

Regulatory Branch

SUBJECT: D-8551

Mr. Homero Castillo
Alpha Engineering
P.O. Box 1251
Kingsville, Texas 78364

Dear Mr. Castillo:

This is in response to your August 13, 1997, letter requesting a jurisdictional determination and permit requirements for a proposed Solid Waste Landfill project. The site is located at the intersection of FM 2130 and FM 2619, Kleberg County, Texas.

I have completed my review of the information submitted and have determined that a Corps of Engineers permit is not required to proceed with the project. This determination is valid for a period of 5 years unless new information warrants a revision before the expiration date.

If you have any questions concerning this matter, please contact me at the letterhead address or call (512) 884-3385.

Sincerely,

James E. Gilmore
South Unit Leader
Enforcement Section

21

4.0 REGIONAL AFQUIFERS

4.0 Regional Aquifers

The Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. Only in South Texas the base of the Evangeline coincides with the base of the Goliad. The upper boundary of the Evangeline probably follows closely the top of the Goliad Sand where present, but this relationship is somewhat speculative (Muller, 1979). (See Figure 4.11) Ground water flow direction in the Evangeline is in a Northerly direction based on a water level map of the Goliad sand. There are two very significant cones of depression in the Evangeline (Goliad) aquifer located to the northwest of the City of Kingsville MSWLF site. These depressions are primarily due to large groundwater production rates by the City of Kingsville and the Exxon King Ranch Gas Plant. The extent of salt water intrusion from the Gulf of Mexico into the Evangeline (Goliad) aquifer is shown on Figure 4.16.

The Goliad consists of fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay. Recharge within the site area occurs along the outcrop which is located in western Hidalgo, central-eastern Starr, central Jim Hogg, Duval, southeastern Webb, northeastern Brooks, northern Jim Wells, and extreme northeast Zapata counties, as well as other counties to the north. The maximum width of the outcrop is west of Falfurrias where the Goliad Sand extends for nearly 50 miles at the surface and completely overlaps the underlying Lagarto Clay and Oakville Sandstone and nearly overlaps the Catahoula Tuff (Shafer, 1973). (See Figure 4.12)

The water of the Goliad is under artesian pressure and is yielded to flowing and nonflowing wells. The average coefficient of transmissibility determined during drawdown of the fresh to slightly saline water section of the Goliad Sand in southwestern Kleberg County measured in well no. RR-83-41-803, was about 34,400 gpd per foot. The specific capacity of the well was 17.8 gpm per foot. This was derived from a screened interval of 126 feet near the north boundary of Kenedy and south boundary of Kleberg Counties.

Fresh water of domestic use quality in the Evangeline is found in well developed sands at depths of 500 feet and greater in the MSWLF area. From surface to the fresh water sands in the Evangeline the lithology is predominately a clay described as silty, calcareous, firm to hard with occasionally silty sands.

The regional Chicot aquifer lies approximately 220 feet below ground surface in the vicinity of the MSWLF according to two deep well logs obtained from a local mineral company. (See Section 4.2) The Light Olive Green Clay layer serves as aquiclude between the uppermost aquifer below the landfill site and the Chicot aquifer. In Kleberg County, and specifically the MSWLF, the waters from the Chicot aquifer are generally slightly-saline to saline and yield only marginal quantities of water.

The local unconfined water table aquifer tends to flow in all directions away from the landfill site. The only exception is that for a period of time after excessive rainfall events, ground water in this local uppermost aquifer tends to flow toward the site from the northwest. This determination is based on water levels recorded in wells completed for use in the current expansion phase. However, the largest gradients for ground water flow are in the northeast and southwest directions. The flow toward the southwest is along a caliche channel which slopes to the southwest toward some lower elevation caliche pits. The flow toward the northeast is toward the Santa Gertrudis creek. However, the ground water tends to flow through some fairly tight clay in that direction. The high point of ground water at the MSWLF site is at least partially a following of the surface topography and influenced by direct recharge from any ponding which is not promptly removed. Attachment 5, Appendix E gives a more thorough analysis of ground water direction and rate of ground water flow.

The initial interpretation, based on available data and monitor well density and location, indicated a predominate flow to the north or west. Completion of monitor and observation wells in the current expansion program indicate a northeast flow direction. Later analysis shows that ground water flows slowly away from MSWLF in all directions. This is based on measurements of the top of the saturated zone as evidence by water levels in wells. The initial flow direction determined by REI when the landfill was started was toward the northeast.

4.1 Water Quality

The water quality of the Goliad is highly variable. Chloride contents in the wells sampled ranged from 94 to 9,100 mg/l, exceeding 250 mg/l in 60% of the samples. Sulfate content ranged from 26 to 4,630 mg/l. In Kleberg County, 33% of the samples exceeded 250 mg/l sulfate. Dissolved-solids content ranged from 601 to 49,900 mg/l. Over 75% exceeded 1,000 mg/l dissolved-solids. In summary, ground water that meets most of the quality standards of the U.S. Public Health Service is available from wells less than 1,000 feet deep in the Goliad Sand, Principally in southern Jim Wells County, the western one-half of Kleberg County, and in a few other relatively small areas throughout the report area. Shallow, moderately saline to very saline water overlies the fresh to slightly saline water at most places (Shafer, 1973). (See Figure 4.13)

The Beaumont Clay and Lissie Formation, undifferentiated, (Chicot Aquifer) yields small quantities of slightly to moderately saline water to a few shallow wells used mostly for stock needs in eastern Kleberg and Kenedy Counties. Test wells drilled near Riviera, 15 miles south of Kingsville, in southern Kleberg County show that in this area the shallow sands of the Beaumont and Lissie (Chicot) usually contain very saline water. This group is not considered a supply of useable water because of the highly mineralized water associated with formations in most places. The casings of many wells are cemented through these formations. (Shafer, 1973)

Water held in the Beaumont Clay and Lissie Formation, undifferentiated, (Chicot) is under water-table (unconfined) conditions. There were no recoverable aquifer tests from reference material on this formation as it occurs in the area of the site. This formation is not recognized as a useable source of ground water.

Historical ground water monitoring from in-place monitor wells indicates that the sulfates range approximately from 45 to 500 mg/l, chlorides from approximately 50 to 500 mg/l, and dissolved-solids from approximately 500 to 6,000 mg/l. Values of pH have consistently ranged between 7.00 and 8.00. More detailed analytical data from the ground water monitor wells at the site is given in Table 5.1 in Attachment 5.

4.2 Hydraulic Connection

No hydraulic connection was found between the uppermost fluvial-deltaic beds which will host the MSWLF and the deeper Chicot and Evangeline (Goliad) aquifers.

Deep elevations prepared from water well data located in the vicinity show that the Chicot aquifer is located approximately 200 feet below ground surface in the MSWLF vicinity. This data is confirmed by electric logs from two (2) deep uranium tests located on the southeast side and adjacent to the MSWLF acreage block (URI, Inc. well nos. 2001 & 2016). These wells exhibit the top of the main Chicot sand body at depths of 220 & 225' of measured depth, respectively. The top of the deeper Evangeline (Goliad) sands are found at approximately 500' MD. A confining clay, at the base of the fluvial–deltaic section which will host the MSWLF, is indicated in both URI wells to depths of 120' and 130' respectively. In addition, four deep borings (wells 21,23,24,25) at the MSWLF confirm that the "light olive green clay" is ubiquitous under the site with a minimum proven thickness of 38'.

TABLE 4.2.1

WELL #	ELEVATION (feet)	TOTAL DEPTH (feet)	TOP LT OLIVE GRN CLAY (ft.,+M.S.L.)	FOOTAGE OF CLAY
21	52.4	84	+6.4	38
23	49.5	86	+13.5	38
24	47.4	72	+15.4	40
25	61.1	88	+11.1	38

The "light olive green clay" is the aquiclude for the MSWLF facility.

4.3 Recharge

Recharge within a 5 mile radius is from downward percolation of surface water, infiltration from streams, impoundments and water retained in abandoned caliche pits. (Figure 4.14) Flow through the soils is very slow.

4.4 Water Use

A survey of, and for, water wells within a 1 mile radius of the MSWLF site was prepared by Agency Information Consultants (AIC). All known water wells within the survey area produce water for domestic use from the Evangeline Aquifer (Goliad Sand). Thirty one wells were identified in the survey area. (See Figure 4.15) Depth to the top of the perforated or screened interval varies from 524 feet to 726 feet, with an average depth of 621 feet. (See Figures 4.12 & 4.13) There are no known water wells completed in the Chicot aquifer for potable water. There are a few stock wells. The water from the Chicot is mostly very saline. This salinity causes casing corrosion problems with the good fresh water wells in the Goliad aquifer unless they are cemented properly through the Chicot.

Figure 4.11
Regional Groundwater Elevations
Evangeline (Goliad) Aquifer
Texas Water Development Board
Report #173 (July 1973)

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26

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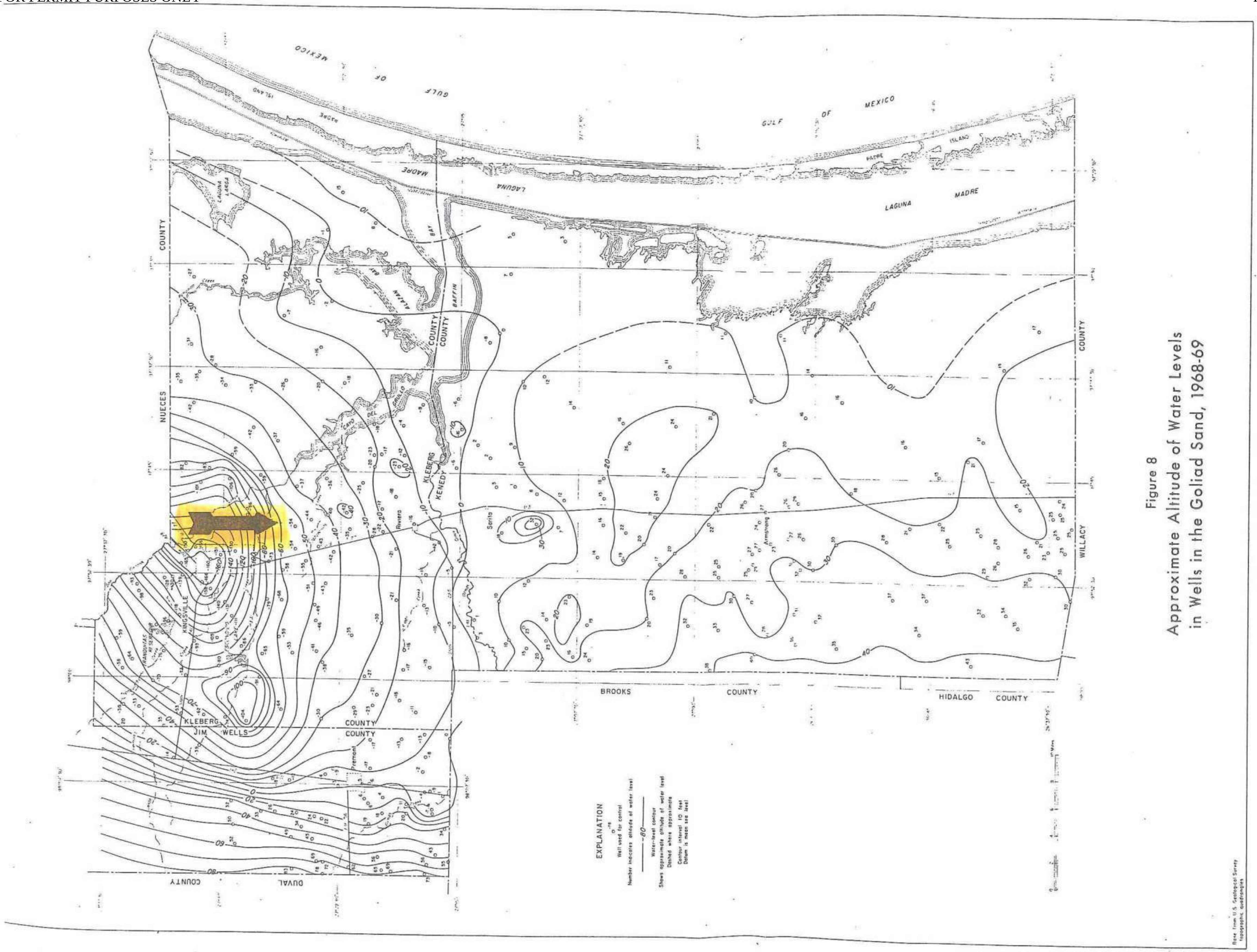

Figure 8
Approximate Altitude of Water Levels in Wells in the Goliad Sand, 1968-69

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Figure 4.12
Regional Stratigraphic &
Hydrogeologic Section
EGA-Texas Coastal Zone
Kingsville Area 1977

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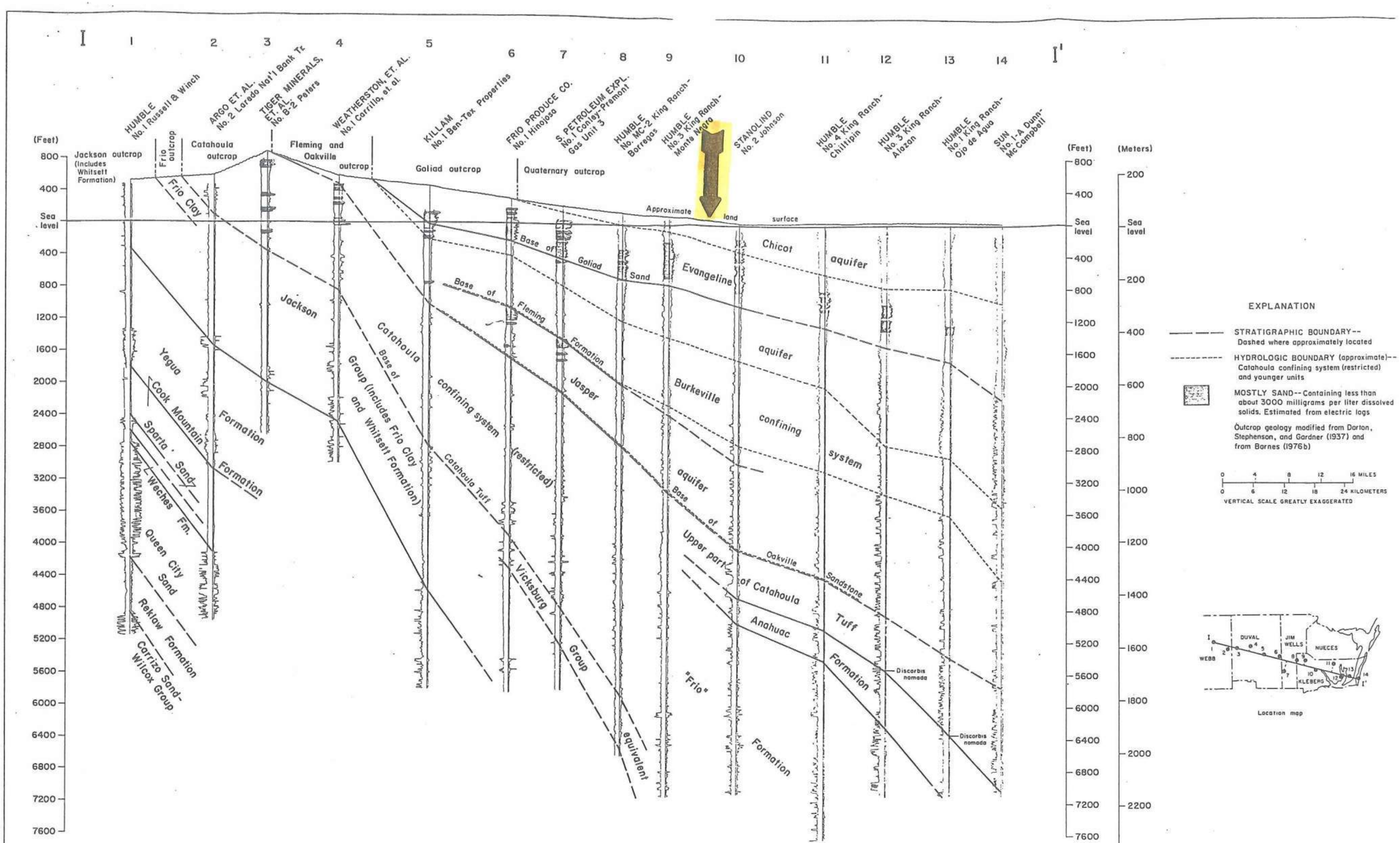

Figure 10
Stratigraphic and Hydrogeologic Section I-I'

Figure 4.13
Regional Groundwater Quality
Cross-Section
EGA-Texas Coastal Zone
Kingsville Area 1977

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28

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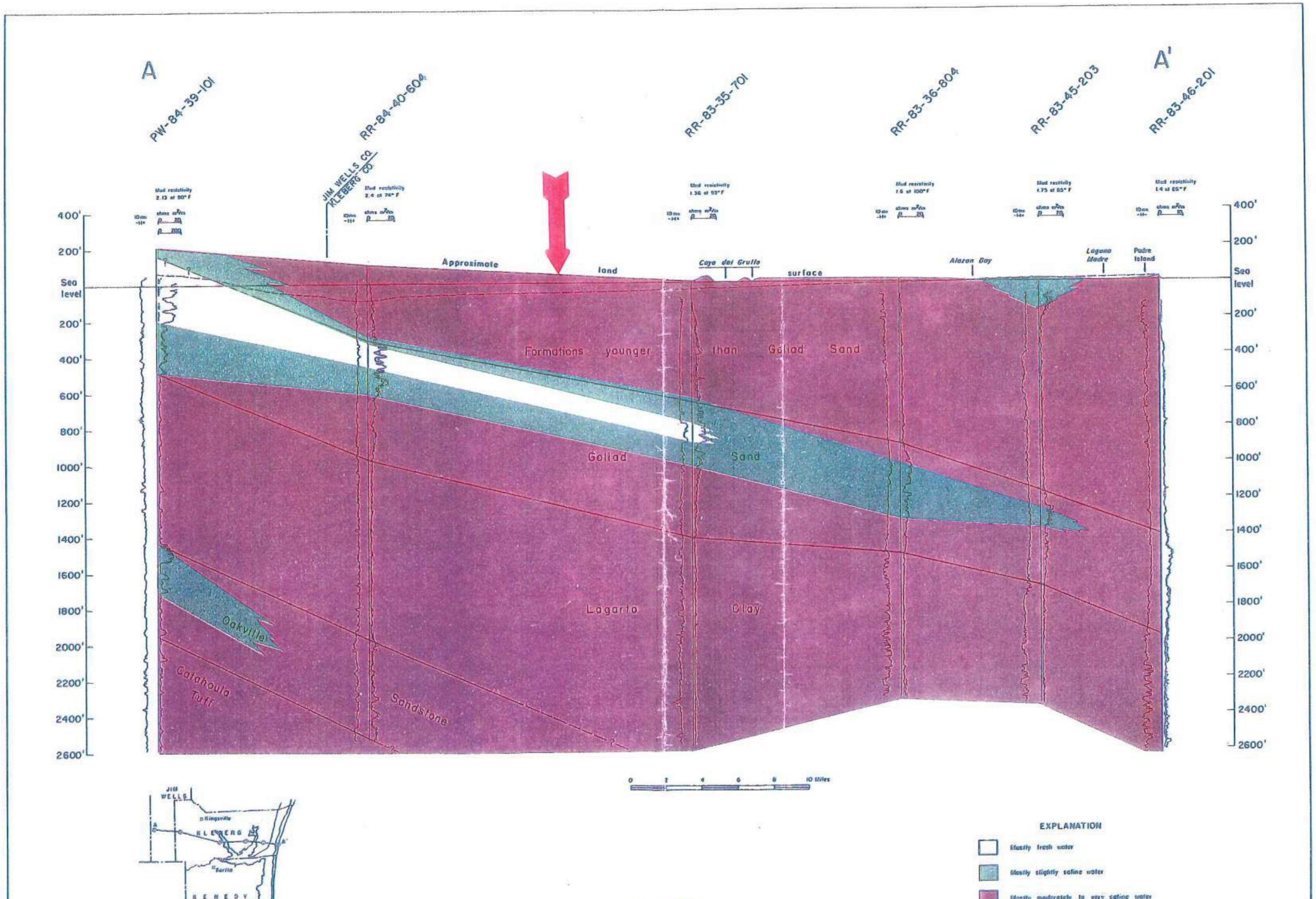

Figure 19
Correlation of Geologic Units Along Line A-A',
Kleberg and Southern Jim Wells Counties

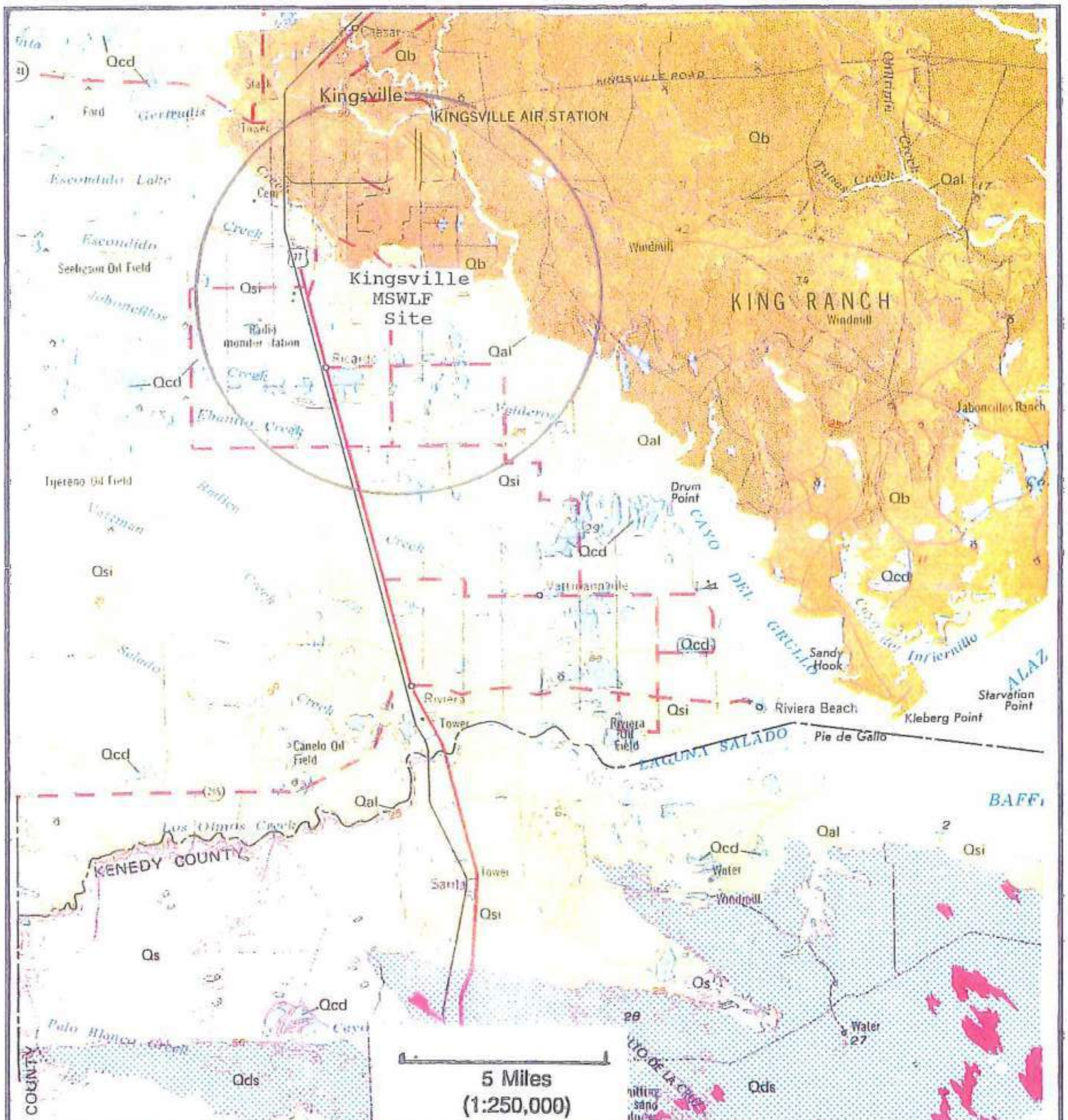

Figure 4.14
Regional Map showing
Recharge Area
Geologic Atlas of Texas
Corpus Christi Sheet - 1975

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29

EXPLANATION

F S

Fill and Spoil

Fill, F, material dredged for raising land surface above alluvium and barrier island deposits and for creating land. Spoil, S, dredged material forming islands along waterways. Properties highly variable, mixed mud, silt, sand, and shell; mud and silt winnowed when reworked

Qal

Alluvium

Clay, silt, sand, and gravel, organic material abundant locally; includes point bar, natural levee, stream channel, backswamp, coastal marsh, mud flat, clay dune, sand dune, and oyster reef deposits. Includes some terrace deposits along streams other than the Nueces

Qbi

Barrier island deposit

Sand, silt, and clay; mostly sand, well sorted, fine grained, abundant shells and shell fragments; interfingers with silt and clay in landward direction; includes beach ridge, spit, tidal channel, tidal delta, washover fan, and sand dune deposits; "high to very high permeability, low water-holding capacity, low compressibility, low shrink-swell potential, good drainage, high shear strength, low plasticity"

Qcd Qsd Qds Qs Qsi

Windblown deposits

Includes clay dune and clay-sand dune deposits, Qcd; active dunes and dune complexes; Qsd; stabilized sand dune deposits, Qds; sand sheet deposits, Qs; and silt sheet deposits, Qsi. Small areas of Pleistocene deposits within these various units not separately mapped

Clay dune and clay-sand dune deposits, Qcd, clay, silt, and sand ranging from mostly clay and silt in coastal areas to a mixture of clay, silt, and sand inland; light gray, calcareous; forms elongate deposits mostly on downwind side of intermittently wet basins, relief 5-30 feet; physical properties similar to those of the sandy and silty Beaumont

Active dunes and dune complexes on mainland, Qsd, banner dunes common, local barchan dunes; relief up to 30 feet; "very high permeability, low water-holding capacity, low compressibility, low shrink-swell potential, good drainage, high shear strength, low plasticity, unstable because of migration"

Stabilized sand dune deposits, Qds, strong relict eolian grain, sparse grass; includes active blowout areas with depressed relief, hummocky, locally becomes fresh-water marsh in wet season, and well-stabilized sand dunes with dense live-oak mottes and scrub; "moderate to very high permeability, low to moderate water-holding capacity, low compressibility, low shrink-swell potential, good to fair drainage, high shear strength, low plasticity, shallow water table"

Sand sheet deposits, Qs, no relict grain, sparse grass; physical properties similar to those of "Stabilized sand dune deposits," Qds

Silt sheet deposits, Qsi, silt and fine sand in thin, locally discontinuous sheet winnowed from other "Windblown deposits," brush and grass covered, rests on various Pleistocene deposits; has physical properties similar to those of other "Windblown deposits," but because of its thinness engineering plans should consider the nature of the underlying materials

QUATERNARY

Recent or Late (?) Pleistocene

Qd

Deweyville Formation

Sand, silt, clay, and gravel, includes point bar, natural levee, and stream channel deposits, surface characterized by relict meanders of much larger radius of curvature than those of present streams; occurs along Nueces River at three levels: 5-20, 20-30, and 40-55 feet above level of Recent floodplain

Pleistocene

Qbb Qb Qb

Beaumont Formation

Beaumont Formation, Qb, with barrier island and beach deposits, Qbb, mapped separately. Beaumont Formation, Qb, mostly clay, silt, sand, and gravel; includes mainly stream channel, point bar, natural levee, and backswamp deposits, and to a lesser extent coastal marsh, mud flat, lagoonal, Recent and older lake, clay dune, and sand dune deposits; concretions and massive accumulations of calcium carbonate (caliche) and concretions of iron oxide and iron-manganese oxides in zone of weathering; surface pitted by shallow lakes or dry lake beds with associated clay dunes which in places align along meanderbelt ridges; pimple mounds only in vicinity of Qbb unit; thickness 100± feet

The stippled overprint (source shown in Index to Geologic Mapping) shows areas that are "Dominantly clay and mud of low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, level to depressed relief, low shear strength, and high plasticity; geologic units include interdistributary muds, abandoned channel-fill muds, and fluvial overbank muds." The nonstippled areas are "Dominantly clayey sand and silt of low-moderate permeability, moderate drainage, level relief with local mounds and ridges, and high shear strength; geologic units include meanderbelt, levee, crevasse splay, and distributary sands"

Barrier island and beach deposits, Qbb, mostly fine-grained sand, shells scarce; surface slightly higher than that of surrounding deposits, characterized by numerous pimple mounds and poorly defined relict beach ridges; includes many Recent, locally active sand dunes; probably part of "Ingleside" barrier island system; thickness less than 60 feet

Ql

Lissie Formation undivided

Sand, silt, clay, and minor amount of gravel; iron oxide and iron-manganese nodules common in zone of weathering, in upper part locally calcareous, some concretions of calcium carbonate; surface fairly flat and featureless except for numerous rounded shallow depressions and pimple mounds, lower part very gently rolling; characterized by "moderate permeability, moderate drainage, and high shear strength; geologic units include meanderbelt, levee, crevasse splay, and distributary sands and floodbasin mud over meanderbelt sand;" thickness 200± feet

QUATERNARY

Fault

U
D

U, *upthrown side;* D, *downthrown side; dashed where inferred*

Figure 4.14a
Map Explanation
Geologic Atlas of Texas
Corpus Christi Sheet - 1975

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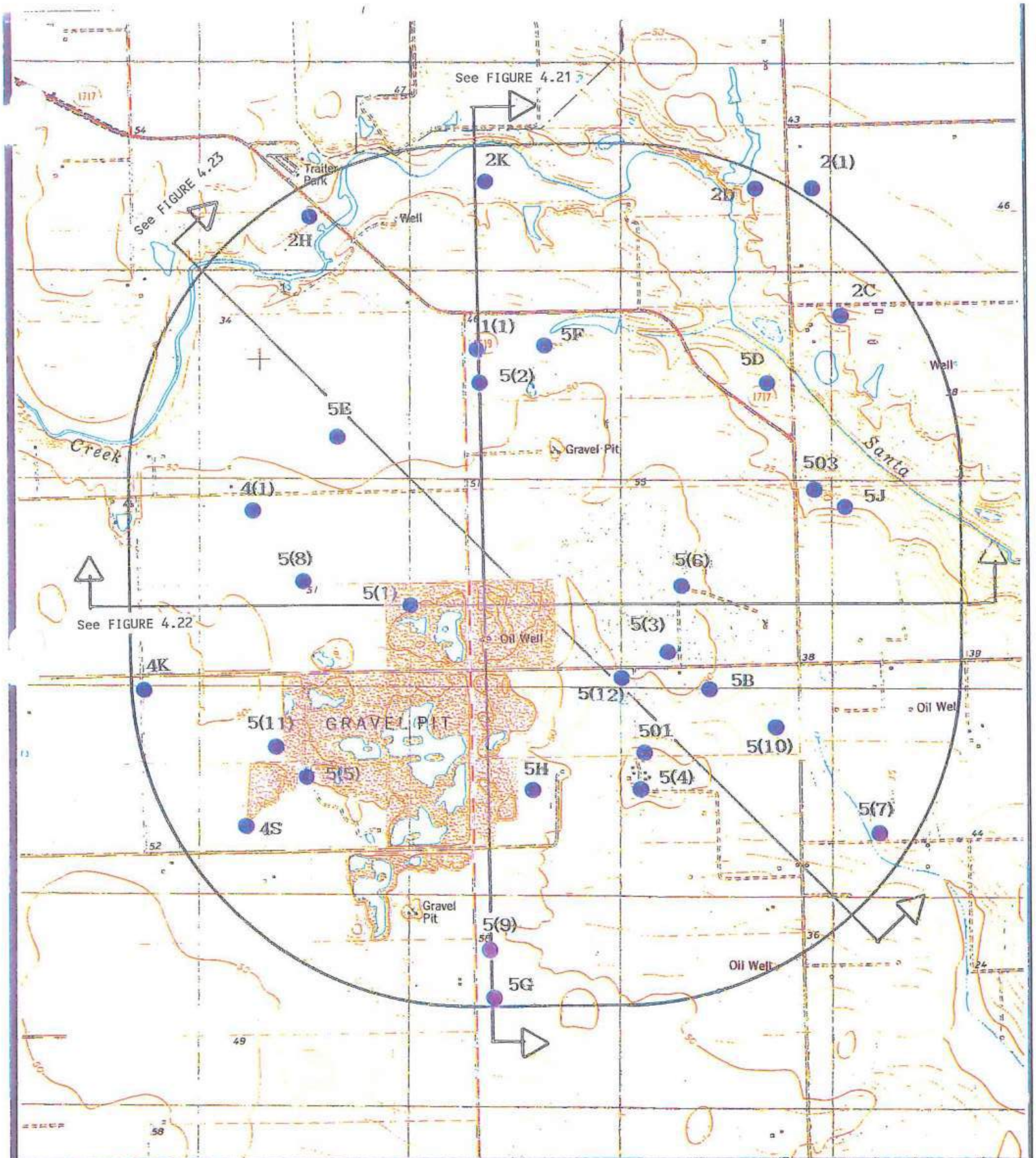


Finch Energy & Environmental
Figure 4.15

Subject Property:
Kingsville Landfill, FM 2130 & FM 2619, Kingsville, TX

1 Mile Water Well Survey
Prepared by Agency Information Consultants
AIC #02-0049190 07/28/97

Ricardo, TX (1979)
7.5' USGS Quad, Scale 1:24000

31

5.0 SUBSURFACE REPORT

5.0 SUBSURFACE INVESTIGATION

Hydrogeological/geotechnical investigations were conducted at the City of Kingsville (COK) Municipal Solid Waste Landfill (MSWLF) to characterize subsurface conditions and assist with the development of landfill disposal cell designs as required in 30 TAC §330.56(d)(5)(A). The following sections describe the field activities performed as a part of the subsurface investigations at the COK MSWLF site.

5.1 Overview

Hydrogeologic/Geotechnical Site Assessment field activities included the following: 1) Reconnaissance/Geologic Mapping; 2) Drilling and Soil Sampling; 3) Piezometer Installation; 4) Piezometer Development; 5) Field Hydraulic Testing; and 6) Site Surveying. These field activities were performed to assess the following factors:

- The availability, quality, and quantity of on-site soil which is suitable for cover and liner material;
- The influence that geologic factors will have on landfill design;
- The potentiometric conditions and predominant groundwater flow characteristics; and
- Characterization of the site-specific groundwater flow regime in order to design a groundwater monitoring network that complies with State and Federal standards based upon subsurface conditions.

5.2 Site Reconnaissance and Mapping

F.E.E., Inc. conducted a site reconnaissance and field mapping effort during initial hydrogeologic/geotechnical activities. Specific tasks performed included the following:

terrain analysis;

locating surface water features; and

locating seeps, rock outcrops and formation contact exposures.

As a part of the site reconnaissance, the currently permitted site was traversed by a F.E.E., Inc employee in order to identify surface geologic or hydrologic features and to characterize the formations which crop out at the site. All stream beds and drainages were explored to identify formation outcrops and to locate surface water features (i.e., seeps, ponds). No seeps were noted on-site.

5.3 Drilling and Soil Sampling

F.E.E geologists provided technical oversight of all drilling and sampling activities. This section describes subsurface exploration procedures performed during the hydrogeological/geotechnical investigation activities.

5.3.1 Soil Borings

The field portion of this hydrogeological/geotechnical investigation consisted of the drilling and sampling of seven (7) geotechnical borings to assess subsurface hydrogeological and geotechnical conditions of the underlying materials. All soil borings were completed in accordance with the Soil Boring Plan approved by TNRCC in a letter dated June 4, 1997, (see Appendix A).

An original program of 12 borings was proposed and approved, with a stipulation that seven borings be completed initially. Upon completion of the initial seven borings the homogeneity of the sediments was demonstrated. This data was submitted to TNRCC, (see Appendix A), in the form of geological cross sections. Consequently, the remaining five borings were not being required at that time (see Appendix A). Five of these wells were subsequently completed as Monitor Wells. All borings were completed to a depth approximately 10 feet above MSL. Nine other previous soil borings were available to assist in the subsurface investigation. The completions will be discussed in the Ground Water Characterization Section. The location of these borings (as well as previous borings drilled at the site) are presented on Figure 4.17. In April, 1998 four (4) deeper soil borings were completed to better define the aquiclude below the landfill site per TNRCC's NOD letter. These deeper borings were drilled to varying depths between 72 feet and 88 feet below ground surface (BGS). Core samples were taken from these deep borings at two (2) foot intervals.

Professional Services, Inc (PSI), a F.E.E. drilling subcontractor, drilled the borings utilizing 4.25" I.D. hollow-stem auger during July, 1997. The subcontractor advanced the borings until target depths, or specific lithologic zone, were encountered. Borings were completed using a CME-75 Hollow System Auger rig. The CME-75 system uses a 5 foot long core barrel which recovers 3 inch diameter cores from a 10 inch boring.

In one well (completed as MW 16) zone of highly calcified sandy clay was encountered. Drilling time with auger methods was very slow and the interval was drilled using the split spoon. No commercial additives were used in the boring operation.

Water for mixing grout was obtained on site and supplied by the City of Kingsville from a South Texas Water Authority connection. Installation and plugging of the borings were in accordance with current rules and prudent operational procedures. Documentation of this work has been submitted.

Subsurface soil and sediment core samples were collected from each soil boring on a continuous basis to a depth of approximately 30 beet below expected base grades (or approximately 50 feet below ground surface) and on 5-foot centers, thereafter, for lithologic classification and selection of geotechnical laboratory samples for potential analyses. Depths of the borings vary from +4.83 MSL to +11.38 feet MSL with on average of +8.37 feet MSL. The proposed depth of excavation is +40.00 feet MSL. This meets the stipulation of all borings being 5 feet deeper than the deepest excavation and also the 30 feet depth requirement. Core samples were collected using either a split spoon for unconsolidated samples or a 3-inch outside diameter (O.D.) Shelby tube for undisturbed samples of cohesive material. Upon sample retrieval, each core was classified as described in Section 5.3.2 below. Each sample was labeled (at a minimum) with the following information: project name; boring number; and sample depth range.

The geologist or geotechnical engineer sealed the soil core samples with plastic wrap, and plastic bags, then placed them in protective crates for transport to the laboratory. The geologist or geotechnical engineer also sealed the samples of cohesionless materials in plastic bags, and packaged them in protective crates for transport to the laboratory.

5.3.2 Classification and Logging of Soils

The F.E.E., Inc. geologist or geotechnical engineer visually classified the samples in the field in accordance with ASTM D2487 and D2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and used field soil borehole forms to record soil classification at each boring location. The borehole forms included additional information such as ground surface elevation, north and east coordinates, surface conditions, ground water elevation, driller's name, and the make of the drilling rig. The geologist or geotechnical engineer later checked the accuracy, consistency, and format. The soil borehole logs prepared as part of this investigation are included within Appendix B. (Hand drawn field logs will be supplied separately.)

5.4 Piezometer Installation and Development

A total of 7 piezometers (B-12 through B-18) were constructed during the July, 1997 phase of this investigation to evaluate the water-bearing strata underlying the site. All but B-17 and B-18 were converted to groundwater monitoring wells. During the April, 1998 phase of this investigation four more borings (B-21,23, 24, and 25) were completed. These borings were all grouted upon completion, except 24 which was made into a monitor well. Appendix C includes detailed Piezometer Construction Summaries. The following sections describe piezometer installation and development protocols utilized during the investigation. Texas Water Well Driller's Reports for Borings B-12 through B-18, B-21, B-23, B-24, and B-25 are shown in Appendix K.

5.4.1 Piezometer Installation

All piezometers were constructed using new, 2" I.D. (B-17 and B-18) or 4" I.D., Schedule 40, flush-threaded polyvinyl chloride (PVC) well risers, 5 or 10-foot screens, bottom plugs, and fittings. Five piezometers, B-12 through B-16, were converted to groundwater monitoring wells. Later, in April, 1998 soil boring 24 was made into a monitor well. Each piezometer was fitted with a vented top-end cap and all the joints were screwed together with O-rings (no glue was used). centralizers were also installed that were made of inert material compatible with the casing on piezometers. Riser lengths ranged between 2.5 and 3.0 feet above ground surface. The geologist or geotechnical engineer measured each piezometer's screen and riser lengths to the nearest 0.01 foot and recorded all the information pertaining the construction of each piezometer on a Piezometer Construction Summary form prior to installation.

The sand filter pack consisted of washed and pre-graded 20/40 sand (95% minimum silica and visibly free of dust, mica, and organic matter), and extended from the bottom of the borehole to approximately two feet above the screened interval. A one-foot fine sand filter pack seal ("sugar sand", 100% passing the No. 30 sieve and less than 2% passing the No. 200 sieve, and visibly free of clay, mica, and organic matter) followed the 20/40 filter pack to help prevent any intrusion of high pH water associated with the bentonite seal.

A minimum three-foot bentonite seal, utilizing bentonite pellets, immediately followed placement of the sugar sand. Where more than twenty feet of water was present in the borehole, a high solids bentonite slurry was pumped or carefully tremied into place. A one-foot layer of sugar sand was immediately tremied to provide weight during hydration of the bentonite seal and help enhance the expansion of the pellets sideways. Approximately five gallons of clean, potable water was then added and a minimum two-hour hydration time was allowed for the bentonite to hydrate before proceeding further.

A bentonite powder grout consisting of Benseal bentonite, bentonite catalyst, and clean potable water was then mixed by recirculation with a grout pump and tremied via a side-discharge tremie pipe into the annular space from the top of the sugar sand to a depth of five feet below the ground surface upon hydration of the bentonite seal. The bottom tremie pipe had side-discharge exits to avoid washing of the sugar sand and consequent erosion of the bentonite seal. The grout was allowed to settle a minimum of twelve hours. More grout was added, when necessary, to bring the top of the grout to five feet below the ground surface.

The five-foot annular space separating the top of the bentonite powder grout and the ground surface was filled with a Type I Portland Cement grout, making sure to slope the cement away from the well at the surface to prevent infiltration; however, care was taken not to create a mushroom that would later be subject to frost heave. The cement cap was checked for settlement twenty-four hours after installation and additional cement was placed, as needed, to create slightly mounded conditions. A vented, five-foot long, six-inch square, locking protective casing with removable cap covered the piezometer stick-up and extended 2 feet below and 3 to 3.5 feet above the ground surface. A 1/4-inch drain plug was installed just above the concrete cap and concrete was placed in the annular space between the protective casing and riser up to the ground surface. To complete installation, gravel was placed from the ground surface to six inches below the top of the riser.

To finalize surface completion, a circular, mounded concrete pad (2-inch diameter piezometers) or a 5'X5'X6" sloping concrete pad (4-inch diameter piezometers) was constructed for each piezometer, and the protective casings were locked with locks which were all keyed-alike.

5.4.2 Piezometer Development

Each piezometer installed during this investigation was vigorously developed to insure proper hydraulic connection with the screened formation. Development of piezometers consisted of a combination of surging with a PVC surge block, followed by bailing with Teflon bailers, and a modified air-lift method of surging the well with filtered air to evacuate fluids and suspended solids within the well bore. Both of these procedures were conducted to maximize hydraulic communication within the screened formation. Each piezometer was developed until the discharge was relatively free of fine sand and silt, and the field parameters collected from discharge (pH and specific conductance) had stabilized. A minimum of four well volumes was evacuated from each piezometer during the development process. A copy of the piezometer development records are included within Appendix C.

5.5 Drilling Equipment Decontamination Procedures

All drill rigs, tools, and downhole equipment were thoroughly decontaminated using a pressurized steam cleaner prior to, and upon completion of, drilling activities at the site. Decontamination of equipment between drilling locations was performed when that location included the installation of a piezometer. Clean, potable water used for decontamination, piezometer installation and development, was obtained from the on-site water source.

5.6 Horizontal and Vertical Datum Survey Activities

Following completion of each phase of field activities, McCumber Surveying performed a site survey of subsurface exploration boring locations performed during this investigation. The survey was performed at the completion of field efforts to provide accurate locations of all subsurface exploration borings and piezometer installations. Standard ground control methods were utilized to conduct each survey.

Horizontal and vertical control utilized for the site survey is taken from Texas State Planar Coordinates, and is referenced to the National Geodetic Vertical Datum (NGVD) of 1929, formerly known as the Mean Sea Level Datum. Tables found in Attachment 5 summarize site survey data collected during this investigation.

Figure 4.16
Regional Elevation Map
Of the Toliad
TWDB-Groundwater Resource
July 1973

REVISION 1
38

FOR PERMIT PURPOSES ONLY

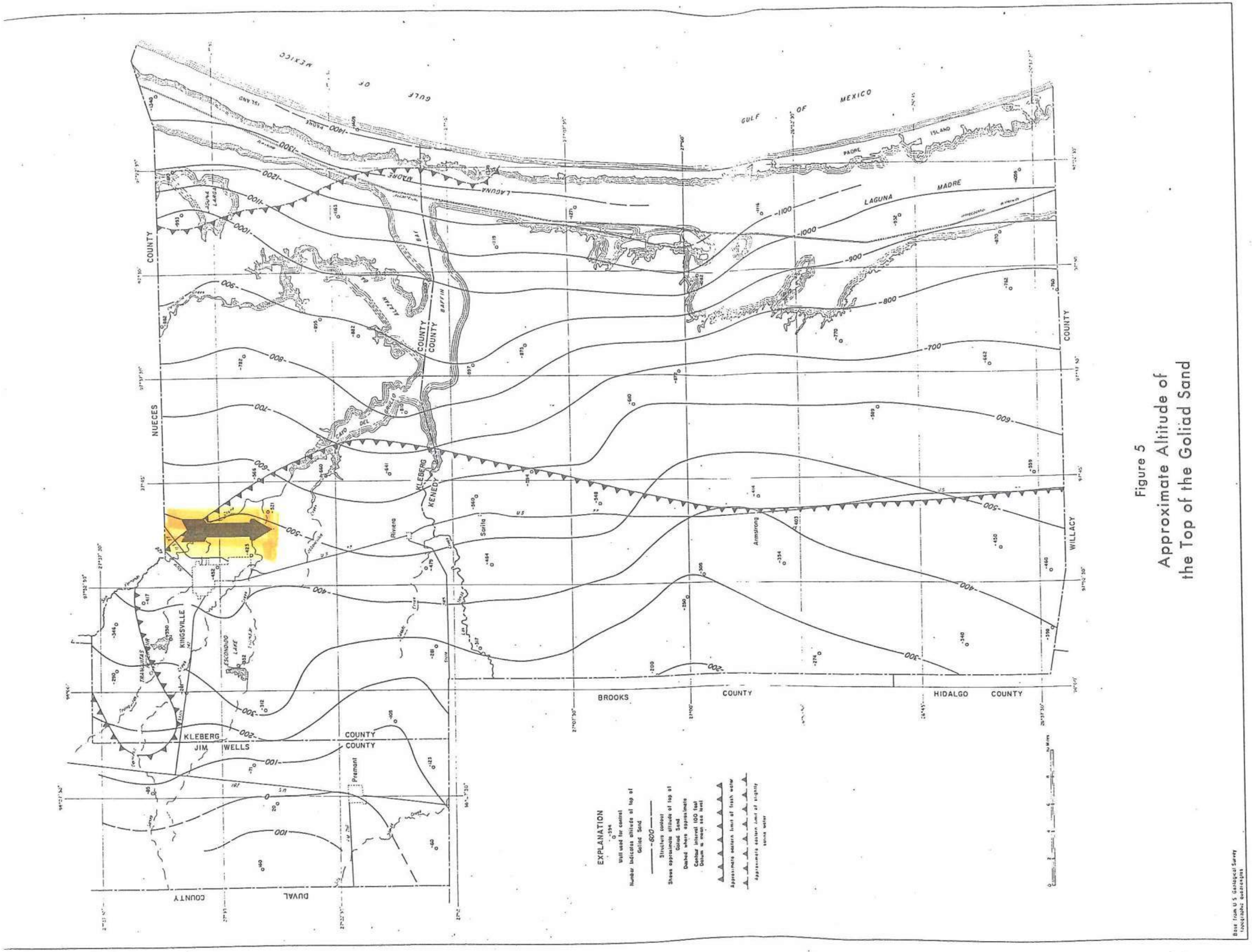


Figure 5
Approximate Altitude of
the Top of the Goliad Sand

6.0 SITE SPECIFIC CONDITIONS

6.0 SITE-SPECIFIC STRATIGRAPHIC CONDITIONS AND SUBSURFACE GEOLOGIC INTERPRETATIONS

This section describes the soils, sediments, geologic and groundwater conditions encountered by F.E.E., Inc. during the Hydrogeological/Geotechnical Investigations at the City of Kingsville, (COK), Municipal Solid Waste Landfill, (MSWLF) site as required in 30 TAC §330.56(d). The section also describes the characteristics of the soil samples collected and tested during the investigation. The locations of all subsurface boring explorations performed for the design of engineered cells, and for the Geological/Geotechnical investigation are shown on Figure 4.17. Subsurface geologic correlations showing stratigraphy and structure beneath the site are presented on the following exhibits included herein;

Cross Section Location Map

Cross sections A-A' through I-I' (9 total) [Note Maximum ground water levels.]

Structure Map – Top "Light Olive Green Clay"

Isopach Map Sand Units I & II

Isopach Map Sand Units III & IV

Information from sample borings at the COK- MSWLF site and electrical logs of uranium test wells which immediately offset the site to the southeast were used in the construction of the geologic maps and cross sections as part of this investigation.

The primary geologic formations exposed at the surface of the site are recent Holocene South Texas Eolian Plain Deposits. The topsoil (approx 0 feet - 20 feet) consists of a clay which is black, silty and contains humic material. This soil is overlain in the extreme northeast corner with a veneer of loess. Sediments encountered in borings at the site are Holocene to Pleistocene in age and consist of clays, silts, sands, and caliches deposited in two (2) separate and distinct environments of deposition. Cross section A – A' serves to illustrate theses environments of deposition. The cross section traverses the MSWLF site using four (4) deep borings all deep enough to penetrate a minimum thickness of 38' of a massive, low permeability, light olive green clay ("Light Olive Green Clay") believed to have been deposited in a marine (estuarian) environment. The interpretation of a marine environment of deposition for this unit is based upon the presence of sand filled burrows in the top surface of the massively bedded clay. The clay also contains sparse pelecypod molds scattered throughout and a single, correlative, thin bedded, pebble conglomerate (rip up clasts) believed to represent a storm deposit.

As noted in Section 4.2 the "Light Olive Green Clay" is the aquiclude for the MSWLF facility. In turn, the "Light Olive Green Clay" is capped by a sheet sand ("Orange sand") possibly 2 to 10' thick across the site of the MSWLF. The "Orange sand" is believed to have been deposited in a near shore or beach environment based on sample descriptions. The sand is extremely well sorted and clean, grains are well rounded and composed of approximately 90% fine quartz grains and 10% fine multicolored shell fragments giving the overall sand color an orange cast.

Stratigraphically above the "Orange sand", the environment of deposition changes to fluvial-deltaic for the remaining 40 to 50' of section, measured back to surface. These beds are comprised of sands, silts, caliches and clays deposited as superimposed channel sands and clayey dunes or bars. A detailed cross section net was constructed using all sample borings at the MSWLF and four significant sand bodies are believed to be present within the fluvial-deltaic sequence. Location of these sand bodies are shown on isopach maps included herewith. Bodies I & II are superimposed, caliche or sand filled channels with Body I having the larger areal extent. Bodies III & IV are interpreted as dunes or bars of limited extent and are comprised of clayey sand. All of the above sand bodies are incised into, or embedded within, a tan, silty clay containing abundant mottles of organic matter.

Taken together, the marine clay section ("Light Olive Green Clay") overlain by fluvial-deltaics section represents a single regressive cycle, with respect to sea level, at the top of the Pleistocene Beaumont formation. The sea level regression was probably caused by an onset of a period of Wisconsan (Stage unknown) glacial ice formation. Bone fragments of large vertebrates and mammoth teeth recovered from the fluvial-deltaic section in nearby areas, i.e. Taylor Ranch, date from approximately 8,000 to 10,000 years B. P. It is believed that the entire fluvial-deltaic section is comprised of Holocene sediments with the Holocene – Pleistocene boundary represented by the top of the "Light Olive Green Clay" or "Orange sand".

The shallow subsurface geological structure at the Kingsville MSWLF site is shown by the Structure Map- Top "Light Olive Green Clay" to be monoclinal dip to the northeast at approximately 20 feet per mile. This horizon was chosen is most representative of structure affecting and underlying the MSWLF site. Any structural mapping on beds above the "Light Olive Green Clay" are less correlative and would reflect local scouring of channel sands causing structural inconsistencies due to stratigraphic variation within the fluvial-deltaic section. Correlations are excellent on the top of the "Light Olive Green Clay" and the surface is the most likely to be planar in nature. Some scouring of this surface probably occurs at the extreme southwest corner of the MSWLF site due to the incisement of the overlying Body I, caliche bearing channel.

Deposition of the above sediments postdates uplift of the Kingsville Dome. Pre-uplift formations are Miocene and older and exhibit west dip at depth in the vicinity of the MSWLF site. There is no evidence of folding or soft sediment deformation in subsurface boring samples. Some fracture and slump deformation does occur on steeply excavated caliche outcrops.

Quantitative descriptions of the physical characteristics of the investigated sediments are presented in Appendix G, Geochemical Laboratory Test Report and Appendix B, Boring Logs. A qualitative description of the shallow beds which can be correlated across the area as exhibited on cross sections A-A' through I-I' is presented below. The descriptions should aid in the confirmation of interpretations made regarding subsurface structure and environments of deposition of the sand bodies and the clays within and upon which the sand bodies were deposited.

6.0.1 Body I- Caliche Bearing Channel

This is the youngest, most extensive, sand containing body that can be correlated across the site. Body I is internally complex and comprised of a melange of interbeds of caliche, clays and sands which, in themselves, are noncorrelative. The individual beds within this body appear to be of limited extent, and probably represent braided deposits within a single channel approximately ½ mile in width. The base of this channel is placed at the base of the lowest caliche encountered in the borings at the site. When grouped together, it can be shown via cross section and isopach mapping that the body can obtain a maximum thickness of 40' and, as a whole, cuts downward into underlying beds. Body I was deposited as a channel system which trends in a down dip direction, southwest to northeast, across the MSWLF site. Much of the caliche contained within this body has been previously removed from the site by mining operations.

6.0.2 Body II- Sand Filled Channel

Body II was deposited as a channel filled with a homogeneous, well sorted, very fine grained to fine grained, clean, unconsolidated sand. Body II differs from Body I in the simplicity of fill sediment. The preserved length and width of this channel sand is less than one half mile due to truncation and incisement by the overlying channel, Body I. Body II is interpreted as being a channel due to downcutting evident on the cross sections. Maximum preserved thickness of this channel sand is 20' as evidenced in Boring Nos. 10 and 17. Deposition of the Body II channel sand was oriented in a dip direction, southwest to northeast across the site.

6.0.3 Body III- Clayey Sand (Clay Dune)

Sand Body III lies under the eastern edge of the MSWLF site and is composed of a homogeneous, very fine grained, well sorted, clayey sand. Well # 13 is the only known penetration of the sand encountering a thickness of 17'. At it's base, the sand appears conformable with the underlying "Orange" sand which is interpreted as a near shore or beach sand. Sand Body III is interpreted as a clay dune based on clay content, sorting and stratigraphic position within an overall regressive section. Sand Body III could possibly be present in the two URI deep wells but poor sample descriptions of the rotary drilled wells preclude an interpretation and the E-logs obtained were shut off below this shallow interval.

6.0.4 Body IV- Clayey Sand (Clay Dune)

Sand Body IV is believed to be a time and stratigraphic equivalent of Sand Body III, described above, and underlies a portion of the western edge of the MSWLF site. Boring #s 16 and 23 penetrated 18' and 12' respectively, immediately above the underlying "Orange" sand. Body IV sand is similar in all respects to the homogeneous, very fine grained, well sorted, clayey sand which comprises Body III above. Cross section G-G'(wells 16 and 23) illustrates the top of Sand Body IV as being concave downward with a flat base, indicating deposition as a "buildup" or Clay Dune. Again, Sand Body IV appears conformable with the underlying "Orange" which is interpreted as a near shore or beach sand.

Sand Bodies III and IV above are typical of the type IX soil which is comprised of stabilized clay dunes and dune complexes as indicated by the Environmental Atlas.

6.0.5 Sandy Clay Bed

The Sandy Clay Bed was deposited penecontemporaneous with Bodies I through IV and is composed of a homogeneous, tan, sandy clay containing abundant decomposed organic material. Thickness of this clay ranges from 40 to 60' under the MSWLF site with the above decribed Sand Bodies deposited within or adjacent to this clayey interval. The basal contact is abrupt with the underlying "Orange" Sand.

6.0.6 "Orange" Sand

As noted earlier, the "Orange sand" appears to have been deposited in a near shore or beach environment. The sand is extremely well sorted and clean, grains are well rounded and composed of approximately 90% fine quartz grains and 10% fine multicolored shell fragments giving the overall sand color an orange cast. The thin (< 5'), sheet-like nature of the sand represents a beach environment of short duration developed at the top of the Beaumont clay (Light Olive Green Clay). It is present in all well control of sufficient depth.

6.0.7 "Light Olive Green Clay"

Tops on the "Light Olive Green Clay" are necessary to make the above interpretations of shallower beds in that it is the most definitive, planar marker bed under the MSWLF site. As noted earlier, this massive, low permeability, clay was deposited in a marine environment based upon the presence of sand filled burrows in it's top contact with the overlying "Orange" sand. The clay also contains sparse pelecypod molds scattered throughout and a single, correlative, thin bedded, pebble conglomerate (rip up clasts) believed to represent a storm deposit. This clay is pure and therefore exhibits characteristic low permeabilities with a proven thickness of at least 38'. E-logs from the URI deep uranium wells indicate a much thicker section is present under the site.

6.1 Holocene Stratigraphy as related to Groundwater Migration Pathways

Detailed correlation of borings show that the Holocene sediments which will host the proposed City of Kingsville MSWLF were deposited in a fluvial-deltaic environment. The massive "Light Olive Green Clay" which is believed to be of Pleistocene age and deposited in a near shore marine environment underlies the section. As noted previously, the clay serves as the aquiclude between the Holocene sediments hosting the MSWLF and the underlying, saline, "Chicot" sand and the even deeper regional "Evangeline"(Goliad) aquifer.

Although excellent vertical separation exists between the Holocene sediments which will host the MSWLF and underlying Pleistocene beds, lateral migration of groundwater occurs within and through the host beds. From a potentiometric standpoint, it is evident from existing monitor well data that migration of groundwater within the Holocene host sediments is occurring in almost all directions away from the MSWLF site, the exception being to the northwest.

From a geologic perspective, it is evident that migration of groundwater should occur primarily away from the MSWLF site to the northeast and southwest. Controlling this trend is the presence of the incised channel containing sands, clays and caliche noted on cross sections and maps as Sand Body I. This body, which hosts the thin to massively bedded caliche deposits in the area, strikes northeast and is approximately ½ mile in width. Body I trends directly through both the existing and proposed landfill sites. Other sand bodies in the host section are noted on the cross sections as II, III, and IV. Sand body II is, again, an incised, sand filled channel with limited areal extent. Sand Body II is truncated along its strike on the northeast and southwest by the overlying Body I. Sand Bodies III and IV are interpreted as being clay dunes or bars of limited areal extent. It should be noted that the entire Holocene section which contains all of the above sand bodies is permeable and therefore all are in communication. Even so, the orientation of Sand Body I should exert an influence on preferential ground water migration to the northeast and southwest and away from the City of Kingsville's MSWLF site.

Note that ground water modeling using site specific data was performed using HELP3 and Multi-Media computer models. The results of these studies are given in Attachment 15, Appendices B & C, and in Attachment 10, Appendices C & D. The HELP3 model is used to estimate liner leakage rates for inputs to the Multi-Media model. The maximum rates were of course encountered for cases with minimum solid waste cover over the bottom liner system. The Multi-Media model used site specific data in the form of the average hydraulic conductivity measured in the wells on site and the average gradient over the entire site, i.e. gradient of ~~3.31~~ 5.19 x 10^{-3} ft/ft to the northeast and hydraulic conductivity of 130 m/yr (4.12 x 10^{-4} cm/sec).

The primary impact of construction of the lined landfill cells will be the gradual reduction of any groundwater recharge to the uppermost aquifer from surface rainfall. Current recharge from the surface causes some dilution of groundwater and can potentially carry surface contamination to groundwater, as in the case of agricultural or oil and gas materials.

The primary impact of ponds and mined areas within the landfill site is dilution caused by surface recharge. This recharge and associated groundwater dilution will be reduced as onsite ponds and mined areas are eliminated as landfill expansion proceeds.

6.2 Hydrogeologic Conditions

This section describes groundwater conditions encountered during this investigation. The local groundwater flow regime at the site was determined by the collection of physical data (such as the elevation of the potentiometric surface) and the completion of in-situ hydraulic conductivity (bail) testing from on-site groundwater monitoring points. Depth-to-water measurements were obtained from existing on-site monitor wells and piezometers from August 4, 1997 every 2 weeks to February 18, 1998. Previous data collected from monitor wells during the period from March 29, 1991 through June 25, 1997 are also included. Two additional ground water level measurements are also included for May 18 and June 16, 1998. The depth-to-water measurements were subtracted from a surveyed reference datum (top of PVC casing) to establish a potentiometric surface relative to NGVD. The groundwater elevation data and resultant potentiometric contour maps for each relatively permeable stratum are presented in Attachment 5~~as Figures 5.10 through 5.28, respectively~~, Appendices A, B, and C . The water level data measured from soil boring and monitoring well measurements (hydrographs[redacted] are included within Appendix D.

The potentiometric contours presented within each map were constructed using the program Surfer (Version 6.04) by ~~straight-line (linear)~~ interpolation between data points. The primary layer potentiometric contour map from the water level measurement event indicated that ground water appears to flow generally outward from the landfill site in all directions. There are rather strong gradients to the northeast and to the southwest. There is some mounding near the center of the site. ~~The estimated hydraulic gradient toward the northeast is 6.91x10^{-3} ft/ft. The estimated hydraulic gradient toward the southwest is 8.18x10^{-3} ft/ft. The estimated hydraulic gradient toward the southeast is 1.21x10^{-3} ft/ft. The estimated gradient from the northwest is 2.16x10^{-3} ft/ft. (These gradients were estimated from 05-18-98 contour.)~~ The hydraulic gradient was calculated for each of the four quadrants of the landfill site and for the entire site for each monitoring data set over a ten month period from August 4, 1997 through June 16, 1998. These calculations are shown in Attachment 15, Appendix G. The average gradient for the four quadrants over that 10 month period are as follows. The average hydraulic gradient toward the northeast is 7.99 x 10^{-3} ft/ft. The average hydraulic gradient toward the southwest is 2.16 x 10^{-3} ft/ft. The average hydraulic gradient toward the southeast is 1.44 x 10^{-3} ft/ft. The average hydraulic gradient toward the northwest is 3.87 x 10^{-3} ft/ft. Note that the gradient in the northwest quadrant actually changed direction over the 10 month period. The average hydraulic gradient and direction over the entire site is ~~3.31~~ 5.19 x 10^{-3} ft/ft toward the northeast[redacted] This flow gradient and direction is generally consistent with the 9/29/97 and 9/15/97 measuring events and appears to be influenced by Santa Gertrudis Creek located to the north-northeast.

F.E.E., Inc. prepared a hydrograph of existing monitor wells on site using data collected from previous ground water sampling events since May 1991, and data collected during this investigation. Based on the seasonal data for the site collected to date, the potentiometric surface was slightly lower during periods of low precipitation (summer and early fall) and slightly higher during periods of excess precipitation (winter and spring). The hydrograph indicates no significant changes in groundwater elevations since 1991 until the excessive precipitation event of October 8 -12, 1997. (Appendix F).

6.2.1 Surface Water Hydrology

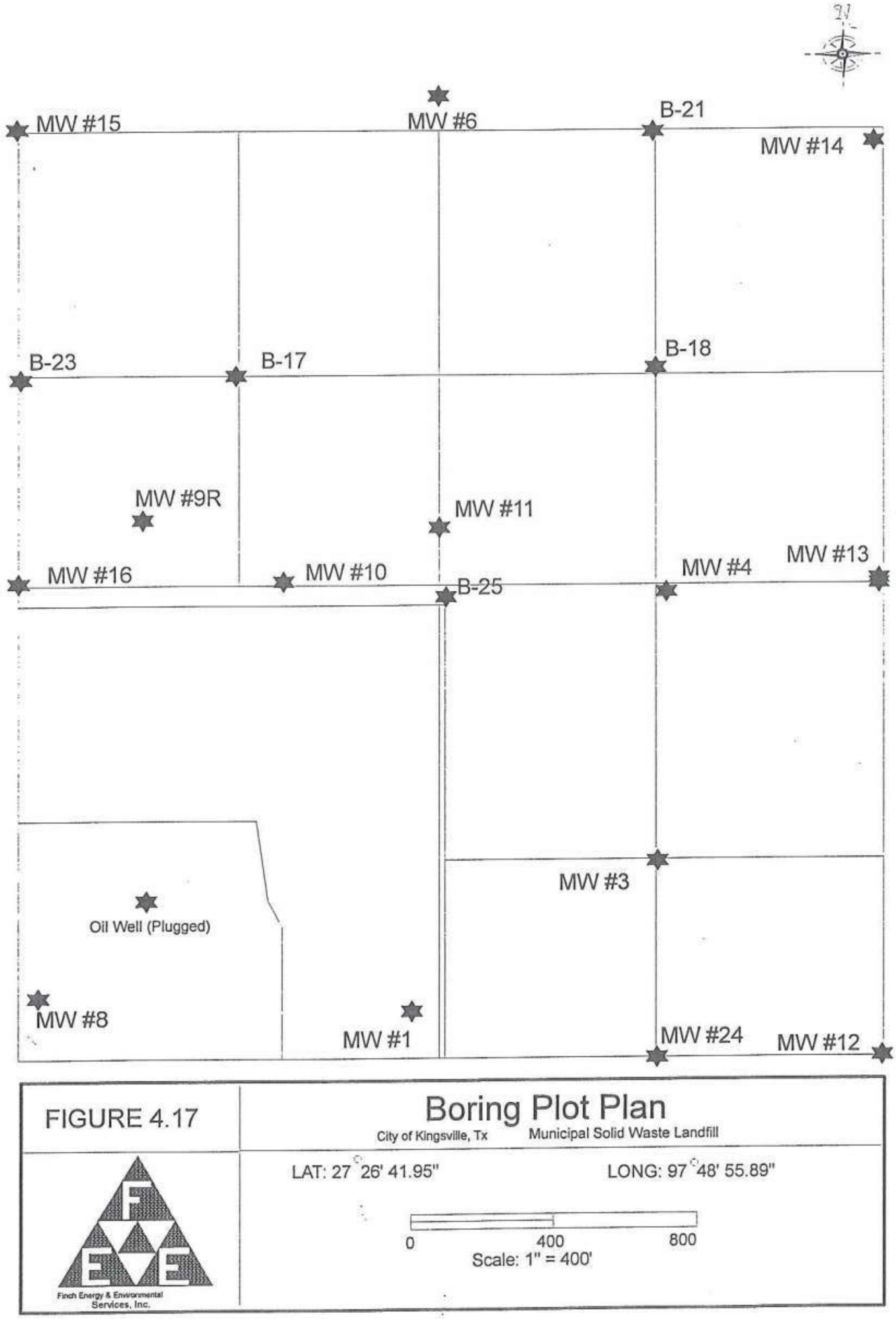
COK MSWLF is located entirely within the Kleberg County Drainage Watershed. All of the soils are characterized by ~~low permeability and poor drainage~~ high to very high permeability and drainage which results in ~~high runoff potential~~ significant recharge from surface percolation. The average yearly rainfall total for the Kingsville area is approximately 30 inches, and is more or less evenly distributed throughout the year. However, monthly rainfall totals generally fall below the overall average of four inches per month during the late fall, winter, and spring. Monthly totals for the summer and early fall generally exceed the overall average.

The topography of the watershed is gently sloping. Ground elevations in the Kleberg County Drainage Watershed vary from 125 feet in the extreme northwest to sea level in the East (Gulf of Mexico). Predevelopment ground contours at COK MSWLF varied from approximately 50 to 65 feet NGVD. Ground slope in the area varies from about two feet per mile to 6 feet per mile.

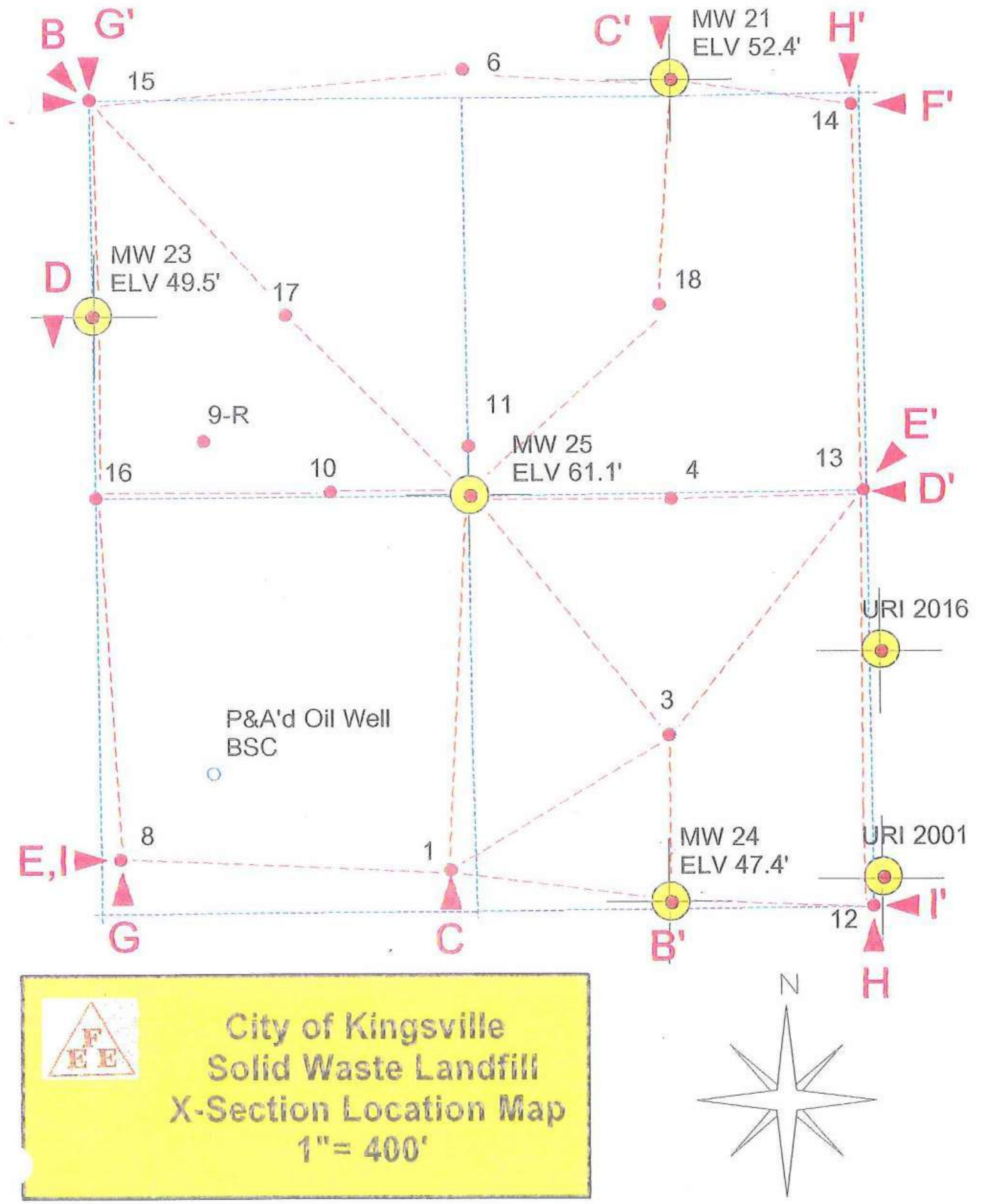
Santa Gertrudis Creek flows from the northwest to the southeast approximately one mile northeast of COK MSWLF before resuming its easterly flow towards Baffin Bay. Surface water runoff from the facility and the vicinity generally follows the easterly down-dip of the surface towards Baffin Bay via Santa Gertrudis Creek east of the site. Uncontaminated surface water from the southern half of the site flows to Santa Gertrudis Creek via drainage ditches to the south of the site, which also crosses the facility's southwest corner. Uncontaminated surface water from the northern half of the site flows to a drainage ditch, which also flows to Santa Gertrudis Creek and ultimately into Baffin Bay.

6.2.2 Groundwater Hydrology

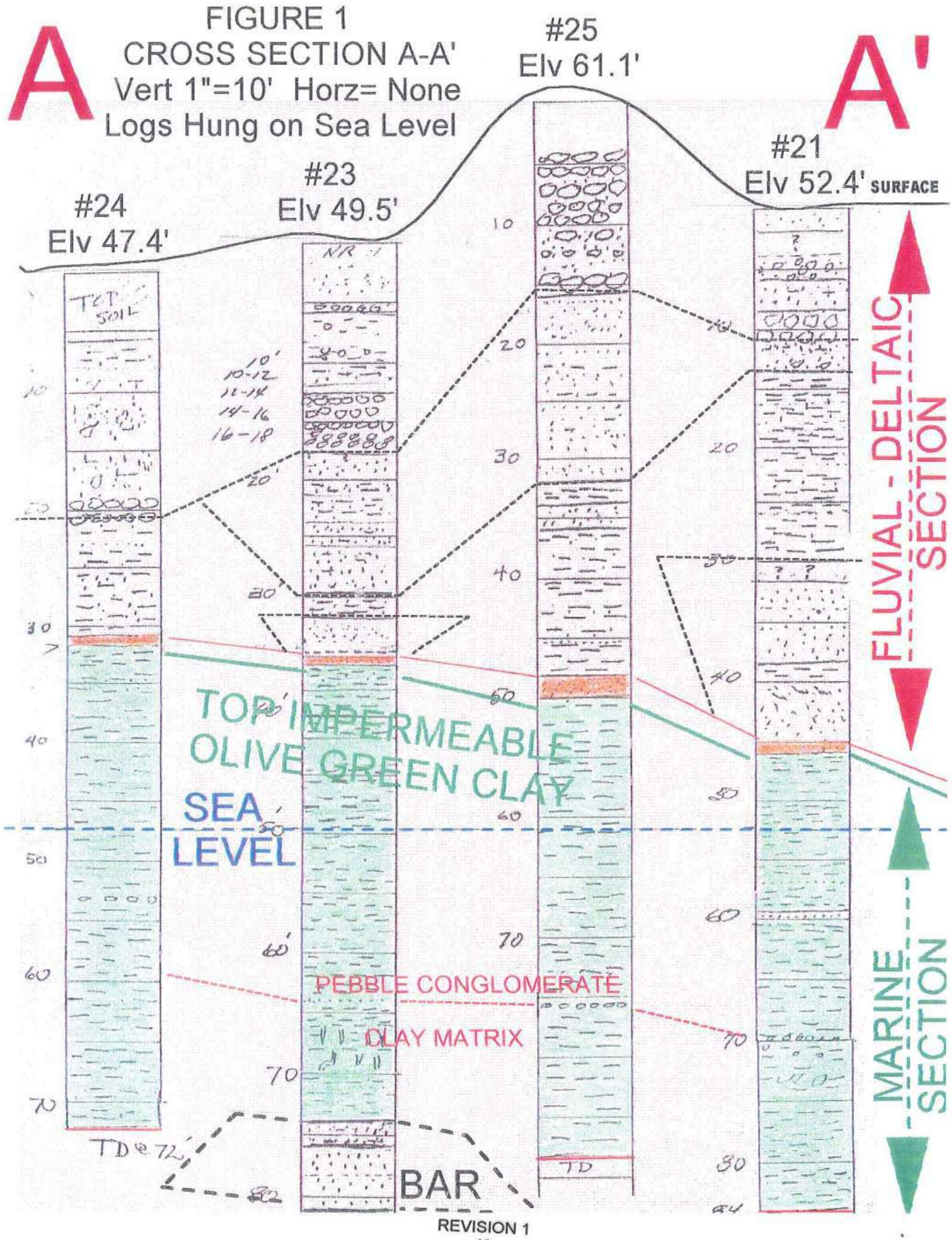
Aquifer (slug) tests were performed in piezometers and monitor wells screened in the uppermost aquifer sand unit utilizing both rising head and falling head methodologies where possible. Results of these tests are shown in Attachment 5 as Appendix E, and are included as Appendix E of this Attachment. Based upon these results, the average (geometric mean) horizontal hydraulic conductivity of the uppermost aquifer is approximately 4.1 x 10^{-4} cm/sec in the subsurface soils above +10' MSL. ~~The average vertical hydraulic conductivity of the Light Olive Green Clay layer is 3.31x10^{-8} cm/sec.~~ These results were obtained using bail, or pump, tests and analyzed using the Horslev graphical method. Note that the Horslev method uses the sand filter pack around the monitor well screen rather than the well screen length in this calculation (Fetter, 1988).


MW #15
MW #6
B-21
MW #14
B-23
B-17
B-18
MW #9R
MW #11
MW #16
MW #10
B-25
MW #4
MW #13
MW #3
Oil Well (Plugged)
MW #8
MW #1
MW #24
MW #12
FIGURE 4.17
Boring Plot Plan
City of Kingsville, Tx
Municipal Solid Waste Landfill
LAT: 27° 26' 41.95"
LONG: 97° 48' 55.89"
0
400
800
Scale: 1" = 400'
Finch Energy & Environmental Services, Inc.

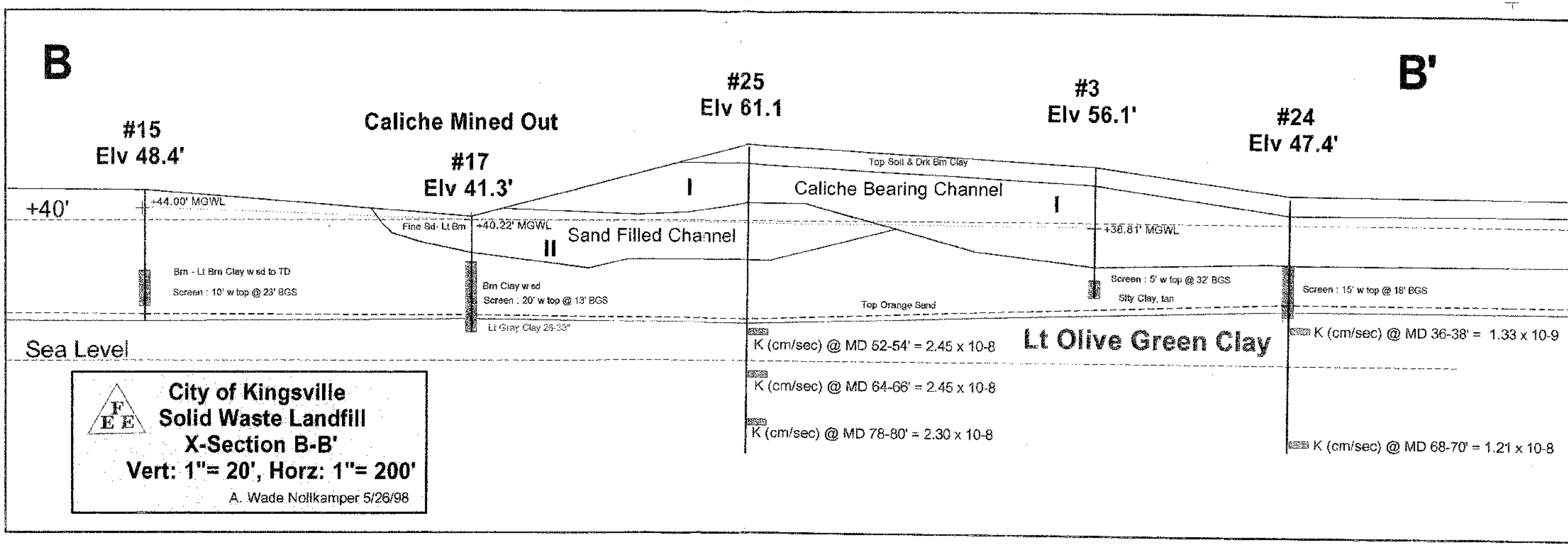
47

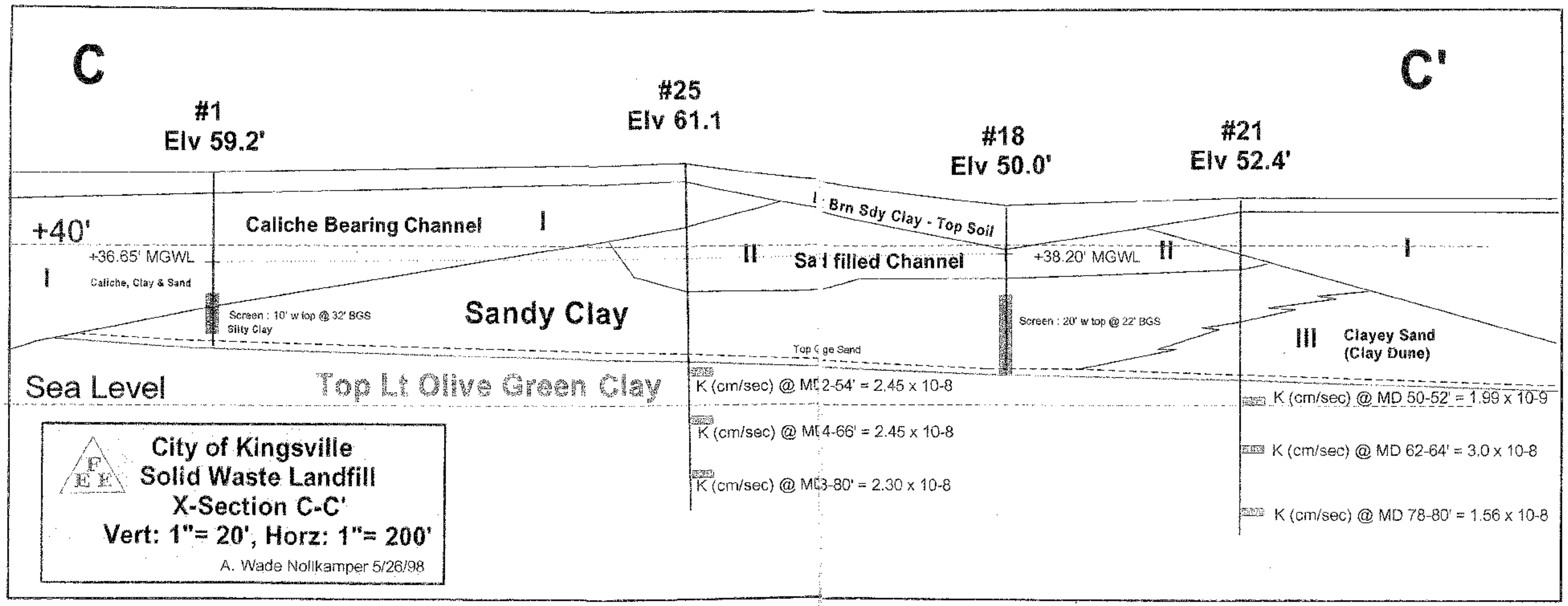


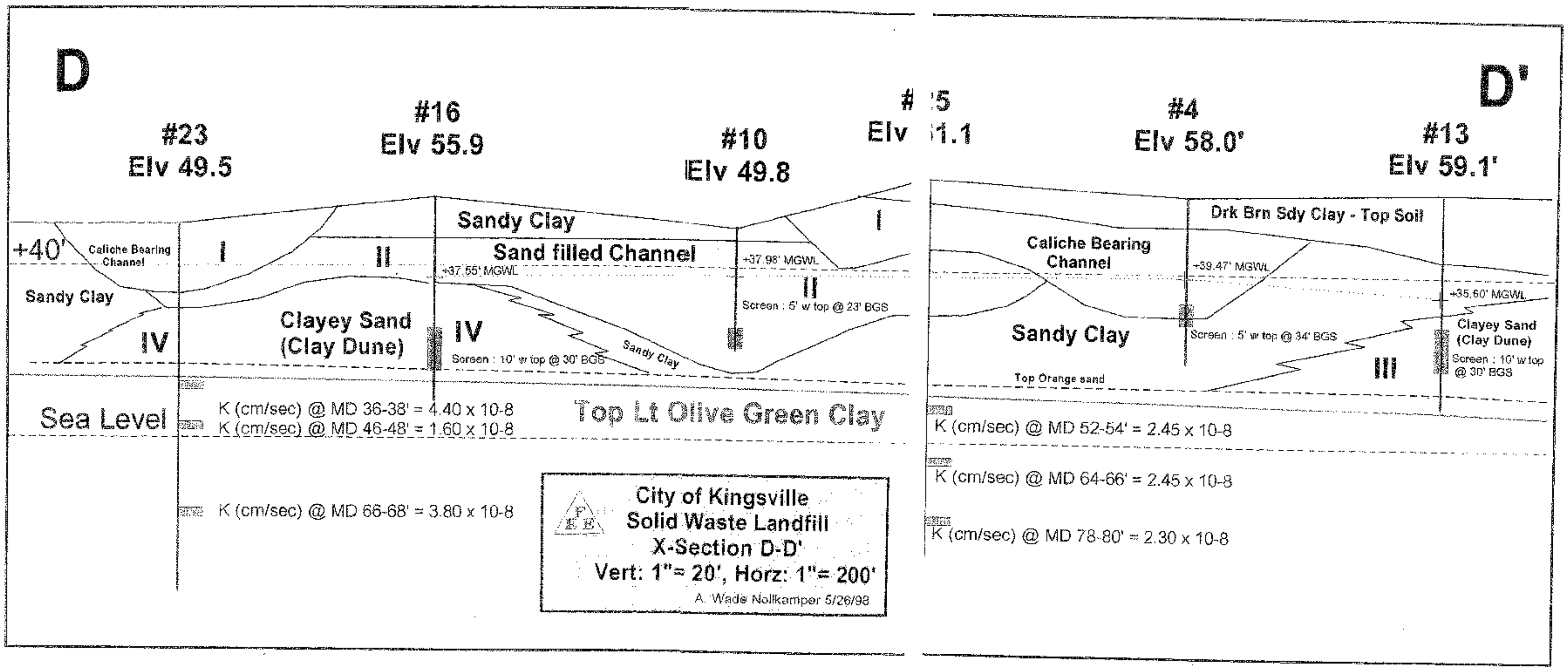
REVISION 1
48



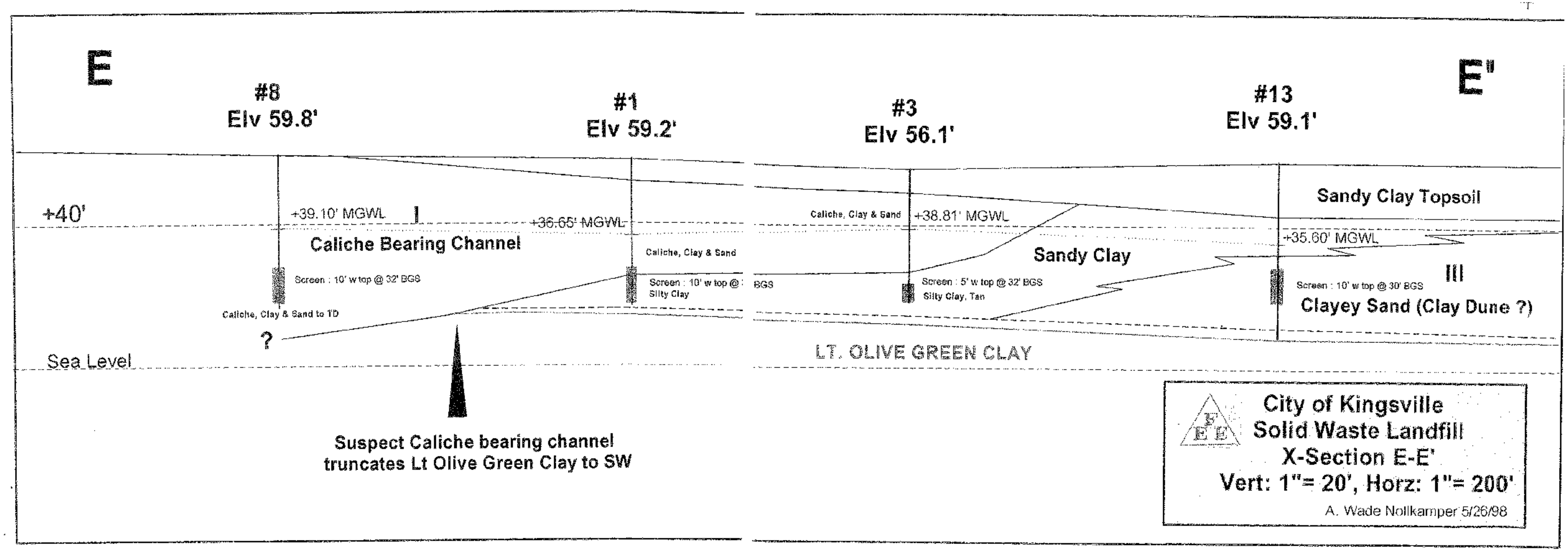
REVISION 1
49


B
B'
#15
Elv 48.4'
Caliche Mined Out
#17
Elv 41.3'
#25
Elv 61.1
#3
Elv 56.1'
#24
Elv 47.4'
Top Soil & Drk Brn Clay
Caliche Bearing Channel
I
I
+40'
+44.00' MGWL
Fine Sd- Lt Brn
+40.22' MGWL
Sand Filled Channel
II
+38.81' MGWL
Brn - Lt Brn Clay w sd to TD
Screen : 10' w top @ 23' BGS
Brn Clay w sd
Screen : 20' w top @ 13' BGS
Lt Gray Clay 26-33"
Screen : 5' w top @ 32' BGS
Silty Clay, tan
Screen : 15' w top @ 18' BGS
Top Orange Sand
Sea Level
K (cm/sec) @ MD 52-54' = 2.45 x 10-8
Lt Olive Green Clay
K (cm/sec) @ MD 36-38' = 1.33 x 10-9
K (cm/sec) @ MD 64-66' = 2.45 x 10-8
K (cm/sec) @ MD 78-80' = 2.30 x 10-8
K (cm/sec) @ MD 68-70' = 1.21 x 10-8
City of Kingsville
Solid Waste Landfill
X-Section B-B'
Vert: 1"= 20', Horz: 1"= 200'
A. Wade Nollkamper 5/26/98

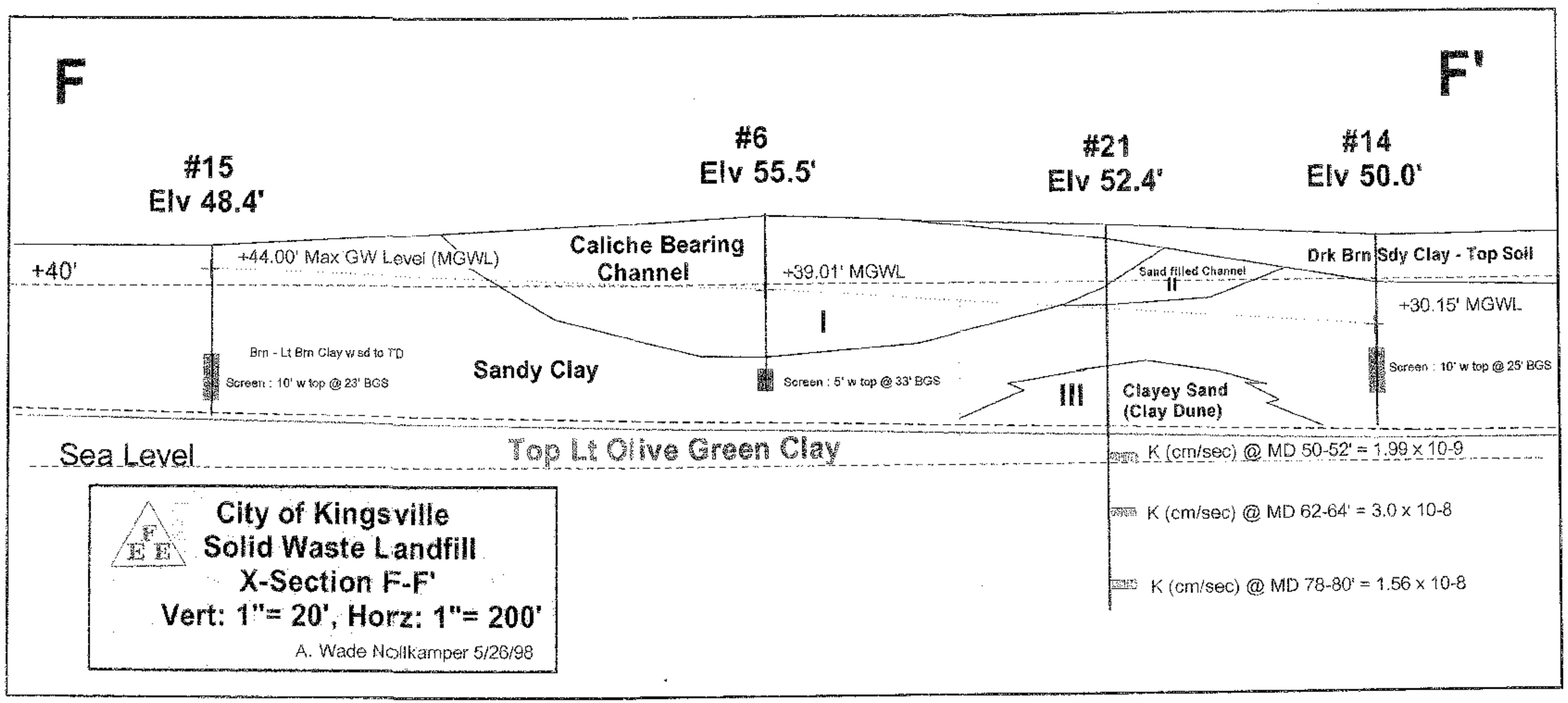

C
C'
#1
Elv 59.2'
#25
Elv 61.1
#18
Elv 50.0'
#21
Elv 52.4'
+40'
Caliche Bearing Channel
I
Brn Sdy Clay - Top Soil
+36.65' MGWL
I
Caliche, Clay & Sand
II
Sa I filled Channel
+38.20' MGWL
II
I
Sandy Clay
Screen : 10' w top @ 32' BGS
Silty Clay
Screen : 20' w top @ 22' BGS
III
Clayey Sand
(Clay Dune)
Sea Level
Top Lt Olive Green Clay
K (cm/sec) @ MD 52-54' = 2.45 x 10-8
K (cm/sec) @ MD 64-66' = 2.45 x 10-8
K (cm/sec) @ MD 78-80' = 2.30 x 10-8
K (cm/sec) @ MD 50-52' = 1.99 x 10-9
K (cm/sec) @ MD 62-64' = 3.0 x 10-8
K (cm/sec) @ MD 78-80' = 1.56 x 10-8
City of Kingsville
Solid Waste Landfill
X-Section C-C'
Vert: 1"= 20', Horz: 1"= 200'
A. Wade Nollkamper 5/26/98



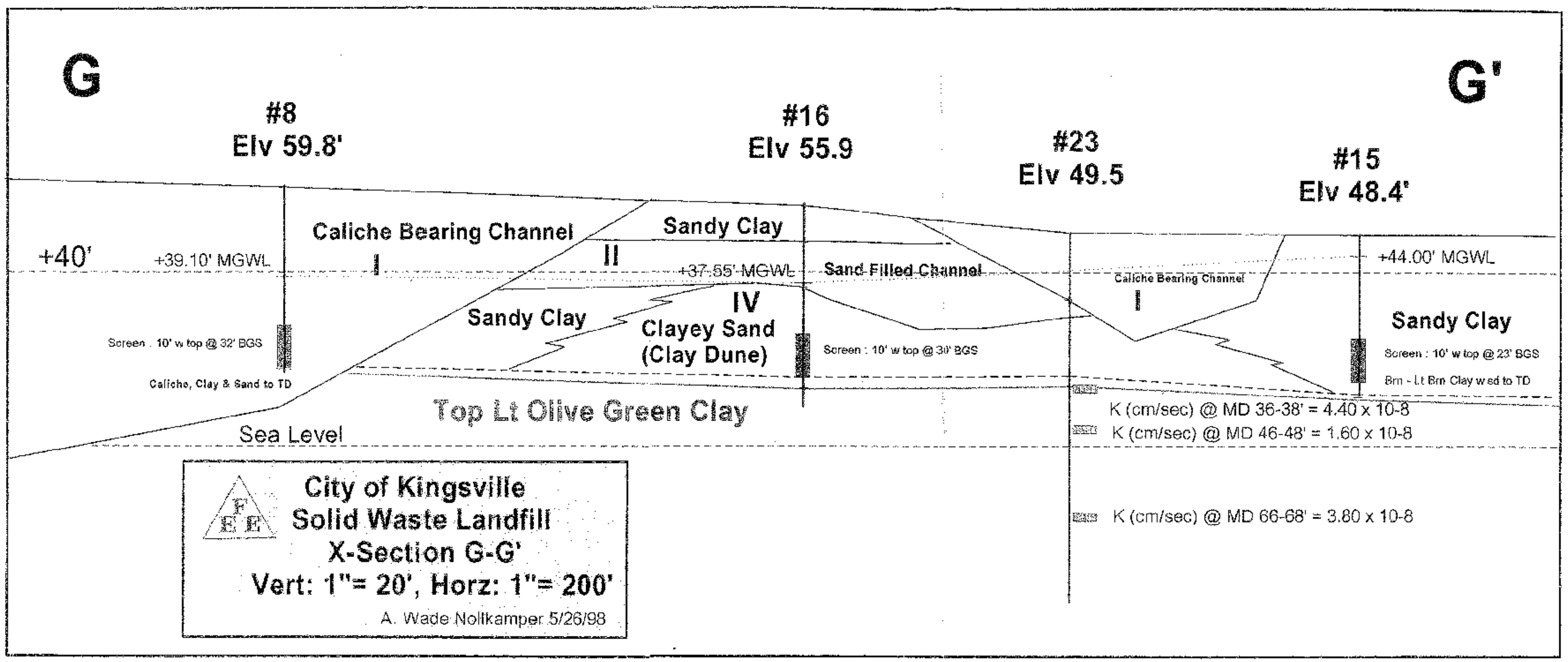
REVISION 1-52

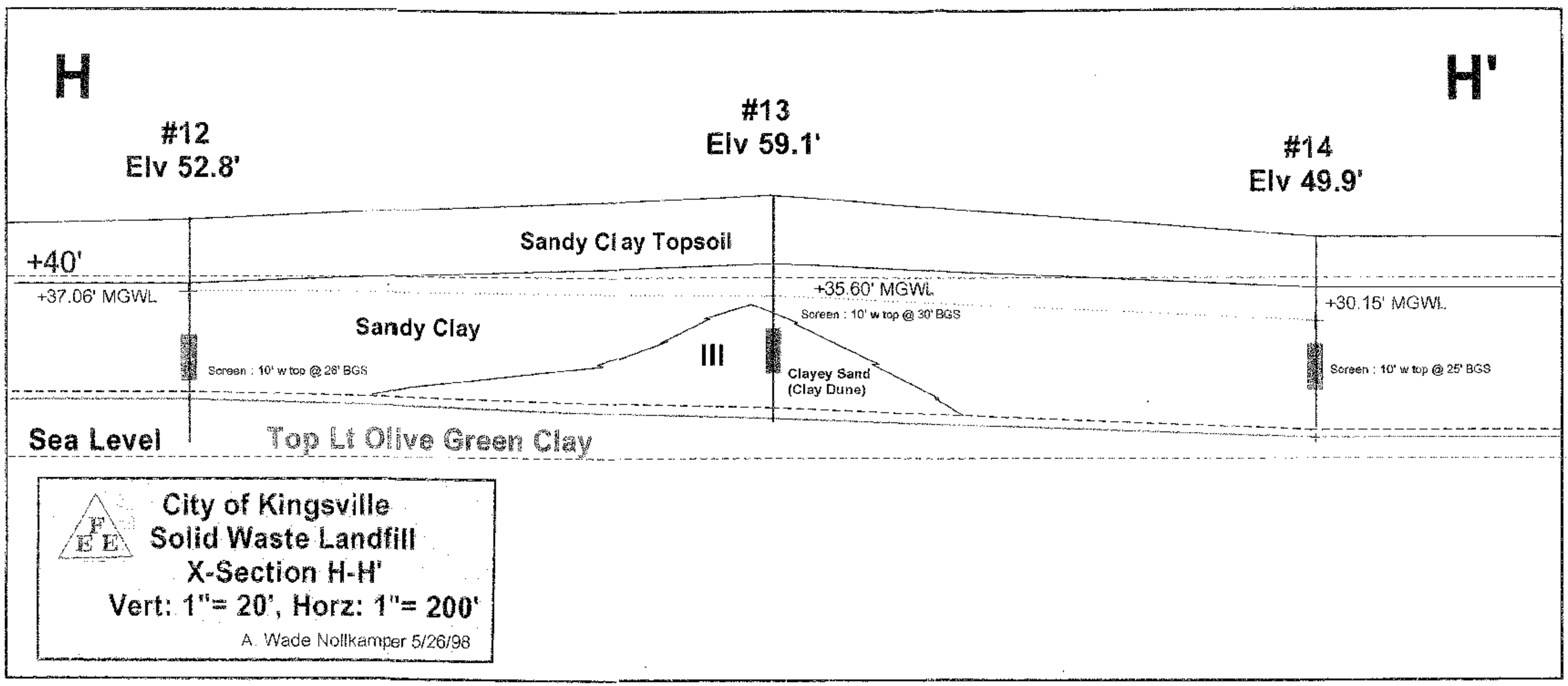


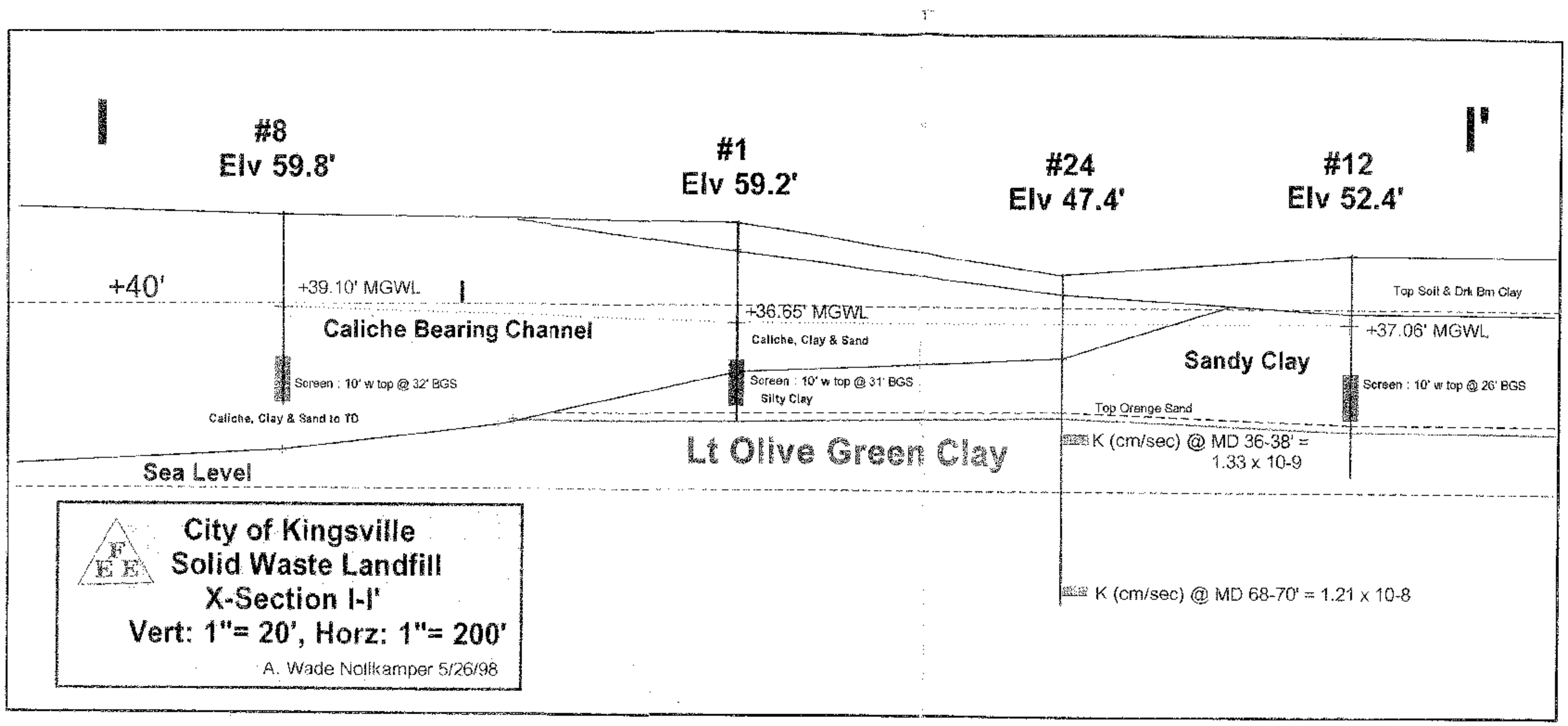
REVISION 1-53



REVISION 1-54


G
G'
#8
Elv 59.8'
#16
Elv 55.9
#23
Elv 49.5
#15
Elv 48.4'
Caliche Bearing Channel
I
Sandy Clay
II
+40'
+39.10' MGWL
+37.55' MGWL
Sand Filled Channel
Caliche Bearing Channel
I
+44.00' MGWL
IV
Sandy Clay
Clayey Sand
(Clay Dune)
Sandy Clay
Screen . 10' w top @ 32' BGS
Screen : 10' w top @ 30' BGS
Screen : 10' w top @ 23' BGS
Caliche, Clay & Sand to TD
Brn - Lt Brn Clay w sd to TD
Top Lt Olive Green Clay
Sea Level
K (cm/sec) @ MD 36-38' = 4.40 x 10-8
K (cm/sec) @ MD 46-48' = 1.60 x 10-8
K (cm/sec) @ MD 66-68' = 3.80 x 10-8
City of Kingsville
Solid Waste Landfill
X-Section G-G'
Vert: 1"= 20', Horz: 1"= 200'
A. Wade Nollkamper 5/26/98


H
H'
#12
Elv 52.8'
#13
Elv 59.1'
#14
Elv 49.9'
Sandy Clay Topsoil
+40'
+37.06' MGWL
+35.60' MGWL
+30.15' MGWL
Screen : 10' w top @ 30' BGS
Sandy Clay
III
Screen : 10' w top @ 28' BGS
Clayey Sand
(Clay Dune)
Screen : 10' w top @ 25' BGS
Sea Level
Top Lt Olive Green Clay
City of Kingsville
Solid Waste Landfill
X-Section H-H'
Vert: 1"= 20', Horz: 1"= 200'
A. Wade Nollkamper 5/26/98


I
I'
#8
Elv 59.8'
#1
Elv 59.2'
#24
Elv 47.4'
#12
Elv 52.4'
+40'
+39.10' MGWL
+36.65' MGWL
+37.06' MGWL
Top Soil & Drk Brn Clay
Caliche Bearing Channel
Caliche, Clay & Sand
Sandy Clay
Screen : 10' w top @ 32' BGS
Screen : 10' w top @ 31' BGS
Silty Clay
Screen : 10' w top @ 26' BGS
Caliche, Clay & Sand to TD
Top Orange Sand
Lt Olive Green Clay
K (cm/sec) @ MD 36-38' = 1.33 x 10-9
Sea Level
K (cm/sec) @ MD 68-70' = 1.21 x 10-8
City of Kingsville
Solid Waste Landfill
X-Section I-I'
Vert: 1"= 20', Horz: 1"= 200'
A. Wade Nollkamper 5/26/98

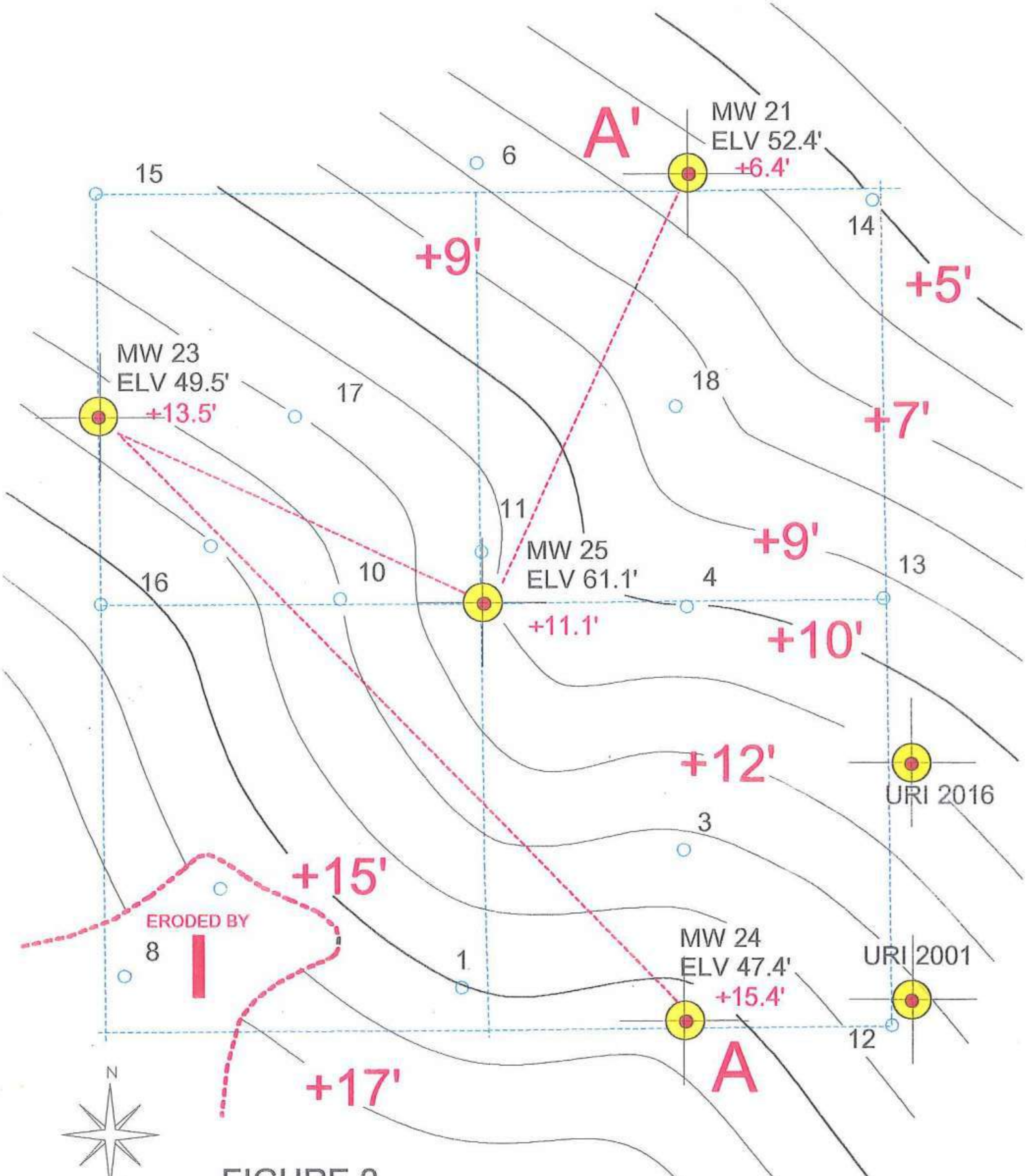
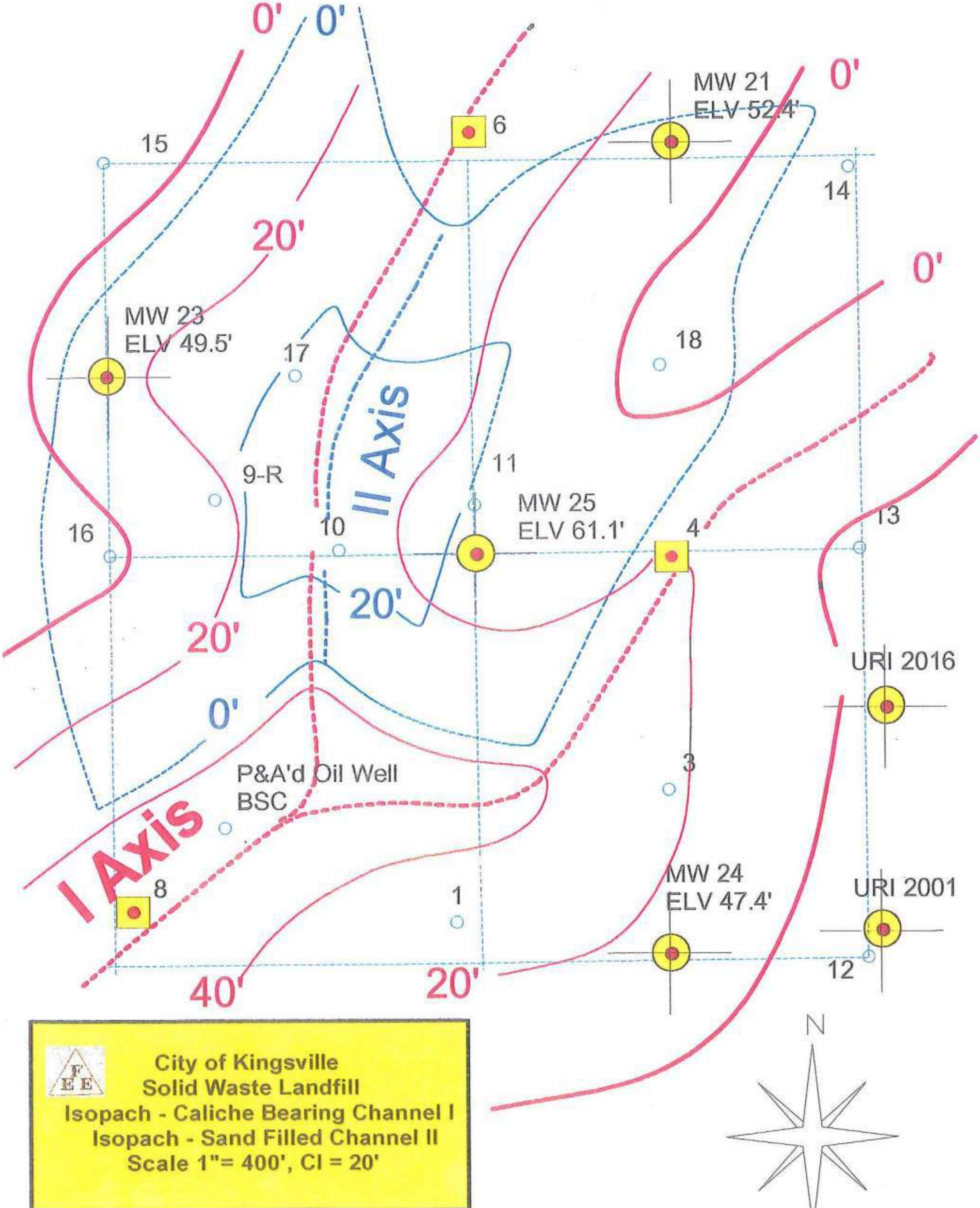


FIGURE 2
STRUCTURE TOP OLIVE GREEN CLAY
C.I.= 1' SCALE: 1"= 400'
A.W.N. 4/30/98
REVISION 1
58



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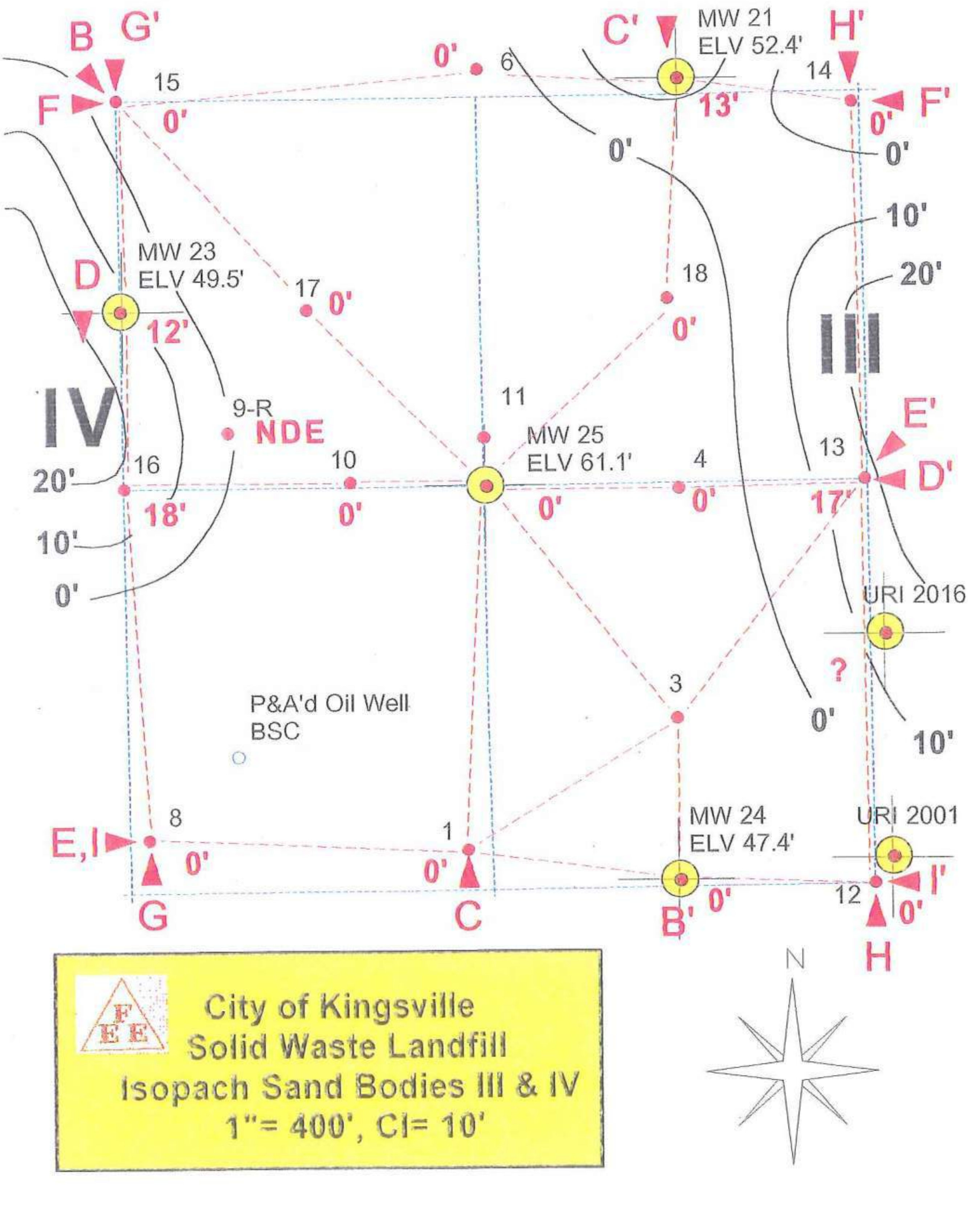
59



REVISION 1
60

an equation derived from Darcy's Law,

$V = Ki/n_e$ where: V =velocity (length/time)

K =hydraulic conductivity (length/time)

i =hydraulic gradient (length/length)

n_e=effective porosity (decimal)

As calculated from the potentiometric maps of groundwater flow within each stratum (See Attachment 5, Appendix G), the horizontal hydraulic gradient across the site ranges from 1.44×10^{-3} ft/ft to 7.99×10^{-3} ft/ft. Horizontal hydraulic conductivity values within each stratum, which are stated above, were obtained from in-situ hydraulic conductivity tests (Appendix E). An effective porosity for a silty clay loam (the predominant lithology screened by piezometers in each stratum) is estimated to be 0.43 (Dean, et. al., 1989). Using these parameters, the horizontal velocity of ground water within uppermost aquifer deposits beneath the site is estimated to range from ~~0.0014~~ 0.0033 ft/day to ~~0.0068~~ 0.0086 ft/day, or ~~0.5~~ 1.2 ft/year to ~~2.5~~ 3.1 ft/year, respectively.

F.E.E. prepared a hydrograph of existing monitor wells on site using data collected from previous ground water sampling events since May 1991, and data collected during this investigation. Based on the seasonal data for the site collected to date, the potentiometric surface was slightly lower during periods of low precipitation (summer and early fall) and slightly higher during periods of excess precipitation (winter and spring). The hydrograph indicates no significant changes in groundwater elevations since 1991 until the excessive precipitation event of October 8 -12, 1997. (Appendix F).

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6.2.3 Relationship of Ponded Water to Water Table

During the six day period from September 19 through September 25, 1967 massive amounts of rainfall fell in South Texas which exceeded annual average rainfall (30 inches). This large rainfall resulted in numerous ponds of water in the relatively flat South Texas area. A joint study of the relationship of this ponded water to groundwater levels in the uppermost, unconfined aquifer was made jointly by the United States Geological Survey and the Texas Water Development Board. (TDWB, #138, December, 1971) This data is relevant to water levels below the City of Kingsville, Texas (COK) Municipal solid Waste Landfill (MSWLF) site.

The King Ranch site was most representative of the COK MSWLF site. It had water in ponds well above the normal water level in the uppermost aquifer. The massive rainfall from Hurricane Beulah resulted in water table water levels continuing to rise below and around the pond for a period of eight to eleven months after these above normal rainfall events. The COK MSWLF had a similar large rainfall event during the period October 8 through 12, 1997.

The COK MSWLF site has several excavations which are adjacent to the currently permitted MSWLF and on the same land for which MSWLF expansion is proposed. These excavations were prepared for two reasons: first, to provide cover soil for the existing MSWLF; second, to prepare the excavations for future MSWLF cells. The net result of these excavations was to provide depressions in the earth's surface which collect ponded water from rainfall events. This ponded water provides recharge to the uppermost, unconfined aquifer by percolation through the unsaturated zone to the ground water table. This recharge causes higher than normal water levels (mounding) below and near these ponds. This is the same result as experienced in the 1968-69 TDWB studies of ponded water on the King Ranch.

The King Ranch study showed that water table water levels were influenced by recharge from ponded water as far as 500 feet from the pond. This was confirmed by both water levels and dilution of total dissolved solids (TDS) in the ground water. The COK MSWLF site experienced similar results after the excessive rainfall events of October 8-12,1997. Unfortunately, this rainfall event was right in the middle of a six month study of water levels being made as part of the permitting process for the expansion of the COK MSWLF. This event requires that the design be modified to protect against such events so that groundwater levels will not rise into bottom liners of the expanded landfill. The proposed design change is to provide pumping capacity for non-active excavations such that ponded water is not allowed to accumulate in excavations after rainfall events. The rainfall in expanded active areas will be handled by the leachate collection system.

In April, May and June, 1998, both the topography and ground water levels on the landfill site and off-site were mapped. The topographic map and the groundwater contour during the May, 1998 period confirm that the ground water flow from the landfill is leaving the landfill in all directions except to the northwest where groundwater is entering the uppermost aquifer under the landfill. This study shows a very steep gradient to the northeast toward monitor well #14 as indicated previously. However, there is also ground water flow to the southwest toward the caliche pit on the southwest corner of the intersection of FM 2619 and CR 2030. There is also ground water flow toward the Martin Hamilton caliche pit at the southeast corner of FM 2619 and CR 2030. There is also ground water flow toward the VT Collins caliche pit at the northwest corner of FM 2619 and CR 2030. There is flow toward the landfill from the northwest corner of the landfill , i.e. monitor well #15. By superimposing the current topographic map onto the current ground water contour, it appears that there is no major disruption of ground water flow due to the local depressions. There does seem to be a small impedance to flow under the low point of the old landfill on the northeast corner of the intersection of FM 2619 and CR 2030. This impedance is indicated by a flattening of the ground water contour in the vicinity of the low area at the southwest corner of the 235 closed landfill, i.e. P&A'd Oil Well. There certainly is recharge from the surface ponding as indicated earlier from the study by Baker of King Ranch ponding studies after Hurricane Beulah.

The May 1998 studies show that there were at that time nine (9) ponds or depressions in the vicinity of the landfill which intersect the ground water table. Eight of these depressions are located in adjacent caliche pits and one is located on site in a former caliche pit which is now inactive. These ponds are shown blue cross hatching on the topographic map in Appendix N. A Surfer ground water contour map using depression water surfaces and ground water monitor well levels was prepared for May 18, 1998. This contour is also shown in Appendix N. The Topographic Map and the Ground Water Contour Map are of the same scale and may be overlain for analysis. The number of ponds or depressions may vary as ground water level varies due to drought or excessive precipitation events. There are also five other ponds or depressions on the landfill site which hold water after rainfall but do not intersect the ground water table. One pond is the excavation where sector 2 is proposed on the southeast corner of the 160 acres. The second pond is about center on the east side of the landfill just north of the service road coming to the current office and weigh station. The third pond (much shallower) is due north of the second pond and also on the east side. The fourth pond is in the same triangular shaped area as the ~~leachate collection pond~~ contaminated water evaporation pond but immediately to the north and east. The fifth pond is a long narrow pond immediately south of monitor well #6 at the center of the north side of the landfill. The only pond on site which intersects ground water is in the northwest 40 acre quadrant about the center of the west side and extending about half way across the quadrant. These ponds which do not intersect ground water can be identified on the topographic map in Appendix N by the numbers Pd-1, 2, 3, 4 and 5. These ponds will dry up after pumping or dry conditions.

The uppermost aquifer water table in the vicinity of the landfill site is almost totally supplied by recharge from the surface. This recharge is accelerated by the presence of ponds or depressions as described above which provide a static head through saturated soil. This is explained in the King Ranch ponding study above. The water table in the uppermost aquifer approximately follows the land surface since most of the recharge is from the surface. Since the landfill site is the high point in the area, it also contains the high point in the water table. Ground water tends to flow away from the landfill on all sides except to the northwest during most of the six month test period. However, in the earlier weeks of the test period (August & September, 1997) the ground water gradient was away from the landfill toward the northwest, also. Therefore, the monitor well system will need to monitor the points of compliance on all sides of the landfill site. The steepest ground water gradients are to the northeast and to the southwest. The gradient to the northeast is steep due to stiff clay formation on its way toward Santa Gertrudis creek. The gradient to the southwest is steep due to the caliche channel which rather steeply slopes toward the southwest (relative to the rather flat surrounding terrain).

7.0 GROUNDWATER CHARACTERIZATION

7.0 GROUNDWATER CHARACTERIZATION

This section describes the historical groundwater conditions that have existed at the City of Kingsville MSWLF site as required in 30 TAC §330.56(e). A delineation of the waste management area, the property boundary, and the proposed locations of all groundwater monitoring wells are shown on Figure 4.17.

7.1 Background

Currently a total of five groundwater monitoring wells exist to monitor quality in the uppermost aquifer sands along the perimeter of the currently permitted fill area. A series of sampling and analysis events to characterize the background quality of the groundwater occurred in the third and fourth quarters of 1996, and the first, second, and third quarters of 1997.

Beginning in the third quarter of 1996, the groundwater monitoring requirements included the annual sampling of each well for total organic carbon (TOC), iron, manganese, pH, chloride, potassium, total dissolved solids, and a groundwater elevation measurement. Following establishment of background values, the following additional parameters were sampled: calcium, magnesium, sodium, carbonate, phenolphthalein alkalinity as $CaCO_3$, alkalinity as $CaCO_3$, hardness as $CaCO_3$, bicarbonate, sulphate, specific conductance, anion/cation balance, fluoride, and nitrate (as nitrogen). No known plumes of contamination have been identified as entering the groundwater from the facility.

7.2 Groundwater Quality

In order to compare with regional groundwater quality data, relevant analytes were selected from groundwater samples collected from groundwater monitor wells screened within the uppermost aquifer sands at the City of Kingsville MSWLF site. These analytes included pH, manganese (dissolved), iron (dissolved), chlorides, and total dissolved solids (TDS). Groundwater samples collected from the uppermost aquifer sand (MW-1 through MW-11) have reported pH values (field) ranging from 7.08 standard units (s.u.) from MW-4 to 7.66 s.u. from MW-11. Dissolved manganese concentration have ranged from Non-Detect from MW-10 to 0.67 µg/l from MW-3. Dissolved iron concentration have ranged from non-detect (MW-4) to 0.68 µg/l (MW-4). Chloride values have ranged from 66 milligrams per liter (mg/l or parts per million - ppm) from MW-11 to 2600 mg/l from MW-4. TDS concentrations ranged from 1580 mg/l (MW-11) to 5,780 mg/l (MW-4). More complete analytical data from the MSWLF ground water monitor wells is available in Table 5.1 of Attachment 5.

As part of the study performed by Shafer (1973), 272 groundwater samples were collected from water wells in the Kleberg, Kennedy, and Southern Jim Wells County area, ranging in depth from 25 feet below ground surface (ft bgs) to 1,206 ft bgs. Groundwater samples were collected from 1913 to 1969 in order to determine the quality of groundwater supplies in the area. The analyses consisted of dissolved mineral constituents, which determined the fitness of water for industrial, agricultural, and domestic use without reference to the sanitary quality of the sample. A summary list of chemical analyses of groundwater samples collected from the Goliad aquifer in North Central Kleberg County is included within Table 5.2.

In general, the samples were fairly uniform throughout the northwestern portion of Kleberg County. Specific conductance and chloride content generally increased with depth, as a result of brackish or salt water intrusion. The Total Dissolved Solids contents were high and ranged from 894 ppm to 2,000 ppm. Figure 4.16 shows the extent of salt water intrusion from the Gulf of Mexico into the Evangeline (Goliad) aquifer in 1973.

The analytical results of the groundwater samples from the site reported values well within the regional values reported in the studies by Shafer (1973). The highest value for chloride has been reported at 2,600 mg/l, which was within the regional chloride values which ranged from 135 mg/l to 2,700 mg/l. The highest value for TDS has been 5,780 mg/l, well within range of the regional values of 175 mg/l to 21,200 mg/l.

8.0 GEOTECHNICAL CHARACTERIZATION

8.0 GEOTECHNICAL CHARACTERIZATION

In order to determine the soil characteristics of the shallow soils at the site and to determine the suitability for site soils for liner material as well as evaluate depths, geotechnical laboratory testing of selected soil samples was performed. In accordance with 30 TAC §330.56(d)(5)(B), the following sections present a summary of the geotechnical properties of shallow soils beneath the site.

8.1 Geotechnical Laboratory Testing

All soil samples collected during the F.E.E., Inc. July, 1997 investigation were transported to the geotechnical laboratory where tests were performed on selected samples in order to evaluate and further classify the samples. Geotechnical laboratory test results are summarized by boring on Table 4.1 and by stratigraphic unit on Table 4.2. Geotechnical tests were performed on samples by Professional Services, Inc (PSI), of Corpus Christi, Texas. During the second phase of geotechnical studies at the landfill site in April, 1998, additional samples were taken from four (4) deep borings. These samples were also tested for selected geotechnical parameters at the PSI laboratories. The complete geotechnical laboratory test results are presented in Appendix G.

Atterberg Limits (ASTM D-4318), percent passing the No. 200 mesh sieve (ASTM D-1140), and full gradation tests (ASTM D-422) were performed on selected soil samples to determine the index of properties on the subsurface materials. A total of 44 Atterberg Limits and 24 grain size analyses were performed. The index and classification test results are summarized on Tables 4.1 and 4.2, and on the individual boring logs included in Appendix B. Grain size distribution curves are presented in Appendix G.1.

Short-term and long-term bearing strength characteristics and the moisture and density of the soils were evaluated by means of unconfined compression tests (ASTM D-2166), and eleven unconsolidated-undrained three-point triaxial compression tests (ASTM D-2850). The strength test results are summarized on Tables 4.1 and 4.2 and on the boring logs in Appendix B. The individual laboratory strength test results are included in Appendix G.2.

Three consolidation (odometer) tests (ASTM D-2435) were performed on samples obtained from the borings to evaluate the compressibility and rebound characteristics of cohesive materials subjected to varying load conditions. Stress-strain curves plotted using the test data are shown in Appendix G.2. Settlements within the soils underlying the landfill due to the imposed waste load were estimated using the information from these curves.

Horizontal and vertical permeability characteristics of the cohesive soils were evaluated by means of flexible wall permeability tests (ASTM D-5084). Thirteen vertical permeability tests and twelve horizontal permeability tests were performed on samples obtained from the borings. Permeability test results are summarized on Tables 4.1 and 4.2. The individual laboratory permeability test data sheets are presented in Appendix G.4.

8.2 Geotechnical Data Evaluation

This section summarizes the results of the geotechnical laboratory testing performed on soil samples collected during the hydrogeological investigation performed by F.E.E., Inc. at the City of Kingsville, Texas (COK) Municipal Solid Waste Landfill (MSWLF) during the month of July, 1997. A discussion of the geotechnical results for each of the stratigraphic units is presented below.

8.2.1 Top Soil and dark Brown Clay Unit

Very little geotechnical data was determined from top soil samples.

8.2.2 Caliche Bearing Channel (I) Layer

The Caliche Bearing Channel consists of a caliche vein running from northeast to southwest across the landfill site. The Isopach (Figure 4.29) shows that the thickness varies from 0 to 40 feet in thickness across the site. The 40 foot thickness is at the extreme southwest corner. The zero is on the edges of the channel. The channel splits and goes to both sides of monitor wells 18 and 14. The main channel in the new site are is approximately 20 feet thick maximum. Much of this layer has already been excavated in the caliche mining process which ceased more than twenty years ago.

The moisture content of this stratum ranged from 8.3 to 11.5 percent with an average of approximately 9.6 percent, and the caliche layer had an average dry density of 81 pounds per cubic foot (pcf). The liquid limits and plasticity indices ranged from 31 to 39 and 13 to 19, respectively, with an average liquid limit and plasticity index of 35 and 16, respectively.

Unconfined compression tests performed on samples from this unit indicate an average cohesion of 5,660 pounds per square foot (psf). Permeability tests performed on samples from this stratum indicated an average horizontal permeability of $3.0x10^{-4}$ cm/sec.

8.2.3 Sand Filled Channel (II) Layer

The Sand Filled Channel (II) is a discontinuous layer located below the main caliche bearing channel. Where the caliche has been excavated the Sand Filled Channel is exposed in the vicinity of monitor well #17. The maximum thickness of this layer of approximately 20 feet occurs in the vicinity of monitor wells # 10 and #17. The precise location and shape of this discontinuous unit is shown in Isopach map Figure 4.29. The Sand Filled Channel is composed primarily of SC and SP-SC soils.

The moisture content of this stratum ranged from 18 to 35 percent, with an average of approximately 26 percent. The Sand Filled Channel layer had an average dry density of 82 pcf, and an average wet density of 104 pcf. The liquid limits and plasticity indices ranged from 41 to 58 and non to 33, respectively, with an average liquid limit and plasticity index of 47 and 17, respectively (neglecting the non plasticity index readings).

Cohesion intercept from unconsolidated-undrained triaxial compression tests ranged from 3,100 to 13,000 psf with an average of 8,600 psf. Consolidated-undrained triaxial compression tests were performed on samples from this unit indicating an average effective cohesion of 200 psf and an effective angle of internal friction of 24 degrees. Vertical and horizontal permeability tests performed on samples from this stratum indicated an average vertical and horizontal permeability of 3.0×10^{-5} cm/sec and 1.0×10^{-4} cm/sec, respectively. Percent passing the No. 200 mesh averaged 40 percent.

8.2.4 Clayey Sand (Clay Dune) (III) Layer

The Clayey Sand (Clay Dune) (III) Layer is present at the extreme eastern side of the landfill site. (See Figure 4.30) It is present below the top soil and sandy clay units below monitor well #13. The Clayey Sand (III) Layer and consists SC , SP-SC and CH soils. The unit is encountered typically between elevations 6 and 26 feet NGVD. This is a discontinuous clay dune unit. The maximum thickness of the unit is estimated to be about 30 feet. (See Figure 4.26)

Moisture tests were performed on samples from this unit, indicating a water content of 23 percent. The liquid limits and plasticity indices ranged from 56 to 63 and 30 to 48, respectively, with an average liquid limit and plasticity index of 59 and 27, respectively. Permeability tests performed on this layer indicated vertical and horizontal permeabilities of 2.3×10^{-5} and 1.75×10^{-5} cm/sec, respectively.

8.2.5 Clayey Sand (Clay Dune) (IV) Layer

The Clayey Sand (Clay Dune) (IV) Layer is present under the Caliche Bearing Channel and the Sand Filled Channel and the Sandy Clay unit at the extreme western edge of the landfill site. Section D - D', Figure 4.22, shows this Clay Dune to be of maximum thickness of about 24 feet and centered between monitor wells 16 and 23. The Clayey Sand (IV) Unit consists primarily of SC and SP-SC type soils. Figure 4.30 is the isopach of this formation.

The moisture content of the Clayey Sand (IV) Layer ranged from 19 to 25 percent, with an average of approximately 22 percent. The liquid limits and plasticity indices of this layer averaged 52 and 21, respectively. The percent passing the No. 200 sieve mesh ranged between 30 and 46 percent with an average of 19 percent. Compressive strength of this layer was 5,500 psf. Effective cohesion and angle of internal friction for this layer were 200 psf and 24 degrees, respectively. Vertical permeability was 3.3×10^{-6} cm/sec.

8.2.6 Sandy (Silty) Clay Unit

The Sandy (Silty) Clay Unit is the most continuous soil unit above the aquiclude described below. The other discontinuous units (Caliche Bearing Channel, Sand Filled Channel, and two Clay Dunes (III & IV) seem to be located within the Sandy (Silty) Clay Unit. This unit is found in every boring log at the site except 7, 8 and 23. Borings 7 & 8 are totally in the Caliche Bearing Channel. Boring 23 penetrates three types of discontinuous units which separate it from the Sandy (Silty) Clay Unit. (See Section D - D', Figure 4.22) The Sandy (Silty) Clay Unit is composed primarily of CH type soils with minor amounts of CL and SC types.

The moisture content of the Sandy (Silty) Clay Unit ranged from 9 to 38 percent with an average moisture content of 23 percent. The Liquid Limit of this soil ranged from 30 to 83 % with an average of 60 %. The Plasticity Index ranged from 15 to 60 % with an average of 39 %. The percent passing the No. 200 sieve mesh ranged from 31 to 85 % with an average of 60 %. Unconfined compressive strength of this soil averaged 7,680 psf. Effective cohesion and angle of internal friction for this unit were 200 psf and 24 degrees, respectively. The average vertical and horizontal permeabilities were 1.0×10^{-5} cm/sec and 2.8×10^{-6} cm/sec, respectively.

8.2.7 Light Olive Green Clay Confining Layer - Aquiclude

This Light Olive Green Clay Unit was the only truly continuous layer unit at the landfill site. The top of this layer is shown in Figure 4.28 to vary from 5 feet above MSL at the extreme northeast corner of the landfill site to about 17 feet above MSL at the extreme southwest corner of the landfill site where it is slightly truncated by the Caliche Bearing Channel sloping gently towards the southwest. This Unit is at least 38 feet thick at the landfill site. All of the deep borings terminatedl in this unit. It forms the aquiclude for the local uppermost aquifer in the vicinity of the landfill site.

The moisture content of this soil varied from 18 % to 38 % and averaged 29 %. The average wet and dry densities of this soil are 125 pcf and 98 pcf, respectively. The liquid limit of this soil unit varied from 51 % to 79 % and averaged 67%. The Plasticity Index of this soil varied from 25 % to 51 % and averaged 35 %. The average percent passing a number 200 mesh sieve was 81 %. The average unconfined compressive strength of this clay was 8,300 psf. The vertical permeability of this clay averaged $3.3x10^{-8}$ cm/sec. The vertical permeability ranged from $1.33x10^{-9}$ cm/sec to $6.18x10^{-8}$ cm/sec.

Table 4.1
SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING
City of Kingsville MSWLF, Permit 235 B
Kingsville, Texas

Boring No Ground El (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-12	S1	0-2	CL	7.2								
52.38	S2											
	S3	5-7	CL	14.1					60			
	S4	7-8	CL	13.6	127.53	112.3	41	28				(1) 200 (2) 26 (3) 3.4
	S5											
	S6	14-19	SC	19.1	121.84	102.3	51	28	48			(3) 1.7
	S7	19-24	SC	23.6	118.76	96.1	48	26	33			(3) 2.4
	S8											
	S9	29-34	CH	24.7			53	29				
	S10	34-36	CH	23.2			51	24				
	S11	36-41	CH	25.2					51			
	S12											
	S13	46-47	CH	29								
	S14	47-48	CH	30.2			59	25				(1) 200 (2) 26 (3) 6.5
B-13	S1	0-2										
59.13	S2	2-4	CL				30	12			0.0001	
	S3	5-8	CL	8	108.79	100.7			62	5.80E-06		
	S4	8-10	CL	9.4			43	26	66			
	S5											
	S6	15-20	CH				59	36				
	S7	20-25	CH	21.3			59	29				
	S8	25-26	CH	21.3	114.94	94.8				3.40E-07	5E-06	
	S9	26-27	CH	21.6	123.27	101.4	63	29				(3) 2.3
	S10	27-30	SC	18.6					48			
	S11	30-35	SC	23.9	116.5	94	59	28	46			(3) 3.2
	S12	35-36	SC	20.3	112.63	93.6				0.00046	3E-05	
	S13	37-40										
	S14	40-45	SC	26.9	112.92	96.9	56	24				(3) 0.38
	S15	45-46	SPSC	24.7					30			
	S16	48-49	SPSC	26.7				NON				

1 *Effective Cohesion (psf)*
2 *Effective Angle of Internal Friction (degrees)*
3 *Unconfined Compressive Strength (tsf)*

71

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring No. Ground El (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-14	S1	0-2										
49.94	S2	5-10	CL	11.5	116.69	104.7	44	26	56			
	S3	10-11	CL	14.4	113.11	95.1			53		5E-07	(1) 200 (2) 26 (3) 4.0
	S4	11-15	CH	19	113.11	95.1	63	37			5E-07	
	S5	15-20	CH	22.2								
	S6	20-25	CH	24.8	108.57	86.99	58	33		6.90E-05		
	S7	25-30	SC	28.5					46			
	S8	30-33	CL	29.3	114.2	88.3	50	27	66			
	S9	33-34	CH	25.7	123.66	98.54	61	33		1.20E-07		
	S10	34-35										(1) 200 (2) 24 (3) 3.0
	S11	35-37	CH	26	104.29	82.1	64	37	85			
	S12	39-40	CL	29.5			41	15				
B-15	S1	0-2										
48.39	S2	5-10	SC	12.3	126.4	112.6	30	19	47			
	S3	10-12	CL	11.6					51			
	S4	12-13	CH	12.9	113.38	100.4						(1) 200 (2) 21 (3) 1.55
	S5	13-14	CH	15.3			68	46	55	3E-07		
	S6	14-16	CH	15.3	97.04	84.2	79	56				
	S7	16-19	CH	15.3			79	56	65			
	S8	19-22	CH	21.2			83	60				
	S9											
	S10	23-24	CH	20.1						2.40E-07		(3) 1.56
	S11	24-25	CH	21.3	121.79	100	50	32	53			(1) 200 (2) 24 (3) 1.53
	S12											
	S13	25-28	CH	26.5			52	35	58			
	S14	28-29	CH	29								

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

72

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring No. Ground El. (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-16	S1	0-2	CL									
55.96	S2	3-5		9.3	114.66	104.9						(1) 200 (2) 26 (3) 2.9
	S3	5-10	SC	11.6			45	23	31			
	S4											
	S5											
	S6											
	S7											
	S8	16-18	SP-SC	27.3				NON	22			
	S9	18-20	SP-SC	22.3			43	13	24			
	S10											
	S11											
	S12											
	S13											
	S14	26-29	SC	24.5			50	29	30			
	S15											
	S16											
	S17	33-35	SC	19.4			41	24	46	1.20E-05		
	S18	35-37	SC	21						4E-06		
	S19											
	S20											
	S21											
	S22											
	S23	45-47	CH	30.6	110.03	84.3	79	51	83			

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring No. Ground El. (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-17	S1											
41.35	S2	2-5	SP-SC	21.6				NON				
	S3	5-8	SP-SC	35					25			
	S4	8-9	SP-SC	31.4	85.07	64.6		NON		0.0001	3E-05	
	S5	9-10	CL	32			41	19	66			
	S6											
	S7											
	S8	17-18	CH	31.5	95.09	82.7	66	46				
	S9											
	S10											
	S11											
	S12	24-29	CH	38	108.86	78.9	74	52	83			
	S13											
	S14	31-32	CH	23								
	S15	32-33	CH		115.38	93.8	62	41		6.70E-07		(1) 200 (2) 24 (3) 2.27
B-18	S1	0-2										
50.04	S2	3-5										
	S3	5-9	CH	15.2	97.82	84.9	59	44	60			
	S4	9-10	CL	14.8	127.25	110.8						(1) 200 (2) 21 (3) 5.4
	S5	10-15	CH	18.3					45			
	S6											
	S7	12-18	CH	23.8	122.97	99.3	58	33	57			(1) 200 (2) 24 (3) 4.91
	S8											
	S9											
	S10	24-29	CH	26.5			66	47	78			
	S11	29-30	CH	31.9						0.0023		
	S12											
	S13											
	S14	34-39	CH	34.9			73	48	81			
	S15	39-42	CH	31.1	106.75	81.4						(1) 200 (2) 24 (3) 1.57

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring No Ground El (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-21	S1	1-2										
52.41	S2	2-4										(3) 4.5
	S3	4-6										(3) 4.5
	S4	6-8										(3) 4.5
	S5	8-10										(3) 4.5
	S6	10-12										(3) 4.5
	S7	12-14										(3) 4.5
	S8	14-16										(3) 4.5
	S9	16-18										(3) 4.5
	S10	18-20										(3) 2.3
	S11	20-22										(3) 2.3
	S12	22-24										(3) 3.5
	S13	24-26										(3) 4.5
	S14	26-28										(3) 4.5
	S15	28-30										(3) 4.5
	S16	30-32										(3) 4.5
	S17	32-34										
	S18	34-36										
	S19	36-38										
	S20	38-40										(3) 4.3
	S21	40-42										
	S22	42-44										
	S23	44-46										
	S24	46-48										(3) 4.5
	S25	48-50										(3) 4.0
	S26	50-52		37.8			75	40	95	1.99×10^{-9}		(3) 4.5
	S27	52-54										(3) 4.5
	S28	54-56										(3) 4.5
	S29	56-58										(3) 4.5
	S30	58-60										(3) 3.8
	S31	60-62										(3) 4.5

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.1 (cont'd)
SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING
City of Kingsville MSWLF, Permit 235 B
Kingsville, Texas

Boring Ground (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-21	S32	62-64		27.7			51	25	86	$3.00x10^{-8}$		(3) 4.5
52.41	S33	64-66										(3) 4.5
(cont'd.)	S34	66-68										(3) 4.5
	S35	68-70										(3) 4.5
	S36	70-72										(3) 2.5
	S37	72-74										(3) 3.5
	S38	74-76										(3) 2.8
	S39	76-78										(3) 3.0
	S40	78-80		24.6			62	33	78	$1.56x10^{-8}$		(3) 4.0
	S41	80-82										(3) 4.5
	S42	82-84										(3) 4.5
B-23	S1	1-2										
49.5	S2	2-4										(3) 4.5
	S3	4-6										(3) 4.5
	S4	6-8										(3) 2.0
	S5	8-10										(3) 0.8
	S6	10-12										(3) 0.5
	S7	12-14										
	S8	14-16										
	S9	16-18										
	S10	18-20										
	S11	20-22										
	S12	22-24										(3) 2.0
	S13	24-26										(3) 2.3
	S14	26-28										
	S15	28-30										
	S16	30-32										(3) 4.5
	S17	32-34										
	S18	34-36										(3) 3.0
	S19	36-38		36.9			73	37	88	$4.4x10^{-8}$		(3) 3.8

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring No Ground El. (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-23	S20	38-40										(3) 4.3
52.41	S21	40-42										(3) 4.5
(cont'd.)	S22	42-44										(3) 4.5
	S23	44-46										(3) 4.5
	S24	46-48								1.6×10^{-8}		(3) 4.5
	S25	48-50										(3) 3.0
	S26	50-52										(3) 4.0
	S27	52-54										(3) 4.5
	S28	54-56										(3) 4.3
	S29	56-58										(3) 4.5
	S30	58-60		27.7			62	32	80			(3) 4.5
	S31	60-62										(3) 4.5
	S32	62-64										(3) 4.5
	S33	64-66										(3) 4.5
	S34	66-68		24.3			59	31	76	3.80×10^{-8}		(3) 2.8
	S35	68-70										(3) 4.0
	S36	70-72										(3) 3.3
	S37	72-74										(3) 2.5
	S38	74-76										(3) 4.3
	S39	76-78										
	S40	78-80										
	S41	80-82										(3) 4.5
	S42	82-84										(3) 4.5
B-24	S1	1-2										(3) 4.5
47.38	S2	2-4										(3) 4.5
	S3	4-6										(3) 4.5
	S4	6-8										(3) 3.0
	S5	8-10										
	S6	10-12										
	S7	12-14										

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring No. Ground El. (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-24	S8	14-16										
47.38	S9	16-18										
(cont'd.)	S10	18-20										
	S11	20-22										(3) 4.5
	S12	22-24										(3) 4.3
	S13	24-26										(3) 4.5
	S14	26-28										(3) 4.5
	S15	28-30										(3) 4.5
	S16	30-32										
	S17	32-34		36.4			79	38	80	8.30×10^{-7}		
	S18	34-36										(3) 4.3
	S19	36-38								1.33×10^{-9}		(3) 4.5
	S20	38-40										(3) 4.5
	S21	40-42										(3) 4.5
	S22	42-44										(3) 4.5
	S23	44-46										(3) 3.5
	S24	46-48										(3) 4.5
	S25	48-50										(3) 4.5
	S26	50-52		27.7			71	36	68	3.28×10^{-9}		(3) 4.5
	S27	52-54										(3) 4.5
	S28	54-56										(3) 4.5
	S29	56-58										(3) 2.3
	S30	58-60										(3) 4.5
	S31	60-62										(3) 4.3
	S32	62-64										(3) 1.8
	S33	64-66										(3) 4.5
	S34	66-68		17.7			50	30	66	6.00×10^{-7}		(3) 4.5
	S35	68-70								1.21×10^{-8}		(3) 3.5
	S36	70-72										(3) 3.0

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)

3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring No. Ground El. (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-25	S1	1-2										(3) 4.5
61.12	S2	2-4										
	S3	4-6										(3) 4.5
	S4	6-8										
	S5	8-10										
	S6	10-12										
	S7	12-14										
	S8	14-16										
	S9	16-18										
	S10	18-20										
	S11	20-22										
	S12	22-24										
	S13	24-26										
	S14	26-28										
	S15	28-30										
	S16	30-32										
	S17	32-34										(3) 3.8
	S18	34-36										
	S19	36-38										(3) 2.8
	S20	38-40										(3) 8.3
	S21	40-42										(3) 2.5
	S22	42-44										(3) 4.3
	S23	44-46										(3) 4.3
	S24	46-48										(3) 3.3
	S25	48-50										
	S26	50-52										(3) 3.0
	S27	52-54		31.8			77	43	87	2.45×10^{-8}		(3) 4.5
	S28	54-56										(3) 4.5
	S29	56-58										(3) 4.5
	S30	58-60										(3) 4.5
	S31	60-62										(3) 4.5

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring No. Ground El. (ft MSL)	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-25	S32	62-64										(3) 4.5
61.12	S33	64-66		30.5			77	39	92	2.30x10^{-8}		(3) 4.5
(cont'd.)	S34	66-68										(3) 4.5
	S35	68-70										(3) 4.5
	S36	70-72										(3) 4.5
	S37	72-74										(3) 4.5
	S38	74-76										(3) 4.5
	S39	76-78										(3) 4.5
	S40	78-80		20.5			58	31	83	6.18x10^{-9}		(3) 4.5
	S41	80-82										(3) 4.5
	S42	82-84										(3) 4.5
	S43	84-86										(3) 4.5

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.2
SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT
City of Kingsville MSWLF, Permit 235 B
Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/seo)	Other Tests Remarks
Top Soil (Dark Brown Clay) Unit												
B-1	S-1	0-1										
	S-2	1-2										
	S-3	2-3		8.3			34	17				
	S-4	3-4										
	S-5	4-6										
B-2	S-1	1-2										
	S-2	4-5										(3) 4.5
B-4	S-1	1-3										(3) 4.5
	S-2	3-5										(3) 4.5
B-5	S-1	1-3										
	S-2	3-5										
B-10	S-1	0-1										
	S-2	1-2										
B-11	S-1	0-5										
B-12	S-1	0-2										
	S-2	2-3									$1.6x10^{-4}$	
	S-3	5-7										
	S-4	7-8										
	S-5	9-15									$2.0x10^{-4}$	
B-13	S-1	0-2								$5.8x10^{-6}$	$1.0x10^{-4}$	
	S-2	2-4										
	S-3	5-8										
	S-4	8-10										
	S-5	10-15										

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)
SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT
City of Kingsville MSWLF, Permit 235 B
Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Top Soil (Dark Brown Clay) Unit												
B-14	S-1	0-2										
	S-2	5-10										
	S-3	10-11										
B-18	S-1	0-2										
	S-2	2-5									$1.0x10^{-4}$	
	S-3	5-9										
	S-4	9-10										
B-21	S-1	0-2										
	S-2	2-4										
B-24	S-1	0-2										
	S-2	2-4										
	S-3	4-6										
B-25	S-1	0-2										
	S-2	2-4										
	S-3	4-6										
Average:				8.3			34	17		$5.8x10^{-6}$	$1.4x10^{-4}$	(3) 4.5

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd.)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Caliche Bearing Channel (I) Unit												
B-1	S-6	6.5-7.0										
	S-7	7.0-8.5		9.1			31	13				
	S-8	8.5-10.5										
	S-9	10.5-12										
	S-10	12-13		8.3			39	19				
	S-11	14-15										
	S-12	20-21										
	S-13	23-24										
	S-14	24-25										
	S-15	30-31										
B-2	S-3	8-10										(3) 4.5
	S-4	13-15										
B-3	S-1	8-10										
	S-2	14-16										
B-4	S-3	8-10										(3) 4.5
	S-4	12.5-14.5										
	S-5	18-19										
	S-6	23-25										
B-5	S-3	8-9										
	S-4	13-15										
	S-5	18-20										
	S-6	23-25										
	S-7	29-30		11.5		81	35	16			3.0×10^{-4}	

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.2 (cont'd.)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Caliche Bearing Channel (I) Unit												
B-6	S-1	3-5										
	S-2	7-9										
	S-3	12-14										
	S-4	17.5-19.5										
	S-5	23.5-25.5										
	S-6	28-30										
B-8	S-1	0-8										
	S-2	8-18										
	S-3	18-24										
	S-4	24-28										
	S-5	28-30										
	S-6	31-36										
	S-7	36-43										
B-9	S-1	0-10										
	S-2	10-20										
B-11	S-2	5-10										
	S-3	10-15										
B-21	S-3	4-6										(3) 4.5
	S-4	6-8										(3) 4.5
	S-5	8-10										(3) 4.5
	S-6	10-12										(3) 4.5
	S-7	12-14										(3) 4.5

1 *Effective Cohesion (psf)*
2 *Effective Angle of Internal Friction (degrees)*
3 *Unconfined Compressive Strength (tsf)*

Revision 1

Table 4.2 (cont'd.)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Caliche Bearing Channel (I) Unit												
B-23	S-1	0-2										
	S-2	2-4										(3) 4.5
	S-3	4-6										(3) 4.5
	S-4	6-8										(3) 2.0
	S-5	8-10										(3) 0.8
	S-6	10-12										(3) 0.5
	S-7	12-14										
	S-8	14-16										(3) 3.0
B-24	S-4	6-8										
	S-5	8-10										
	S-6	10-12										
	S-7	12-14										
	S-8	14-16										
	S-9	16-18										
	S-10	18-20										
B-25	S-4	6-8										
	S-5	8-10										
	S-6	10-12										
	S-7	12-14										
	S-8	14-16										
	S-9	16-18										
Average:				9.63		81	35	16			$3.0x10^{-4}$	(3) 2.83

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Sand Filled Channel (II) Unit												
B-9	S-2	10-20										
	S-3	20-28										
	S-4	28-36										
B-9R	S-1	5-7										
B-10	S-3	2-11										
B-11	S-4	15-20										
	S-5	22-24										
	S-6	26-28										
	S-7	31-34										
B-16	S-4	10-11										
	S-5	11-12										
	S-6	12-14										
	S-7	14-16										
	S-8	16-18	SP-SC	27.3				NON	22			
	S-9	18-20	SP-SC	22.3			43	13	24			
B-17	S-1	0-2										
	S-2	2-5	SP-SC	21.6				NON				
	S-3	5-8	SP-SC	35					25			
	S-4	8-9	SP-SC	31.4	85.07	64.6		NON		0.0001	$3x10^{-5}$	
	S-5	9-10	CL	32			41	19	66			

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Sand Filled Channel (II) Unit												
B-18	S-5	11-15	CH	18.3					45			
	S-6	15-17										
	S-7	17-18	CH	23.8	122.97	99.3	58	33	57			(1) 200 (2) 24 (3) 4.91
B-21	S-8	14-16										(3) 4.5
	S-9	16-18										(3) 4.5
B-23	S-9	16-18										
	S-10	18-20										
B-25	S-9	16-18										
	S-10	18-20										
	S-11	20-22										
	S-12	22-24										
	S-13	24-26										
	S-14	26-28										
	S-15	28-30										
	S-16	30-32										
	S-17	32-34										(3) 4.5
Average:				26.46	104.02	81.95	47.3	17.3	39.8	0.0001	$3x10^{-5}$	(1) 200 (2) 24 (3) 4.6

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

87

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Clayey Sand (Clay Dune) (III) Unit												
B-13	S-9	26-27	CH	21.6	123.97	101.4	63	29		$3.4x10^{-7}$	$5.0x10^{-6}$	(3)2.3
	S-10	27-30	SC	18.6					48			
	S-11	31-35	SC	23.9	116.5	94	59	28	46			(3) 3.2
	S-12	35-36	SC	20.3	112.63	93.6				$4.6x10^{-5}$	$3x10^{-5}$	
	S-13	37-40										
	S-14	40-45	SC	26.9	112.92	96.9	56	24				(3) 0.38
	S-15	45-46	SPSC	24.7					30			
	S-16	48-49	SPSC	26.7				NON				
B-21	S-17	32-34										
	S-18	34-36										
	S-19	36-38										
	S-20	38-40										
	S-21	40-42										(3) 4.3
	S-22	42-44										
	S-23	44-46										
Average:				23.24	111.51	96.48	59.3	27	41.3	$2.3x10^{-5}$	$1.75x10^{-5}$	(3) 3.27

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Clayey Sand (Clay Dune) (IV) Unit												
B-16	S-9	18-20	Sp-SC	22.3			43	13	24			
	S-10	20-22										
	S-11	23-24										
	S-12	24-25										
	S-13	25-26										
	S-14	26-29	SC	24.5			50	29	30			
	S-15	29-31										
	S-16	31-33										
	S-17	33-35	SC	19.4			41	24	46	1.2×10^{-5}		
	S-18	35-37	SC	21						4×10^{-6}		
	S-19	37-39										
	S-20	39-41										
	S-21	41-43										
B-23	S-11	20-22										
	S-12	22-24										(3) 2.0
	S-13	24-26										(3) 2.3
	S-14	26-28										
	S-15	28-30										
	S-16	30-32										(3) 4.5
	S-17	32-34										
	S-18	34-36										(3) 3.0
Average:				21.8	116.5	96.48	52	21.13	18.83	3.3×10^{-6}		(3) 2.75

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Sandy (Silty) Clay Unit												
B-1	S-17	35-36										
	S-18	40-41										
B-2	S-6	23-25		8.3		99				5.6×10^{-6}		(3) 4.5
	S-7	25-27										
B-3	S-3	29-31										
	S-4	32-34										
B-4	S-7	28-30										
	S8	33-35										
	S-9	38-40										
B-5	S-8	33-35										(3) 4.2
	S-9	38-40										
	S-10	46-48										
B-6	S-7	33-35										
	S-8	38-40										
B-9	S-5	36-48										
B-9R	S-2	10-12										
	S-3	15-17										
B-10	S-4	11-12										
	S-5	13-14										
	S-6	14-15										
	S-7	15-16										
	S-8	17-19										
	S-9	19-29										

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Sandy (Silty) Clay Unit

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
B-11	S-7	31-35										
	S-8	36-40										
	S-9	41-45										
	S-10	46-48										
B-12	S-6	14-19	SC	19.1	121.84	102.3	51	28	48			(3) 1.7
	S-7	19-24	SC	23.6	118.76	96.1	48	26	33			(3) 2.4
	S-8	24-29	CH									
	S-9	29-34	CH	24.7			53	29				
	S-10	34-36	CH	23.2			51	24				
	S-11	36-39	CH	25.2					51			
B-13	S-6	15-20	CH				59	36				
	S-7	20-25	CH	21.3			59	29				
	S-8	25-26	CH	21.3	114.94	94.8				3.4×10^{-7}	5×10^{-6}	
B-14	S-4	11-15	CH	19	113.11	95.1	63	37			5×10^{-7}	
	S-5	15-20	CH	22.2								
	S-6	20-25	CH	24.8	108.57	86.99	58	33		6.9×10^{-5}		
	S-7	25-30	SC	28.5					46			
	S-8	30-33	CL	29.3	114.2	88.3	50	27	66			
	S-9	33-34	CH	25.7	123.66	98.64	61	33		1.2×10^{-7}		
	S-10	34-35										
	S-11	35-37	CH	26	104.29	82.1	64	37	85			
	S-12	39-40	CL	29.5			41	15				

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Sandy (Silty) Clay Unit												
B-15	S-1	0-2										
	S-2	5-10	SC	12.3	126.4	112.6	30	19	47			
	S-3	10-12	CL	11.6					51			
	S-4	12-13	CH	12.9	113.38	100.4						(1) 200 (2) 21 (3) 1.55
	S-5	13-14	CH	15.3			68	46	55	3x10^{-7}		
	S-6	14-16	CH	15.3	97.04	84.2	79	56				
	S-7	16-19	CH	15.3			79	56	65			
	S-8	19-22	CH	21.2			83	60				
	S-9	22-23										
	S-10	23-24	CH	20.1						2.4x10^{-7}		(3) 1.56
	S-11	24-25	CH	21.3	121.79	100	50	32	53			(1) 200 (2) 24 (3) 1.53
	S-12	25-28	CH	26.5			52	35	58			
	S-13	28-29	CH	29								
	S-14	29-31										
	S-15	31-37										
B-16	S-1	0-2	CL									
	S-2	3-5		9.3	114.66	104.9						(1) 200 (2) 24 (3) 2.9
	S-3	5-8	SC	11.6			45	23	31			
B-17	S-6	10-15										
	S-7	15-17										
	S-8	17-18	CL	31.5	95.09	82.7	66	46				
	S-9	19-22										
	S-10	22-23										
	S-11	23-24										
	S-12	24-29	CH	38	108.86	78.9	74	52	83			

92

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)
SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT
City of Kingsville MSWLF, Permit 235 B
Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Sandy (Silty) Clay Unit												
B-18	S-8	19-21										
	S-9	21-23										
	S-10	24-29	CH	26.5			66	47	78			
	S-11	29-30	CH	31.9						$2.3x10^{-7}$		
	S-12	30-31										
	S-13	31-34										
	S-14	34-39	CL	34.9			73	48	81			
	S-15	39-42	CH	31.1	106.75	81.4						(1) 200 (2) 24 (3) 1.57
S-21	S-10	18-20										(3) 2.3
	S-11	20-22										(3) 2.3
	S-12	22-24										(3) 3.5
	S-13	24-26										(3) 4.5
	S-14	26-28										(3) 4.5
	S-15	28-30										(3) 4.5
	S-16	30-32										(3) 4.5
B-24	S-11	20-22										(3) 4.5
	S-12	22-24										(3) 4.3
	S-13	4-26										(3) 4.5
	S-14	26-28										(3) 4.5
	S-15	28-30										(3) 4.5
	S-16	30-32										
	S-17	32-34		36.4			79	38	80	$8.3x10^{-7}$		

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Sandy (Silty) Clay Unit												
B-25	S-17	32-34										(3) 3.8
	S-18	34-36										
	S-19	36-38										(3) 2.8
	S-20	38-40										(3) 3.8
	S-21	40-42										(3) 2.5
	S-22	42-44										(3) 4.3
	S-23	44-46										(3) 4.3
	S-24	46-48										(3) 3.3
	S-25	48-50										
	S-26	50-52										(3) 3.0
Average:				23.3	112.7	93.1	60.1	39.1	59.5	1.02×10^{-5}	2.75×10^{-6}	(1) 200 (2) 24 (3) 3.84

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Light Olive Green Clay (Aquiclude) Unit												
B-12	S-12	41-46										
	S-13	46-47		29								
	S-14	47-48		30.2			59	25				
B-16	S-21	41-43										
	S-22	43-45										
	S-23	45-47		30.6			79	51	83			
B-17	S-13	29-31										
	S-14	31-32		23								
	S-15	32-33										(3) 2.27
B-21	S-24	46-48										(3) 4.5
	S-25	48-50										(3) 4.0
	S-26	50-52		37.8			75	40	95	1.99×10^{-9}		(3) 4.5
	S-27	52-54										(3) 4.5
	S-28	54-56										(3) 4.5
	S-29	56-58										(3) 4.5
	S-30	58-60										(3) 3.8
	S-31	60-62										(3) 4.5
	S-32	62-64		27.7			51	25	86	3×10^{-8}		(3) 4.5
	S-33	64-66			119.8	94.2						(3) 4.5
	S-34	66-68										(3) 4.5
	S-35	68-70										

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth ft (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Light Olive Green Clay (Aquiclude) Unit												
B-21	S-36	70-72										(3) 2.5
	S-37	72-74										(3) 3.5
	S-38	74-76										(3) 2.8
	S-39	76-78										(3) 3.0
	S-40	78-80		24.6			62	33	78	$1.56x10^{-8}$		(3) 4.0
	S-41	80-82										(3) 4.5
	S-42	82-84										(3) 4.5
B-23	S-19	36-38		36.9			73	37	88	$4.4x10^{-8}$		(3) 3.8
	S-20	38-40										(3) 4.3
	S-21	40-42										(3) 4.5
	S-22	42-44										(3) 4.5
	S-23	44-46										(3) 4.5
	S-24	46-48								$1.6x10^{-8}$		(3) 4.5
	S-25	48-50										(3) 3.0
	S-26	50-52										(3) 4.0
	S-27	52-54										(3) 4.5
	S-28	54-56										(3) 4.3
	S-29	56-58										(3) 4.5
	S-30	58-60		27.7			62	32	80			(3) 4.5
	S-31	60-62										(3) 4.5
	S-32	62-64										(3) 4.5
	S-33	64-66										(3) 4.5
	S-34	66-68		24.3			59	31	76	$3.8x10^{-8}$		(3) 2.8
	S-35	68-70										(3) 4.0

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Light Olive Green Clay (Aquiclude) Unit												
B-23	S-36	70-72										(3) 3.3
	S-37	72-74										(3) 2.5
	S-38	74-76										(3) 4.3
	S-39	76-78										
	S-40	78-80										
	S-41	80-82										
	S-42	82-84			125.8	105.3						(3) 4.5
	S-43	84-86										(3) 4.5
B-24	S-17	32-34		36.4			79	38	80			
	S-18	34-36										(3) 4.3
	S-19	36-38								1.33×10^{-9}		(3) 4.5
	S-20	38-40										(3) 4.5
	S-21	40-42										(3) 4.5
	S-22	42-44										(3) 4.5
	S-23	44-46										(3) 3.5
	S-24	46-48										(3) 4.5
	S-25	48-50										(3) 4.5
	S-26	50-52		27.7			71	36	68	3.28×10^{-9}		(3) 4.5
	S-27	52-54			114.5	86.2						(3) 4.5
	S-28	54-56										(3) 4.5
	S-29	56-58										(3) 2.3
	S-30	58-60										(3) 4.5

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Boring Number	Sample Number	Depth (ft bgs)	USCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Permeability Vertical (cm/sec)	Permeability Horizontal (cm/sec)	Other Tests Remarks
Light Olive Green Clay (Aquiclude) Unit												
B-24	S-31	60-62										(3) 4.3
	S-32	62-64										(3) 1.8
	S-33	64-66										(3) 4.5
	S-34	66-68		17.7			50	30	66			(3) 4.5
	S-35	68-70								1.21×10^{-8}		(3) 3.5
	S-36	70-72										(3) 3.0
B-25	S-27	52-54		31.8			77	43	87	2.45×10^{-8}		(3) 4.5
	S-28	54-56										(3) 4.5
	S-29	56-58										(3) 4.5
	S-30	58-60			139	104.3						(3) 4.5
	S-31	60-62										(3) 4.5
	S-32	62-64										(3) 4.5
	S-33	64-66		30.5			77	39	92	2.3×10^{-8}		(3) 4.5
	S-34	66-68										(3) 4.5
	S-35	68-70										(3) 4.5
	S-36	70-72										(3) 4.5
	S-37	72-74										(3) 4.5
	S-38	74-76										(3) 4.5
	S-39	76-78										(3) 4.5
	S-40	78-80		20.5			58	31	68	6.18×10^{-8}		(3) 4.5
	S-41	80-82										(3) 4.5
	S-42	82-84										(3) 4.5
	S-43	84-86										(3) 4.5
	S-44	86-88										(3) 4.5
Average:				28.53	124.78	97.5	66.57	35.07	80.54	3.31×10^{-8}		(3) 4.15

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

8.3 Engineering Analyses

The following sections present the results and methodologies of the engineering analyses pertaining to the design of the landfill. The soil conditions described in the preceding section were used throughout the analyses.

8.3.1 Slope Stability

F.E.E., Inc. used the program PCSTABL5M, developed at Purdue University, to determine the stability of the final cover configuration slopes and open cut excavation sideslopes. The landfill facility is outside the 0.10 g seismic impact zone, at a seismic contour interval below 0.05 g. Therefore, the modeled slopes were not analyzed under dynamic (earthquake) loading conditions. A seismic impact zone is defined as an area with a 10 percent or greater probability that a maximum horizontal acceleration on lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10 g in 250 years.

Generalized cross-sections of the modeled final closed landfill configuration showing the most critical failure surfaces calculated are presented in Appendix H.1. These figures also contain tables summarizing the soil strength properties used in the models. Final cover slope stability calculations are also presented in Appendix H.1.

8.3.1.1 Final Cover Slopes

Slope stability analyses were performed on the final cover configuration to determine the maximum allowable height that will satisfy the minimum factor of safety (2.0) requirement for the short-term and long-term cases under static loading conditions. The computer program PCSTABL5M determines the factor of safety for a circular-type failure surface using the Bishop Modified method and for a block-type failure surface, using the Simplified Wedge method.

The calculations include an assumption that the short-term stability will be more critical than the long-term stability. The long-term conditions produce an increase in the foundation strength as a result of the gradual dissipation of pore water pressure. Pore water pressure dissipation is associated with the consolidation of the foundation soils as a result of the added waste load. Long-term consolidated-undrained laboratory strength test results confirm this significant increase in strength from long-term loading.

Under the condition that the final cover cap is properly compacted, the maximum allowable landfill height that will satisfy a minimum factor of safety of 2.0 (short-term case) under static loading conditions is approximately 125 NGVD. The final cover configuration was then designed beginning at the inside crest of the perimeter levee (elevation 60 NGVD) and proceeding up at a 4H:1V slope to elevation 119 feet NGVD, then along a 6 percent slope to a maximum peak elevation of 125 feet NGVD. After determining the maximum landfill height and side slopes, hundreds of trial failure surfaces were generated to verify the slope stability. The assumptions made for the slope stability analyses are as follows:

1) The potentiometric head will be one and one half feet below the ~~base excavation~~ elevation of the top of the protective soil cover above the sumps. (~~Base Excavation~~ The Protective Soil cover above the sump is 42.5' MSL; GW level is 41.0' MSL)

2) The landfill will slope approximately two percent along the base. The slope stability analyses was performed assuming a flat bottom.

3) A two-foot compacted cohesive soil liner (covered by synthetic geoclay liner) with a cohesion intercept of 200 psf and a total density of 112 pcf will be placed along the excavation sideslopes and over the bottom of the landfill.

4) A textured (double-sided) 60-mil HDPE geomembrane will be placed over the compacted cohesive soil liner along the base and sideslopes of new landfill cells 2 through 7. An angle of internal friction of 20 degrees was assumed for the soil/HDPE geomembrane interface.

5) The granular drainage blanket for the leachate collection system was conservatively assumed to have a similar strength characteristics as the solid waste.

6) Various resources were investigated to determine geotechnical design strength values for the solid waste. A significant amount of research has been conducted since 1988 on the subject of slope stability modeling techniques for waste fills. Based on these resources, F.E.E., Inc. used an average total density of 32 pcf, a cohesion intercept of 1000 psf , and an angle of internal friction of 20 degrees for the solid waste.

7) The final cover load was not included in the analyses since it's contribution to the driving force will be negligible.

8) The minimum allowable factor of safety will be 2.0 for static loading conditions.

9) Based on excavation depths, the relatively strong underlying in-situ soils, and the low interface friction angle of the cohesive soil/smooth HDPE liner, the most critical failure will be a block-type failure along the compacted cohesive soil/smooth HDPE geomembrane interface located in the existing landfill area.

10) The perimeter levee fill was assumed to have the same geotechnical properties as

as the compacted cohesive soil liner.

8.3.1.2 Open Cut Excavation Slopes

Slope stability analyses were performed on temporary open cut excavations from crest of perimeter levee elevation 60 feet NGVD to average base grade elevation 40 feet NGVD at both 4H:1V and 3H:1V sideslopes. The 3H:1V was selected. The cross sections consist of a typical open cut excavation. A perimeter levee was included in the model. The excavation sideslopes were analyzed using short-term soil strength properties based on the sampling and testing of soils underlying the landfill area. A long-term strength analysis was not performed since the excavation will be backfilled with refuse prior to the development of long-term strength characteristics. Minimum factor of safety of 2.55 was calculated for circular-type failure surfaces, respectively. Both exceed the minimum design factor of safety requirement of 2.0 for static loading conditions. The open cut excavation slope stability calculations are presented in Appendix H.1.

8.3.2 Settlement Analysis

The settlement analysis was performed by Mr Ralph N. Lewis of Professional Services, Inc. (PSI). His calculations show that conservatively the final landfill cover will settle 3.0 inches at the center and 1.5 inches at the edge of the landfill. The settlement calculations are shown in Appendix H.2

8.3.3 Perforated Pipe

The maximum anticipated deflection of the leachate collection system pipe due to the loads imposed by the waste overburden was analyzed using the Driscopipe Design Manual and Spangler's modified formula. The sections where pipes are under maximum loading conditions were analyzed for the six-inch diameter, SDR 17 HDPE or Schedule 80 PVC perforated collection lines that are located in trenches along the floor of the landfill. The results of the calculations indicated an estimated maximum deflection of approximately 1.0 percent (0.064 inches) for the six-inch diameter collection lines under maximum loading conditions. These deflections are within the maximum allowable cross-sectional deflection of 4.2 percent for HDPE, as recommended by Driscopipe and 5.0 percent for PVC, as recommended by American Water Works Association. The perforated pipe deflection calculations are presented in Appendix H.3.

8.3.4 Liner Puncture Resistance

The puncture resistance of the protective geotextile fabric wrapped around the gravel in the leachate collection system was analyzed. The most critical case for puncture will occur when the drainage sand is placed over the geotextile. During placement of the sand , the contact pressure of the bulldozer tracks will induce stresses between the gravel and the geotextile. The analysis, as presented in Appendix H.4, shows there should not be any puncture of the geotextile by the gravel.

8.3.5 Anchor Trench Analysis

The filling sequence of the landfill will cause stresses due to the weight of the waste on the sidewall liner. To keep the liner in place when the stresses occur requires the anchoring of the liners in an anchor trench at the top of the slope. Ideally, the anchor trench is designed so that the liner will pull out before tearing or shearing. The recommended run out length of the liner, the allowable anchor trench depth, and all calculations are presented in Appendix H.5.

8.4 Landfill Design

Disposal Cells 1 through 7 at City of Kingsville MSWLF have been designed in accordance with current TNRCC and EPA Subtitle D regulations. The existing landfill layout, final design, and various construction design details are presented in Attachments 1,2,6,7,12, and 15 of the Site Development Plan (Part III). The temporary construction dewatering system, liner, leachate collection system, and final cover components of the landfill are discussed herein.

8.4.1 Temporary Construction Dewatering System

Disposal cells located within the proposed expansion area (2 through 7) will be constructed utilizing a temporary construction dewatering system beneath the composite liner system. The purpose of this temporary dewatering system is in case excessive rain fall occurs during the construction period causing an abnormal rise in ground water levels.

Excavation of the proposed disposal cells will be initiated as indicated in the Site Development Plan (Part III). The excavation of the disposal cells will be made through the various units to the approximate base grade elevations presented in the Site Development Plan. During excavation activities temporary sumps will be constructed for the collection of groundwater from excessive precipitation. Water collected in the sumps will be pumped, using pumps and hoses, to the facility's detention ponds via the perimeter drainage system and discharged in accordance with the existing discharge permits (TNRCC Discharge Permit No. 10696001 and NPDES Permit No. TX0023418). As excavation proceeds, the groundwater table will be lowered or drained, as required, allowing completion of excavation activities and commencement of composite liner construction.

Composite liner construction will occur at the maximum excavation depths (i.e. minimum excavation elevations) as designed with regard to the design base grades for the proposed excavation area. The disposal cells within the expansion area (2 through 7) will be constructed utilizing a temporary construction dewatering system installed beneath the soil component of the composite liner system. The dewatering system will enable the removal of any residual groundwater which may accumulate during disposal cell excavation to subgrade elevations and during liner construction. The system shall cover the entire bottom and portions of the sideslopes of the excavated cells. The dewatering system shall consist of a geocomposite composed of a high density polyethylene (HDPE) drainage net with geotextile heat-bonded to each side. The filter fabrics or geotextiles shall have the appropriate physical filtration and permissivity properties (thickness, permeability, etc.) to prevent clogging by the underlying and overlying clayey soils. The riser pipe for the dewatering sump, installed parallel to the sideslope of the cell shall exit the cell in such a manner as not to penetrate the composite lining system within the planned limits of waste disposal, as indicated in Figure 15.12.

The requirements of this temporary construction dewatering system were evaluated with respect to the amount of rainfall precipitation anticipated and the ability of the geocomposite to transmit the rainfall precipitation to the sump. As excavation proceeds, should excessive precipitation cause increases in groundwater level, the groundwater will be removed by pumping. As indicated by these calculations, the anticipated initial (maximum) flow from this unit through the base of a typical cell is 40 gallons per acre per day.

The required transmissivity for the temporary construction dewatering system to transmit the maximum flows from precipitation expected during construction of the liner system was also estimated to be 40 gal/acre/day. Based on these calculations, the geocomposite must have a transmissivity greater than, or equal to, 4.0×10^{-6} m^2/sec to be capable of transmitting the anticipated flows. The geocomposite to be used for construction of this system has a transmissivity of $1.0 \times 10^{-3} m^2$/sec (factor of safety = 250), which significantly exceeds the required transmissivity for the system. The factor of safety for this design is sufficient to allow for minor residual seepage from excessive precipitation.

The temporary construction dewatering system, including sumps, will be developed prior to construction to address specific conditions of individual disposal cell(s). Pumping of the construction dewatering system will be discontinued, with the system abandoned in place, after construction of the composite liner system is completed. Water collected by the temporary construction dewatering system will be discharged in accordance with he facility's existing discharge permits.

8.4.2 Composite Liner System

In accordance with the requirements of the 30TAC §330.200, the liner system to be installed in cells 2 through 7 will consist of a minimum one-foot thick compacted soil liner with a hydraulic conductivity of 1×10^{-5} cm/sec or less, overlain by a GeoClay synthetic liner, overlain by a 60-mil HDPE liner. This composite liner system will be installed over the entire floor and sideslope areas of the cells. A plan view of the completed liner system (base grades) is shown on Figures 15.2 through 15.7 of Attachment 15. The composite liner system (compacted cohesive soil and flexible membrane liner) shall be constructed using the guidelines of the Soils and Liner Quality Control Plan presented as Attachment 10 of the Site Development Plan (Part III).

8.4.3 Leachate Collection System

The design of the leachate collection system (LSC) for new cells within the landfill includes two-foot deep leachate collection trenches designed to collect leachate from a granular drainage layer on each side of the cell. The floor area on each side of the leachate collection pipe is sloped toward the pipe at a minimum grade of two percent. The leachate collection trenches will contain perforated, six-inch diameter SDR-17 HDPE or Schedule 80 PVC pipe surrounded by gravel. Filter geotextile will completely surround the gravel to prevent clogging of the leachate collection pipes.

A cross section through the collection trench and LCS pipe detail is shown on Figures 15.9 and 15.10 of Attachment 15. The gravel-filled collection trench is sloped on a minimum one half percent slope toward a LCS sump, located at the outer edge of the cells. A one-foot thick granular drainage layer, with a minimum permeability of 6×10^{-3} cm/sec, overlies the geomembrane liner and LCS trenches. A one-foot thick protective cover layer, with a minimum permeability of 1×10^{-4} cm/sec, will overlie the granular drainage blanket to provide protection for the LCS. Two feet of protective cover will overlie the geocomposite drainage layer if utilized in place of the granular drainage layer (see Figure 15.11).

8.4.4 Landfill Closure System

The final cover design and placement will be in accordance with the final closure plan requirements. The thickness and design of the final cover are given in Attachment 12. This design is based upon the design of a combination synthetic Geoclay and 60 mil HDPE Flexible Membrane bottom liner. The final cover system is comprised of, from the bottom up, 18 inches of compacted earthen material with a hydraulic conductivity of 1×10^{-5} cm/sec or less, a flexible membrane liner, a geonet/geotextile drainage layer, and 18 inches of protective soil cover, of which the uppermost 6 inches will be soil capable of supporting native vegetation. Six inches of permeable soil (hydraulic conductivity ≥

1×10^{-3} cm/sec) may be used in place of the geonet/geotextile drainage layer and included as part of the 18-inch protective cover. The minimum grade on the final cover is approximately six percent and approximately 25% on the embankment slopes. At locations where the final cover ends at the perimeter levees, a gravel toe drain replaces the lower six inches of the vegetative cover and the drainage material is extended outward from the cover to enhance drainage. Final cover contours and final cover details are depicted in Figures 12.1 and 12.2 of the Final Closure Plan (Attachment 12).

8.4.5 Surface Water Runoff and Erosion Control

Surface water runoff from the City of Kingsville, Texas MSWLF will be managed through a hydraulic control system composed of vegetated slopes, diversion berms, terrace channels, letdown chutes, energy dissipaters, erosion control devices, and surface water detention ponds. Plans, design details and supporting calculations for surface water runoff and erosion control are presented in Attachment 6.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Geology/Hydrogeology

Based upon the results of field and laboratory investigations performed during this study, the following conclusions have been developed:

- The site is located in the Gulf Coastal Plain of Texas with the Beaumont Clay and Lissie Formation undifferentiated near the surface. This formation underlies thin loess (Eolian silt) deposits on the surface.

- The site is underlain by sediments that can be divided into five discontinuous units [Caliche Bearing Channel Unit (I), Sand Filled Channel Unit (II), Clayey Sand (Clay Dune) (III), Clayey Sand (Clay Dune) (IV), Sandy (Silty) Clay] and one continuous unit [Light Olive Green Clay Aquiclude]. The water bearing zone is made up of the five discontinuous units which are all in communication. The normal ground water level is at approximately 35 ft NGVD.

- The uppermost aquifer beneath the base grade of the existing site can be defined as a discontinuous fluvial-deltaic environment which is all in which all units are in hydraulic communication with each other and bounded by the 38 foot thick plus Light Olive Green Clay aquiclude at depths of 5' to 17' above mean sea level. Groundwater movement is to all sides of the landfill except to the Northwest. The gradient varies from about of 6.91×10^{-3} ft/ft to the northeast to 1.2×10^{-3} ft/ft to the southeast to 8.18×10^{-3} ft/ft to the southwest. A horizontal flow velocity of 0.5 to 5 ft/year at a depth of 45' below ground surface.

- The MSWLF site has a Light Olive Green Clay layer of more than 38 feet thickness which forms an aquiclude between the uppermost local aquifer and the Chicot aquifer which is the uppermost regional aquifer. The Chicot aquifer is located between 200 and 300 feet below mean sea level (MSL) and does not contain potable water.

9.2 Proposed Monitoring Well Network

Based upon an understanding of the local ground water flow regime and site stratigraphy, the site groundwater monitoring network will monitor the local uppermost aquifer confined by the Light Olive Green Clay given in this report. The monitor well network completed within the local uppermost aquifer will be comprised of a total of twenty four (24) monitor wells at various stages through the life of this landfill. The sequence of monitor well activation and plugging is given in Appendix M. A sector by sector discussion of the wells at various stages through the life of this landfill. The sequence of monitor well activation and plugging is given in Appendix M. A sector by sector discussion of the sequence of activation and plugging and points of compliance follows:

__Sector 2__ Monitor wells 1, 3, 4, 10, 11, 12, 19, and 24 will be the active monitor well circuit when sector 2 is opened. Monitor wells 8, 13, and 28 will be active, but not point of compliance wells. Monitor wells 3, 12, 19, and 24 will be the point of compliance wells for the new sector 2. Monitor wells 1, 10, and 11 will continue to serve as point of compliance wells for the previous sector 235-A (sector 1) as it will not be finally closed at this point. Monitor well 4 is slightly too far away to be a true point of compliance well, but will serve as a back-up for monitor well 3 which will have to be plugged and abandoned before sector 2 is completely filled due to the advancement of placement of solid waste. Since the main direction of ground water flow is away from the site toward the northeast and the southwest, monitor wells 8, 28, and 13 will serve as monitoring wells in those directions.

__Sector 3__ Monitor wells 1, 4, 10, 11, 12, 13, 19, and 24 will be the active monitor well circuit when sector 3 is opened. Monitor wells 8 and 28 will be active, but not point of compliance wells. Monitor wells 4, 13, and 19 will be the point of compliance wells for new sector 3. Monitor wells 12, and 24 will continue to serve as point of compliance wells for sector 2. Monitor wells 1, 10, and 11 will continue to serve as point of compliance wells for sector 1. Monitor wells 8 and 28 will continue to serve as monitoring wells for flow toward the southwest.

__Sector 4__ Monitor wells 1, 10, 11, 12, 13, 14, 18, 19, 20, and 21 will be the active monitor well circuit when sector 4 is opened. Monitor wells 6, 8, 26 and 28 will be active, but not point of compliance wells. Monitor wells 13, 14, 18, 20 and 21 will be point of compliance wells for the new sector 4. Monitor wells 13 and 19 will continue to serve as point of compliance wells for sector 3. Monitor wells 12 and 24 will continue to serve as point of compliance wells for sector 2. Monitor wells 1, 10 and 11 will continue to serve as point of compliance wells for sector 1. Monitor wells 8 and 28 will continue to serve as monitoring wells for flow toward the southwest. Monitor well 26 will serve as a backup for monitor well 18 which will have to be plugged and abandoned due to the advancement of placed solid waste prior to the completion of sector 4. Monitor wells 6 will serve as monitoring well for flow toward the northwest.

__Sector 5__ Monitor wells 1, 10, 11, 12, 13, 14, 20, 21, and 26 will be the active monitor well circuit when sector 5 is opened. Monitor wells 6, 10, 11, 21 and 26 will be point of compliance wells for the new sector 5. Monitor wells 13, 14 and 20 will continue to serve as point of compliance wells for sector 4. Monitor wells 13 and 19 will continue to serve as point of compliance wells for sector 3. Monitor wells 12, 19 and 24 will continue to serve as point of compliance wells for sector 2. Monitor wells 1, 10, 11, and 24 will continue to serve as point of compliance wells for sector 1. Monitor well 22 will serve as a backup to monitor well 26 which will have to be plugged and abandoned prior to the completion of sector 5 due to the advancement of placement of solid waste. Monitor well 11 will also have to be plugged and abandoned prior to the completion of filling sector 5 due to the advancing placement of solid waste. Monitor wells 8, 27 and 28 will serve as monitor wells for flow toward the southwest.

Sector 6 Monitor wells 1, 6, 10, 12, 13, 14, 17, 20, 21 and 22 will be the active monitor well circuit when sector 6 is opened. Monitor wells 6, 10, 17, and 22 will be the point of compliance wells for new sector 6. Monitor wells 10 will have to be relocated prior to the completion of sector 6. It will be required to plug and abandon the old 10 and drill a new one approximately 25 feet to the south of it's current location to stay on the perimeter of the landfill and out of the advancing placement of solid waste. Monitor well 17 will also have to be plugged and abandoned due to the advancement of placement of solid waste prior to the filling of sector 6. Monitor well 21 will continue to serve as point of compliance will for sector 5. Monitor wells 13, 14, 20 and 21 will continue to serve as point of compliance wells for sector 4. Monitor wells 13 and 19 will continue to serve as point of compliance wells for sector 3. Monitor wells 12, 19 and 24 will continue to serve as point of compliance wells for sector 2. Monitor wells 1, 10 (relocated) and 24 will continue to serve as point of compliance wells for sector 1. Monitor wells 8, 27 and 28 will continue to serve as monitor wells for flow toward the southwest.

Sector 7 Monitor wells 1, 6, 10 (relocated), 12, 13, 14, 15, 16, 19, 20, 21, 22, 23, 24 will be the active monitor well circuit when sector 7 is opened. Monitor wells 6 and 22 will continue to serve as point of compliance wells for sector 6. Monitor wells 6 and 21 will continue to serve as point of compliance wells for sector 5. Monitor wells 13, 14, 20 and 21 will continue to serve as point of compliance wells for sector 4. Monitor wells 13 and 19 will continue to serve as point of compliance wells for sector 3. Monitor wells 12, 19 and 24 will continue to serve as point of compliance wells for sector 2. Monitor wells 1, 10 (relocated) and 24 will continue to serve as point of compliance wells for sector 1. Monitor wells 8, 27 and 28 will continue to serve as monitoring wells for flow toward the southwest.

This design will provide for a monitor well spacing of not more than 650 feet around the perimeter of the landfill site. The seven (7) Phase I wells were drilled as soil borings in July, 1997. Five (5) of these wells which are around the MSWLF perimeter will be used as designated monitor wells. The remaining two (2) wells were completed as piezometers, and are used primarily for ground water level measurements. The piezometers were completed in accordance with TAC 238.44 specifications and will be removed as operations require. Four (4) more soil borings were drilled in April 1998. One of these four borings was made into a monitor well. Eight more monitor wells will be required over the life of the 235-B permit.

The first seven borings were drilled at the approved location to depths of approximately ten (10) feet above MSL. These monitor wells were plugged back and completed at total depths of 15 to 20 feet above MSL. In April, 1998 four deep borings were drilled to depths of 72 to 88 feet below ground surface (BGS). One of these borings (No. 24) was converted into a monitor well and plugged back to the top of the aquiclude clay.

Ten (10) of the seventeen (17) monitor wells which exist at the time of this permit application are completed in or within one foot of the Light Olive Green Clay aquiclude. These ten wells include all of the wells drilled for this permit application (MW-12 through MW-18 and MW-24). Monitor well #1 is also within one foot of the aquiclude. Seven wells terminate within at least eight feet above the aquiclude. ~~It would seem reasonable to redrill and deepen these two wells on the exterior of the landfill site, i.e. #6 and #8. Further,~~ Monitor well #6 ~~should~~ will eventually have to be moved about 45 feet south of its current location to remove it from CR 2040 right-of-way. ~~All~~ Any wells deepened will be terminated in the aquiclude clay. The rest of the wells should be maintained but not ~~deepened nor~~ plugged and abandoned. They will be useful for water level information. Monitor wells # 10 or #11 ~~should~~ could be deepened by the time sector 5 becomes active as they can serve as exterior well to the active landfill. If #10 is chosen to be deepened, it should be moved south about 20 feet and out of the active area when sector 6 is activated.

As discussed in section 6.1, all of the fluvial-deltaic sand bodies above the light olive green clay aquiclude are in communication with each other. These units essentially act as one body from a hydrogeologic standpoint. The caliche bearing channel running northeast to southwest is the primary avenue for pollutant migration as indicated by the rather steep gradients in those two directions. However, the groundwater flows away from the landfill in all directions except to the northwest, currently. There were some earlier dates in which the ground water flowed toward the northwest also. Thus, the point of compliance must be around the entire landfill site. The ground water flow to the northeast (MW #14) is strongly influenced by the clay environment surrounding that well and possibly by the clay dune (III) on top of the aquiclude clay at the northwest corner of the site.

Since this is an unconfined aquifer, there is direct recharge from the surface by percolation through the soil. Ponding in the area will create hydrostatic head to accelerate this recharge process. As discussed in section 6.3.2, there are a significant number of ponds in the area of the landfill. There are fourteen potential ponds in the area of the landfill. Nine of these are permanent ponds in which the ground water intersects the surface. One of these is in the northwest quadrant of the landfill. The other eight are off site. In addition, there are five depressions on the landfill site which will hold water after extensive rainfall, but which do not intersect with the ground water table. The plan for this permit is to properly fill and compact the pond on site which intersects the ground water table, and to obtain pumps to rapidly remove water from the temporary ponds outside of the waste area to surface drainage to minimize infiltration. This is shown in Attachment 15. Both of these will serve to drastically reduce the water level in this uppermost unconfined aquifer.

Background values ~~will be~~ have been established for ~~these wells~~ this MSWLF site ~~as required~~ from the six quarters of background data from MW-1, 3, 4, 10 and 11 for permit

235-A. That data ~~will be~~ has been submitted ~~as appropriate~~. Present data suggest a groundwater flow direction away from the landfill site in all directions except to the northwest. Therefore, the points of compliance for the water table aquifer ~~for Sector 2~~ will be located on all sides ~~with monitor wells 1, 3, 24, 12, and 19 designated as the Points of Compliance~~ of the MSWLF site as indicated above. ~~Monitor Wells 4, 8, 10, and 11 will remain activated for water level contours and back up. A new monitor well, # 28 will be drilled between #1 and #8 to trace the ground water flow to the southwest toward the lower level caliche pits in that direction.~~ It may be necessary periodically to alter the use of northwest perimeter monitor wells depending on the direction of ground water flow. The drainage ditch on FM 2619 next to MW #15 should be deepened and lined in order to minimize the infiltration on of water removed from the landfill site and pumped into surface drainage.

At the present time (235-A), this is a single unit facility. The proposed new landfill (235-B) is comprised of several sectors which will be activated in various stages of operation (i.e. closure, active, and proposed expansion).

The construction and operation of the new landfill should have a minimal impact on ground water flow with the possible exception of the extreme northwest corner. This may also be prevented by removing ponded water in depressions to surface water and by lining the ditch next to MW# 15 as described above.

The current monitor well network for Cell 1 includes existing monitor wells MW-1, 3, 4, 10, & 11. New monitor wells will be activated and the new monitor well network certified as each individual cell is activated. These certifications will be submitted to the Executive Director as required in TAC regulations. Monitor Well Site Survey data is shown in Appendix M.

The Monitor Wells have been completed as specified in TAC 330.242 specifications. The certification for these new monitor wells is given in Appendix M. Monitor wells will be constructed following ASTM guidelines. A schematic for proposed monitor wells in included as Appendix I.

~~As previously discussed, the uppermost aquifer beneath the site is the Light Olive Green Clay units shown in this report.~~ As previously discussed, the Light Olive Green Clay layer in this report is the aquiclude beneath the uppermost aquifer at the site. It is, therefore, proposed that the groundwater monitoring system for City of Kingsville MSWLF monitor the local uppermost aquifer as bounded by the Light Olive Green Clay. Proposed groundwater monitoring well locations, which comprise a network designed to monitor groundwater quality around the permitted landfill and expansion area, are shown on ~~Figure 4.17.~~ Figure 5.2 in Attachment 5. Point of Compliance wells are also shown on this figure. Recommended elevations for well screens along with approximate horizontal survey coordinates at each proposed location are summarized in ~~Appendix B~~ Table 5.3 and Table

5.6 in Attachment 5.

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As required by §330.231(e)(3), the Executive Director will be notified in writing of any changes in the direction and rate of groundwater flow that may require the installation of additional monitor wells. Any additional monitor wells installed will be addressed in a modification to the Site Development Plan.

The site groundwater monitoring network will be sampled for constituents listed in the Groundwater Sampling and Analysis Plan (GWSAP), presented as Attachment 11 of Part III. The development of background values for each constituent, and the sampling, analysis and statistical comparison procedures to be utilized in evaluation of groundwater monitoring data, are also addressed in the GWSAP.

9.3 Landfill Design

The information presented within this report was used in developing a geotechnical characterization of the site for utilization in the landfill design process.The characterization was used in the foundation analysis of the landfill design as related to slope stability, settlement, and constructability. The information presented in Section 7.0 "Geotechnical Characterization" and Appendix H "Engineering Design Calculation and Analysis" is provided in accordance with 30 TAC §330.203(d), to the executive director as demonstration of the foundation evaluation for the design presented within the Permit Amendment Application.

10.0 REFERENCES

10.0 REFERENCES

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The United States Department of Agriculture. General Soil Map, Kleberg County, Texas. Soil Conservation Service in Cooperation with Texas Agricultural Experiment Station, 4-R-36365, October 1977.

ATTACHMENT 4

Geology Report

APPENDICES

Finch Energy & Environmental Services, Inc.
P.O. Box 73/1204 W. King, Kingsville, TX 78364
Phone: (512) 592-9810 Fax: (512) 592-5552

STATE OF TEXAS
RAY N. FINCH
30926
REGISTERED
PROFESSIONAL ENGINEER
6-26-98

THIS DOCUMENT IS ISSUED FOR PERMITTING PURPOSES ONLY INCLUDING PAGES 1 THROUGH 110 AND Appendices A-P.

APPENDIX A

APPENDIX A

SOIL BORING PLAN APPROVAL

November 1997

APPENDIX A-1

TNRCC Boring Plan Approval Letter

6-05-1997 11 47AM FROM TNRCC/MSW/PERM 512 239 6000 P. 1

Boring Plan Accepted

Barry R. McBee, *Chairman*
R. B. "Ralph" Marquez, *Commissioner*
John M. Baker, *Commissioner*
Dan Pearson, *Executive Director*

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

June 4, 1997

Fax Transmittal Memo # of Pages 2

To: Steve Vaughn	From: Burgess Stengl
Co.: Finch Energy & Envir.	Co.: TNRCC
Dept.:	Phone # 512-239-6641
Fax # 512-592-5552	Fax # " " 6000

RCFX14

The Honorable Filemon Esquivel
Mayor of Kingsville
P.O. Box 1458
Kingsville, TX 78363-1458

RE: City of Kingsville Landfill, Kleberg County
Permit No. MSW 235-A
Proposed Lateral Expansion, Soil Boring Plan

Dear Mayor Esquivel:

The Texas Natural Resource Conservation Commission (TNRCC) received a Fax Memo from Mr Homero Castillo, P.E., dated June 2, 1997, which details a proposed soil boring plan for the above-referenced facility. Mr. Ricardo Guzman, City of Kingsville, and Mr. Castillo met with TNRCC staff on May 22 and 29, 1997 to discuss the amendment application and the boring plan. The plan specifies the number, and shows the location, of the proposed soil borings on the landfill expansion acreage. Specifically, seven borings (B-12 through B-18) will be completed initially at the site. All borings will be completed to an elevation of 10 feet above mean sea level (msl). If the geology appears to be consistent across the site, the seven borings will be adequate. However, if after the initial seven borings are completed and logged it is determined that the geology varies across the site, then an additional five borings (B-19 through B-23) will be completed. These five borings will also be completed to 10 feet msl. The necessity of additional borings will be mutually agreed upon by the City of Kingsville and the TNRCC.

Upon review of the proposed soil boring plan, it is determined that the requirements of 30 TAC 330.56(d)(5)(A) will be met, and the plan is therefore approved. It is anticipated that this soil boring plan will accurately characterize the in-situ geologic, and hydrogeologic properties of the surface and subsurface strata at these sites. Please be advised that additional soil borings may be requested by the TNRCC if the site investigation based upon this soil boring plan is inconclusive

If you should find it necessary to modify this approved plan, another plan detailing any proposed modifications must be submitted to the TNRCC for approval before implementation of the

6-05-1997 11:48AM FROM TNRCC/MSW/PERMITS 512 239 6000 P.

Honorable Esquivel
MSW 235-A
Page 2

modifications. If you should have any questions concerning this matter, please contact Burgess Stengl, at (512) 239-6641. Any written correspondence should include the Municipal Solid Waste Division Mail Code, MC-124.

Sincerely,

W.A. "Lonnie" Robinson, P.E., Leader
Permits Section, Team II
Municipal Solid Waste Division

WAR/bhs

cc: Ricardo Guzman, City of Kingsville Public Works Director
Homero ~~Guzman~~ CASTILLO, P.E., Alpha Engineering
TNRCC Region 14 - Corpus Christi
Jean Doyle, MSW Permits

APPENDIX A-2

Letter Requesting Deleting of
Phase II of Boring Plan

FEE FILE

FINCH ENERGY AND ENVIRONMENTAL SERVICES
F.E.E., Inc.
Mailing Address: P.O. Box 73
512-592-9810
1204 W. King
Kingsville, TX 78364-0073
Fax 512-592-5552

July 21, 1997

Mr. Burgess Stengl
TNRCC MSW Permits Section
P.O. Box 13087
Austin, Texas 78753

RE: Phase II Bore Hole Drilling
City of Kingsville Landfill
Permit TNRCC MSW-235A

Dear Mr. Stengl:

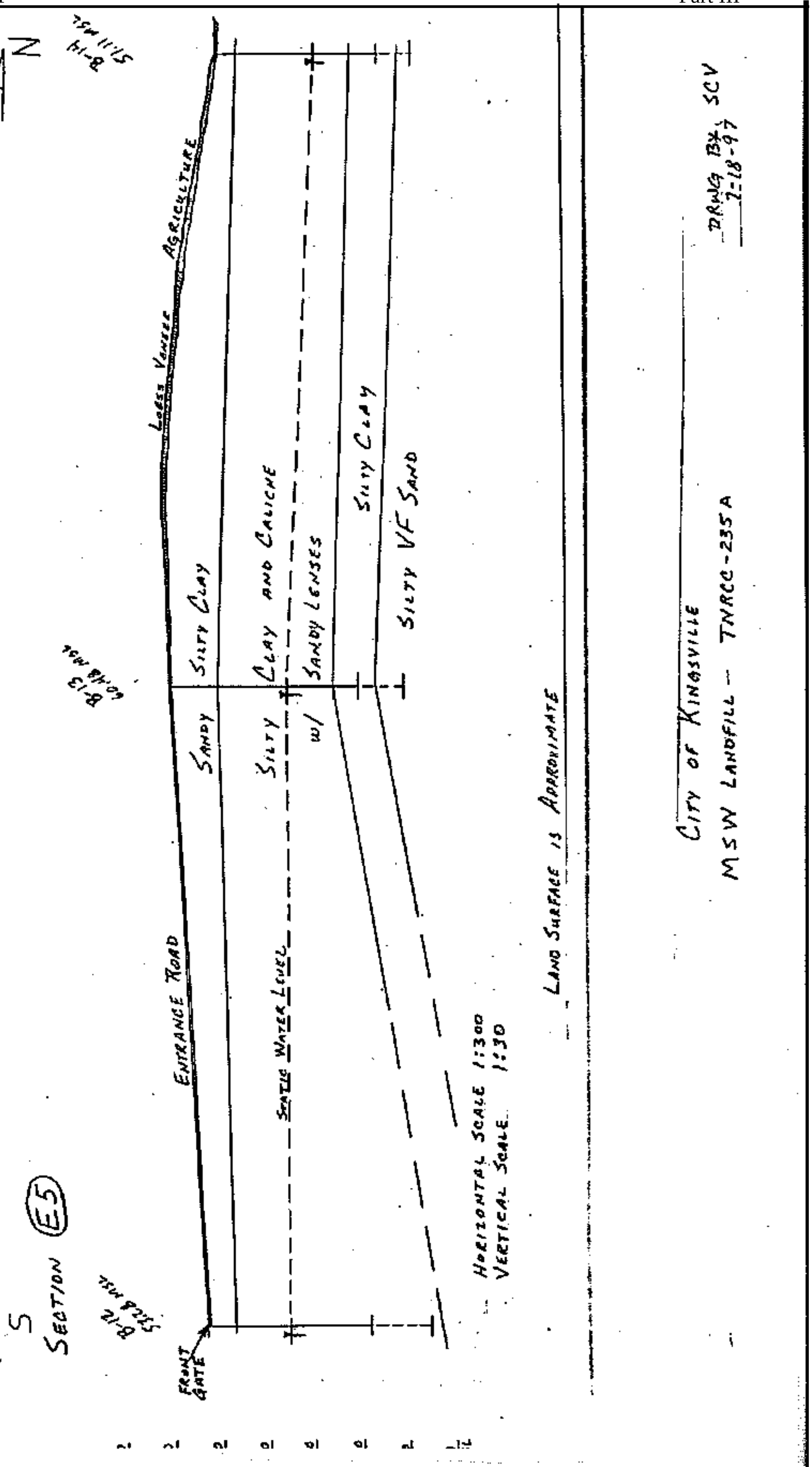
Finch Energy and Environmental Services, Inc., on behalf of the City of Kingsville, requests that the Phase II bore hole drilling program be omitted. Based on the Phase I bore hole lithology, we submit that the formations are relatively consistent across the site. We have included geology sections constructed from boring logs of the existing monitor wells and the Phase I borings completed to date. Static water levels are included which show that the groundwater levels are consistent. The elevations of the existing monitor wells and the new bore holes, now monitor wells, are to be surveyed in the near future. This information will be compiled and included in the submittal of the Amendment to the Site Development Plan (SDP) which is in process. New groundwater contours and characterization will be accomplished as this information becomes available.

Thank you for your assistance. Should you have any questions or comments, please contact our Kingsville office at (512) 592-9810.

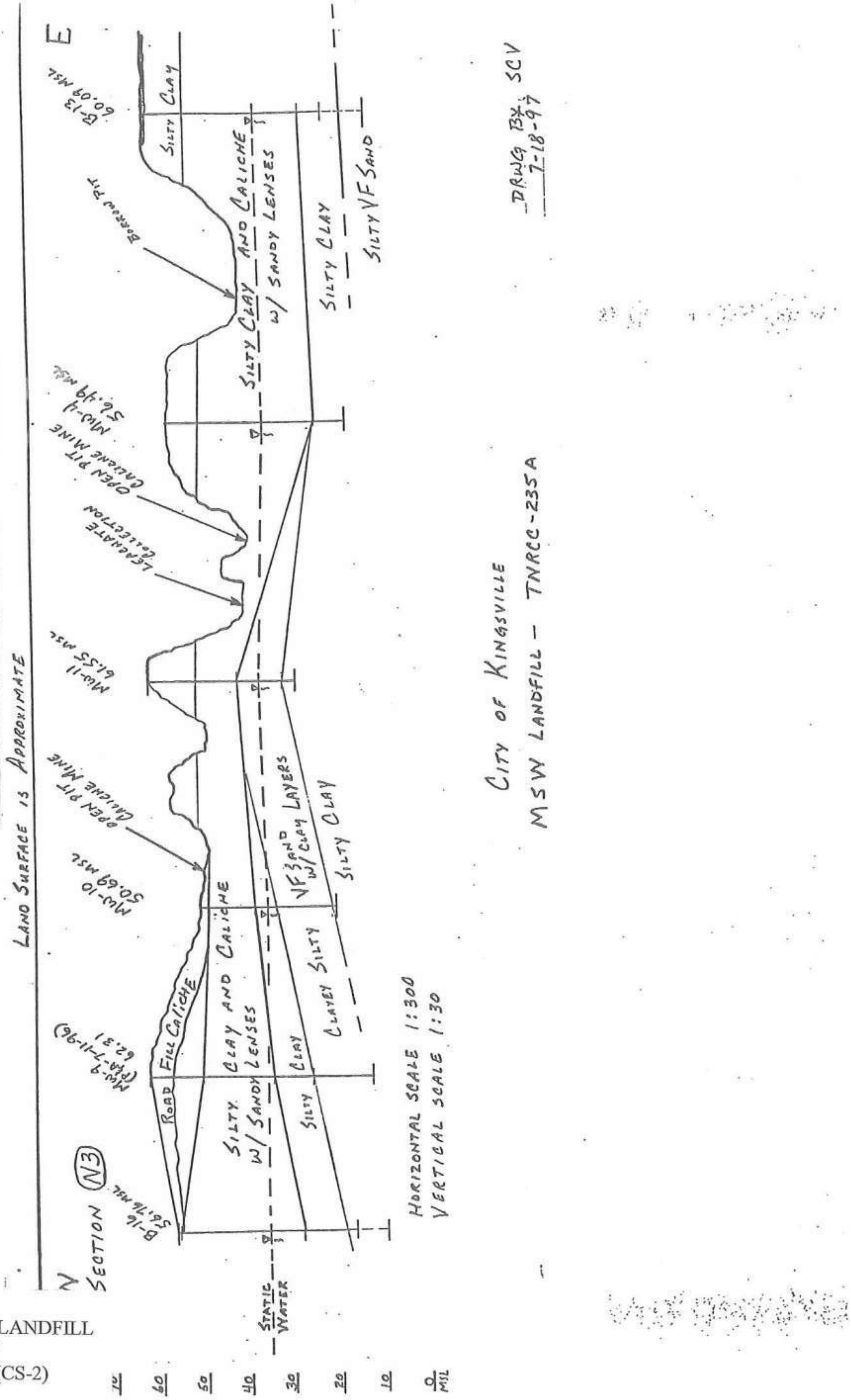
Respectfully Submitted,

Steven C. Vaughn
Environmental Geologist

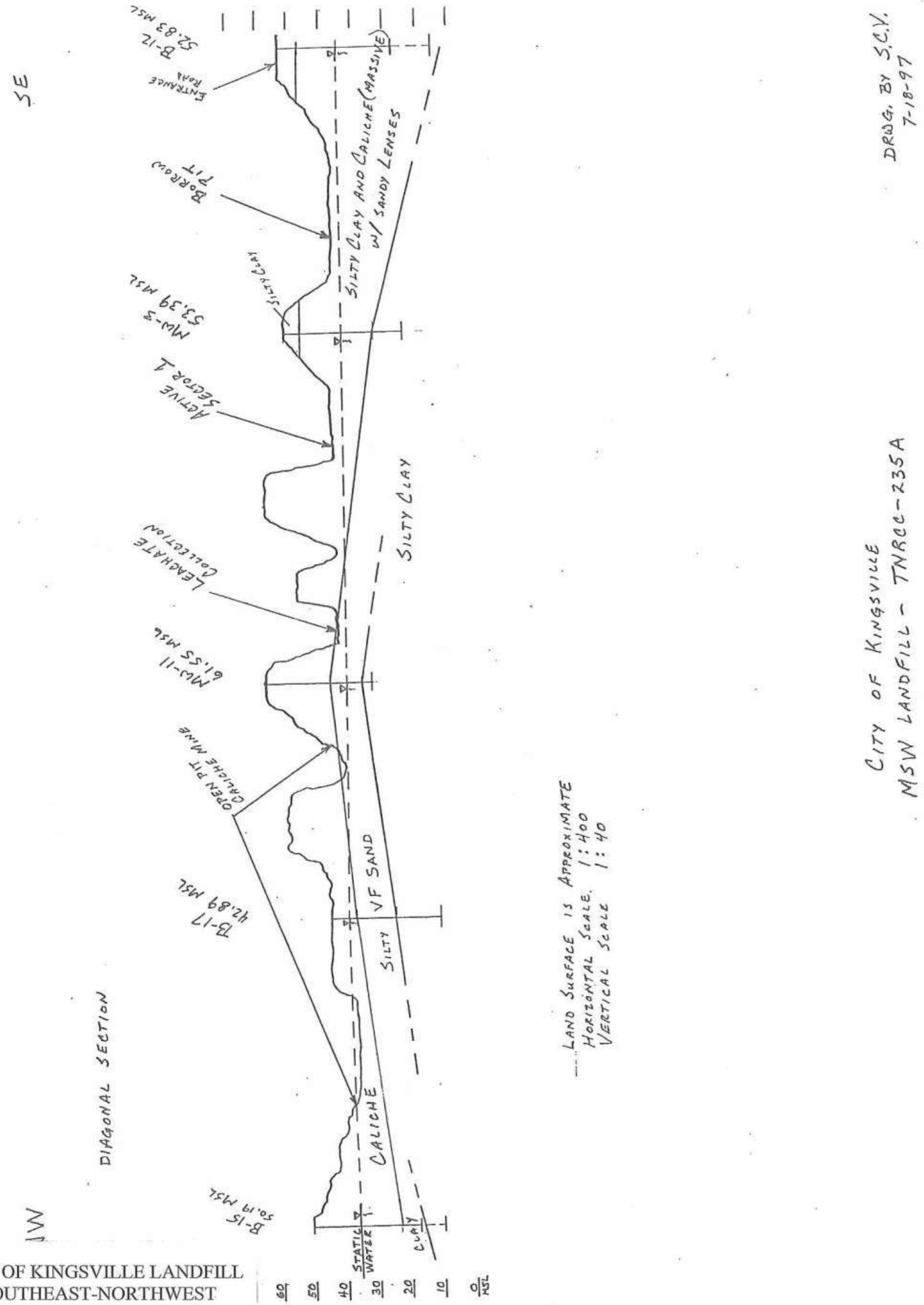
cc: Ricardo Guzman, Public Works Director
Homero Castillo, Alpha Engineering
File



CITY OF KINGSVILLE LANDFILL
SOUTH-NORTH
CROSS-SECTION (CS-1)



CITY OF KINGSVILLE LANDFILL
EAST-WEST
CROSS-SECTION (CS-2)



CITY OF KINGSVILLE LANDFILL
SOUTHEAST-NORTHWEST
CROSS-SECTION (CS-3)

ATTACHMENT A3

APPENDIX A-3

TNRCC Letter of Approval
(Deletion of Phase II of Boring Plan)

RECEIVED AUG 1 5 1997

Barry R. McBee, *Chairman*
R. B. "Ralph" Marquez, *Commissioner*
John M. Baker, *Commissioner*
Dan Pearson, *Executive Director*

THE STATE OF TEXAS

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

August 11, 1997

Ricardo Guzman, City Engineer
City of Kingsville
P.O. Box 1458
Kingsville, TX 78363-1458

RE: City of Kingsville Landfill, Kleberg County
MSW Permit No. 235-A
Soil Boring Plan, Phase I Completion

Dear Mr. Guzman:

The Texas Natural Resource Conservation Commission (TNRCC) received a letter, dated July 21, 1997, from Mr. Steven C. Vaughn with Finch Energy and Environmental Services, Inc. The letter was sent on behalf of the City of Kingsville, and requests that Phase II of the soil boring plan be omitted. The TNRCC approval letter for the soil boring plan was dated June 4, 1997, and specified that seven borings would be completed. If after those seven borings were completed, and it was determined that the geology did not vary significantly across the site, then an additional five borings would not be necessary.

The July 21, 1997 letter from Finch Energy and Environmental provides a cross-section showing that the strata below the site are fairly consistent. For this reason, Phase II of the soil boring plan does not appear to be necessary at this time. Please be advised, however, that additional soil borings may be requested by the TNRCC if the site investigation based upon Phase I of the soil boring plan is inconclusive.

If you should find it necessary to modify this approved plan, or conduct additional borings, another plan detailing any proposed modifications must be submitted to the TNRCC for approval before implementation of the modifications. Should you have any questions concerning this matter, please contact Burgess Stengl, at (512) 239-6641. Any written correspondence should include the Municipal Solid Waste Division Mail Code, MC-124.

Sincerely,

W.A. Robinson

W.A. "Lonnie" Robinson, P.E., Leader
Permits Section, Team II
Municipal Solid Waste Division

WAR/bhs

cc: Homero Castillo, P.E., Alpha Engineering
Ray Finch, FEE ✓
TNRCC Region 14 - Corpus Christi

APPENDIX A-4

TNRCC NOD Letter
(Addition of Deep Borings to Plan)

Texas Natural Resource Conservation Commission

INTEROFFICE MEMORANDUM

(512)-239-6643

To: MSW 235-B

From: Susie Alden, Geologist SA
MSW, Permits Team

Thru: Lonnie Robinson, P.E., Leader WAR 3/30/98
Team, MSW Permits Section

Date: March 26, 1998

Subject: City of Kingsville Landfill, Kleberg County
MSW Permit Application No. 235-B
First Technical Review, Notice of Deficiency

The following are technical deficiencies found in the above-mentioned permit application for expansion of the Kingsville Landfill. The application was submitted to the TNRCC MSW Permits Section on January 9, 1998, and was declared administratively complete on January 28, 1998. The items identified in this memo need further clarification, have not been addressed, or must be revised to adequately comply with the regulatory requirements.

AWN (29) Rcvd 11-15-98

Attachments to the Site Development Plan - Attachment 4 - Geology Report, §330.56(d)(5)(A)(i) and (ii)

The following is an excerpt from 30 TAC §330.56(d)(5)(A)(i):

> "A sufficient number of borings shall be performed to establish subsurface stratigraphy and to determine geotechnical properties of the soils and rocks beneath the facility . . . The number of borings necessary can only be determined after the general characteristics of a site are analyzed and will vary depending on the heterogeneity of subsurface materials. Locations with stratigraphic complexities such as non-uniform beds that pinch out, vary significantly in thickness, coalesce, or grade into other units, will require a significantly greater degree of subsurface investigation than areas with simple geologic frameworks." (Emphasis added)

In Section 6.1 of Attachment 4, Stratigraphic Conditions, Page 36, it is stated that all of the sediments encountered appeared to be very homogeneous in the vertical and horizontal direction. However, the stratigraphy at the site is indicative of fluvial deltaic sedimentology which can clearly be described as complex and fits the scenario described in 30 TAC §330.56(d)(5)(A)(i) which is underlined above. This geologic framework is not simple, and it is not homogeneous.

The following is an excerpt from 30 TAC §330.56(d)(5)(A)(ii):

> "Borings shall be sufficiently deep to allow identification of the uppermost aquifer and underlying hydraulically interconnected aquifers. Borings shall penetrate the uppermost aquifer and all deeper hydraulically interconnected aquifers and shall be

deep enough to identify the aquiclude at the lower boundary."

Based on a review of the materials submitted with the application, it appears that the uppermost aquifer in the immediate vicinity of the landfill and underlying hydraulically interconnected aquifers have not been identified for the site. Many of the borings which were completed at the site were terminated in an uncemented sand. On application Page 38, Section 6.1.4. of Attachment 4, Sand Unit, it is stated that the deepest sediment is a clay which is sandy grading laterally to a sand. The vertical and horizontal extent of this sand body was not defined through those borings. Since sand bodies can generally act as aquifers, the lack of definition of the extent of this sand body serves to underscore the point being made that the uppermost aquifer and any underlying hydraulically interconnected aquifers have not been identified. Until the uppermost aquifer(s) is defined, the identification of the aquiclude at the lower boundary cannot claim to have been made. In application Section 6.1.5., Confining Clay Layer (Aquiclude), Page 39, it is stated that the confining layer for the Chicot Aquifer is a shale/clay layer more than 200 feet thick at approximately -200 feet MSL. The aquiclude for the uppermost aquifer(s) at the landfill site may or may not be the same as the aquiclude for the Chicot Aquifer, which is the regional aquifer in the area. However, more information must be presented to support the conclusion that this deeper shale/clay layer is indeed the aquiclude for the uppermost aquifer in the vicinity of the facility.

The 1973 report written by Shafer and Baker, *Ground-Water Resources of Kleberg, Kenedy, and Southern Jim Wells Counties, Texas*, also provides further information on these issues. They write the following about the general stratigraphy found in this portion of the West Gulf Coastal Plain:

> "The lithology, dip, and thickness of many of the geologic formations change in the direction of dip; and the lithology and thickness commonly change laterally along the strike. Sand beds may grade laterally into clay or silt within short distances. These sand beds and other beds containing water are interconnected with similar beds on a different level, so that a series of water-bearing beds within a formation, or even within a group of formations, function as a single aquifer."

The boring information included in the application materials confirms the assessment of the geology in the area as is described in Schafer's report. Given the geology at the site, it appears that additional deeper borings will be necessary in order to comply with the requirements of 30 TAC §330.56(d)(5)(A)(i) and (ii). These additional borings must be drilled at the site to better define the subsurface stratigraphy, to identify the uppermost aquifer and any underlying interconnected aquifers, and to identify the aquiclude at the lower boundary of the uppermost aquifer system.

APPENDIX B

APPENDIX B

BORING LOGS

City of Kingsville

Municipal Solid Waste Disposal Facility

Permit Amendment Application MSW 235-B

November 1997

B-0

APPENDIX B

BORING LOGS

November 1997
Revision 1 - June 1998

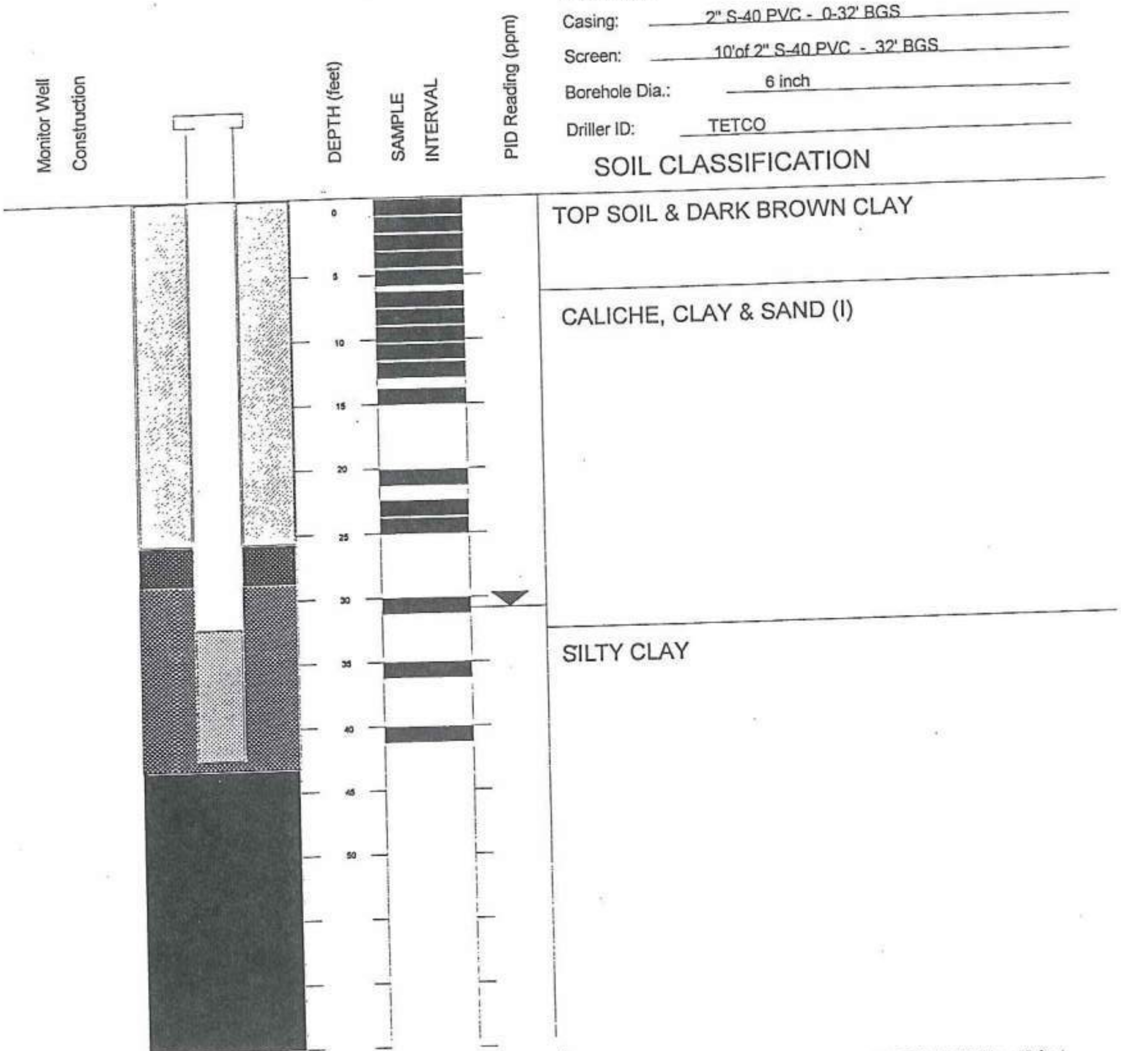
PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City
LAT: 27° 26' 42.2" LONG: 97° 49' 10.6"
MSWLF ID: Permit #235-B

Boring/Well No.: 1
Date Drilled: June 19, 1984
Boring Method: Hollow Stem Auger
Sample Method: SHELBY TUBE & SPLIT SPOON
Surface Elevation: 59.25' MSL
Depth to Water: 31.0' BGS
Total Depth: 42' BGS
Casing: 2" S-40 PVC - 0-32' BGS
Screen: 10'of 2" S-40 PVC - 32' BGS
Borehole Dia.: 6 inch
Driller ID: TETCO



Water depth on Drilling = 30.19ft. BGS

TOTAL DEPTH = 42 feet

B-1

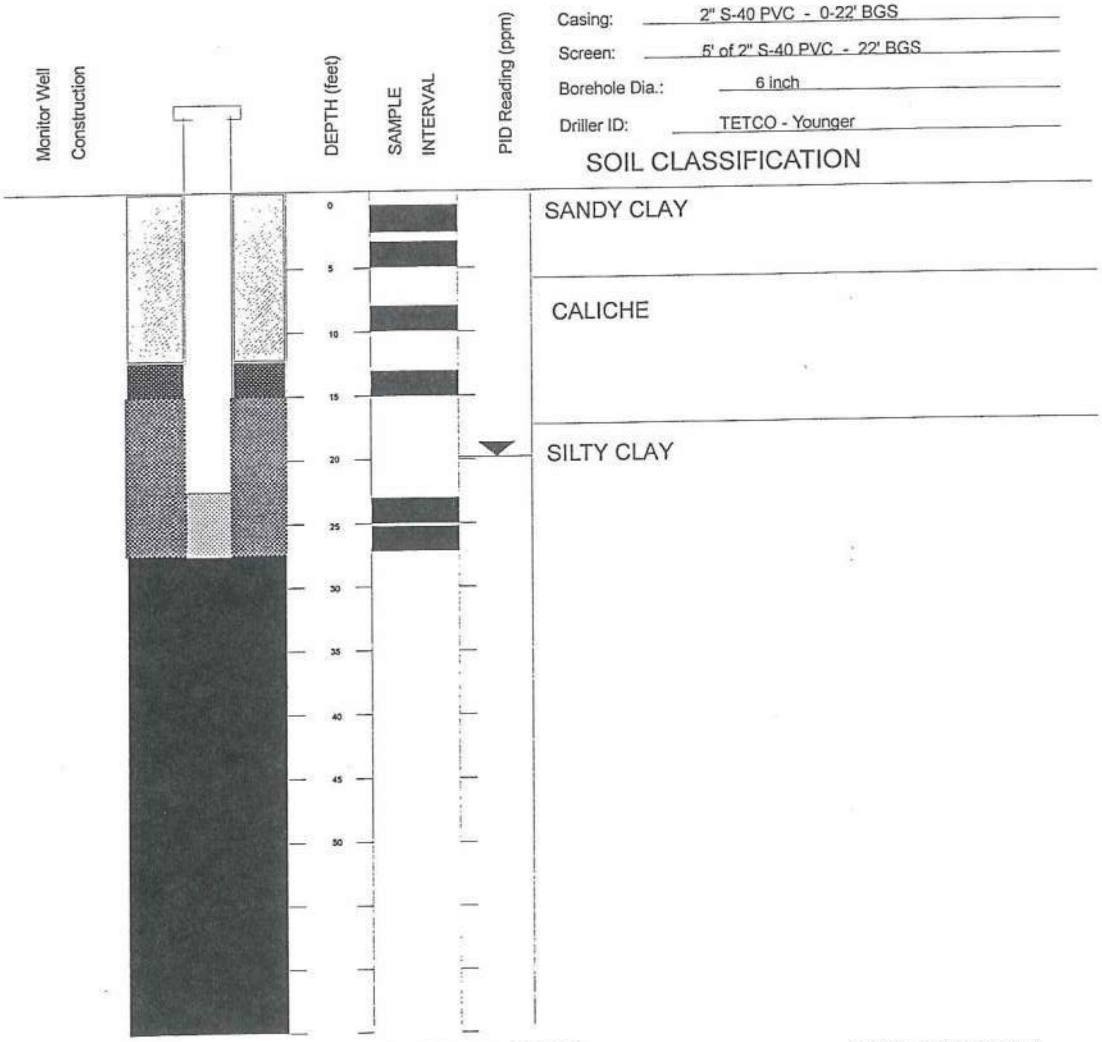
PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville
Project Name:	Kingsville Landfill
Project Location:	5 mi SE of City
MSWLF ID:	Permit #235-B

Boring/Well No.:	2
Date Drilled:	October 6, 1984
Boring Method:	Hollow Stem Auger
Sample Method:	SHELBY TUBE & SPLIT SPOON
Surface Elevation:	52.64' MSL
Depth to Water:	19.9' BGS
Total Depth:	27' BGS
Casing:	2" S-40 PVC - 0-22' BGS
Screen:	5' of 2" S-40 PVC - 22' BGS
Borehole Dia.:	6 inch
Driller ID:	TETCO - Younger



Water depth on Drilling = 25.49 ft. BGS

TOTAL DEPTH = 27 feet

B-2

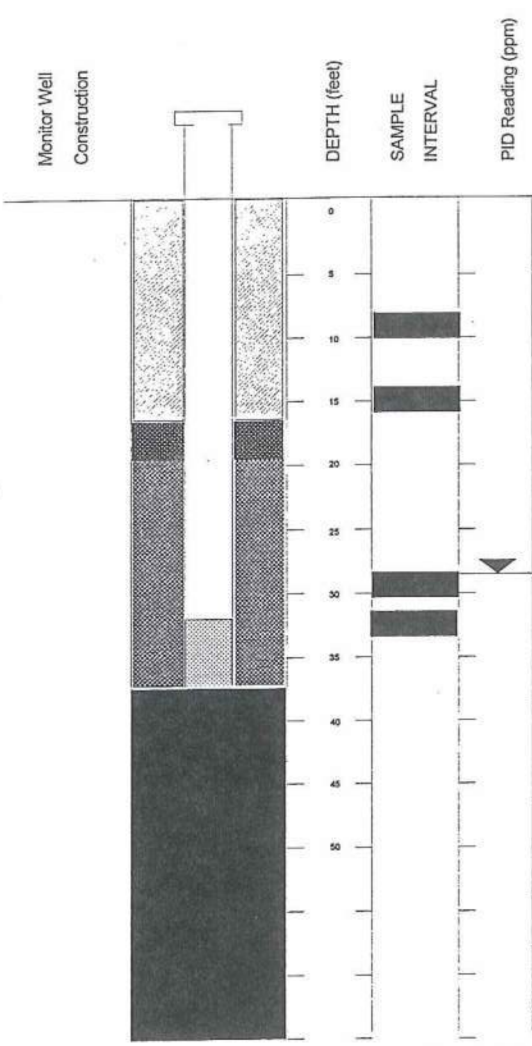
PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City
LAT: 27° 26' 50.3" LONG: 97° 49' 03.9"
MSWLF ID: Permit #235-B

Boring/Well No.: 3
Date Drilled: October 3, 1984
Boring Method: HOLLOW STEM AUGER
Sample Method: SHELBY TUBE & SPLIT SPOON
Surface Elevation: 56.10' MSL
Depth to Water: 27.7' BGS
Total Depth: 37 ' BGS
Casing: 2" S-40 PVC - 0-32' BGS
Screen: 5' of 2" S-40 PVC - 32' BGS
Borehole Dia.: 6 inch
Driller ID: TETCO - Younger



SOIL CLASSIFICATION

SANDY CLAY, TOP SOIL & DARK BROWN CLAY

CALICHE (I)

SILTY CLAY, TAN

Water depth on Drilling = 29.24 ft. BGS

TOTAL DEPTH = 37 feet

B-3

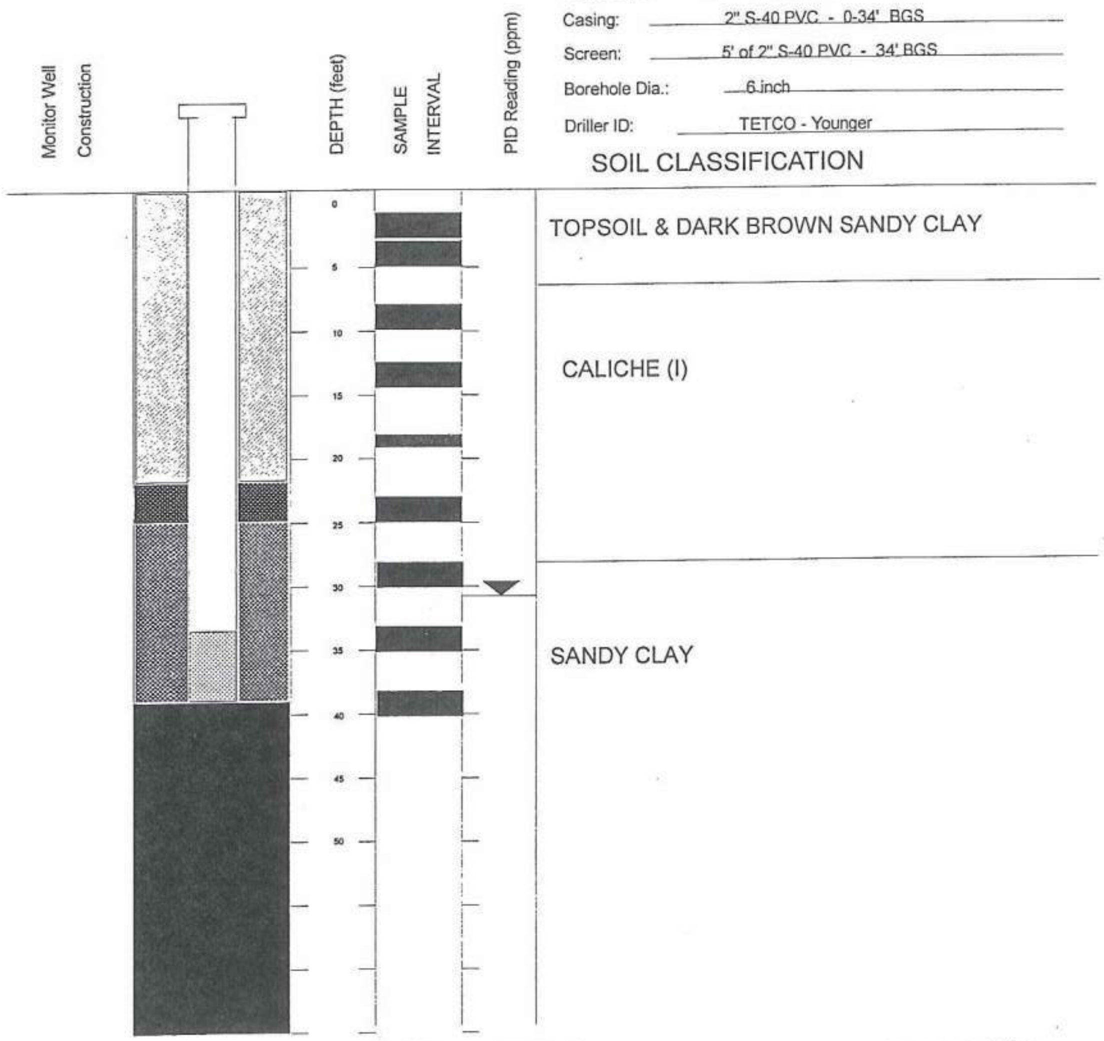
PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City
LAT: 27° 26' 55.2" LONG: 97° 49' 03.9"
MSWLF ID: Permit #235-B

Boring/Well No.: 4
Date Drilled: October 3, 1984
Boring Method: HOLLOW STEM AUGER
Sample Method: SHELBY TUBE & SPLIT SPOON
Surface Elevation: 58.01' MSL
Depth to Water: 31.2' BGS
Total Depth: 39' BGS
Casing: 2" S-40 PVC - 0-34' BGS
Screen: 5' of 2" S-40 PVC - 34' BGS
Borehole Dia.: 6 inch
Driller ID: TETCO - Younger



Water depth on Drilling = 27.98 ft. BGS

TOTAL DEPTH = 39 feet

B-4

PAGE _1_ OF _1_

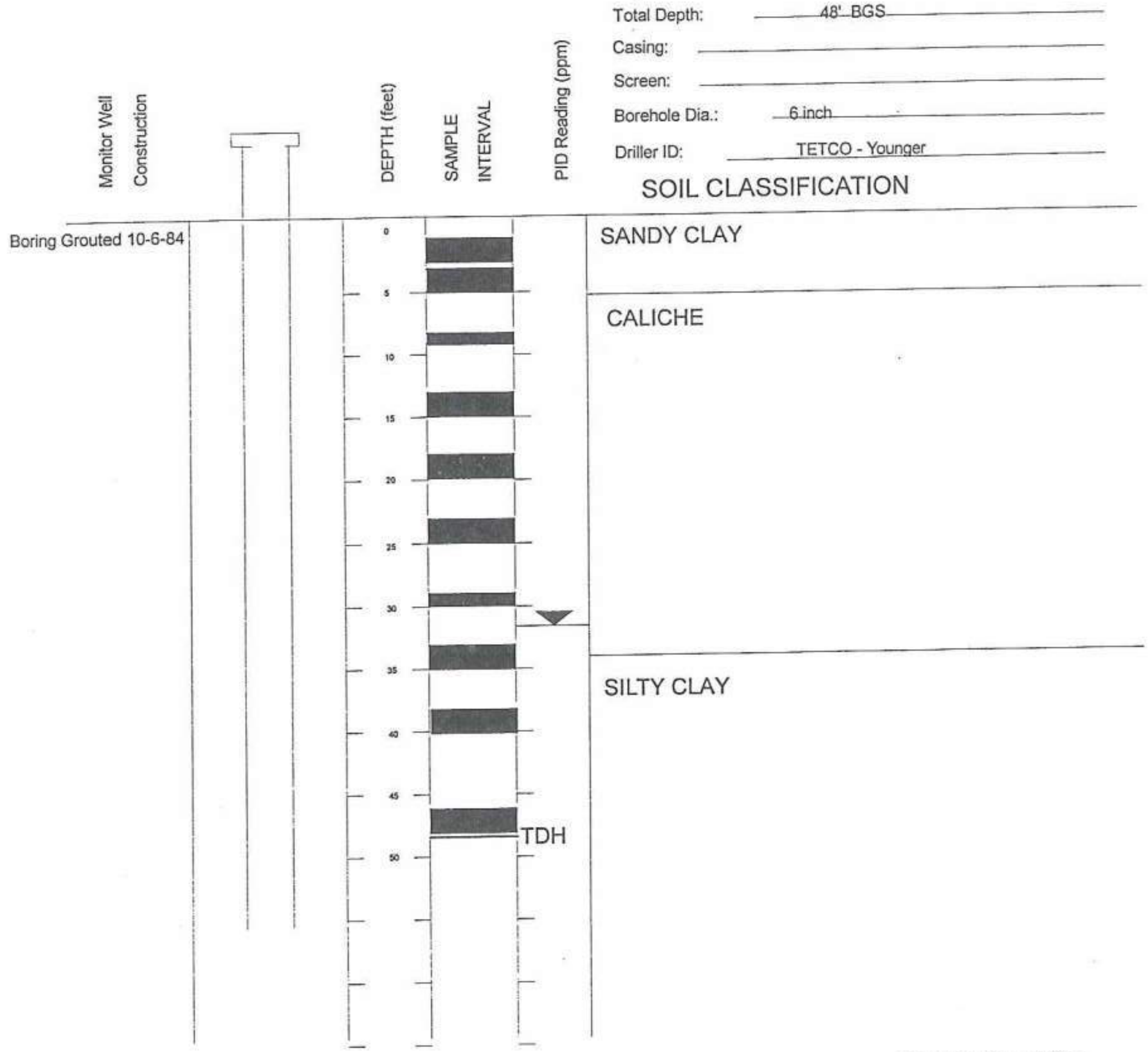
FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City

MSWLF ID: Permit #235-B

Boring/Well No.: 5
Date Drilled: October 5, 1984
Boring Method: Hollow Stem Auger
Sample Method: SHELBY TUBE & SPLIT SPOON
Surface Elevation: 60.54' MSL
Depth to Water: 31.5' BGS
Total Depth: 48' BGS
Casing:
Screen:
Borehole Dia.: 6 inch
Driller ID: TETCO - Younger



TOTAL DEPTH = 48 feet

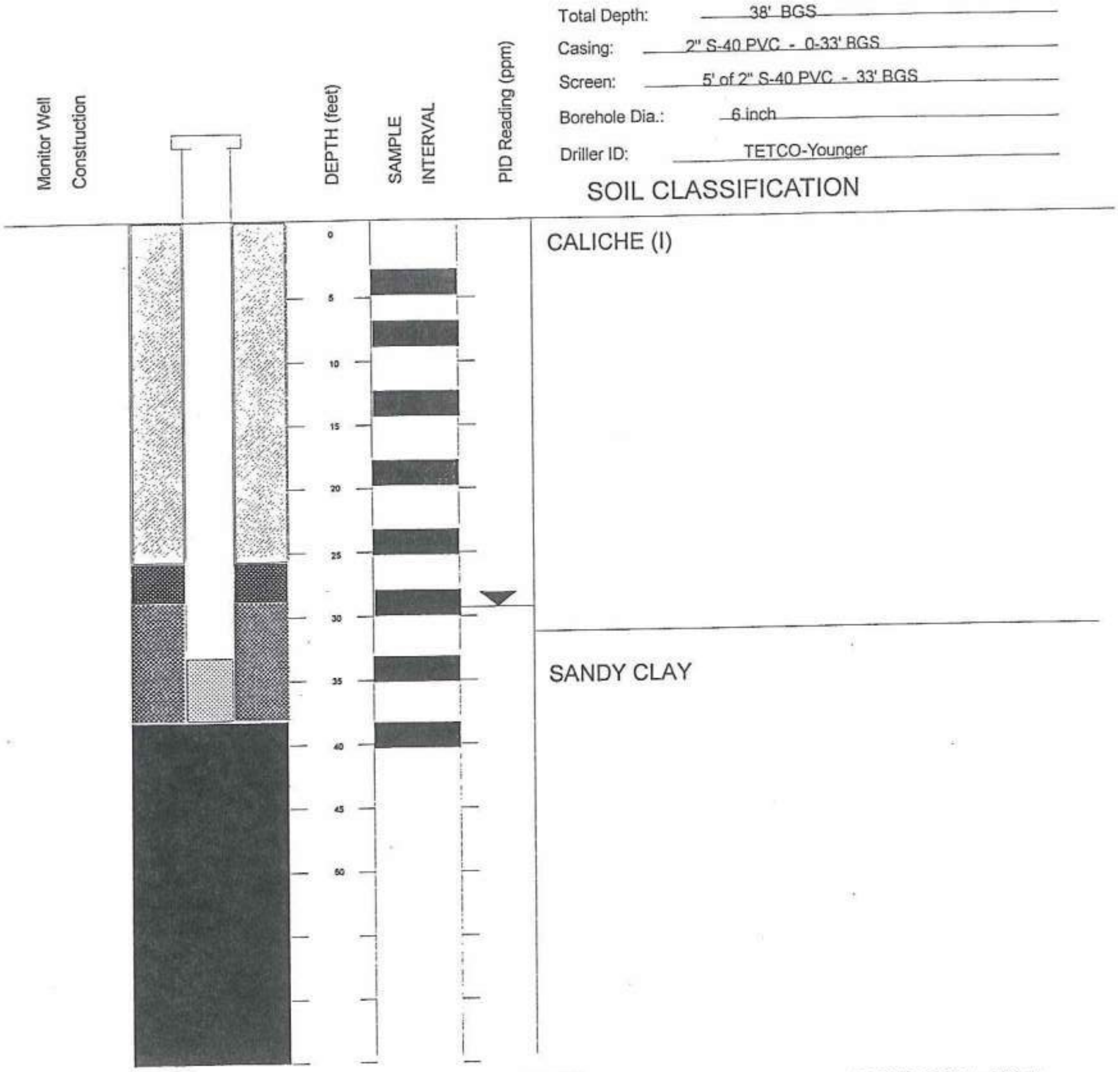
B-5

PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville	Boring/Well No.:	6
Project Name:	Kingsville Landfill	Date Drilled:	October 3, 1984
Project Location:	5 mi SE of City	Boring Method:	HOLLOW STEM AUGER
LAT: 27° 27' 09.2"	LONG: 97° 49' 09.9"	Sample Method:	SHELBY TUBE & SPLIT SPOON
MSWLF ID:	Permit #235-B	Surface Elevation:	55.46' MSL
		Depth to Water:	29.1' BGS
		Total Depth:	38' BGS
		Casing:	2" S-40 PVC - 0-33' BGS
		Screen:	5' of 2" S-40 PVC - 33' BGS
		Borehole Dia.:	6 inch
		Driller ID:	TETCO-Younger



Water depth on Drilling = 27.92 ft. BGS

TOTAL DEPTH = 38 feet

B-6

PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

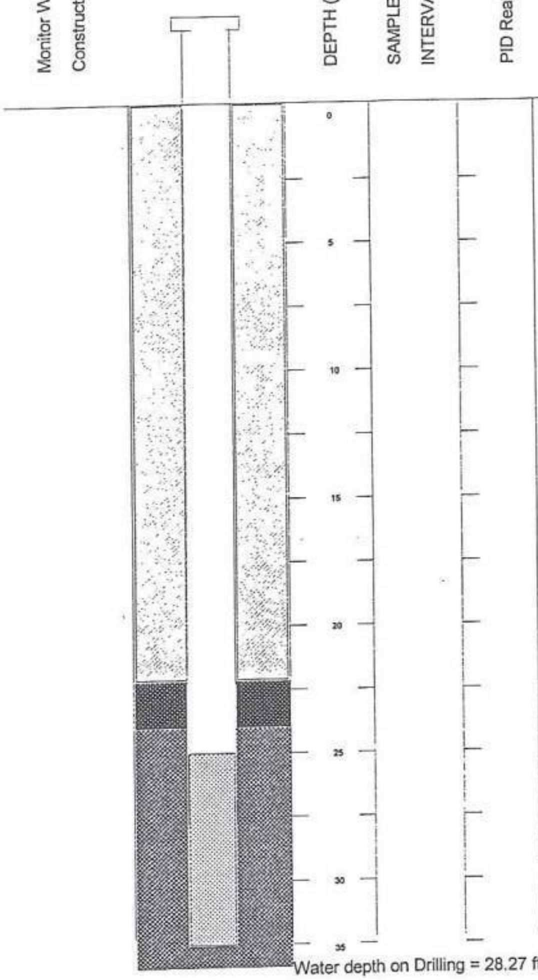
SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City
LAT: 27° 26' 43.9" LONG: 97° 49' 23.3"
MSWLF ID: Permit #235-B

Boring/Well No,: 7
Date Drilled: August 1990
Boring Method:
Sample Method:
Surface Elevation: 61.05 ' MSL
Depth to Water:
Total Depth: 36' BGS
Casing:
Screen:
Borehole Dia.:
Driller ID: Martin Water Wells

Monitor Well Construction | DEPTH (feet) | SAMPLE | INTERVAL | PID Reading (ppm)

SOIL CLASSIFICATION



Monitor Well was P&A on 7-23-91

Water depth on Drilling = 28.27 ft. BGS

TOTAL DEPTH = 36 feet

B-7

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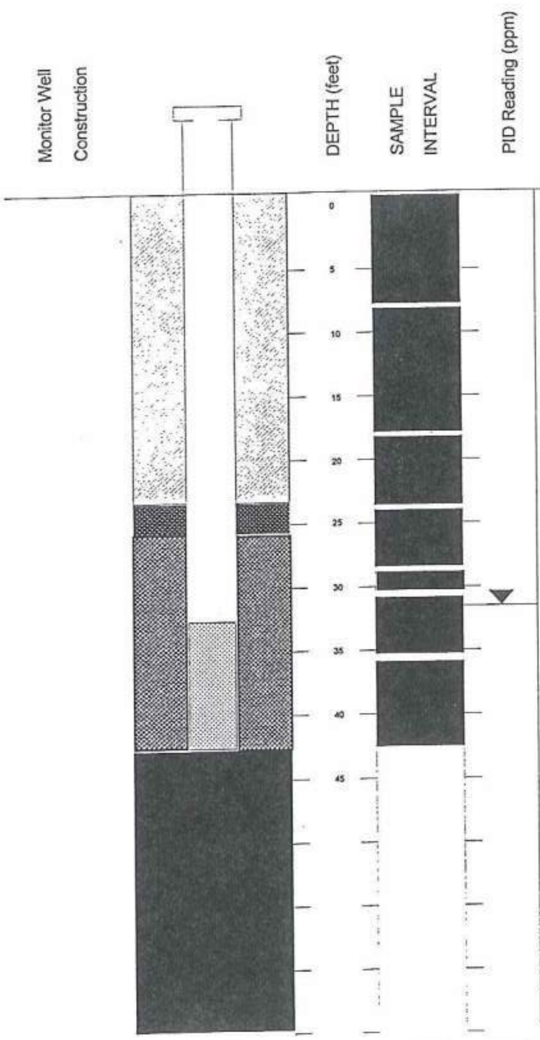
PAGE _1_ OF _1_

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville	Boring/Well No.:	8
Project Name:	Kingsville Landfill	Date Drilled:	July 23, 1991
Project Location:	5 mi. SE of City	Boring Method:	Hollow Stem Auger
LAT: 27° 26' 43.9" LONG: 97° 49' 23.3"		Sample Method:	Split Spoon
MSWLF ID:	Permit #235-B	Surface Elevation:	59.79 ' MSL
		Depth to Water:	32.02' BGS
		Total Depth:	43' BGS
		Casing:	4"S-40 PVC - 0-33' BGS
		Screen:	10' of 4"S-40 PVC - 33' BGS
		Borehole Dia.:	10 inches
		Driller:	Martin Water Wells, Larry Martin



SOIL CLASSIFICATION

Caliche Bearing Channel (I)
(Caliche Clay & Sand to TD)

Water depth on Drilling = 28.0 ft. BGS

TOTAL DEPTH = 43 ft.

B-8

PAGE _1_ OF _1_

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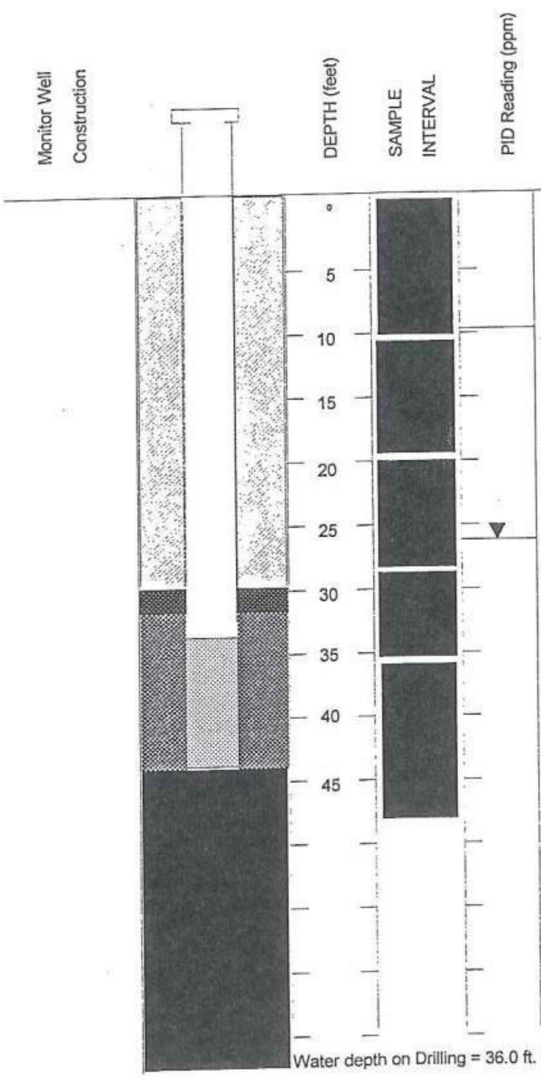
SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 27' 54" LONG: 97° 49' 20.1"
MSWLF ID: Permit #235-B

Boring/Well No.: 9
Date Drilled: March 24, 1992
Boring Method: Hollow Stem Auger
Sample Method: 5 foot core barrel
Surface Elevation: 62.51' MSL
Depth to Water: 26' BGS
Total Depth: 44' BGS
Casing: 4" S-40 PVC - 0-34' BGS
Screen: 10' of 4" S-40 PVC - 34' BGS
Borehole Dia.: 10 inch
Driller: JEDI, Charles L. Jones



SOIL CLASSIFICATION

Monitor Well was P&A on 07-12-96

Caliche, Dark Clay
Road Fill

Caliche, Fine Sand

Very Fine Silty Sand

Very Fine Sandy Silt
w/Clay Stringers

Very Fine Sandy Silt
Wet, Soft w/Clay Stringers

TOTAL DEPTH: 44 feet

B-9

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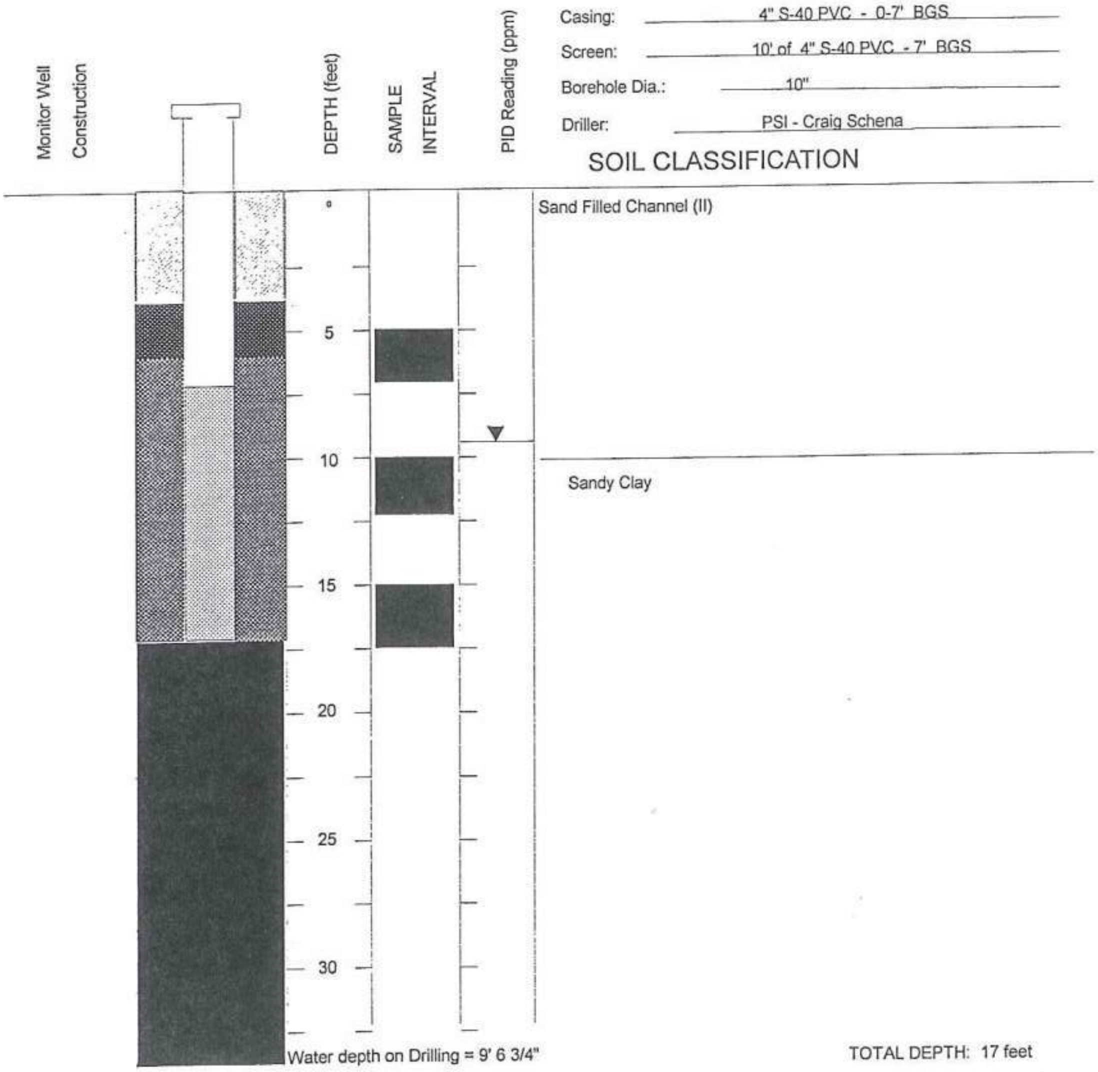
PAGE _1_ OF _1_

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville	Boring/Well No.:	9R
Project Name:	Kingsville Landfill	Date Drilled:	July 11, 1996
Project Location:	5 mi. SE of City	Boring Method:	Hollow Stem Auger
LAT: 27° 26' 57.2" LONG: 97° 49' 20.1 "		Sample Method:	Split spoon
MSWLF ID:	Permit #235-B	Surface Elevation:	41.41' MSL
		Depth to Water:	9.6' BGS
		Total Depth:	17' BGS
		Casing:	4" S-40 PVC - 0-7' BGS
		Screen:	10' of 4" S-40 PVC - 7' BGS
		Borehole Dia.:	10"
		Driller:	PSI - Craig Schena



B-10

PAGE _1_ OF _1_

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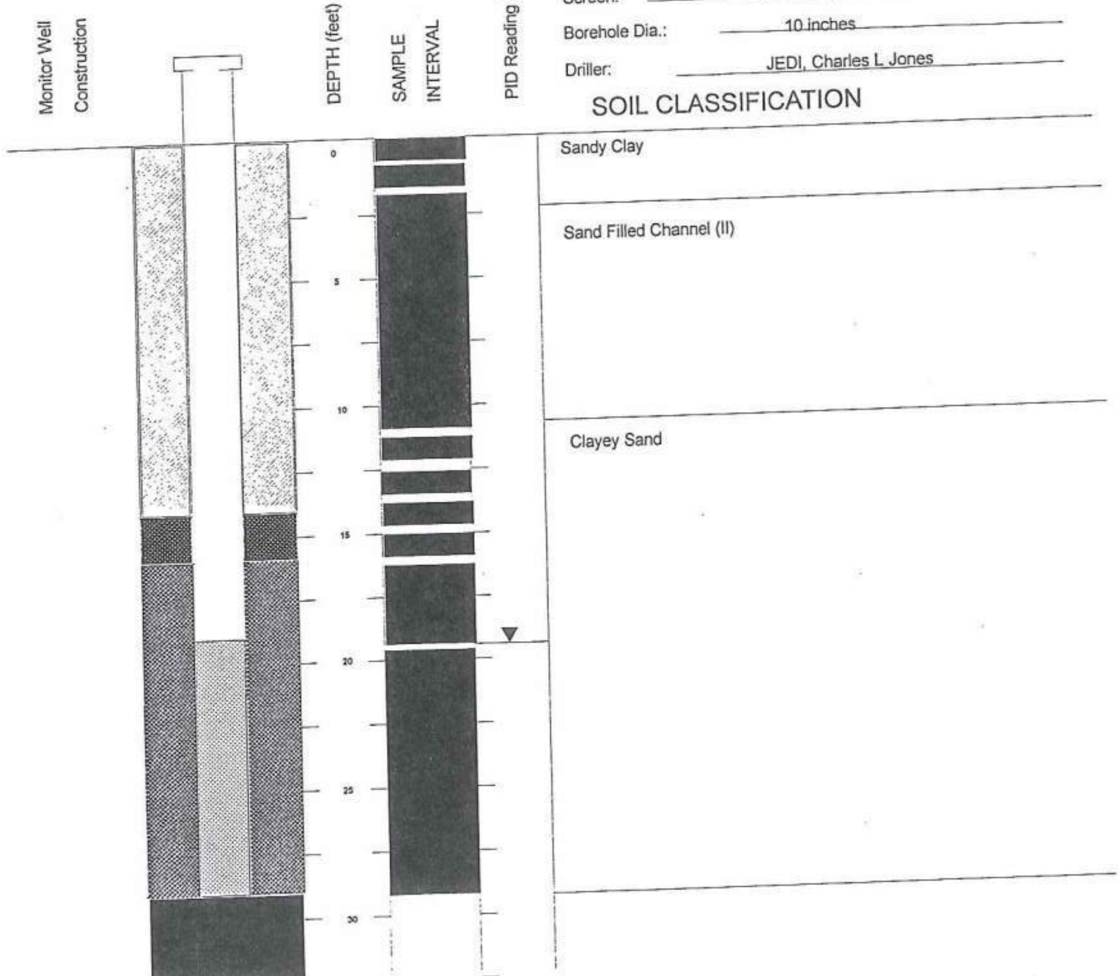
SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 26' 55.2" LONG: 97° 49' 15.3"
MSWLF ID: Permit #235-B

Boring/Well No.: 10
Date Drilled: March 20, 1992
Boring Method: Hollow Stem Auger
Sample Method: Split Spoon
Surface Elevation: 49.78' MSL
Depth to Water: 19.5' BGS
Total Depth: 29' BGS
Casing: 4" S-40 PVC - 0-19' BGS
Screen: 10' of 4" S-40 PVC - 19' BGS
Borehole Dia.: 10 inches
Driller: JEDI, Charles L Jones



Water depth on Drilling = 19.5 ft. BGS

TOTAL DEPTH = 29 ft.

B-11

PAGE _1_ OF _1_

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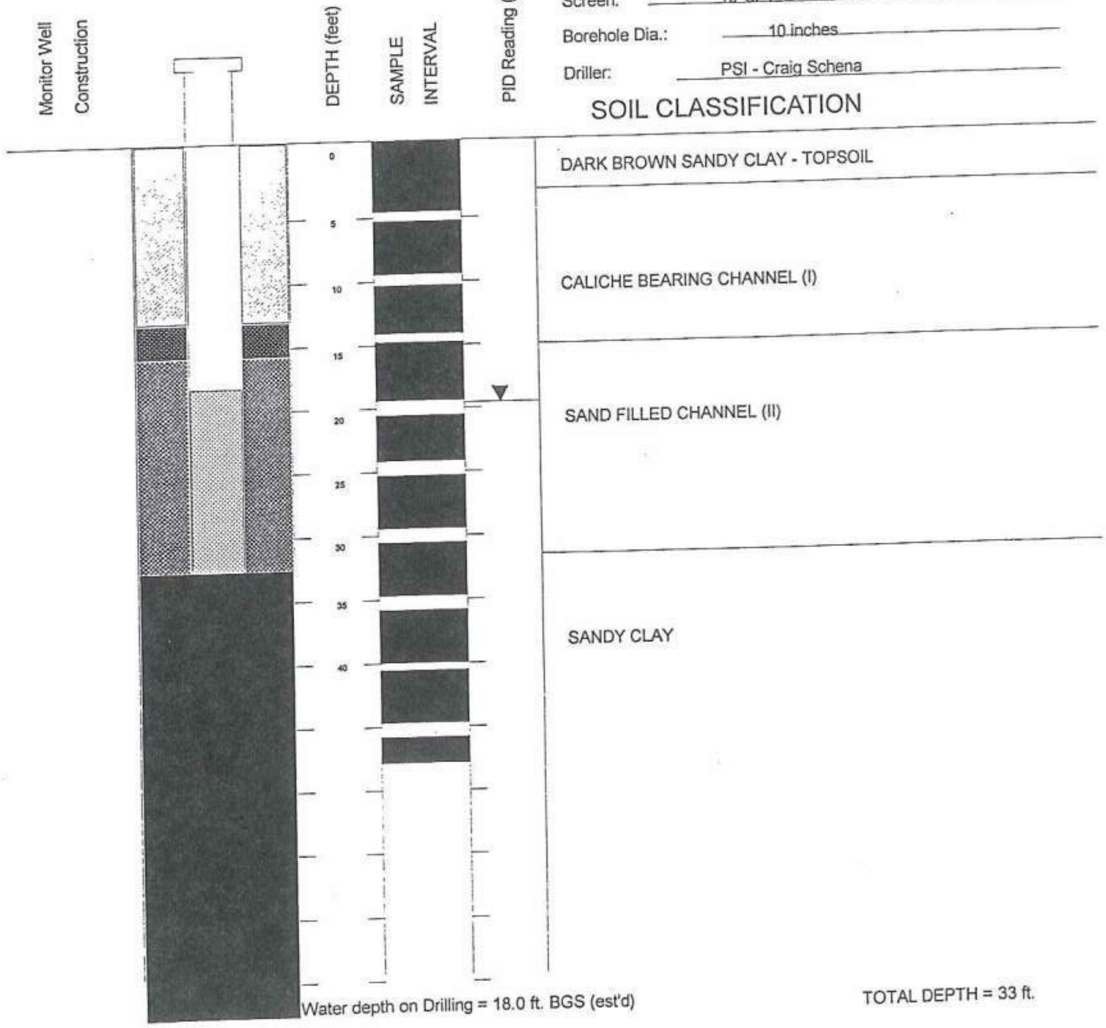
SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 26' 57" LONG: 97° 49' 10"
MSWLF ID: Permit #235 - B

Boring/Well No.: 11
Date Drilled: July 11, 1996
Boring Method: Hollow Stem Auger
Sample Method: Split Spoon
Surface Elevation: 60.20' MSL
Depth to Water: 26.3' BGS
Total Depth: 33' BGS
Casing: 4" S-40 PVC - 0-18' BGS
Screen: 10' of 4" S-40 PVC - 18' BGS
Borehole Dia.: 10 inches
Driller: PSI - Craig Schena



B-12

PAGE _1_ OF _1_

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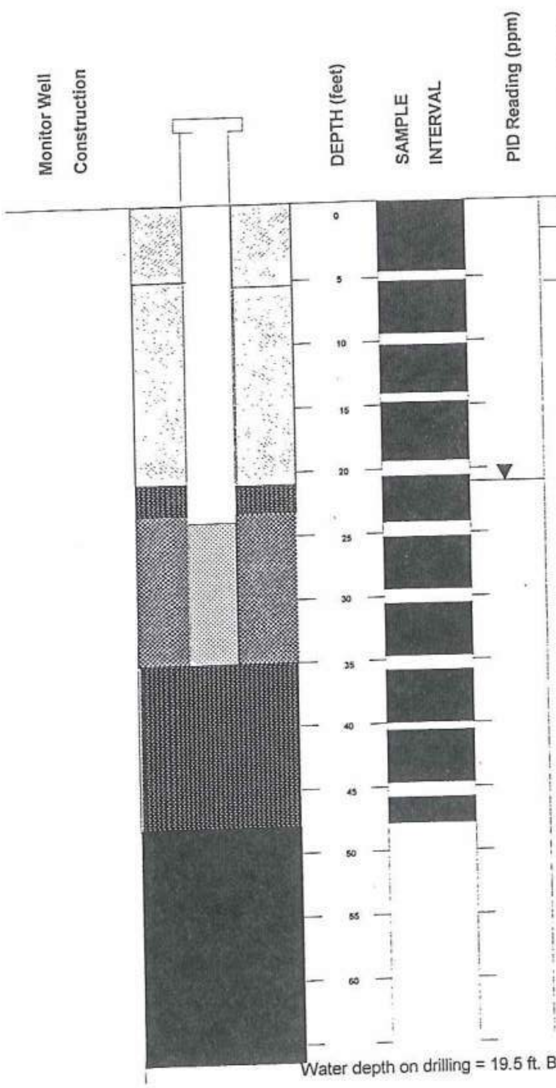
(512) 592-9810 (512) 592-5552 FAX

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 26' 41.9" LONG: 97° 48' 55.9"
MSWLF ID: Permit #235-B

Boring/well no.: 12
Date Drilled: July 7, 1997
Boring Method: Hollow Stem Auger
Sample Method: 5 foot core barrel
Surface Elevation: 52.38' MSL
Depth to Water: 17.3' BGS
Total Depth: 48' BGS
Casing: 4" S-40 PVC - 0-25' BGS
Screen: 10' of 4" S-40 PVC - 25' BGS
Borehole Dia.: 10 inches
Driller: PSI - Craig Schena



SOIL CLASSIFICATION

Topsoil

Clay sandy, silty

Clay silty, calcified,
caliche stringers and nodules, sandy lenses

Water depth on drilling = 19.5 ft. BGS

TOTAL DEPTH = 48 ft.

B-13

PAGE _1_ OF _1_

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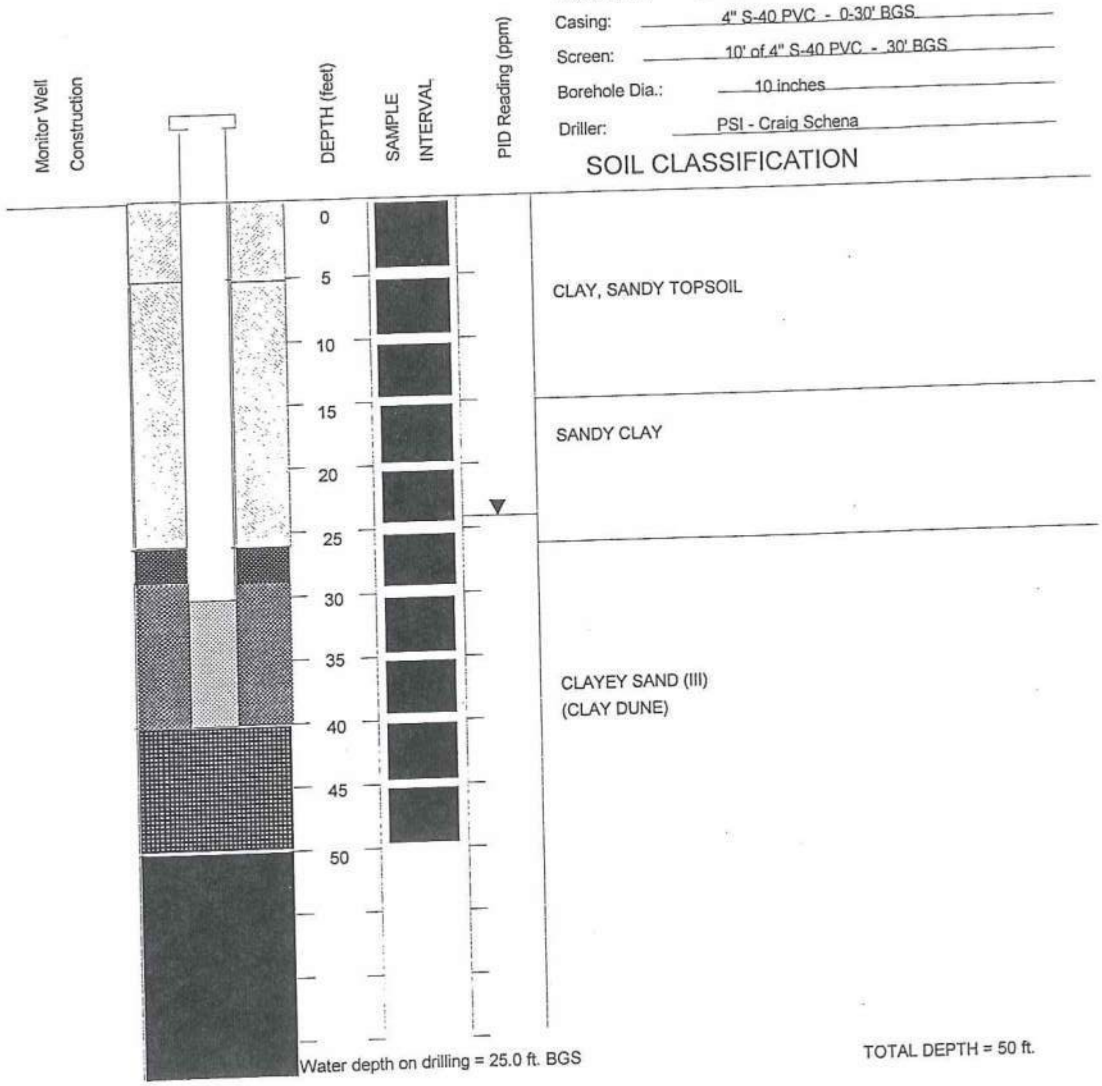
SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 26' 55.7" LONG: 97° 48' 56"
MSWLF ID: Permit #235-B

Boring/Well No.: 13
Date Drilled: July 28, 1997
Boring Method: Hollow Stem Auger
Sample Method: 5 foot core barrel
Surface Elevation: 59.13' MSL
Depth to Water: 24' BGS
Total Depth: 50' BGS
Casing: 4" S-40 PVC - 0-30' BGS
Screen: 10' of 4" S-40 PVC - 30' BGS
Borehole Dia.: 10 inches
Driller: PSI - Craig Schena



B-14

PAGE _1_ OF _1_

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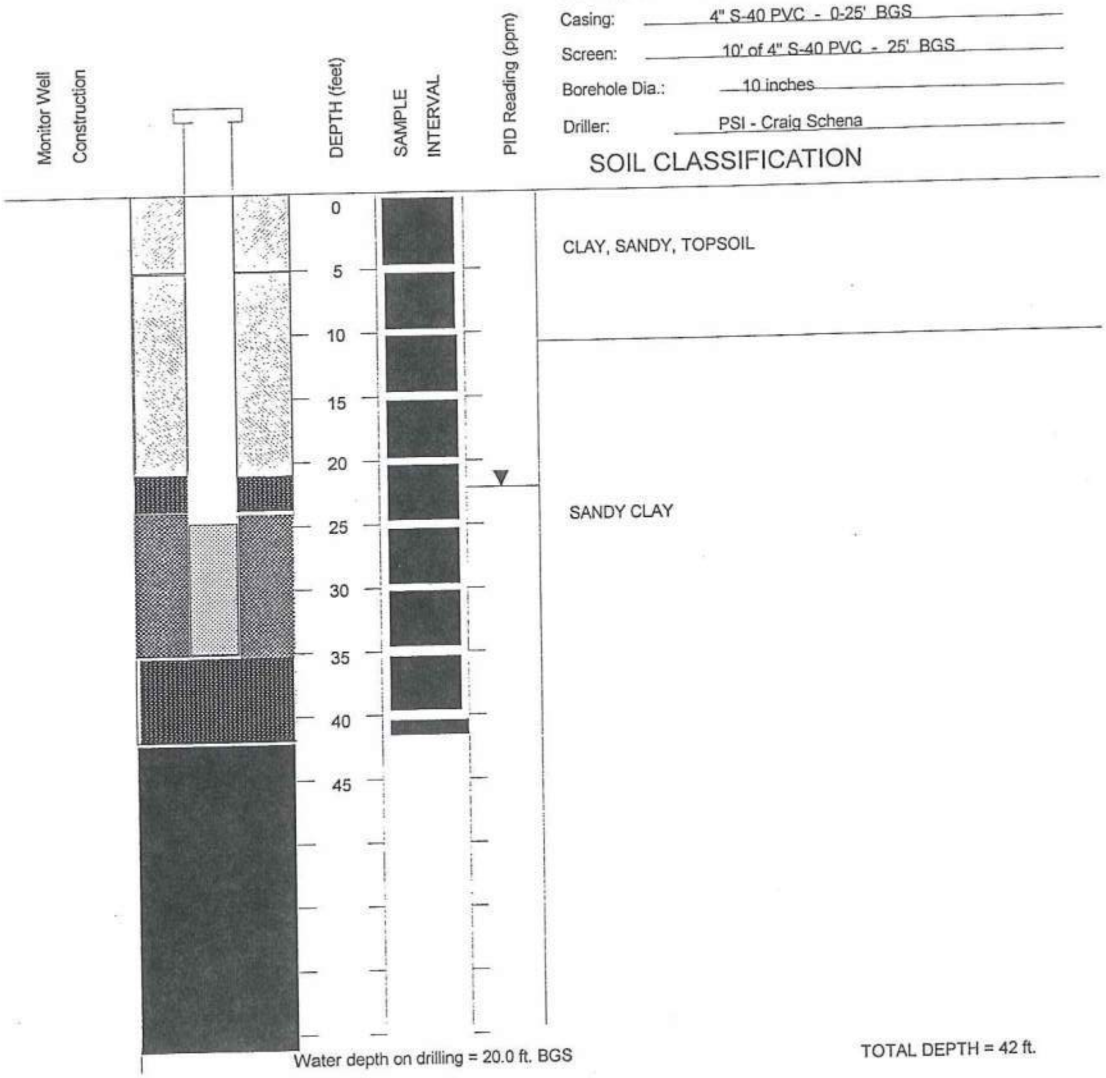
SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 27' 09" LONG: 97° 48' 56.2"
MSWLF ID: Permit #235-B

Boring/Well No.: 14
Date Drilled: July 8, 1997
Boring Method: Hollow Stem Auger
Sample Method: 5 foot core barrel
Surface Elevation: 49.94' MSL
Depth to Water: 22' BGS
Total Depth: 42' BGS
Casing: 4" S-40 PVC - 0-25' BGS
Screen: 10' of 4" S-40 PVC - 25' BGS
Borehole Dia.: 10 inches
Driller: PSI - Craig Schena



Water depth on drilling = 20.0 ft. BGS

TOTAL DEPTH = 42 ft.

B-15

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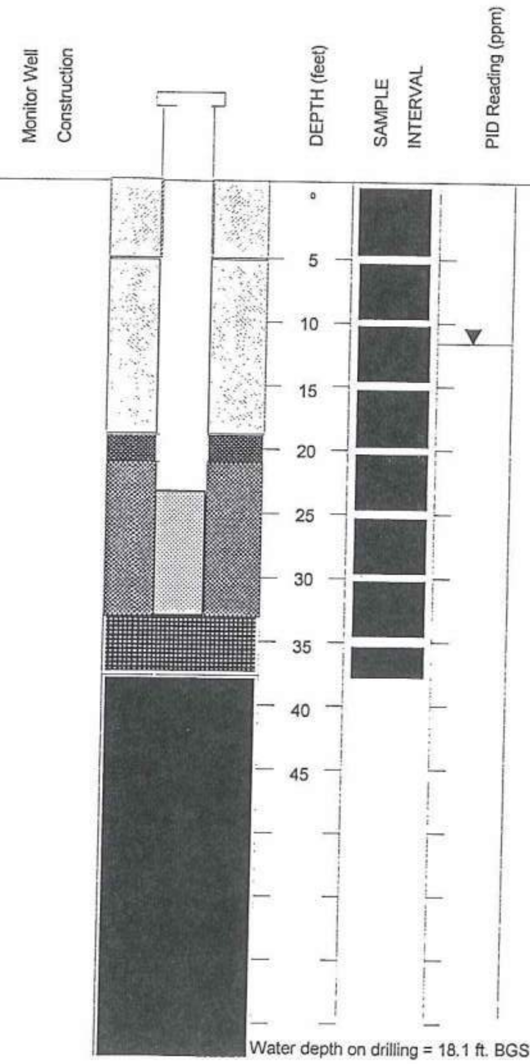
PAGE _1_ OF _1_

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 27' 08.7" LONG: 97° 49' 23.7"
MSWLF ID: Permit #235-B

Boring/Well No.: 15
Date Drilled: July 8, 1997
Boring Method: Hollow Stem Auger
Sample Method: 5 foot core barrel
Surface Elevation: 48.39' MSL
Depth to Water: 12' BGS
Total Depth: 37' BGS
Casing: 4" S-40 PVC - 0-23' BGS
Screen: 10' of 4" S-40 PVC - 23' BGS
Borehole Dia.: 10 inches
Driller: PSI - Craig Schena



SOIL CLASSIFICATION

SANDY CLAY
BRN-LT BRN CLAY WITH SAND TO TOTAL DEPTH

TOTAL DEPTH = 37 ft.

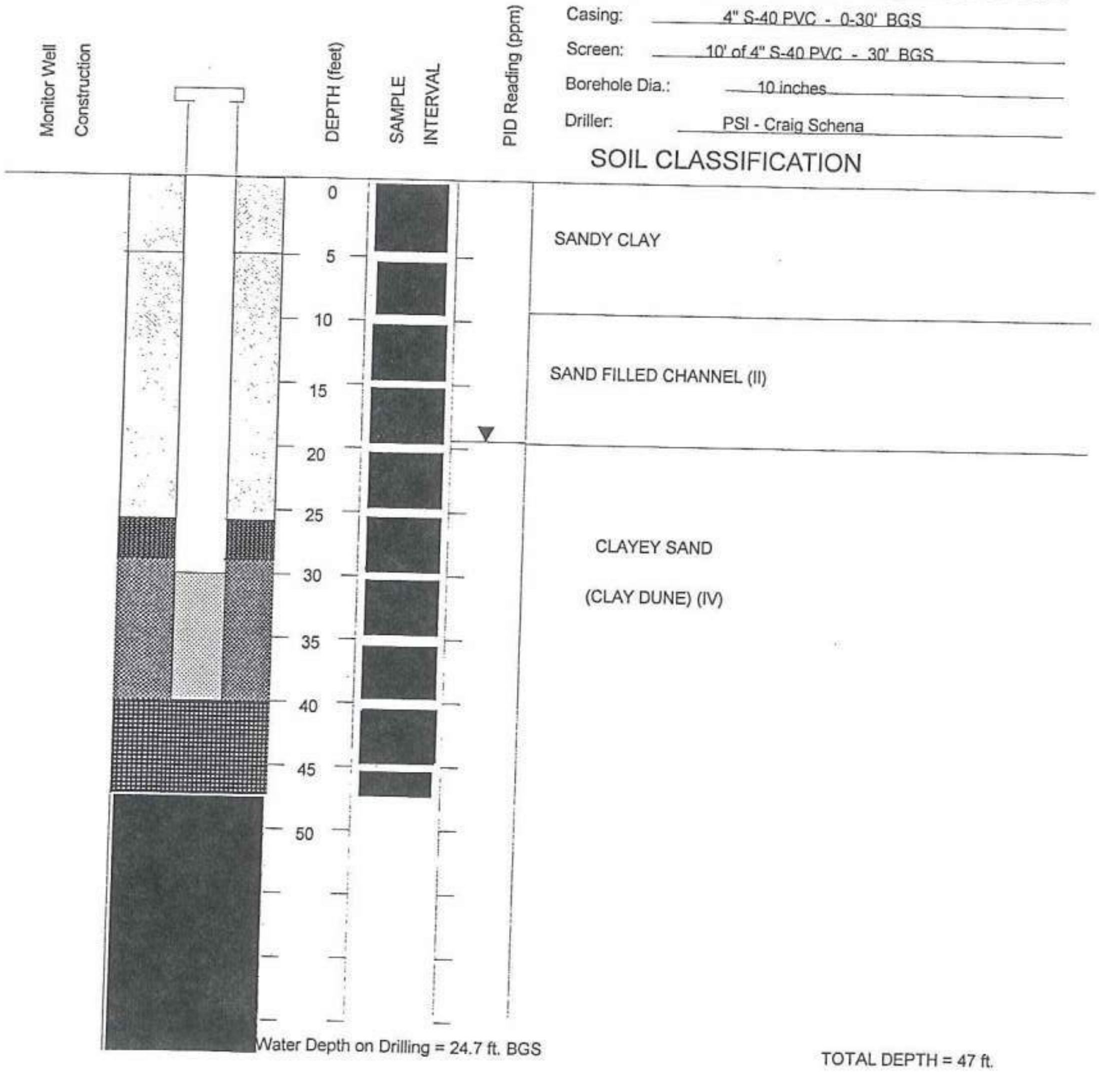
B-16

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073
(512) 592-9810 (512) 592-5552 FAX

PAGE _1_ OF _1_

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville
Project Name:	Kingsville Landfill
Project Location:	5 mi. SE of City
LAT: 27° 26' 55.3" LONG: 97° 49' 23.5"	
MSWLF ID:	Permit #235-B
Boring/Well No.:	16
Date Drilled:	July 10, 1997
Boring Method:	Hollow Stem Auger
Sample Method:	5 foot core barrel
Surface Elevation:	55.96' MSL
Depth to Water:	19' BGS
Total Depth:	47' BGS
Casing:	4" S-40 PVC - 0-30' BGS
Screen:	10' of 4" S-40 PVC - 30' BGS
Borehole Dia.:	10 inches
Driller:	PSI - Craig Schena



B-17

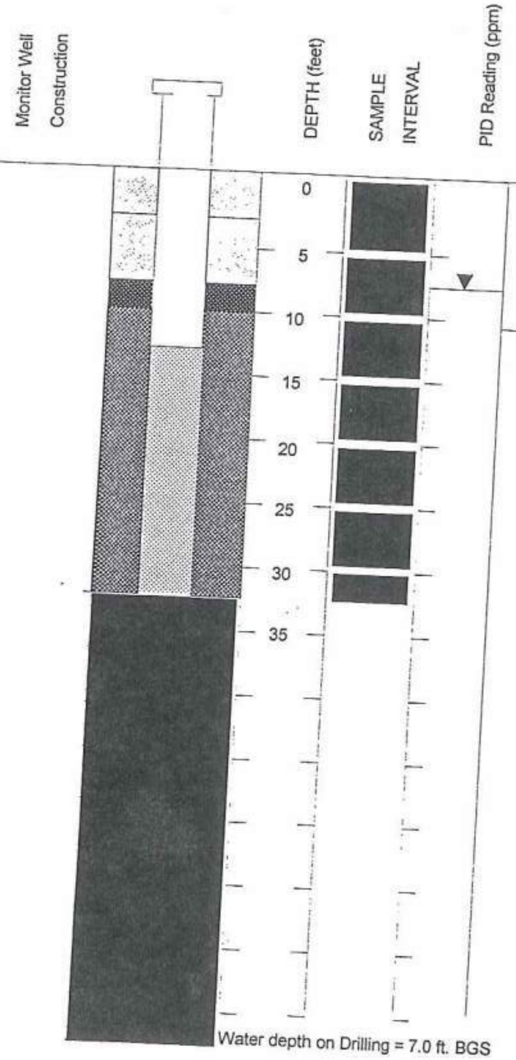
FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073
(512) 592-9810 (512) 592-5552 FAX

PAGE _1_ OF _1_

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 27' 01.3" LONG: 97° 49' 16.4 "
MSWLF ID: Permit #235-B

Boring/Well No.: 17
Date Drilled: July 9, 1997
Boring Method: Hollow Stem Auger
Sample Method: 5 foot core barrel
Surface Elevation: 41.35' MSL
Depth to Water: 7' BGS
Total Depth: 33' BGS
Casing: 2" S-40 PVC - 0-13' BGS
Screen: 20' of 2" S-40 PVC - 13' BGS
Borehole Dia.: 6 inches
Driller: PSI - Craig Schena



SOIL CLASSIFICATION

SAND FILLED CHANNEL (II)

SANDY CLAY

BRN-LT BRN CLAY WITH SAND

Water depth on Drilling = 7.0 ft. BGS

TOTAL DEPTH = 33 ft.

B-18

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
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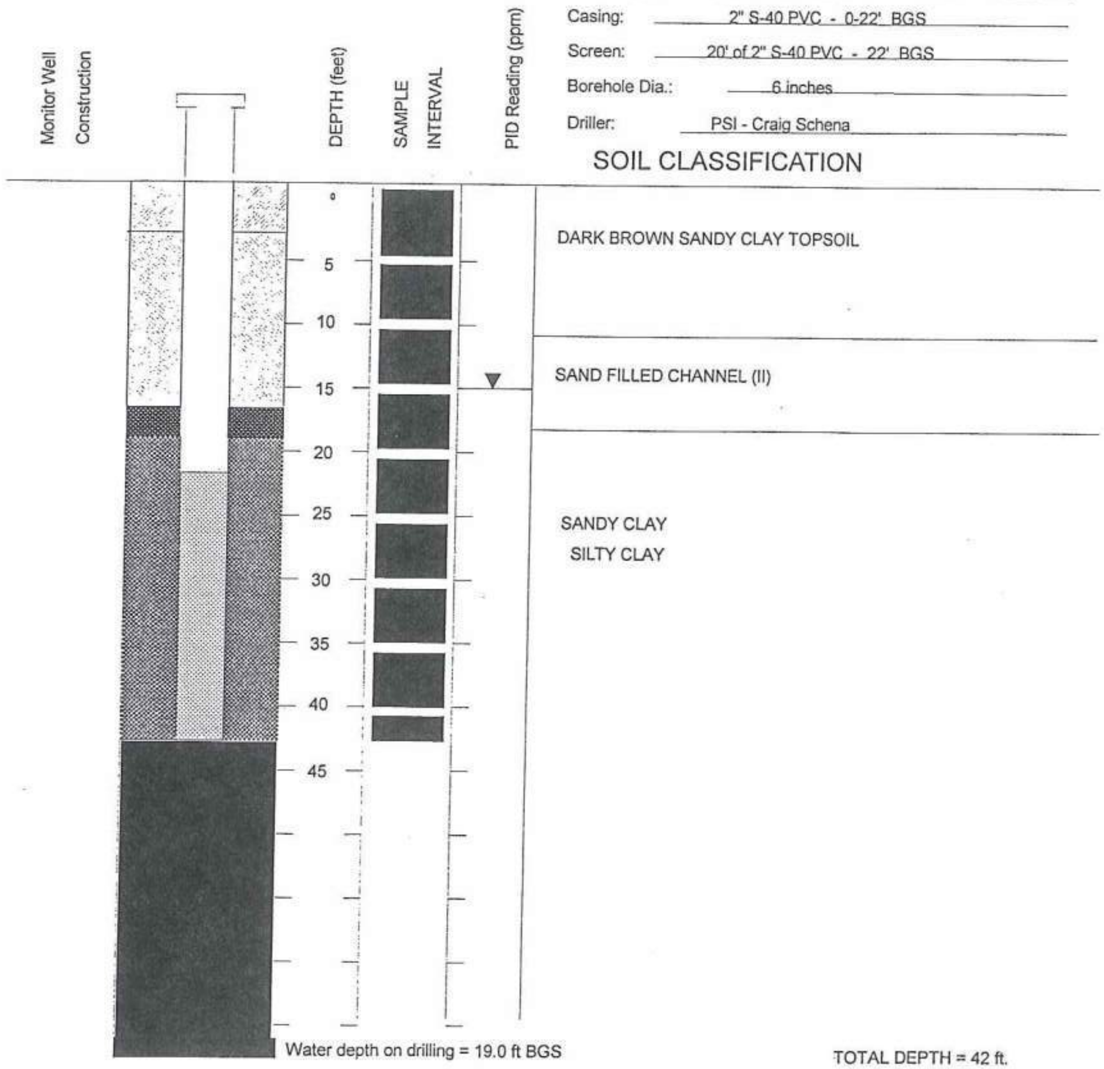
(512) 592-9810 (512) 592-5552 FAX

PAGE _1_ OF _1_

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi. SE of City
LAT: 27° 27' 01.4" LONG: 97° 49' 04 "
MSWLF ID: Permit #235-B

Boring/Well No.: 18
Date Drilled: July 9, 1997
Boring Method: Hollow Stem Auger
Sample Method: 5 foot core barrel
Surface Elevation: 50.04' MSL
Depth to Water: 15' BGS
Total Depth: 42' BGS
Casing: 2" S-40 PVC - 0-22' BGS
Screen: 20' of 2" S-40 PVC - 22' BGS
Borehole Dia.: 6 inches
Driller: PSI - Craig Schena



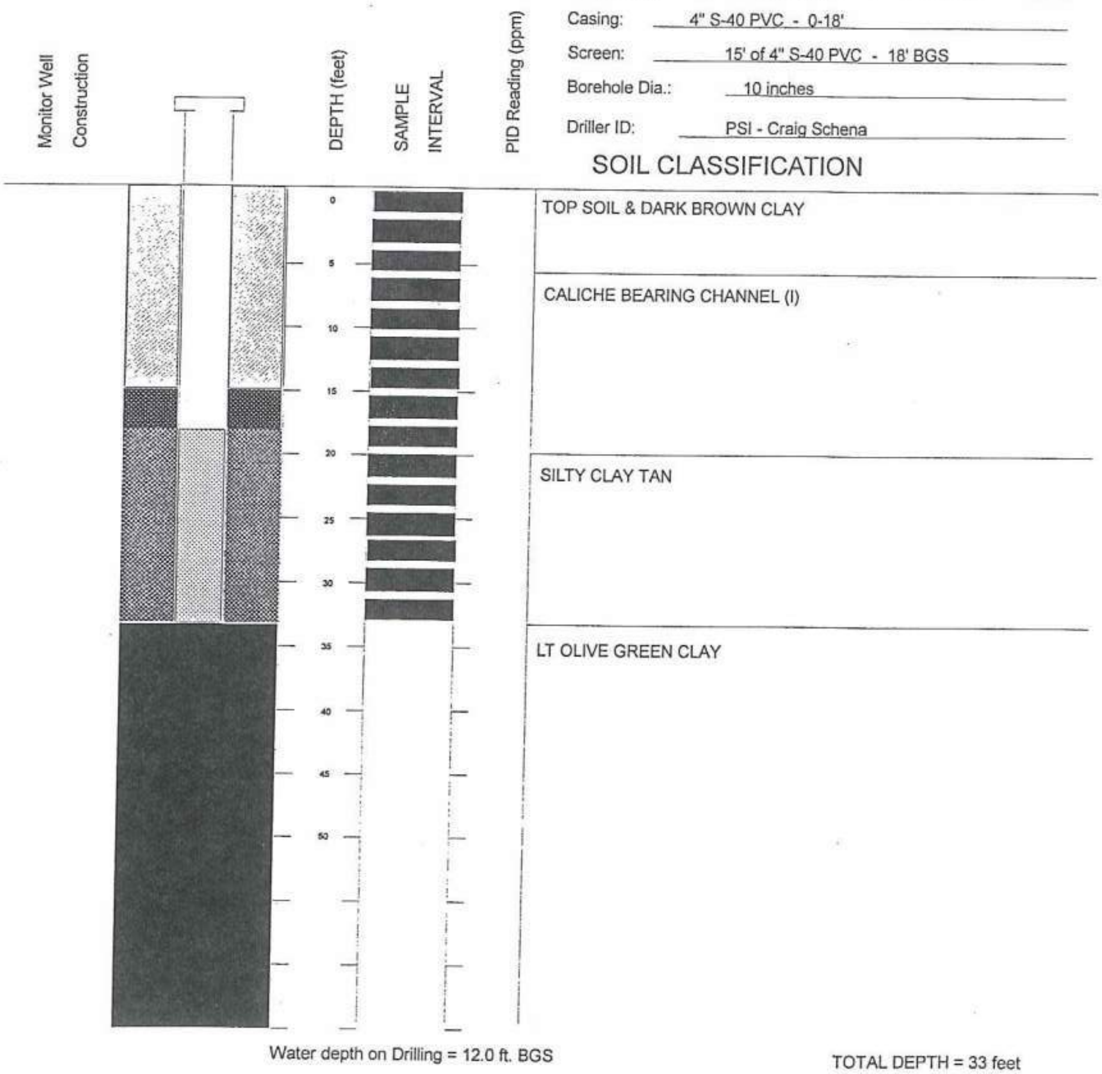
B-19

PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville	Boring/Well No.:	24
Project Name:	Kingsville Landfill	Date Drilled:	April 30, 1998
Project Location:	5 mi SE of City	Boring Method:	HOLLOW STEM AUGER
LAT: 27• 26' 41.9" LONG: 97• 48' 48.9"		Sample Method:	Shelby Tube
MSWLF ID:	Permit #235-B	Surface Elevation:	47.38' MSL
		Depth to Water:	12.58' BGS
		Total Depth:	33' BGS
		Casing:	4" S-40 PVC - 0-18'
		Screen:	15' of 4" S-40 PVC - 18' BGS
		Borehole Dia.:	10 inches
		Driller ID:	PSI - Craig Schena



B-20

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
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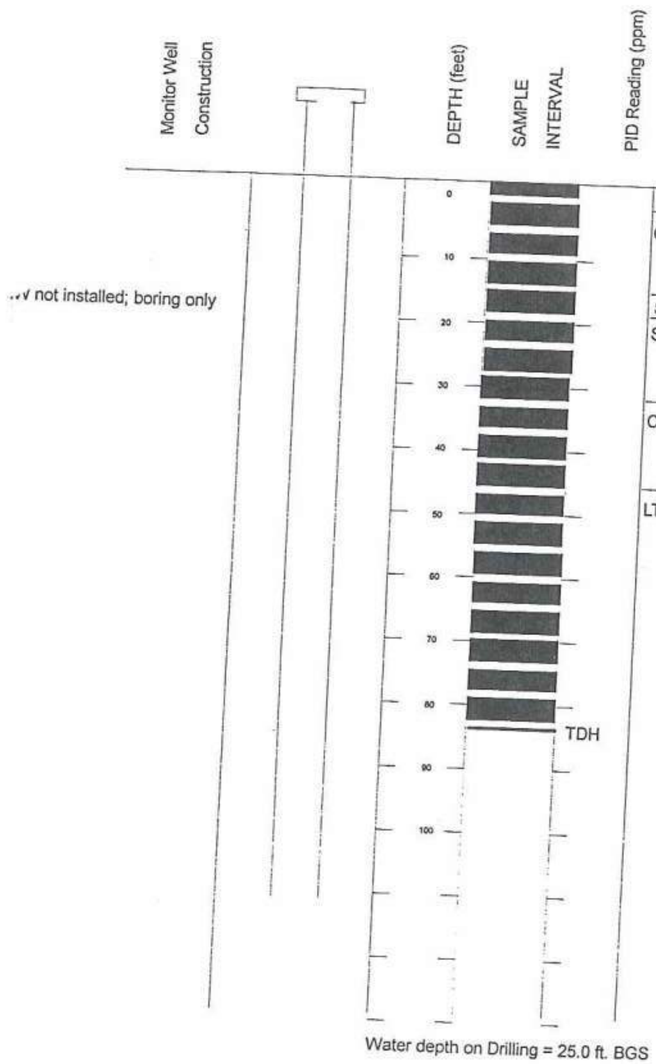
PAGE _1_ OF _1_

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City
LAT: 27° 26' 09" LONG: 97° 48' 47.6"
MSWLF ID: Permit #235-B

Boring/Well No.: 21
Date Drilled: April 27, 1998
Boring Method: HOLLOW STEM AUGER
Sample Method: Shelby Tube
Surface Elevation: 52.41' MSL
Depth to Water: 17.8' BGS
Total Depth: 84' BGS
Casing:
Screen:
Borehole Dia.: 6 inch
Driller ID: PSI - Craig Schena



SOIL CLASSIFICATION

Dark Brown Sand Clay - Topsoil
Caliche Bearing Channel (I)
Sand Filled Channel (II)
Sandy Clay
Clayey Sand (Clay Dune)
LT OLIVE GREEN CLAY

TOTAL DEPTH = 84 feet

B-21

PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City
LAT: 27° 27' 01.4" LONG: 97° 48' 28.2"
MSWLF ID: Permit #235-B

Boring/Well No.: 23
Date Drilled: April 24, 1998
Boring Method: HOLLOW STEM AUGER
Sample Method: Shelby Tube
Surface Elevation: 49.50' MSL
Depth to Water: 8.8' BGS
Total Depth: 86' BGS
Casing:
Screen:
Borehole Dia.: 6 inch
Driller ID: PSI - Craig Schena

Monitor Well Construction	DEPTH (feet)	SAMPLE INTERVAL	PID Reading (ppm)	SOIL CLASSIFICATION
√ not installed; boring only	0			CALICHE BEARING CHANNEL (I)
	10			
	20			SAND FILLED CHANNEL (II)
				CLAYEY SAND (CLAY DUNE)
	30			
	40			LT OLIVE GREEN CLAY
	50			
	60			
	70			
	80			
		TDH		
	90			
	100			

Water depth on Drilling = 25.0 ft. BGS

TOTAL DEPTH = 86 feet

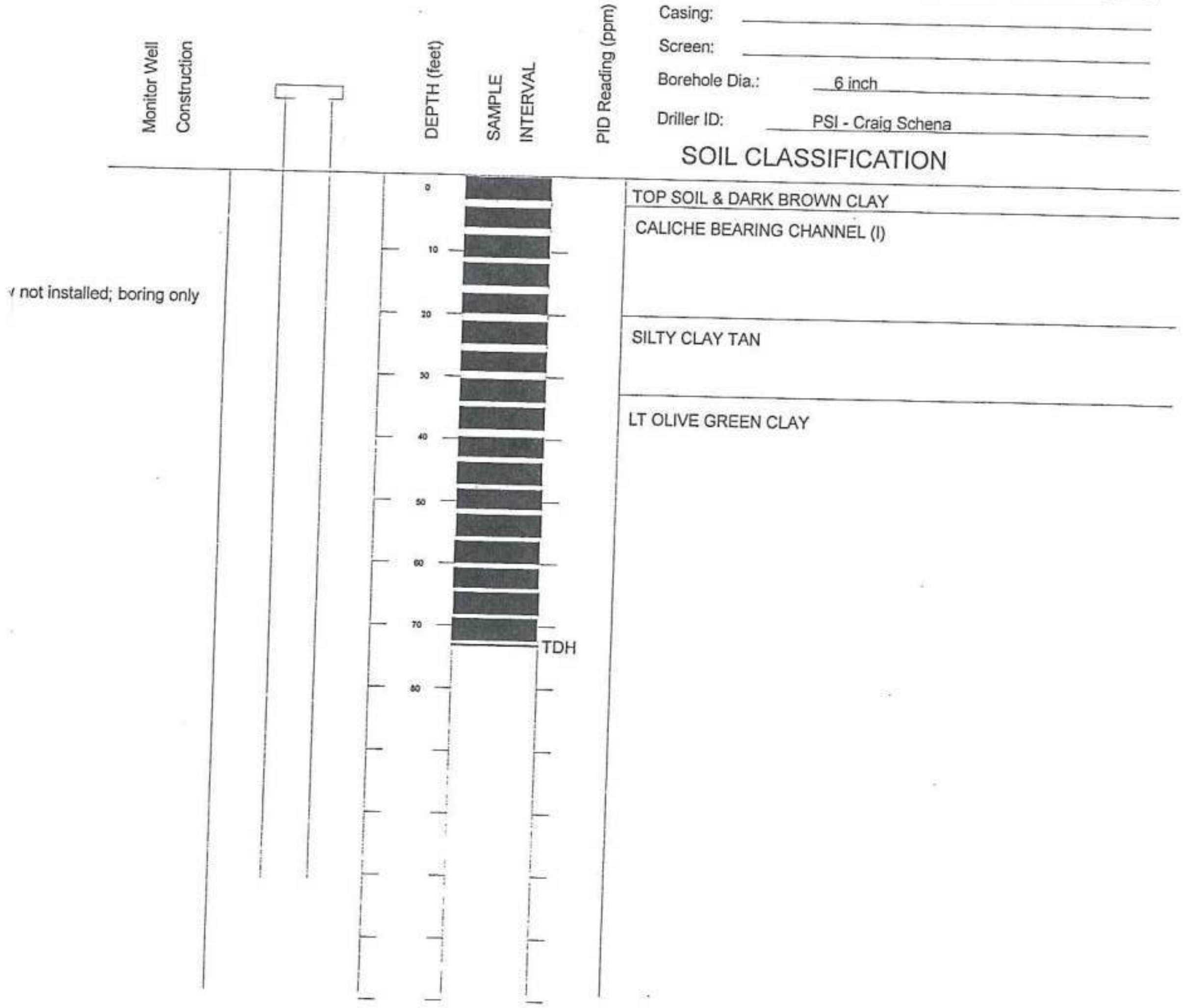
B-22

PAGE _1_ OF _1_

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
P.O. Box 73, Kingsville, Texas 78364-0073

SUBSURFACE EXPLORATION RECORD

Client:	City of Kingsville	Boring/Well No.:	24
Project Name:	Kingsville Landfill	Date Drilled:	April 30, 1998
Project Location:	5 mi SE of City	Boring Method:	HOLLOW STEM AUGER
LAT: 27° 26' 41.9"	LONG: 97° 48' 48.9"	Sample Method:	Shelby Tube
MSWLF ID:	Permit #235-B	Surface Elevation:	47.38' MSL
		Depth to Water:	10.0' BGS
		Total Depth:	72 ' BGS
		Casing:	
		Screen:	
		Borehole Dia.:	6 inch
		Driller ID:	PSI - Craig Schena



Water depth on Drilling = 12.0 ft. BGS

TOTAL DEPTH = 72 feet

B-23

PAGE 1 OF 1

FINCH ENERGY AND ENVIRONMENTAL SERVICES, Inc.
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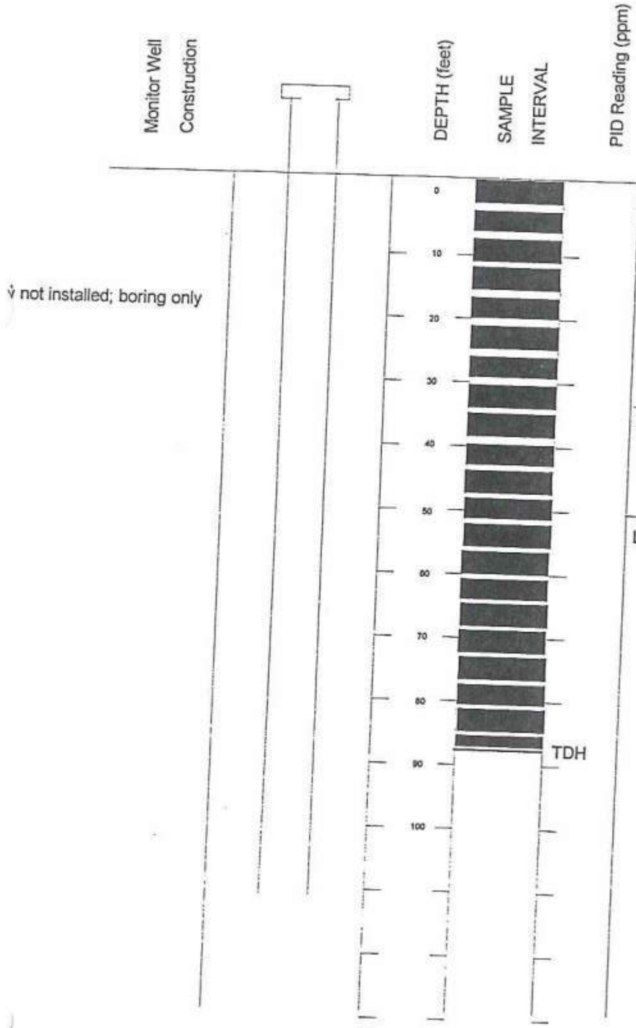
SUBSURFACE EXPLORATION RECORD

Client: City of Kingsville
Project Name: Kingsville Landfill
Project Location: 5 mi SE of City
LAT: 27° 26' 55.2" LONG: 97° 48' 41.8"
MSWLF ID: Permit #235-B

Boring/Well No.: 25
Date Drilled: April 29, 1998
Boring Method: HOLLOW STEM AUGER
Sample Method: SPLIT SPOON
Surface Elevation: 61.12' MSL
Depth to Water: 21.1' BGS
Total Depth: 88' BGS
Casing:
Screen:
Borehole Dia.: 6 inch
Driller ID: PSI - Craig Schena



SOIL CLASSIFICATION

TOP SOIL & DARK BROWN CLAY

CALICHE BEARING CHANNEL (I)

SAND FILLED CHANNEL (II)

SANDY CLAY

LT OLIVE GREEN CLAY

Water depth on Drilling = 31.0 ft. BGS

TOTAL DEPTH = 88 feet

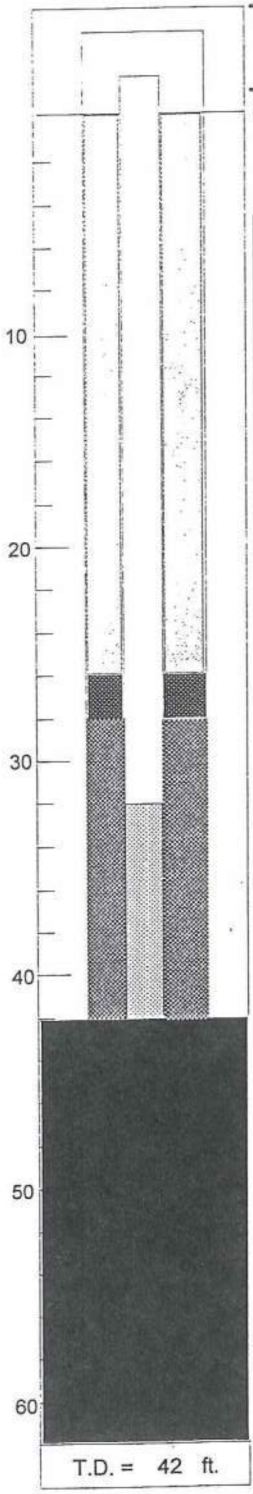
B-24

APPENDIX C

APPENDIX C

PIEZOMETER CONSTRUCTION and DEVELOPMENT SUMMARIES

November 1997
Revision 1 - June 1998



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 1 Boring #: 1

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

SURVEY COORDS:
N: 27 ° 26' 42.2"
E: 97 ° 49' 10.6"

SURFACE ELEVATION: 59.25' MSL
TOP OF CASING ELEV: 61.87' MSL

DRILLING SUMMARY:

Total Depth: 42' BGS
Borehole Diameter: 6"
Casing Stick-up: 2.62
Driller: TETCO - Younger

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drilling	6-19-84		6-19-84	

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)

C1: 2" S-40 PVC - 0-32' BGS
S1: 10' of 2" S-40 PVC - 32' BGS

Filter Pack: 28' - 42'
Fine Sand:
Grout Seal: 0 - 26'
Bentonite Seal: 26' - 28'

WELL DEVELOPMENT:

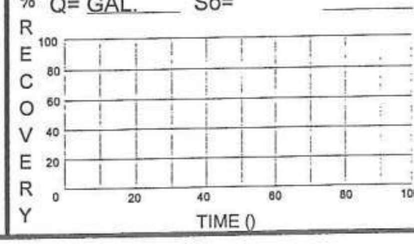
Unknown

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

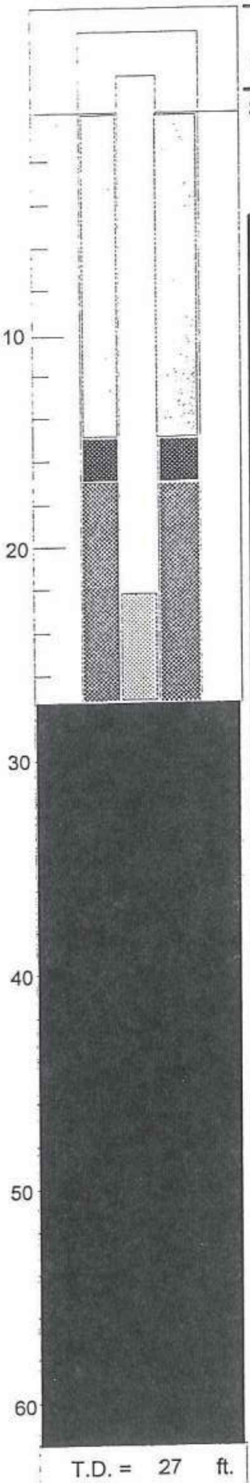
RECOVERY DATA:

% Q= GAL. So=



COMMENTS: Drilled and Constructed by REI

C-1



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 2 Boring #: 2

SURVEY COORDS:
N:
E:

SURFACE ELEVATION: 52.64 ' MSL
TOP OF CASING ELEV:

DRILLING SUMMARY:

Total Depth: 27' BGS
Borehole Diameter: 6'
Casing Stick-up:
Driller: TETCO - Younger

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drilling	10-6-84		10-6-84	
P&A	07-91			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)

C1: 2"S-40PVC - 0-22' BGS
S1: 5' - 2" S-40PVC - 22' BGS

Filter Pack: 15' - 27'
Fine Sand:
Grout Seal: 0 - 13'
Bentonite Seal: 13' - 15'

WELL DEVELOPMENT:

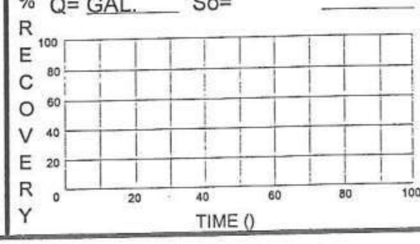
Unknown

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

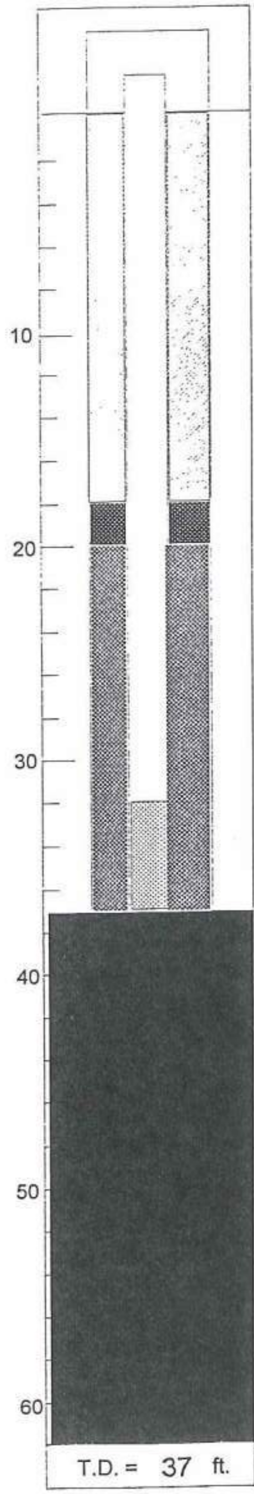
Q= GAL. So=



COMMENTS: Drilled and Constructed by REI

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-2



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 3 Boring #: 3

SURVEY COORDS:
N: 27°26' 50.3"
E: 97°49' 03.9"

SURFACE ELEVATION: 56.10' MSL
TOP OF CASING ELEV: 59.17' MSL

DRILLING SUMMARY:

Total Depth: 37' BGS
Borehole Diameter: 6"
Casing Stick-up: 3.07'
Driller: TETCO - Younger

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill	10-3-84		10-3-84	

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/

C1: 2" S-40PVC - 0-32' BGS
S1: 5' - 2"S-40PVC - 32' BGS

Filter Pack: 20'- 37'
Fine Sand:
Grout Seal: 0 - 18'
Bentonite Seal: 18' - 20'

WELL DEVELOPMENT:

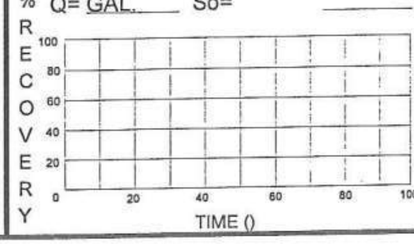
Unknown

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

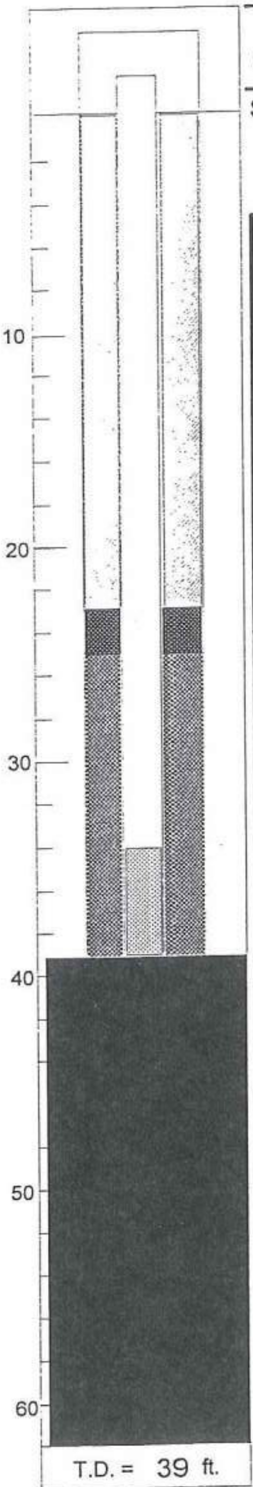
% Q= GAL. So=



COMMENTS: Drilled and Constructed by REI

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-3



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 4 Boring #: 4

SURVEY COORDS:
N: 27° 26' 55.2"
E: 97° 49' 03.9"

SURFACE ELEVATION: 58.01' MSL
TOP OF CASING ELEV: 60.13' MSL

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

DRILLING SUMMARY:

Total Depth: 39' BGS
Borehole Diameter: 6"
Casing Stick-up: 2.12'
Driller: TETCO - Younger

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	10-03-84			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/

C1: 2"S-40PVC - 0-34' BGS
S1: 5' - 2"S-40PVC - 34' BGS

Filter Pack: 20' - 39'
Fine Sand:
Grout Seal: 0 - 23'
Bentonite Seal: 23' - 25'

WELL DEVELOPMENT:

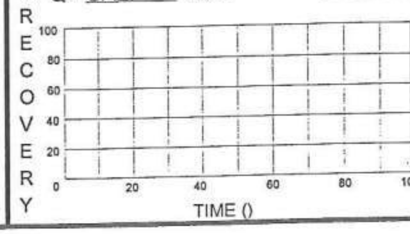
Unknown

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

% Q= GAL. So=



COMMENTS: Drilled and Constructed by REI

C-4

PIEZOMETER CONSTRUCTION SUMMARY

Well #: 5 Boring #: 5

SURVEY COORDS:
N:
E:

SURFACE ELEVATION: 60.54' MSL
TOP OF CASING ELEV:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

DRILLING SUMMARY:

Total Depth: 48' BGS
Borehole Diameter: 6"
Casing Stick-up:
Driller: TETCO - Younger

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	10-05-84			
P&A:	10-06-84			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

Filter Pack:
Fine Sand:
Grout Seal:
Bentonite Seal:

WELL DEVELOPMENT:

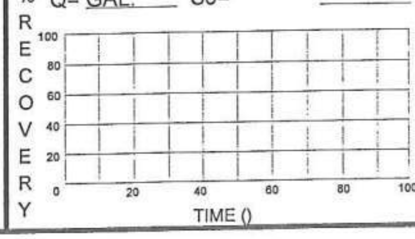
Not Applicable

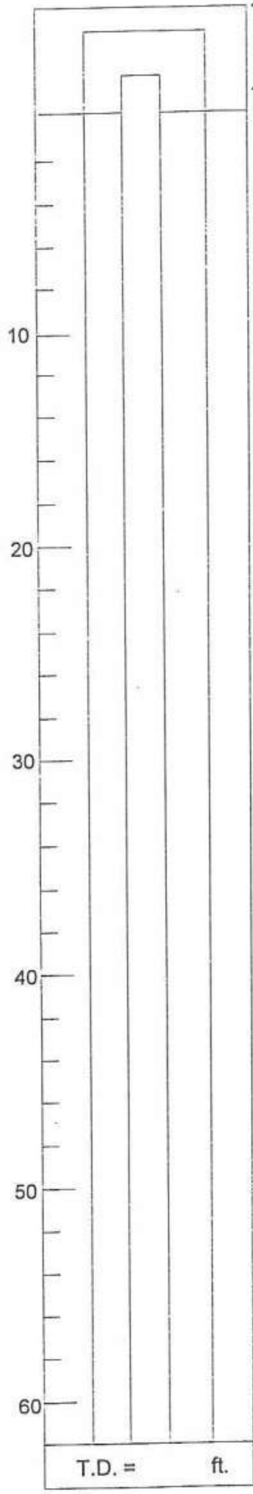
STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

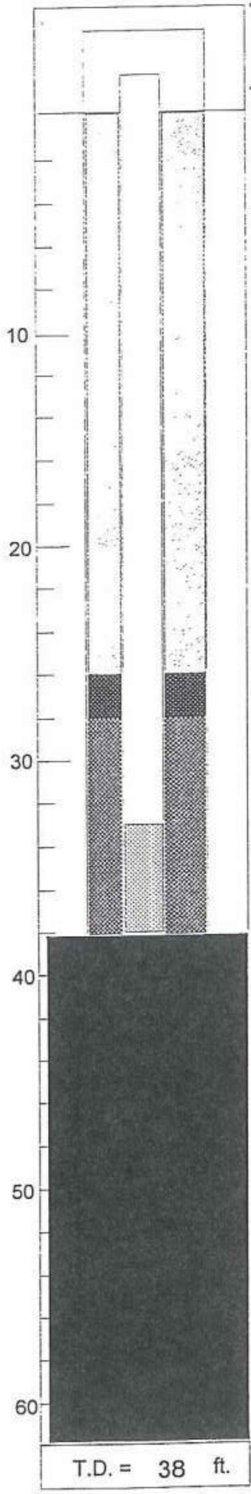
Q= GAL. So=





COMMENTS: Drilled by REI - P&A'd next day

C-5



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 6 Boring #: 6

SURVEY COORDS:
N: 27° 27' 09.2"
E: 97° 49' 09.9"

SURFACE ELEVATION: 55.46' MSL
TOP OF CASING ELEV: 56.60' MSL

DRILLING SUMMARY:

Total Depth: 38' BGS
Borehole Diameter: 6"
Casing Stick-up: 2.95'
Driller: TETCO - Younger

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	10-03-84			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)

C1: 2"S-40PVC - 0-33' BGS
S1: 5'-2"S-40PVC - 33' BGS

Filter Pack: 28' - 38'
Fine Sand:
Grout Seal: 0 - 26'
Bentonite Seal: 26' - 28'

WELL DEVELOPMENT:

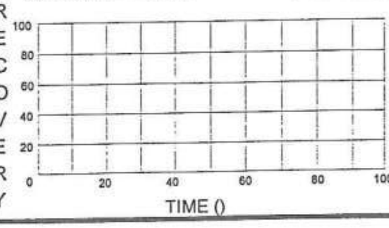
Unknown

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

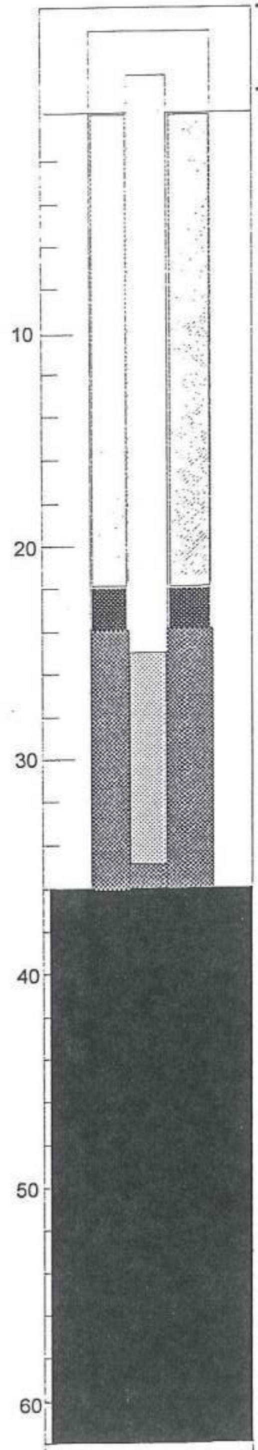
% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-6



T.D. = 36 ft.

PIEZOMETER CONSTRUCTION SUMMARY

Well #: 7 Boring #: 7

SURVEY COORDS:
N: 27° 26' 43.9"
E: 97° 49' 23.3"

SURFACE ELEVATION: 61.05' MSL
TOP OF CASING ELEV: 61.8' MSL

DRILLING SUMMARY:

Total Depth: 36' BGS
Borehole Diameter: 6.5"
Casing Stick-up: 0.75'
Driller: Martin Water Wells

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	08-90			
P&A:	07-91			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1:
S1:

Filter Pack: 24' - 36'
Fine Sand:
Grout Seal: 0 - 22'
Bentonite Seal: 22' - 24'

WELL DEVELOPMENT:

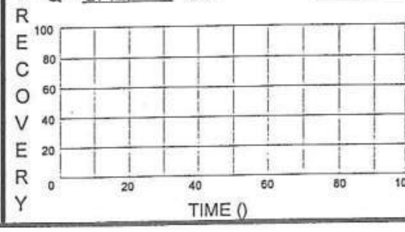
Unknown

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

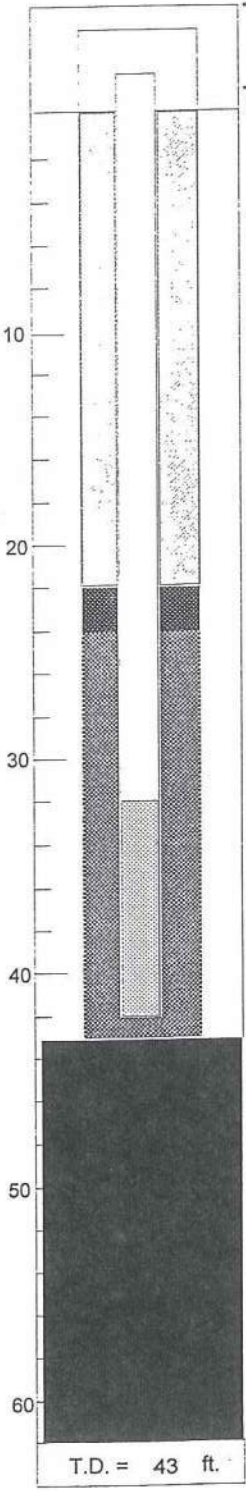
% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-7



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 8 Boring #: 8

SURVEY COORDS:
N: 27°26' 43.9"
E: 97°49' 23.3"

SURFACE ELEVATION: 59.79' MSL
TOP OF CASING ELEV: 61.18' MSL

DRILLING SUMMARY:

Total Depth: 43' BGS
Borehole Diameter: 10"
Casing Stick-up: 1.39'
Driller: Martin Water Well

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-23-91			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/

C1: 4"S-40PVC - 0-32' BGS
S1: 10'-4"S-40PVC - 32' BGS

Filter Pack: 24' - 43'
Fine Sand:
Grout Seal: 0 - 22'
Bentonite Seal: 22' - 24'

WELL DEVELOPMENT:

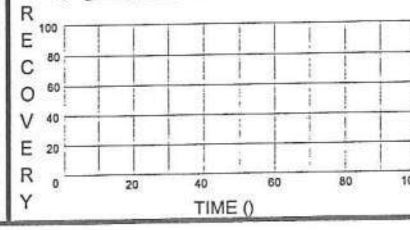
Bailed

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

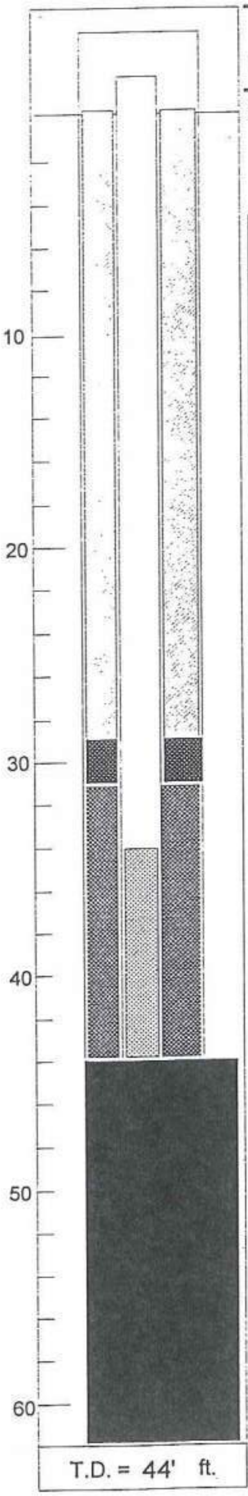
% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-8



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 9 Boring #: 9

SURVEY COORDS:
N: 27 27' 54.0"
E: 97 49' 20.1"

SURFACE ELEVATION: 62.51' MSL
TOP OF CASING ELEV:

DRILLING SUMMARY:

Total Depth: 44' BGS
Borehole Diameter: 10.0"
Casing Stick-up:
Driller: JEDI

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill	3-24-92		3-24-92	
P&A	7-11-96		7-11-96	

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-34' BGS
S1: 10'-4"S-40PVC - 34' BGS

Filter Pack: 31' - 44'
Fine Sand:
Grout Seal: 0 - 29'
Bentonite Seal: 29' - 31'

WELL DEVELOPMENT:

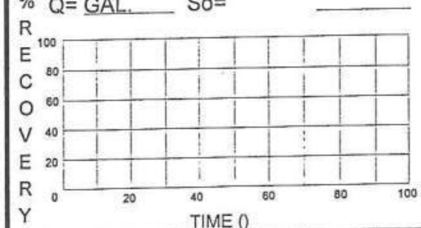
Bailed

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

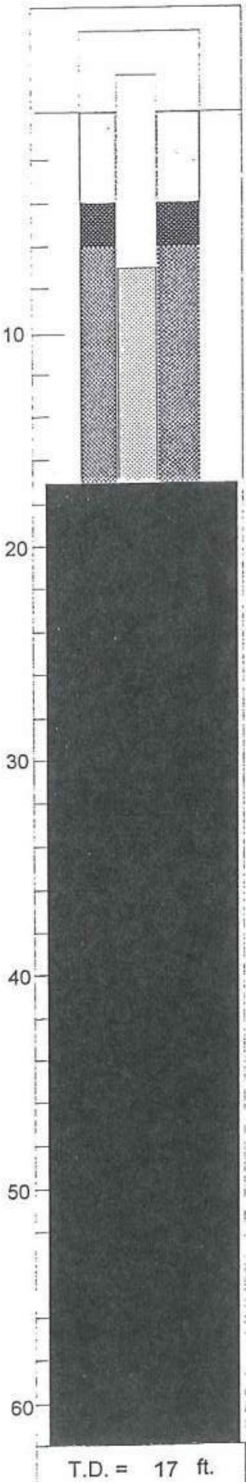
Q= GAL. So=



COMMENTS: Monitor Well was Plugged and Abandoned.
The well was replaced with MW-9R

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-9



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 9R Boring #: 9R

SURVEY COORDS:
N: 27° 26' 57.2"
E: 97° 49' 20.1"

SURFACE ELEVATION: 41.41'
TOP OF CASING ELEV: 44.85'

DRILLING SUMMARY:

Total Depth: 17' BGS
Borehole Diameter: 10.0"
Casing Stick-up: 3.44'
Driller: JEDI

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-11-96			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)

C1: 4"S-40PVC - 0-7' BGS
S1: 10'-4"S-40PVC - 7' BGS

Filter Pack: 6' - 17'
Fine Sand:
Grout Seal: 0 - 4'
Bentonite Seal: 4' - 6'

WELL DEVELOPMENT:

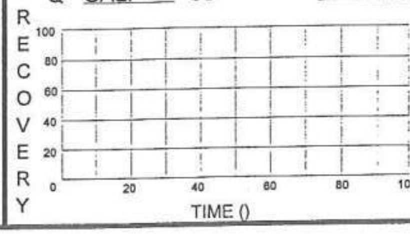
Bailed

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

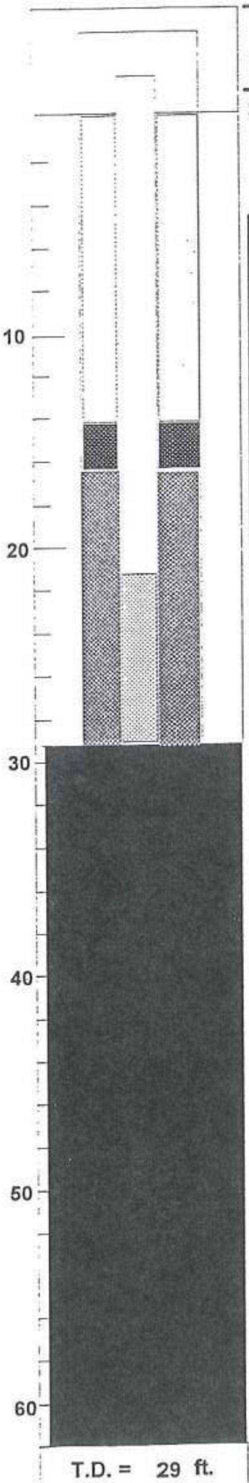
% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-10



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 10 Boring #: 10

SURVEY COORDS:

N: 27° 26' 55.2"

E: 97° 49' 15.3"

SURFACE ELEVATION: 49.78' MSL

TOP OF CASING ELEV: 52.68' MSL

DRILLING SUMMARY:

Total Depth: 29' BGS
Borehole Diameter: 10.0"
Casing Stick-up: 2.90'
Driller: JEDI - Charles Jones

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	03-20-92			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-19' BGS

S1: 10'-4"S-40PVC - 19' BGS

Filter Pack: 16.5' - 29'

Fine Sand:

Grout Seal: 0 - 14.5'

Bentonite Seal: 14.5' - 16.5'

WELL DEVELOPMENT:

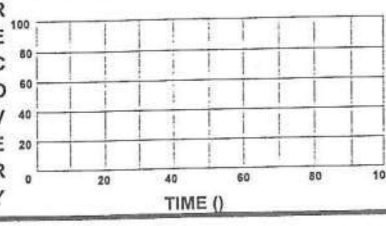
Bailed

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

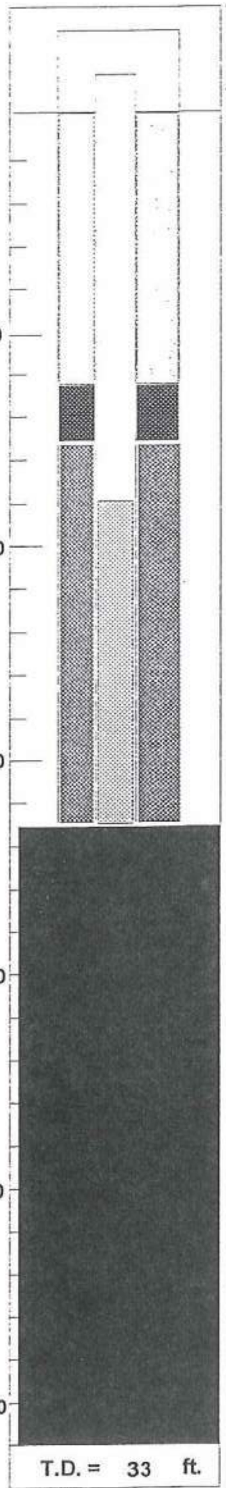
% RECOVERY Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-11



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 11 Boring #: 11

SURVEY COORDS:

N: 27° 26' 57.0"

E: 97° 49' 10.0"

SURFACE ELEVATION: 60.2' MSL

TOP OF CASING ELEV: 62.4' MSL

DRILLING SUMMARY:

Total Depth: 33' BGS
Borehole Diameter: 10"
Casing Stick-up: 2.2'
Driller: PSI

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill	07-11-96			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-18' BGS

S1: 15'-4"S-40 PVC - 18' BGS

Filter Pack: 16' - 33'
Fine Sand:
Grout Seal: 0 - 14'
Bentonite Seal: 14' - 16'

WELL DEVELOPMENT:

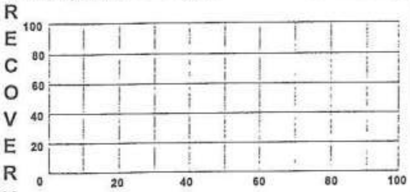
Bailed

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

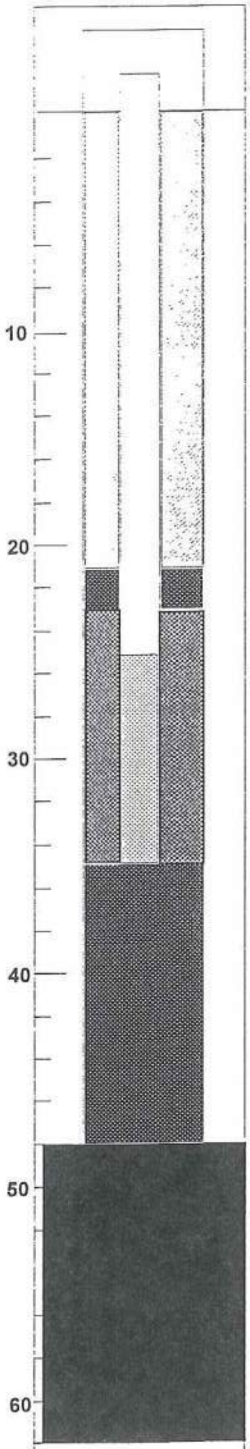
% RECOVERY Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-12



T.D. = 48 ft.

PIEZOMETER CONSTRUCTION SUMMARY

Well #: 12 Boring #: 12

SURVEY COORDS:
N: 27°26' 41.9"
E: 97°48' 55.9"

SURFACE ELEVATION: 52.38' MSL
TOP OF CASING ELEV: 54.88' MSL

DRILLING SUMMARY:

Total Depth: 48' BGS
Borehole Diameter: 10.0"
Casing Stick-up: 2.4 '
Driller: PSI - Craig Schena

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-07-97			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-25' BGS

S1: 10'-4"S-40PVC - 25' BGS

Filter Pack: 23' - 35'
Fine Sand:
Grout Seal: 0 - 21'
Bentonite Seal: 21' - 23'

WELL DEVELOPMENT:

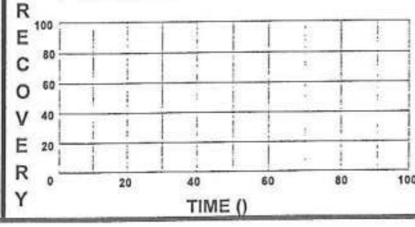
Jet Educted

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

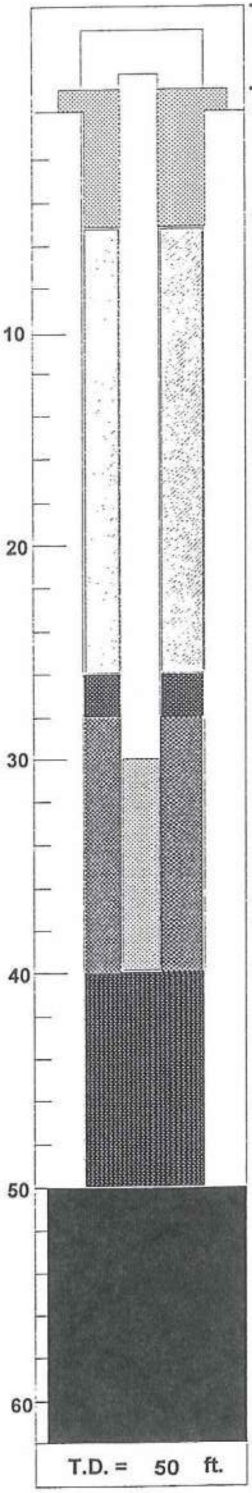
% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-13



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 13 Boring #: 13

SURVEY COORDS:
N: 27° 26' 55.7"
E: 97° 48' 56.0"

SURFACE ELEVATION: 59.13' MSL
TOP OF CASING ELEV: 62.10' MSL

DRILLING SUMMARY:

Total Depth: 50' BGS
Borehole Diameter: 10"
Casing Stick-up: 2.97'
Driller: PSI

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-28-97			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-30' BGS

S1: 10'-4"S-40 PVC - 30' BGS

Filter Pack: 28' - 40'
Fine Sand:
Grout Seal: 5' - 26'
Bentonite Seal: 26' - 28'

WELL DEVELOPMENT:

Jet Educted

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

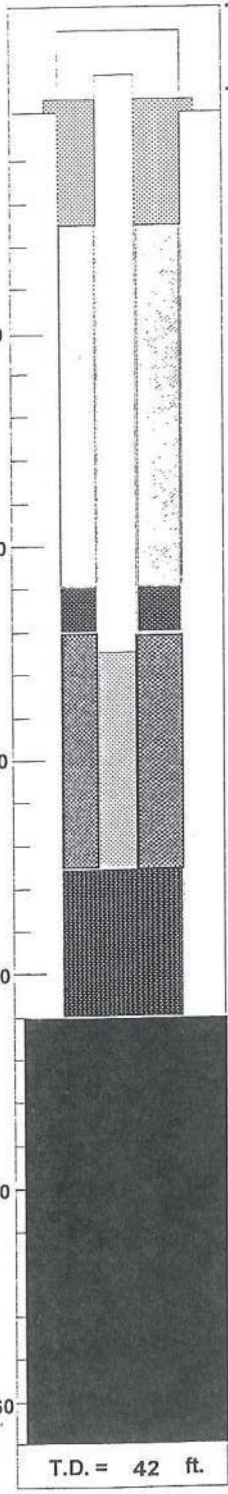
% RECOVERY Q= GAL. So=

RECOVERY: 0, 20, 40, 60, 80, 100
TIME (): 20, 40, 60, 80, 100

COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-14



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 14 Boring #: 14

SURVEY COORDS:
N: 27° 27' 9.0"
E: 97° 48' 56.2"

SURFACE ELEVATION: 49.94' MSL
TOP OF CASING ELEV: 52.68' MSL

DRILLING SUMMARY:

Total Depth: 42' BGS
Borehole Diameter: 10.0"
Casing Stick-up: 2.74'
Driller: PSI - Craig Schena

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-08-98			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-25' BGS
S1: 10'-4"S-40PVC - 25' BGS

Filter Pack: 24' - 35'
Fine Sand:
Grout Seal: 5' - 22'
Bentonite Seal: 22' - 24'

WELL DEVELOPMENT:

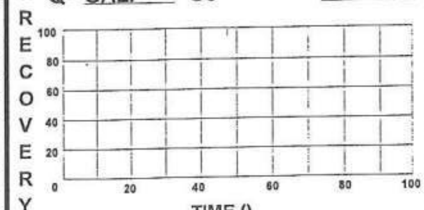
Jet Educted

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

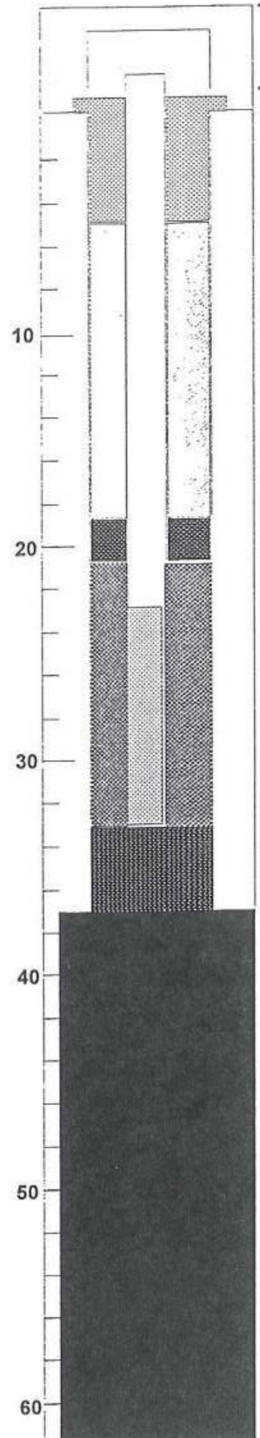
Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-15



T.D. = 37 ft.

PIEZOMETER CONSTRUCTION SUMMARY

Well #: 15 Boring #: 15

SURVEY COORDS:
N: 27°27' 8.7"
E: 97°49' 23.7"

SURFACE ELEVATION: 48.39' MSL

TOP OF CASING ELEV: 51.62' MSL

Total Depth: 37' BGS
Borehole Diameter: 10"
Casing Stick-up: 3.23'
Driller: PSI - Craig Schena

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-08-97			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-23'BGS
S1: 10'-4"S-40PVC - 23' BGS

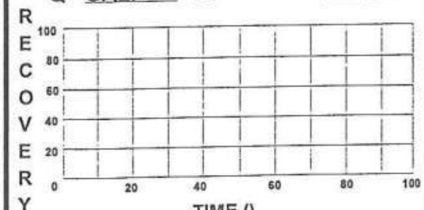
Filter Pack: 21' - 33'
Fine Sand:
Grout Seal: 5' - 19'
Bentonite Seal: 19' - 21'

WELL DEVELOPMENT:
Jet Educted

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

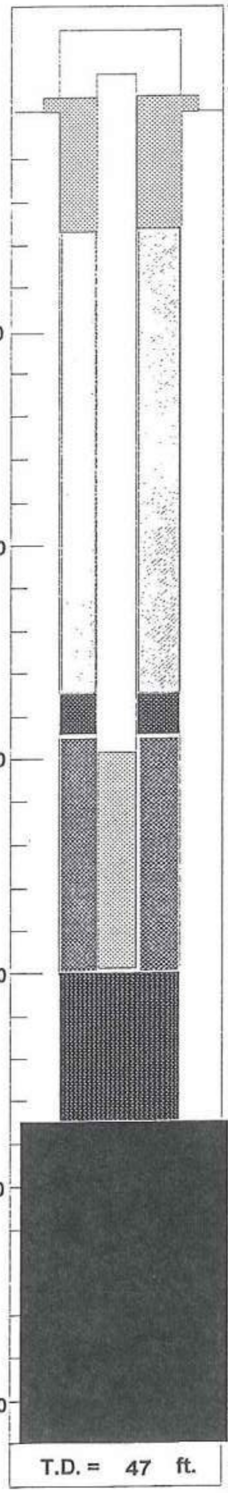
RECOVERY DATA:
% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-16



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 16 Boring #: 16

SURVEY COORDS:
N: 27° 26' 55.3"
E: 97° 49' 23.5"

SURFACE ELEVATION: 55.96' MSL
TOP OF CASING ELEV: 58.84' MSL

DRILLING SUMMARY:

Total Depth: 47' BGS
Borehole Diameter: 10.0"
Casing Stick-up: 2.88'
Driller: PSI - Craig Schena

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-10-97			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-30' BGS
S1: 10'-4"S-40PVC - 30' BGS

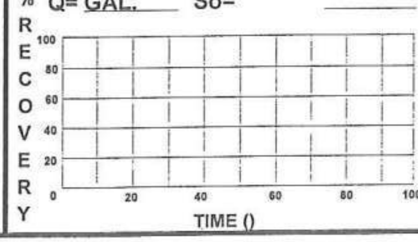
Filter Pack: 27' - 29'
Fine Sand:
Grout Seal: 5' - 27'
Bentonite Seal: 29' - 40'

WELL DEVELOPMENT:
Jet Educted

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

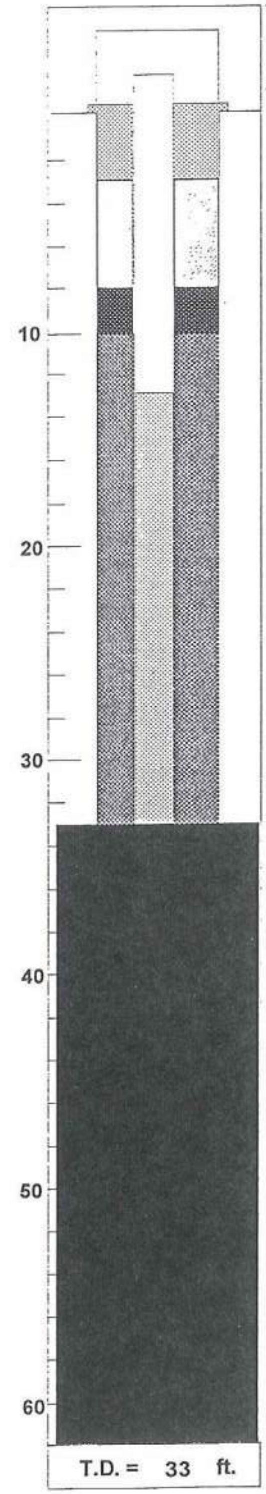
RECOVERY DATA:
% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-17



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 17 Boring #: 17

SURVEY COORDS:

N: 27° 27' 1.34"

E: 97° 49' 16.36"

SURFACE ELEVATION: 41.35'

TOP OF CASING ELEV: 43.87'

Total Depth: 33' BGS

Borehole Diameter: 10"

Casing Stick-up: 2.52'

Driller: PSI

Rig: Rotary

Bit(s): Hollow Stem Auger

Drilling Fluid: None

Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-09-97			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐

Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1: 2"S-40PVC - 0-13' BGS

S1:20'-2"S-40PVC - 13' BGS

Filter Pack: 10' - 33'

Fine Sand:

Grout Seal: 3' - 8'

Bentonite Seal: 8' - 10'

WELL DEVELOPMENT:

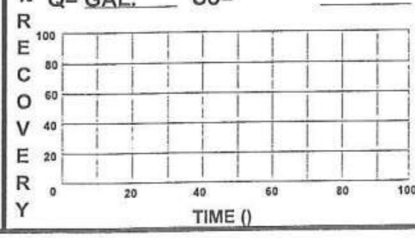
Jet Educted

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

Q= GAL. So=

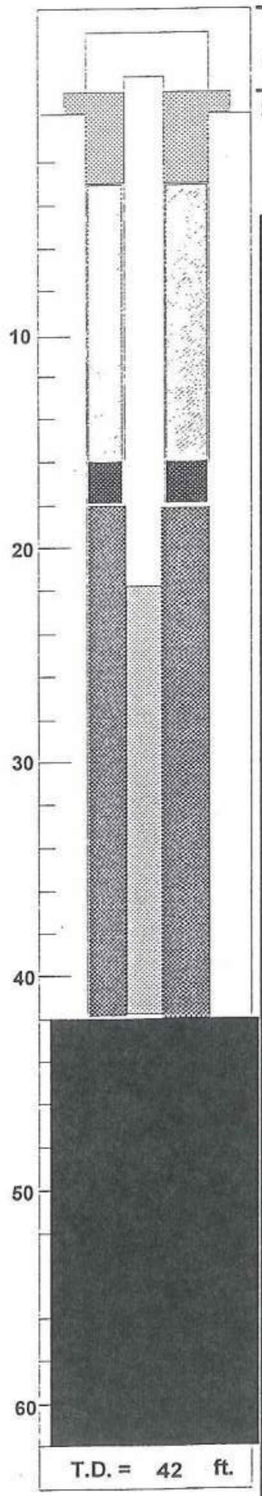


COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)

LOCATION: City of Kingsville, Texas

C-18



PIEZOMETER CONSTRUCTION SUMMARY

Well #: 18 Boring #: 18

SURVEY COORDS:
N: 27° 27' 01.4"
E: 97° 49' 04.0"

SURFACE ELEVATION: 50.04' MSL
TOP OF CASING ELEV: 52.44' MSL

DRILLING SUMMARY:

Total Depth: 42' BGS
Borehole Diameter: 10.0"
Casing Stick-up: 2.40'
Driller: PSI - Craig Schena

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	07-09-97			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/

C1: 2"S-40PVC - 0-22' BGS
S1: 20'-2"S-40PVC - 22' BGS

Filter Pack: 18' - 42'
Fine Sand:
Grout Seal: 3' - 16'
Bentonite Seal: 16' - 18'

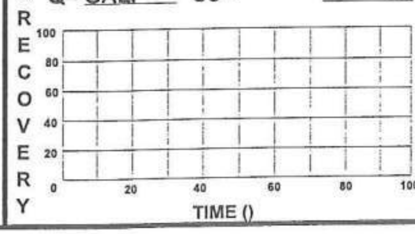
WELL DEVELOPMENT:
Jet Educted

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

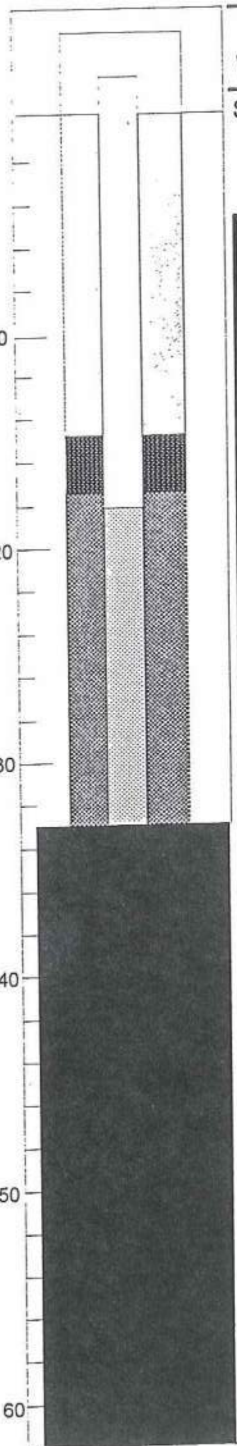
% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-19



T.D. = 33 ft.

PIEZOMETER CONSTRUCTION SUMMARY

Well #: 24 Boring #: 24

SURVEY COORDS:
N: 27° 26' 41.9"
E: 97° 48' 48.9"

SURFACE ELEVATION: 47.38' MSL
TOP OF CASING ELEV: 49.58' MSL

DRILLING SUMMARY:

Total Depth: 33' BGS
Borehole Diameter: 10.0"
Casing Stick-up: 2.20'
Driller: PSI - Craig Schena

Rig: Rotary
Bit(s): Hollow Stem Auger

Drilling Fluid: None
Protective Casing:

CONSTRUCTION TIME LOG:

TASK:	START DATE	START TIME	FINISH DATE	FINISH TIME
Drill:	04-30-98			

WELL DESIGN & SPECIFICATIONS

BASIS GEOLOGIC LOG ☐ GEOPHYSICAL LOG ☐
Casing string(s): C=Casing S=Screen

Depth (ft)	String(s)	Elevation (ft NGVD)
/		/
/		/
/		/
/		/
/		/

C1: 4"S-40PVC - 0-18' BGS

S1: 15'-4"S-40PVC - 18' BGS

Filter Pack: 17' - 33'
Fine Sand:
Grout Seal: 0 - 15'
Bentonite Seal: 15' - 17'

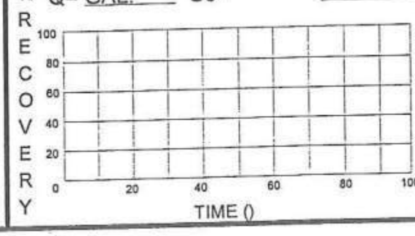
WELL DEVELOPMENT:

STABILIZATION TEST DATA:

Time	pH	Spec. Cond.	Temp. (F)

RECOVERY DATA:

% Q= GAL. So=



COMMENTS:

Site Name: Municipal Solid Waste Landfill (MSWLF)
LOCATION: City of Kingsville, Texas

C-20

APPENDIX D

APPENDIX D

WATER LEVEL MEASUREMENT DATA SHEETS

APPENDIX D (CONTINUED)

November 1997
Revision 1 - June, 1998

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011

LOCATION: MSWLF - Kingsville, Tx

DATE: June 16, 1998

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	25.54	36.32	
MW3	59.17	21.58	37.59	
MW4	60.12	22.69	37.43	
MW6	56.60	20.38	36.22	
MW8	61.17	25.89	35.28	
MW9R	44.84	8.65	36.19	
MW10	52.68	15.58	37.10	
MW11	62.40	24.90	37.50	
MW12	54.87	18.82	36.05	
MW13	62.09	27.10	34.99	
MW14	52.67	22.67	30.00	
MW15	51.62	13.16	38.46	
MW16	58.83	22.27	36.56	
MW17	43.86	7.40	36.46	
MW18	52.43	15.92	36.51	

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville

F.E.E. Job #: K01-01-R011

LOCATION: MSWLF - Kingsville, Tx

DATE: May 18, 1998

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	25.21	36.65	
MW3	59.17	21.04	38.13	
MW4	60.12	21.96	38.16	
MW6	56.60	19.30	37.30	
MW8	61.17	25.19	35.98	
MW9R	44.84	7.93	36.91	
MW10	52.68	15.18	37.50	
MW11	62.40	24.02	38.38	
MW12	54.87	18.09	36.78	
MW13	62.09	26.62	35.47	
MW14	52.67	22.52	30.15	
MW15	51.62	11.98	39.64	
MW16	58.83	21.62	37.21	
MW17	43.86	6.40	37.46	
MW18	52.43	15.09	37.34	

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011

LOCATION: MSWLF - Kingsville, Tx

DATE: February 18, 1998

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	25.67	36.19	
MW3	59.17	20.43	38.74	
MW4	60.12	20.72	39.40	
MW6	56.60	18.64	37.96	
MW8	61.17	23.14	38.03	
MW9R	44.84	6.23	38.61	
MW10	52.68	14.70	37.98	
MW11	62.40	22.22	40.18	
MW12	54.87	17.81	37.06	
MW13	62.09	26.62	35.47	
MW14	52.67	23.10	29.57	
MW15	51.62	8.91	42.71	
MW16	58.83	21.28	37.55	
MW17	43.86	4.37	39.49	
MW18	52.43	14.23	38.20	

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011

LOCATION: MSWLF - Kingsville, Tx

DATE: February 2, 1998

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	25.92	35.94	
MW3	59.17	21.00	38.17	
MW4	60.12	21.52	38.60	
MW6	56.60	19.11	37.49	
MW8	61.17	24.72	36.45	
MW9R	44.84	6.24	38.60	
MW10	52.68	15.23	37.45	
MW11	62.40	23.02	39.38	
MW12	54.87	18.42	36.45	
MW13	62.09	27.17	34.92	
MW14	52.67	23.51	29.16	
MW15	51.62	9.54	42.08	
MW16	58.83	21.74	37.09	
MW17	43.86	3.82	40.04	
MW18	52.43	15.16	37.27	

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011

LOCATION: MSWLF - Kingsville, Tx

DATE: January 20, 1998

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	25.88	35.98	
MW3	59.17	20.73	38.44	
MW4	60.12	21.24	38.88	
MW6	56.60	19.55	37.05	
MW8	61.17	24.91	36.26	
MW9R	44.84	7.35	37.49	
MW10	52.68	15.25	37.43	
MW11	62.40	23.22	39.18	
MW12	54.87	18.49	36.38	
MW13	62.09	26.81	35.28	
MW14	52.67	23.37	29.30	
MW15	51.62	10.54	41.08	
MW16	58.83	21.67	37.16	
MW17	43.86	6.13	37.73	
MW18	52.43	14.88	37.55	

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011

LOCATION: MSWLF - Kingsville, Tx

DATE: January 5, 1998

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	26.05	35.81	
MW3	59.17	20.65	38.52	
MW4	60.12	20.99	39.13	
MW6	56.60	19.42	37.18	
MW8	61.17	24.72	36.45	
MW9R	44.84	6.93	37.91	
MW10	52.68	15.24	37.44	
MW11	62.40	22.99	39.41	
MW12	54.87	18.51	36.36	
MW13	62.09	26.71	35.38	
MW14	52.67	23.63	29.04	
MW15	51.62	9.89	41.73	
MW16	58.83	21.66	37.17	
MW17	43.86	5.58	38.28	
MW18	52.43	14.67	37.76	

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: December 22, 1997

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	26.19	35.67	
MW3	59.17	20.48	38.69	
MW4	60.12	20.73	39.39	
MW6	56.60	19.11	37.49	
MW8	61.17	24.38	36.79	
MW9R	44.84	6.60	38.24	
MW10	52.68	15.19	37.49	
MW11	62.40	22.69	39.71	
MW12	54.87	18.54	36.33	
MW13	62.09	26.61	35.48	
MW14	52.67	23.64	29.03	
MW15	51.62	9.05	42.57	
MW16	58.83	21.71	37.12	
MW17	43.86	4.91	38.95	
MW18	52.43	14.48	37.95	

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: December 8, 1997

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet,MSL)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	26.36	35.50	
MW3	59.17	20.36	38.81	
MW4	60.12	20.52	39.60	
MW6	56.60	18.35	38.25	
MW8	61.17	23.83	37.34	
MW9R	44.84	6.35	38.49	
MW10	52.68	15.06	37.62	
MW11	62.40	22.23	40.17	
MW12	54.87	18.51	36.36	
MW13	62.09	26.49	35.60	
MW14	52.67	23.89	28.78	
MW15	51.62	7.62	44.00	
MW16	58.83	21.70	37.13	
MW17	43.86	4.45	39.41	
MW18	52.43	14.25	38.18	

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: November 24, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	26.69	35.17	
MW3	59.17	20.60	38.57	
MW4	60.12	20.65	39.47	
MW6	56.60	18.23	38.37	
MW8	61.17	23.06	38.11	
MW9R	44.84	6.10	38.74	
MW10	52.68	15.01	37.67	
MW11	62.40	21.72	40.68	
MW12	54.87	18.65	36.22	
MW13	62.09	26.68	35.41	
MW14	52.67	24.25	28.42	
MW15	51.62	8.19	43.43	
MW16	58.83	21.94	36.89	
MW17	43.86	4.01	39.85	
MW18	52.43	14.62	37.81	

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE November 10, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	27.10	34.76	
MW3	59.17	21.20	37.97	
MW4	60.12	22.19	37.93	
MW6	56.60	18.30	38.30	
MW8	61.17	22.73	38.44	
MW9R	44.84	6.24	38.60	
MW10	52.68	15.35	37.33	
MW11	62.40	21.92	40.48	
MW12	54.87	19.34	35.53	
MW13	62.09	27.12	34.97	
MW14	52.67	24.66	28.01	
MW15	51.62	8.14	43.48	
MW16	58.83	22.46	36.37	
MW17	43.86	3.64	40.22	
MW18	52.43	15.14	37.29	

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: October 28, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	27.50	34.36	
MW3	59.17	21.89	37.28	
MW4	60.12	21.81	38.31	
MW6	56.60	17.59	39.01	
MW8	61.17	22.07	39.10	
MW9R	44.84	6.71	38.13	
MW10	52.68	15.58	37.10	
MW11	62.40	22.25	40.15	
MW12	54.87	19.61	35.26	
MW13	62.09	27.55	34.54	
MW14	52.67	25.08	27.59	
MW15	51.62	10.16	41.46	
MW16	58.83	22.75	36.08	
MW17	43.86	4.44	39.42	
MW18	52.43	15.80	36.63	

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: October 16, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	28.57	33.29	
MW3	59.17	22.31	36.86	
MW4	60.12	23.16	36.96	
MW6	56.60	17.74	38.86	
MW8	61.17	22.74	38.43	
MW9R	44.84	6.42	38.42	
MW10	52.68	16.56	36.12	
MW11	62.40	23.76	38.64	
MW12	54.87	19.58	35.29	
MW13	62.09	28.53	33.56	
MW14	52.67	25.46	27.21	
MW15	51.62	10.19	41.43	
MW16	58.83	23.32	35.51	
MW17	43.86	4.28	39.58	
MW18	52.43	16.65	35.78	

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: September 29, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	28.39	33.47	
MW3	59.17	23.90	35.27	
MW4	60.12	24.60	35.53	
MW6	56.60	24.48	32.12	
MW8	61.17	28.14	33.03	
MW9R	44.84	9.85	34.99	
MW10	52.68	18.26	34.42	
MW11	62.40	27.00	35.40	
MW12	54.87	22.09	32.78	
MW13	62.09	29.26	32.83	
MW14	52.67	25.77	26.90	
MW15	51.62	18.65	32.97	
MW16	58.83	24.81	34.02	
MW17	43.86	8.99	34.87	
MW18	52.43	18.71	33.72	

D-14

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: September 15, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	28.28	33.59	
MW3	59.17	23.79	35.38	
MW4	60.12	23.84	35.29	
MW6	56.60	24.69	31.91	
MW8	61.17	28.42	32.76	
MW9R	44.84	10.43	34.42	
MW10	52.68	18.32	34.36	
MW11	62.40	27.35	35.05	
MW12	54.87	22.01	32.87	
MW13	62.09	29.33	32.77	
MW14	52.67	25.95	26.73	
MW15	51.62	18.68	32.94	
MW16	58.83	24.95	33.89	
MW17	43.86	9.68	34.19	
MW18	52.43	18.78	33.66	

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: September 2, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	35.64	26.22	
MW3	59.17	23.63	35.54	
MW4	60.12	25.04	35.09	
MW6	56.60	24.53	32.07	
MW8	61.17	35.76	25.41	
MW9R	44.84	10.45	34.39	
MW10	52.68	18.31	34.37	
MW11	62.40	27.45	34.95	
MW12	54.87	21.82	33.05	
MW13	62.09	29.16	32.93	
MW14	52.67	26.05	26.62	
MW15	51.62	18.47	33.15	
MW16	58.83	24.94	33.89	
MW17	43.86	9.92	33.94	
MW18	52.43	18.92	33.51	

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: August 18, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	22.94	38.92	
MW3	59.17	23.26	35.91	
MW4	60.12	24.76	35.37	
MW6	56.60	24.01	32.59	
MW8	61.17	35.36	25.81	
MW9R	44.84	10.56	34.28	
MW10	52.68	18.16	34.52	
MW11	62.40	27.31	35.09	
MW12	54.87	21.42	33.45	
MW13	62.09	29.15	32.94	
MW14	52.67	25.88	26.79	
MW15	51.62	18.17	33.45	
MW16	58.83	24.63	34.20	
MW17	43.86	9.69	34.17	
MW18	52.43	18.47	33.96	

WATER LEVEL DATA

CLIENT: City of Kingsville

LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: August 4, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	27.67	34.19	
MW3	59.17	22.83	36.34	
MW4	60.12	24.24	35.89	
MW6	56.60	23.31	33.29	
MW8	61.17	27.37	33.80	
MW9R	44.84	10.49	34.35	
MW10	52.68	18.16	34.52	
MW11	62.40	27.10	35.30	
MW12	54.87	20.97	33.90	
MW13	62.09	28.86	33.23	
MW14	52.67	25.65	27.02	
MW15	51.62	17.47	34.15	
MW16	58.83	24.21	34.62	
MW17	43.86	9.33	34.53	
MW18	52.43	18.61	33.82	

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: June 25, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	27.79	34.08	
MW3	59.17	22.11	37.06	
MW4	60.12	22.28	36.85	
MW6	56.60	N/M	N/M	
MW8	61.17	N/M	N/M	
MW9R	44.84	N/M	N/M	
MW10	52.68	17.35	35.33	
MW11	62.40	26.03	36.37	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/M = Not Measured
N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: March 20, 1997

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	30.53	31.34	
MW3	59.17	27.08	32.09	
MW4	60.12	27.33	31.80	
MW6	56.60	28.06	28.54	
MW8	61.17	30.22	30.96	
MW9R	44.84	13.76	31.09	
MW10	52.68	21.33	31.35	
MW11	62.40	30.69	31.71	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: December 23, 1996

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	29.85	32.02	
MW3	59.17	26.03	33.14	
MW4	60.12	26.32	32.81	
MW6	56.60	28.19	28.41	
MW8	61.17	30.38	30.80	
MW9R	44.84	14.02	30.83	
MW10	52.68	20.91	31.77	
MW11	62.40	30.20	32.20	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: July 11, 1996

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	29.00	32.87	
MW3	59.17	22.00	37.17	
MW4	60.12	26.13	33.00	
MW6	56.60	26.29	30.31	
MW8	61.17	29.40	31.78	
MW9R	44.84	12.57	32.28	
MW10	52.68	19.36	33.32	
MW11	62.40	28.77	33.63	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: May 10, 1995 (K/P)

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	29.02	32.85	
MW3	59.17	22.98	36.19	
MW4	60.12	25.02	34.11	
MW6	56.60	N/M	N/M	
MW8	61.17	28.46	32.72	
MW9R	44.84	N/D	N/D	
MW10	52.68	N/D	N/D	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

K/P = Measured by City of Kingsville using a "Plopper".
N/M = Not Measured
N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: March 14, 1994 (K/P)

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	31.40	30.47	
MW3	59.17	26.00	33.17	
MW4	60.12	28.00	31.13	
MW6	56.60	25.25	31.35	
MW8	61.17	28.10	33.08	
MW9R	44.84	N/D	N/D	
MW10	52.68	N/D	N/D	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

K/P = Measured by City of Kingsville using a "Plopper".
N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville

F.E.E. Job #: K01-01-R011

LOCATION: MSWLF - Kingsville, Tx

DATE: April 5, 1993

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	28.61	33.25	
MW3	59.17	27.02	32.15	
MW4	60.12	30.11	30.01	
MW6	56.6	27.11	29.49	
MW8	61.17	29.17	32.00	
MW9R	44.84	N/D	N/D	
MW10	52.68	17.76	34.92	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: September 28, 1992

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	30.6	31.26	
MW3	59.17	25.7	33.47	
MW4	60.12	30.4	29.72	
MW6	56.60	27.0	29.60	
MW8	61.17	28.3	32.87	
MW9R	44.84	N/D	N/D	
MW10	52.68	18.9	33.78	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: August 11, 1992

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	30.02	31.84	
MW3	59.17	25.54	33.63	
MW4	60.12	26.79	33.33	
MW6	56.60	25.25	31.35	
MW8	61.17	27.52	33.65	
MW9R	44.84	N/D	N/D	
MW10	52.68	16.59	36.09	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: April 14, 1992

Well Number	(A) Casing Elevation (feet,MSL)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	36.88	24.98	
MW3	59.17	26.75	32.42	
MW4	60.12	27.39	32.73	
MW6	56.60	21.92	34.68	
MW8	61.17	26.77	34.40	
MW9R	44.84	N/D	N/D	
MW10	52.68	18.49	34.19	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011
LOCATION: MSWLF - Kingsville, Tx

DATE: August 8, 1991

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet,MSL)	(A) - (B) Water Surface Elevation (feet,MSL)	Comments:
MW1	61.86	34.69	27.17	
MW3	59.17	26.86	32.31	
MW4	60.12	24.56	35.56	
MW6	56.60	21.44	35.16	
MW8	61.17	27.5	33.67	
MW9R	44.84	N/D	N/D	
MW10	52.68	N/D	N/D	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville
LOCATION: MSWLF - Kingsville, Tx

F.E.E. Job #: K01-01-R011

DATE: July 30, 1991

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	34.5	27.36	
MW3	59.17	26.69	32.48	
MW4	60.12	23.77	36.35	
MW6	56.60	22.02	34.58	
MW8	61.17	27.67	33.50	
MW9R	44.84	N/D	N/D	
MW10	52.68	N/D	N/D	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

N/D = Not Yet Drilled

Revision 1

WATER LEVEL DATA

CLIENT: City of Kingsville **F.E.E. Job #:** K01-01-R011

LOCATION: MSWLF - Kingsville, Tx

DATE: March 29, 1991

Well Number	(A) Casing Elevation (feet)	(B) Depth to Water (feet)	(A) - (B) Water Surface Elevation (feet)	Comments:
MW1	61.86	35.6	26.26	
MW3	59.17	25.59	33.58	
MW4	60.12	23.98	36.14	
MW6	56.60	21.35	35.25	
MW8	61.17	N/D	N/D	
MW9R	44.84	N/D	N/D	
MW10	52.68	N/D	N/D	
MW11	62.40	N/D	N/D	
MW12	54.87	N/D	N/D	
MW13	62.09	N/D	N/D	
MW14	52.67	N/D	N/D	
MW15	51.62	N/D	N/D	
MW16	58.83	N/D	N/D	
MW17	43.86	N/D	N/D	
MW18	52.43	N/D	N/D	

Revision 1

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

Ground Water Monitor Well #1
Measured Total Depth is 41.67 ft from top of PVC
All Measures from Top of PVC Well Pipe
Elevation Top PVC 61.867 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet,MSL	Comments
03-29-91	35.6	26.27	
07-30-91	34.5	27.37	
08-08-91	34.69	27.18	
04-14-92	36.88	24.99	
08-11-92	30.02	31.85	
09-28-92	30.6	31.27	
04-05-93	28.61	33.26	
* 03-14-94	31.4	30.47	
* 05-10-95	29.02	32.85	
07-11-96	29	32.87	
12-23-96	29.85	32.02	
03-20-97	30.53	31.34	
06-25-97	27.79	34.08	
08-04-97	27.67	34.2	
08-18-97	22.94	38.93	
09-02-97	35.64	26.23	
09-15-97	28.28	33.59	
09-29-97	28.39	33.48	
10-16-97	28.57	33.3	
10-28-97	27.5	34.37	
11-10-97	27.1	34.77	
11-24-97	26.69	35.17	
12-08-97	26.36	35.5	
12-22-97	26.19	35.67	
01-05-98	26.05	35.81	
01-20-98	25.88	35.98	
02-02-98	25.92	35.94	
02-18-98	25.67	36.19	
05-18-98	25.21	36.65	
06-16-98	25.54	36.32	

* City of Kingsville was responsible for the measurements during this period. (used plopper)

** All top of PVC casing elevation have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

Ground Water Monitor Well #3
Measured Total Depth is 37.75 ft from top of PVC
All Measures from Top of PVC Well Pipe
Elevation Top PVC 59.173 Feet, MSL**

	Date	Depth to Water feet	Elevation of water feet	Comments
	03-29-91	25.59	33.58	
	07-30-91	26.69	32.48	
	08-08-91	26.86	32.31	
	04-14-92	26.75	32.42	
	08-11-92	25.54	33.63	
	09-28-92	25.7	33.47	
	04-05-93	27.02	32.15	
*	03-14-94	26	33.17	
*	05-10-95	22.98	36.19	
	07-11-96	22	37.17	
	12-23-96	26.03	33.14	
	03-20-97	27.08	32.09	
	06-25-97	22.11	37.06	
	08-04-97	22.83	36.34	
	08-18-97	23.26	35.91	
	09-02-97	23.63	35.54	
	09-15-97	23.79	35.38	
	09-29-97	23.9	35.27	
	10-16-97	22.31	36.86	
	10-28-97	21.89	37.28	
	11-10-97	21.2	37.97	
	11-24-97	20.6	38.57	
	12-08-97	20.36	38.81	
	12-22-97	20.48	38.69	
	01-05-98	20.65	38.52	
	01-20-98	20.73	38.44	
	02-02-98	21	38.17	
	02-22-98	20.43	38.74	
	[redacted]			

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

Ground Water Monitor Well #4
Measured Total Depth is 40.32 ft from top of PVC
All Measures from Top of PVC Well Pipe
Elevation Top PVC 60.125 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet***	Comments
03-29-91	23.98	35.15	
07-30-91	23.77	35.36	
08-08-91	24.56	34.57	
04-14-92	27.39	31.74	
08-11-92	26.79	32.34	
09-28-92	30.4	28.73	
04-05-93	30.11	29.02	
* 03-14-94	28	31.13	
* 05-10-95	25.02	34.11	
07-11-96	26.13	33	
12-23-96	26.32	32.81	
03-20-97	27.33	31.8	
06-25-97	22.28	36.85	
08-04-97	24.24	35.89	
08-18-97	24.76	35.37	
09-02-97	25.04	35.09	
09-15-97	23.84	36.29	
09-29-97	24.6	35.53	
10-16-97	23.16	36.97	
10-28-97	21.81	38.32	
11-10-97	22.19	37.94	
11-24-97	20.65	39.47	
12-08-97	20.52	39.60	
12-22-97	20.73	39.39	
01-05-98	20.99	39.13	
01-20-98	21.24	38.88	
02-02-98	21.52	38.60	
02-18-98	20.72	39.40	
05-18-98	21.96	38.16	
06-16-98	22.69	37.43	

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

*** One foot has been subtracted from the calculated water depth for MW #4, due to the addition of a 12.00" extension to the top of the well casing between the time of measurement of depth to water and the time of the McCumber elevation survey.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

Ground Water Monitor Well #6
Measured Total Depth is 39.15 ft from top of PVC
All Measures from Top of PVC Well Pipe
Elevation Top PVC 56.604 Feet, MSL**

	Date	Depth to Water feet	Elevation of water feet	Comments
	03-29-91	21.35	35.25	
	07-30-91	22.02	34.58	
	08-08-91	21.44	35.16	
	04-14-92	21.92	34.68	
	08-11-92	25.25	31.35	
	09-28-92	27	29.6	
	04-05-93	27.11	29.49	
*	03-14-94	25.25	31.35	
*	05-10-95	Not	measured	
	07-11-96	26.29	30.31	
	12-23-96	28.19	28.41	
	03-20-97	28.06	28.54	
	06-25-97	Not	measured	
	08-04-97	23.31	33.29	
	08-18-97	24.01	32.59	
	09-02-97	24.53	32.07	
	09-15-97	24.69	31.91	
	09-29-97	24.48	32.12	
	10-16-97	17.74	38.86	
	10-28-97	17.59	39.01	
	11-10-97	18.3	38.3	
	11-24-97	18.23	38.37	
	12-08-97	18.35	38.25	
	12-22-97	19.11	37.49	
	01-05-98	19.42	37.18	
	01-20-98	19.55	37.05	
	02-02-98	19.11	37.49	
	02-18-98	18.64	37.96	
	[redacted]			

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

D-35

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

Ground Water Monitor Well #8
Measured Total Depth is 43.65 ft from top of PVC
All Measures from Top of PVC Well Pipe
Elevation Top PVC 61.178 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	27.67	33.51	
08-08-91	27.5	33.68	
04-14-92	26.77	34.41	
08-11-92	27.52	33.66	
09-28-92	28.3	32.88	
04-05-93	29.17	32.01	
* 03-14-94	28.1	33.08	
* 05-10-95	28.46	32.72	
07-11-96	29.4	31.78	
12-23-96	30.38	30.8	
03-20-97	30.22	30.96	
06-25-97	Not	Measured	
08-04-97	27.37	33.81	
08-18-97	35.36	25.82	
09-02-97	35.76	25.42	
09-15-97	28.42	32.76	
09-29-97	28.14	33.04	
10-16-97	22.07	39.11	
10-28-97	22.74	38.44	
11-10-97	22.73	38.45	
11-24-97	23.06	38.11	
12-08-97	23.83	37.34	
12-22-97	24.38	36.79	
01-05-98	24.72	36.45	
01-20-98	24.91	36.26	
02-02-98	24.72	36.45	
02-18-98	23.14	38.03	
05-18-98	25.19	35.98	
06-16-98	25.89	35.28	

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

Ground Water Monitor Well #9R
Measured Total Depth is 18.29 ft from top of PVC
All Measures from Top of PVC Well Pipe
Elevation Top PVC 44.849 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	12.57	32.28	
12-23-96	14.02	30.83	
03-20-97	13.76	31.09	
06-25-97	Not	Measured	
08-04-97	10.49	34.36	
08-18-97	10.56	34.29	
09-02-97	10.45	34.4	
09-15-97	10.43	34.42	
09-29-97	9.85	35	
10-16-97	9.85	35	
10-28-97	9.85	35	
11-10-97	9.85	35	
11-24-97	6.10	38.74	
12-08-97	6.35	38.49	
12-22-97	6.60	38.24	
01-05-98	6.93	37.91	
01-20-98	7.35	37.49	
02-02-98	6.24	38.60	
02-18-98	6.23	38.61	
05-18-98	7.93	36.91	
06-16-98	8.65	36.19	

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

Ground Water Monitor Well #10
Measured Total Depth is 31.48 ft from top of PVC
All Measures from Top of PVC Well Pipe
Elevation* Top PVC 52.684 Feet, MSL**

	Date	Depth to Water feet	Elevation of water feet	Comments
	03-29-91	Not	Drill'd	
	07-30-91	Not	Drill'd	
	08-08-91	Not	Drill'd	
	04-14-92	18.49	34.19	
	08-11-92	16.59	36.09	
	09-28-92	18.9	33.78	
	04-05-93	17.76	34.92	
*	03-14-94	17.5	35.18	
*	05-10-95	19.02	33.66	
**	07-11-96	19.36	33.32	
	12-23-96	20.91	31.77	
	03-20-97	21.33	31.35	
	06-25-97	17.35	35.33	
	08-04-97	18.16	34.52	
	08-18-97	18.16	34.52	
	09-02-97	18.31	34.37	
	09-15-97	18.32	34.36	
	09-29-97	18.26	34.42	
	10-16-97	16.56	36.12	
	10-28-97	15.58	37.1	
	11-10-97	15.35	37.33	
	11-24-97	15.01	37.67	
	12-08-97	15.06	37.62	
	12-22-97	15.19	37.49	
	01-05-98	15.24	37.44	
	01-20-98	15.25	37.43	
	02-02-98	15.23	37.45	
	02-18-98	14.70	37.98	
	05-18-98	15.18	37.50	
	06-16-98	15.58	37.10	

*The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

** Due to surface water infiltration, a riser was installed and a taller casing protector was added. Three (3) foot was added to the "Top of PVC" datum point.

*** All top of PVC casings have been corrected to McCumber elevation survey of 07-29-97.

D-38

City of Kingsville, TX Landfill - TNRCC MSW Permit #235-A

Ground Water Monitor Well #11
Measured Total Depth is 35.21 ft from top of PVC
All Measures from Top of PVC Well Pipe
Elevation Top PVC 62.401 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	28.77	33.63	
12-23-96	30.2	32.2	
03-20-97	30.69	31.71	
06-25-97	26.03	36.37	
08-04-97	27.1	35.3	
08-18-97	27.31	35.09	
09-02-97	27.45	34.95	
09-15-97	27.35	35.05	
09-29-97	27	35.4	
10-16-97	23.76	38.64	
10-18-97	22.25	40.15	
11-10-97	21.92	40.48	
11-24-97	21.72	40.68	
12-08-97	22.23	40.17	
12-22-97	22.69	39.71	
01-05-98	22.99	39.41	
01-20-98	23.22	39.18	
02-02-98	23.02	39.38	
02-18-98	22.22	40.18	
05-18-98	24.02	38.38	
06-16-98	24.90	37.50	

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

Ground Water Monitor Well #12
Elevation Top PVC 54.879 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	20.97	33.91	
08-18-97	21.42	33.46	
09-02-97	21.82	33.06	
09-15-97	22.01	32.87	
09-29-97	22.09	32.79	
10-16-97	19.58	35.3	
10-28-97	19.61	35.27	
11-10-97	19.34	35.54	
11-24-97	18.65	36.22	
12-08-97	18.51	36.36	
12-22-97	18.54	36.33	
01-05-98	18.51	36.36	
01-20-98	18.49	36.38	
02-02-98	18.42	36.45	
02-18-98	17.81	37.06	
05-18-98	18.09	36.78	
06-16-98	18.82	36.05	

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

D-40

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

Ground Water Monitor Well #13
Elevation Top PVC 62.096 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	28.86	33.24	
08-18-97	29.15	32.95	
09-02-97	29.16	32.94	
09-15-97	29.33	32.77	
09-29-97	29.26	32.84	
10-16-97	28.53	33.57	
10-28-98	27.55	34.55	
11-10-97	27.12	34.98	
11-24-97	26.68	35.41	
12-08-97	26.49	35.60	
12-22-97	26.61	35.48	
01-05-98	26.71	35.38	
01-20-98	26.81	35.28	
02-02-98	27.17	34.92	
02-18-98	26.62	35.47	
[redacted]			

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

Ground Water Monitor Well #14

Elevation Top PVC 52.677 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	25.65	27.03	
08-18-97	25.88	26.8	
09-02-97	26.05	26.63	
09-15-97	25.95	26.73	
09-29-97	25.77	26.91	
10-16-97	25.46	27.22	
10-28-97	25.08	27.6	
11-10-97	24.66	28.02	
11-24-97	24.25	28.42	
12-08-97	23.89	28.78	
12-22-97	23.64	29.03	
01-05-98	23.63	29.04	
01-20-98	23.37	29.30	
02-02-98	23.51	29.16	
02-18-98	23.10	29.57	
[redacted]			

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

D-42

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

Ground Water Monitor Well #15

Elevation Top PVC 51.624 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	17.47	34.15	
08-18-97	18.17	33.45	
09-02-97	18.47	33.15	
09-15-97	18.68	32.94	
09-29-97	18.65	32.97	
10-16-97	10.19	41.43	
10-28-97	10.16	41.46	
11-10-97	8.14	43.48	
11-24-97	8.19	43.43	
12-08-97	7.62	44.00	
12-22-97	9.05	42.57	
01-05-98	9.89	41.73	
01-20-98	10.54	41.08	
02-02-98	9.54	42.08	
02-18-98	8.91	42.91	
05-18-98	11.98	39.64	
06-16-98	13.16	38.46	

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

D-43

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

Ground Water Monitor Well #16

Elevation Top PVC 58.839 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	24.21	34.63	
08-18-97	24.63	34.21	
09-02-97	24.94	33.9	
09-15-97	24.95	33.89	
09-29-97	24.81	34.03	
10-16-97	23.32	35.52	
10-28-97	22.75	36.09	
11-10-97	22.46	36.38	
11-24-97	21.94	36.89	
12-08-97	21.70	37.13	
12-22-97	21.71	37.12	
01-05-98	21.66	37.17	
01-20-98	21.67	37.16	
02-02-98	21.74	37.09	
02-18-98	21.28	37.55	
05-18-98	21.62	37.21	
06-16-98	22.27	36.56	

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

Ground Water Monitor Well #17

Elevation Top PVC 43.868 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	9.33	34.54	
08-18-97	9.69	34.18	
09-02-97	9.92	33.95	
09-15-97	9.68	34.19	
09-29-97	8.99	34.88	
10-16-97	4.28	39.59	
10-28-97	4.44	39.43	
11-10-97	3.64	40.23	
11-24-97	4.01	39.85	
12-08-97	4.45	39.41	
12-22-97	4.91	38.95	
01-05-98	5.58	38.28	
01-20-98	6.13	37.73	
02-02-98	3.82	40.04	
02-18-98	4.37	39.49	
05-18-98	6.40	37.46	
06-16-98	7.40	36.46	

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

City of Kingsville, TX Landfill - TNRCC MSW Permit #235

Ground Water Monitor Well #18

Elevation Top PVC 52.438 Feet, MSL**

Date	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	18.61	33.83	
08-18-97	18.47	33.97	
09-02-97	18.92	33.52	
09-15-97	18.78	33.66	
09-29-97	18.71	33.73	
10-16-97	16.65	35.79	
10-28-97	15.8	36.64	
11-10-97	15.14	37.3	
11-24-97	14.62	37.81	
12-08-97	14.25	38.18	
12-22-97	14.48	37.95	
01-05-98	14.67	37.76	
01-20-98	14.88	37.55	
02-02-98	15.16	37.27	
02-18-98	14.23	38.20	
05-18-98	15.09	37.34	
06-16-98	15.92	36.51	

** All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Summary of Site Survey Data

City of Kingsville, Texas

Municipal Solid Waste Landfill, 235-B

Location Number	Designation	Top of PVC Elevation ft, MSL	Ground Surface ft, MSL	Total Depth of Boring ft, BGS	Bottom Elevation ft, MSL	Current Status	Stabilized GW Level ft, MSL	X-Distance UTM meters	Y-Distance UTM meters	X-Distance Coord. ft	Y-Distance Coord. ft
Benchmark	MW-12							2221994.103	646980.6224	0.104	1.5806
MW-1	MW	61.867	59.249	43	16.249	A	33.47	2220665.243	646999.5297	-1328.7561	20.4879
MW-2	MW					P&A					
MW-3	MW	59.173	56.096	37.5	18.596	A	35.27	2221265.118	647820.8196	-728.8815	841.7778
MW-4	MW	60.125	58.008	40	18.008	A	35.53	2221259.953	648317.7851	-734.046	1338.7433
MW-5	MW					P&A					
MW-6	MW	56.604	55.456	40	15.456	A	32.12	2220718.485	649721.5091	-1275.5146	2742.4673
MW-7	MW				0	P&A					
MW-8	MW	61.178	59.787	43	16.787	A	33.03	2219519.731	647166.5781	-2474.2682	187.5363
MW-9	MW				0	P&A					
MW-9R	MW	44.849	41.411	17	24.411	A	34.99	2219802.581	648511.0793	-2191.4181	1532.0375
MW-10	MW	52.684	49.78	29	20.78	A	34.42	2220240.82	648308.7984	-1753.1797	1329.7566
MW-11	MW	62.401	60.197	33	27.197	A	35.4	2220718.664	648494.0559	-1275.3351	1515.0141
MW-12	B/MW	54.879	52.375	48	4.375	A	32.78	2221993.999	646979.0418	0	0
MW-13	B/MW	62.096	59.131	50	9.131	A	32.83	2221973.889	648365.0778	-20.1103	1386.036
MW-14	B/MW	52.677	49.938	42	7.938	A	26.9	2221949.041	649712.8948	-44.9587	2733.853
MW-15	B/MW	51.624	48.386	37	11.386	A	32.97	2219474.512	649668.9772	-2519.487	2689.9354
MW-16	B/MW	58.839	55.958	47	8.958	A	34.02	2219497.15	648312.4767	-2496.8494	1333.4349
BP-17	B	43.868	41.345	33	8.345	A	34.87	2220139.183	648928.7974	-1854.8164	1949.7556
BP-18	B	52.438	50.039	42	8.039	A	33.72	2221252.488	648943.6517	-741.5117	1964.6099
BP-21	B		52.41	84	-31.59	A		2221237.99	649701.98		2722.9382
BP-23	B		49.5	86	-36.5	A		2219486.9	648937.78		1958.7382
BP-24	B/MW		47.38	72	-24.62	A		2221358.12	646971.06		-7.9818
BP-25	B		61.12	88	-26.88	A		2220722.02	648314.56		1335.5182
S/W Corner	0,0							2219514.47	646930.27	-2479.5292	-48.7718

Revision 1

D-47

Footnotes:

Soil Borings 1, 2, 3, 4, 5, & 6 completed by REI: 6-19-84 to 10-3-84
Soil Borings 7 & 8 completed by Martin Water Well: 7-31-91
Soil Borings 9 & 10 completed by JEDI: 3-20-92 to 3-24-92
Soil Borings 9R & 11 completed by PSI: 7-11-96
Soil Borings 12 through 18 completed by PSI: 7-7-97 to 7-28-97

The deepest excavation elevation is +8.37 feet NGVD

Coordinates for deep soil borings (B-21 - B-25) are currently being verified.

KEY:

A=Active
B=Boring
MW=Monitor Well
P&A=Plugged & Abandoned

D-48

City of Kingsville, Texas

Municipal Solid Waste Landfill
Permit 235-B

Summary of Site Survey Data
South West Corner = 0,0

MW #	X" Coordinate (feet)	Y" Coordinate (feet)
Benchmark	2480.13	9.578676
MW-1	1151.76	50.33381
MW-2		
MW-3	1765.06	861.649
MW-4	1768.07	1358.632
MW-5		
MW-6	1249.75	2771.07
MW-7		
MW-8	9.14996	236.1952
MW-9		
MW-9R	314.069	1575.864
MW-10	748.922	1366.404
MW-11	1229.75	1543.78
MW-12	2480	8
MW-13	2482.68	1394.179
MW-14	2480	2742.223
MW-15	5.08411	2739
MW-16	5.41377	1382.31
BP-17	657.494	1987.991
BP-18	1770.89	1984.537
BP-21	2524.77	2730.57
BP-23	2512.21	1966.473
BP-24	2479.87	0.019279
BP-25	2501.96	1343.338
S/W Corner	0.00407	0.005581

Revision 1

APPENDIX E

APPENDIX E

IN-SITU HYDRAULIC CONDUCTIVITY TEST DATA

STATE OF TEXAS
RAY N. FINCH
30926
REGISTERED PROFESSIONAL ENGINEER
6-26-98

November 1997

THIS DOCUMENT IS ISSUED FOR PERMITTING PURPOSES ONLY.
INCLUDES PAGES E-1 THROUGH E-13

SUMMARY OF IN-SITU HYDRAULIC CONDUCTIVITY TEST RESULTS
Municipal Solid Waste Landfill
Kingsville, Texas

Piezometer Number	Estimated Horizontal Hydraulic Conductivity(K)			
	ft/sec	ft/min	ft/day	cm/sec
MW-11	6.6×10^{-6}	3.96×10^{-4}	0.57	2.01×10^{-4}
MW-12	2.4×10^{-5}	1.43×10^{-3}	2.05	7.24×10^{-4}
MW-13	8.9×10^{-6}	5.33×10^{-4}	0.77	2.71×10^{-4}
MW-14	4.2×10^{-6}	2.49×10^{-4}	0.36	1.27×10^{-4}
MW-15	1.7×10^{-5}	1.05×10^{-3}	1.51	5.31×10^{-4}
MW-16	2.0×10^{-5}	1.22×10^{-3}	1.75	6.18×10^{-4}
Averages	1.35×10^{-5}	8.13×10^{-4}	1.17	4.12×10^{-4}

City of Kingsville MSWLF - Permeability

Well Number 11

X Time min	Depth ft	del h ft	del(h/ho)	Y log	X^2	X*Y	calc'd del(h/ho)	calc'd log
EQUIL	27.34	0	0					
0	30.42	3.08	1	0	0	0	0.957611	-0.01881
0.5	30.25	2.91	0.944805	-0.02466	0.25	-0.01233	0.899938	-0.04579
1	30.01	2.67	0.866883	-0.06204	1	-0.06204	0.845739	-0.07276
1.5	29.85	2.51	0.814935	-0.08888	2.25	-0.13332	0.794804	-0.09974
2	29.68	2.34	0.75974	-0.11933	4	-0.23867	0.746936	-0.12672
2.5	29.44	2.1	0.681818	-0.16633	6.25	-0.41583	0.701952	-0.15369
3	29.38	2.04	0.662338	-0.17892	9	-0.53676	0.659676	-0.18067
3.5	29.3	1.96	0.636364	-0.19629	12.25	-0.68703	0.619947	-0.20765
4	29.02	1.68	0.545455	-0.26324	16	-1.05297	0.58261	-0.23462
4.5	28.95	1.61	0.522727	-0.28172	20.25	-1.26776	0.547522	-0.2616
5	28.88	1.54	0.5	-0.30103	25	-1.50515	0.514548	-0.28857
6	28.69	1.35	0.438312	-0.35822	36	-2.1493	0.454436	-0.34253
7	28.54	1.2	0.38961	-0.40937	49	-2.86559	0.401347	-0.39648
8	28.4	1.06	0.344156	-0.46324	64	-3.70596	0.35446	-0.45043
9	28.29	0.95	0.308442	-0.51083	81	-4.59744	0.313051	-0.50439
10	28.19	0.85	0.275974	-0.55913	100	-5.59132	0.276479	-0.55834
11	28.1	0.76	0.246753	-0.60774	121	-6.68511	0.24418	-0.61229
12	28.01	0.67	0.217532	-0.66248	144	-7.94971	0.215654	-0.66624
13	27.93	0.59	0.191558	-0.7177	169	-9.33008	0.19046	-0.7202
14	27.88	0.54	0.175325	-0.75616	196	-10.5862	0.16821	-0.77415
15	27.81	0.47	0.152597	-0.81645	225	-12.2468	0.148559	-0.8281
132.5	21			-7.54376	1281.25	-71.6194		

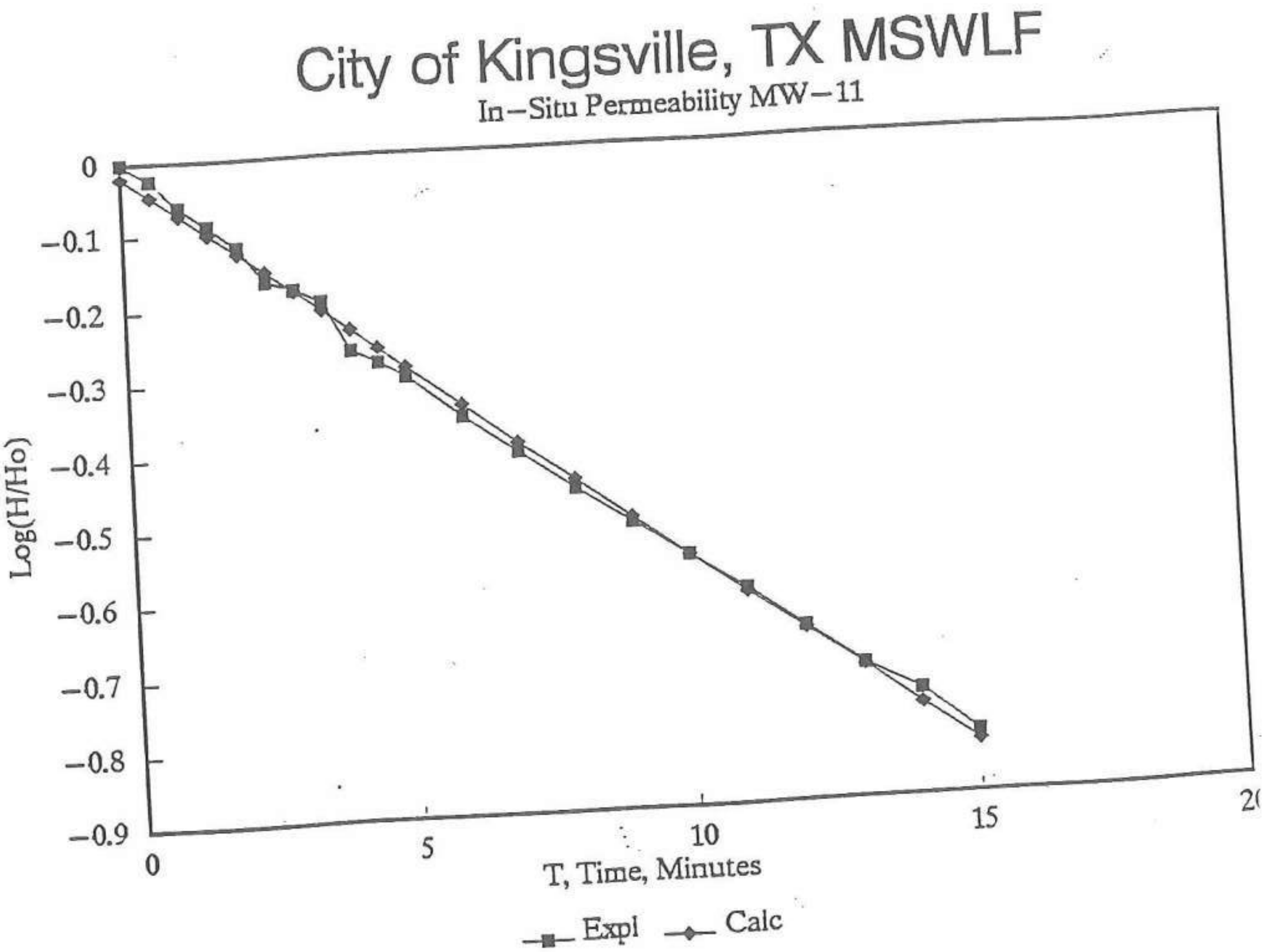
delta=	9350		
alpha=	-175.883	A=	-0.01881
beta=	-504.458	B=	-0.05395

K=	((r^2*ln(L/R))/(2*L*To))		
r=	0.166667	ft	
L=	17	ft	
R=	0.416667	ft	
To=	7.65	min	7.654617
K=	0.000396	ft/min	
	0.000201	cm/sec	
	6.6E-06	ft/sec	
	0.570347	ft/day	

E-2

City of Kingsville MSWLF - Permit 235 B
Attachment 5 - Groundwater Characterization Report

FIGURE 6



E-3

City of Kingsville MSWLF - Permeability

Well Number 12

X Time min	Depth ft	del h ft	del(h/ho)	Y log	X^2	X*Y	calc'd del(h/ho)	calc'd log
EQUIL	21.99	0	0					
0	24.9	2.91	1	0	0	0	0.796294	-0.09893
0.5	24.2	2.21	0.75945	-0.1195	0.25	-0.05975	0.692088	-0.15984
1	23.8	1.81	0.621993	-0.20621	1	-0.20621	0.601519	-0.22075
1.5	23.5	1.51	0.5189	-0.28492	2.25	-0.42737	0.522801	-0.28166
2	23.32	1.33	0.457045	-0.34004	4	-0.68008	0.454386	-0.34258
2.5	23.08	1.09	0.37457	-0.42647	6.25	-1.06617	0.394923	-0.40349
3	22.9	0.91	0.312715	-0.50485	9	-1.51455	0.343242	-0.4644
3.5	22.78	0.79	0.271478	-0.56627	12.25	-1.98193	0.298324	-0.52531
4	22.65	0.66	0.226804	-0.64435	16	-2.5774	0.259284	-0.58622
4.5	22.58	0.59	0.202749	-0.69304	20.25	-3.11868	0.225353	-0.64714
5	22.51	0.52	0.178694	-0.74789	25	-3.73945	0.195862	-0.70805
6	22.39	0.4	0.137457	-0.86183	36	-5.171	0.147954	-0.82987
7	22.31	0.32	0.109966	-0.95874	49	-6.7112	0.111764	-0.9517
8	22.26	0.27	0.092784	-1.03253	64	-8.26023	0.084426	-1.07352
9	22.22	0.23	0.079038	-1.10217	81	-9.91949	0.063775	-1.19535
57.5	15			-8.48881	326.25	-45.4335		

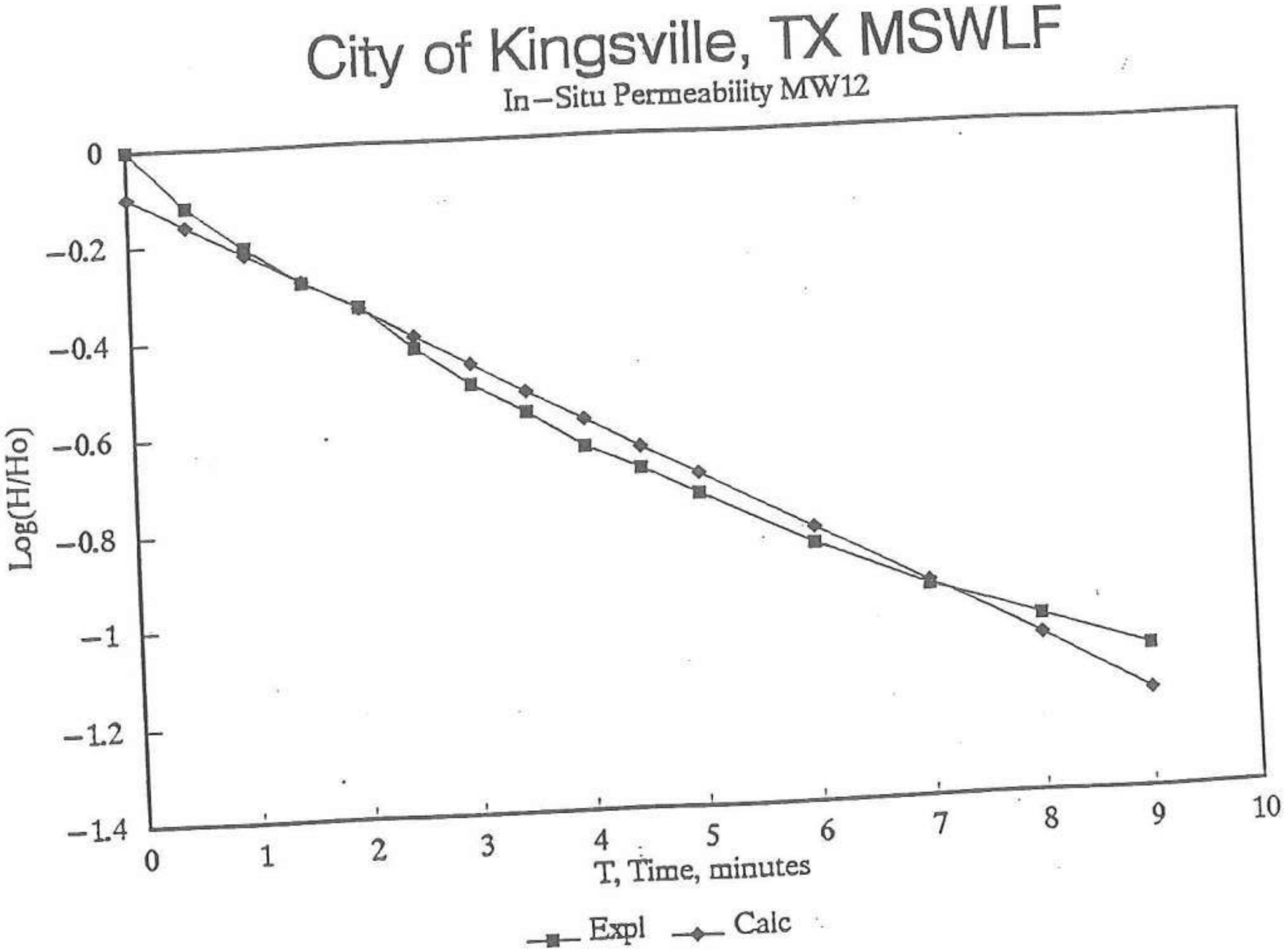
delta= 1587.5
alpha= -157.046
beta= -193.396

A= -0.09893
B= -0.12182

K= ((r^2*ln(L/R))/(2*L*To))
r= 0.166667 ft
L= 12 ft
R= 0.416667 ft
To= 2.73 min
K= 0.001425 ft/min
0.000724 cm/sec
2.4E-05
2.051511

E-4

FIGURE 7


City of Kingsville, TX MSWLF
In-Situ Permeability MW12
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
Log(H/Ho)
0
1
2
3
4
5
6
7
8
9
10
T, Time, minutes
Expl
Calc

City of Kingsville MSWLF - Permeability

Well Number 13

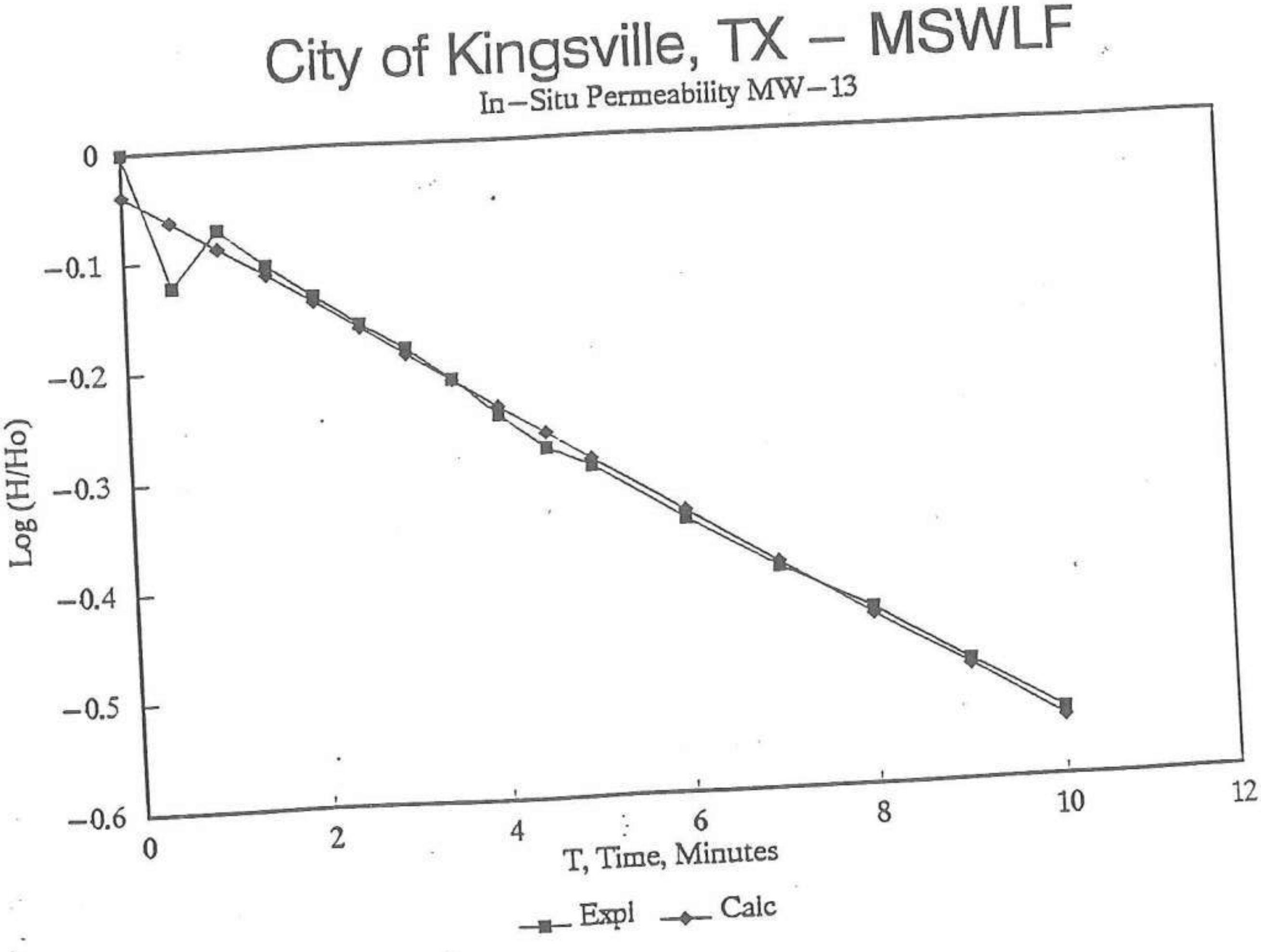
X Time min	Depth ft	del h ft	del(h/ho)	Y log	X^2	X*Y	calc'd del(h/ho)	calc'd log
EQUIL	29.28	0	0					
0	32.6	3.32	1	0	0	0	0.91348	-0.0393
0.5	31.78	2.5	0.753012	-0.1232	0.25	-0.0616	0.861725	-0.06463
1	32.09	2.81	0.846386	-0.07243	1	-0.07243	0.812902	-0.08996
1.5	31.88	2.6	0.783133	-0.10616	2.25	-0.15925	0.766845	-0.11529
2	31.71	2.43	0.731928	-0.13553	4	-0.27106	0.723397	-0.14062
2.5	31.56	2.28	0.686747	-0.1632	6.25	-0.40801	0.682411	-0.16595
3	31.44	2.16	0.650602	-0.18668	9	-0.56005	0.643748	-0.19128
3.5	31.3	2.02	0.608434	-0.21579	12.25	-0.75525	0.607274	-0.21662
4	31.15	1.87	0.563253	-0.2493	16	-0.99719	0.572868	-0.24195
4.5	31.02	1.74	0.524096	-0.28059	20.25	-1.26265	0.54041	-0.26728
5	30.95	1.67	0.503012	-0.29842	25	-1.49211	0.509792	-0.29261
6	30.76	1.48	0.445783	-0.35088	36	-2.10526	0.453662	-0.34327
7	30.61	1.33	0.400602	-0.39729	49	-2.78101	0.403711	-0.39393
8	30.49	1.21	0.364458	-0.43835	64	-3.50682	0.359261	-0.44459
9	30.35	1.07	0.322289	-0.49175	81	-4.42579	0.319704	-0.49525
10	30.24	0.96	0.289157	-0.53887	100	-5.38867	0.284503	-0.54591
67.5	16			-4.04844	426.25	-24.2471		

delta=	2263.75			
alpha=	-88.9673		A=	-0.0393
beta=	-114.684		B=	-0.05066

K=	((r^2*ln(L/R))/(2*L*To))	
r=	0.166667	ft
L=	11	ft
R=	0.416667	ft
To=	7.75	min
K=	0.000533	ft/min
	0.000271	cm/sec
	8.9E-06	ft/sec
	0.767944	ft/day

E-6

FIGURE 8


City of Kingsville, TX – MSWLF
In–Situ Permeability MW–13
0
–0.1
–0.2
–0.3
–0.4
–0.5
–0.6
Log (H/Ho)
0
2
4
6
8
10
12
T, Time, Minutes
Expl
Calc

City of Kingsville MSWLF - Permeability
Well Number 14

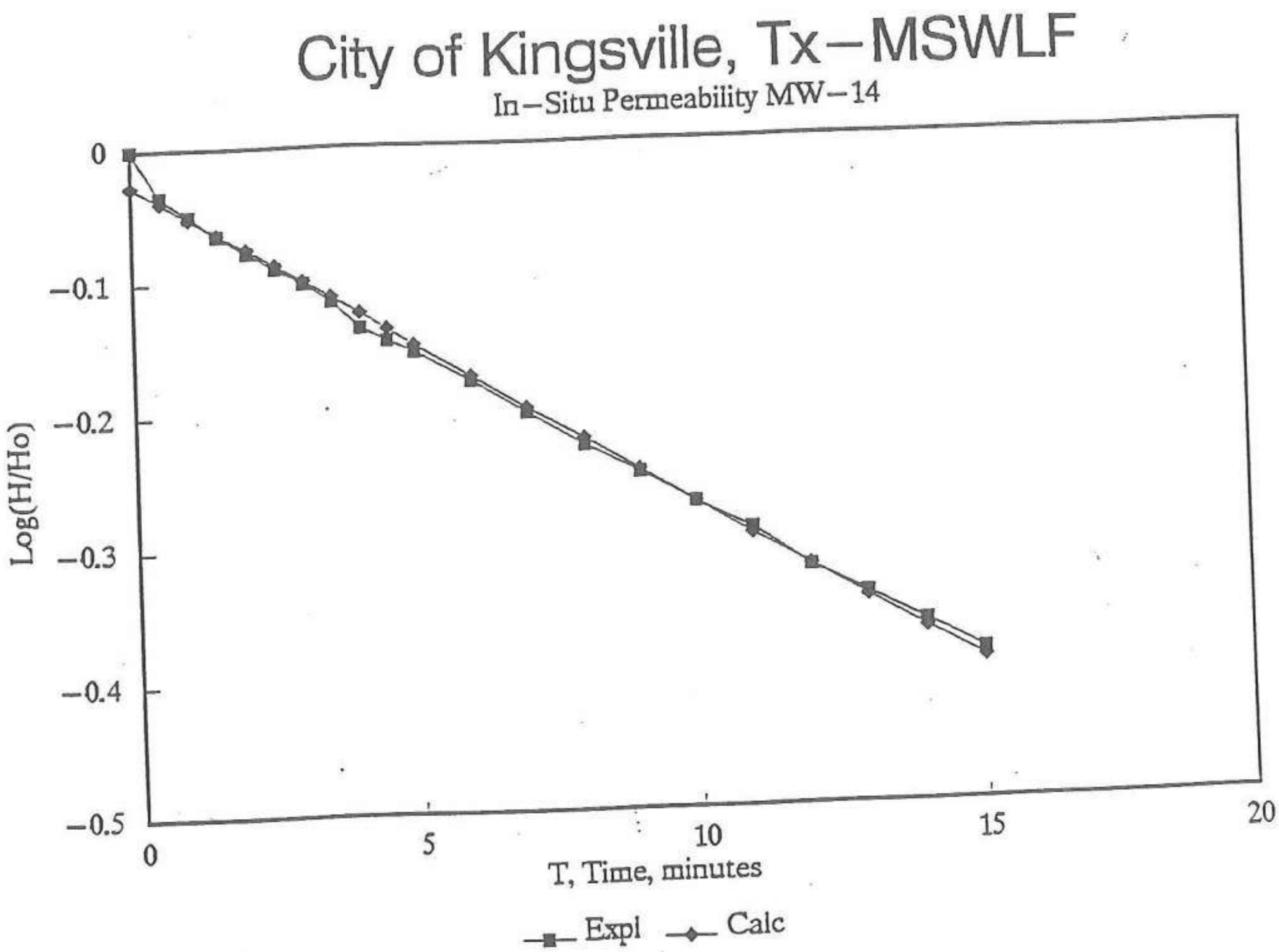
X Time min	Depth ft	del h ft	del(h/ho)	Y log	X^2	X*Y	calc'd del(h/ho)	calc'd log
EQUIL	25.9	0	0					
0	29.48	3.58	1	0	0	0	0.939426	-0.02714
0.5	29.2	3.3	0.921788	-0.03537	0.25	-0.01768	0.913406	-0.03934
1	29.09	3.19	0.891061	-0.05009	1	-0.05009	0.888108	-0.05153
1.5	28.98	3.08	0.860335	-0.06533	2.25	-0.098	0.86351	-0.06373
2	28.89	2.99	0.835196	-0.07821	4	-0.15642	0.839593	-0.07593
2.5	28.81	2.91	0.812849	-0.08999	6.25	-0.22498	0.816339	-0.08813
3	28.73	2.83	0.790503	-0.1021	9	-0.30629	0.793729	-0.10033
3.5	28.64	2.74	0.765363	-0.11613	12.25	-0.40646	0.771745	-0.11253
4	28.52	2.62	0.731844	-0.13558	16	-0.54233	0.75037	-0.12472
4.5	28.46	2.56	0.715084	-0.14564	20.25	-0.65539	0.729587	-0.13692
5	28.41	2.51	0.701117	-0.15421	25	-0.77105	0.70938	-0.14912
6	28.28	2.38	0.664804	-0.17731	36	-1.06384	0.670628	-0.17352
7	28.15	2.25	0.628492	-0.2017	49	-1.4119	0.633994	-0.19791
8	28.02	2.12	0.592179	-0.22755	64	-1.82038	0.599361	-0.22231
9	27.92	2.02	0.564246	-0.24853	81	-2.23678	0.56662	-0.24671
10	27.82	1.92	0.536313	-0.27058	100	-2.70582	0.535667	-0.2711
11	27.73	1.83	0.511173	-0.29143	121	-3.20575	0.506405	-0.2955
12	27.61	1.71	0.477654	-0.32089	144	-3.85064	0.478742	-0.3199
13	27.53	1.63	0.455307	-0.3417	169	-4.44204	0.45259	-0.3443
14	27.45	1.55	0.432961	-0.36355	196	-5.08972	0.427866	-0.36869
15	27.37	1.47	0.410615	-0.38657	225	-5.79849	0.404493	-0.39309
132.5	21			-3.80246	1281.25	-34.8541		

delta=	9350		
alpha=	-253.736	A=	-0.02714
beta=	-228.11	B=	-0.0244

K=	((r^2*ln(L/R))/(2*L*To))	
r=	0.166667	ft
L=	11	ft
R=	0.416667	ft
To=	16.59	min
K=	0.000249	ft/min
	0.000127	cm/sec
	4.2E-06	ft/sec
	0.358744	ft/day

E-8

FIGURE 9


City of Kingsville, Tx—MSWLF
In—Situ Permeability MW—14
Log(H/Ho)
0
−0.1
−0.2
−0.3
−0.4
−0.5
0
5
10
15
20
T, Time, minutes
Expl
Calc

City of Kingsville MSWLF - Permeabiity
Well Number 15

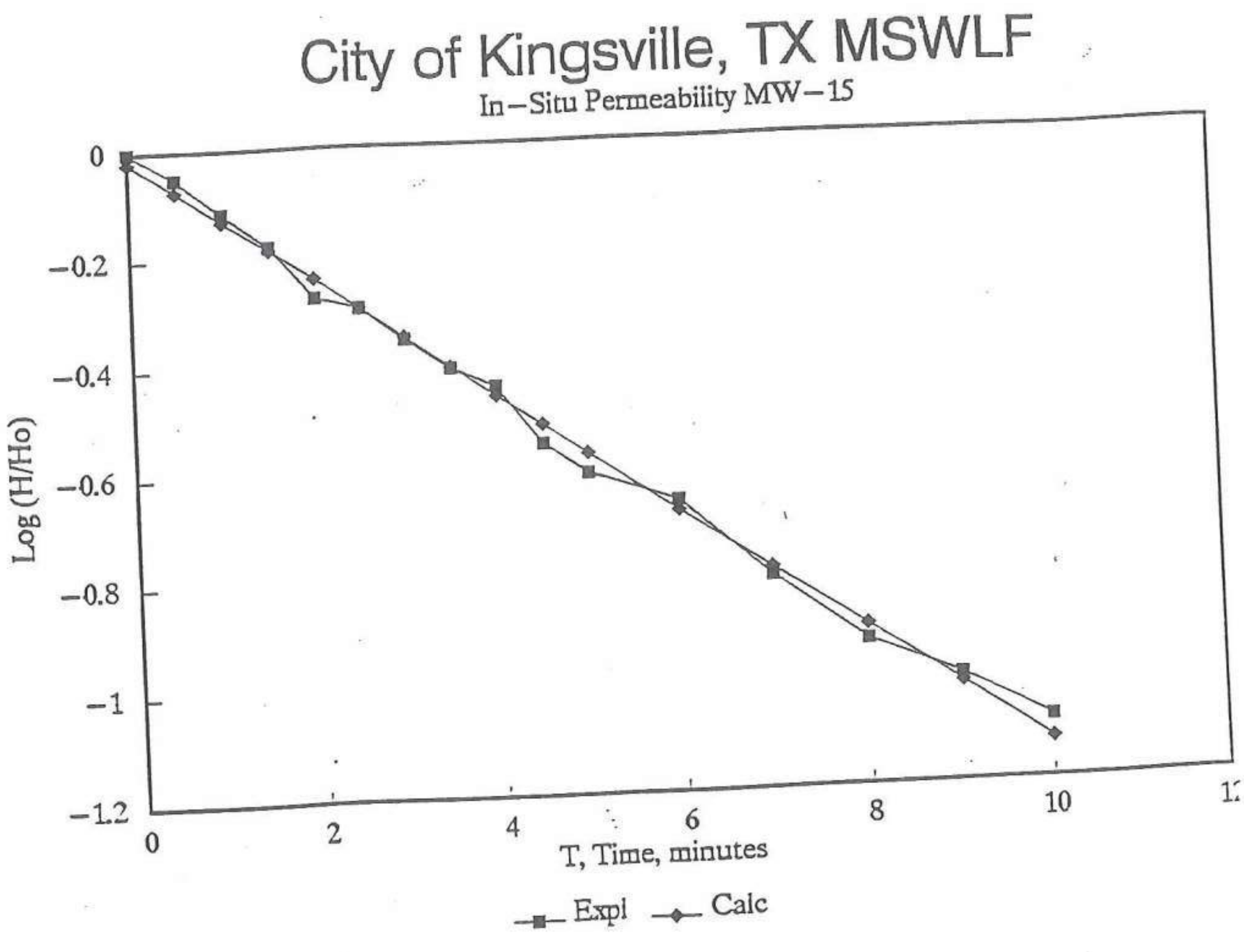
X Time min	Depth ft	del h ft	del(h/ho)	Y log	X^2	X*Y	calc'd del(h/ho)	calc'd log
EQUIL	18.57	0	0					
0	22	3.43	1	0	0	0	0.95653	-0.0193
0.5	21.62	3.05	0.889213	-0.05099	0.25	-0.0255	0.841835	-0.07477
1	21.2	2.63	0.766764	-0.11534	1	-0.11534	0.740892	-0.13025
1.5	20.84	2.27	0.661808	-0.17927	2.25	-0.2689	0.652053	-0.18572
2	20.39	1.82	0.530612	-0.27522	4	-0.55045	0.573867	-0.24119
2.5	20.3	1.73	0.504373	-0.29725	6.25	-0.74312	0.505056	-0.29666
3	20.08	1.51	0.440233	-0.35632	9	-1.06895	0.444496	-0.35213
3.5	19.9	1.33	0.387755	-0.41144	12.25	-1.44005	0.391197	-0.4076
4	19.8	1.23	0.358601	-0.44539	16	-1.78156	0.344289	-0.46308
4.5	19.53	0.96	0.279883	-0.55302	20.25	-2.4886	0.303006	-0.51855
5	19.41	0.84	0.244898	-0.61101	25	-3.05507	0.266674	-0.57402
6	19.31	0.74	0.215743	-0.66606	36	-3.99637	0.206555	-0.68496
7	19.1	0.53	0.154519	-0.81102	49	-5.67713	0.15999	-0.79591
8	18.97	0.4	0.116618	-0.93323	64	-7.46587	0.123922	-0.90685
9	18.91	0.34	0.099125	-1.00382	81	-9.03434	0.095985	-1.01779
10	18.85	0.28	0.081633	-1.08814	100	-10.8814	0.074347	-1.12874
67.5	16			-7.79752	426.25	-48.5926		

delta=	2263.75		
alpha=	-43.6935	A=	-0.0193
beta=	-251.149	B=	-0.11094

K=	((r^2*ln(L/R))/(2*L*To))	
r=	0.166667	ft
L=	12	ft
R=	0.416667	ft
To=	3.72	min
K=	0.001046	ft/min
	0.000531	cm/sec
	1.7E-05	ft/sec
	1.505544	ft/day

E-10

FIGURE 10


City of Kingsville, TX MSWLF
In-Situ Permeability MW-15
Log (H/Ho)
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
0
2
4
6
8
10
T, Time, minutes
Expl
Calc

City of Kingsville MSWLF - Permeability
Well Number 16

X Time min	Depth ft	del h ft	del(h/ho)	Y log	X^2	X*Y	calc'd del(h/ho)	calc'd log
EQUIL	24.91	0	0					
0	27.9	2.99	1	0	0	0	0.95017	-0.0222
0.5	27.3	2.39	0.799331	-0.09727	0.25	-0.04864	0.827222	-0.08238
1	27.1	2.19	0.732441	-0.13523	1	-0.13523	0.720182	-0.14256
1.5	26.82	1.91	0.638796	-0.19464	2.25	-0.29196	0.626994	-0.20274
2	26.54	1.63	0.545151	-0.26348	4	-0.52697	0.545863	-0.26292
2.5	26.36	1.45	0.48495	-0.3143	6.25	-0.78576	0.475231	-0.3231
3	26.13	1.22	0.408027	-0.38931	9	-1.16793	0.413738	-0.38327
3.5	25.98	1.07	0.35786	-0.44629	12.25	-1.56201	0.360202	-0.44345
4	25.82	0.91	0.304348	-0.51663	16	-2.06652	0.313593	-0.50363
4.5	25.71	0.8	0.267559	-0.57258	20.25	-2.57662	0.273016	-0.56381
5	25.6	0.69	0.230769	-0.63682	25	-3.18411	0.237688	-0.62399
6	25.44	0.53	0.177258	-0.7514	36	-4.50837	0.180156	-0.74435
7	25.31	0.4	0.133779	-0.87361	49	-6.11528	0.13655	-0.86471
8	25.22	0.31	0.103679	-0.98431	64	-7.87448	0.103498	-0.98507
9	25.16	0.25	0.083612	-1.07773	81	-9.69958	0.078446	-1.10543
57.5	15			-7.2536	326.25	-40.5434		

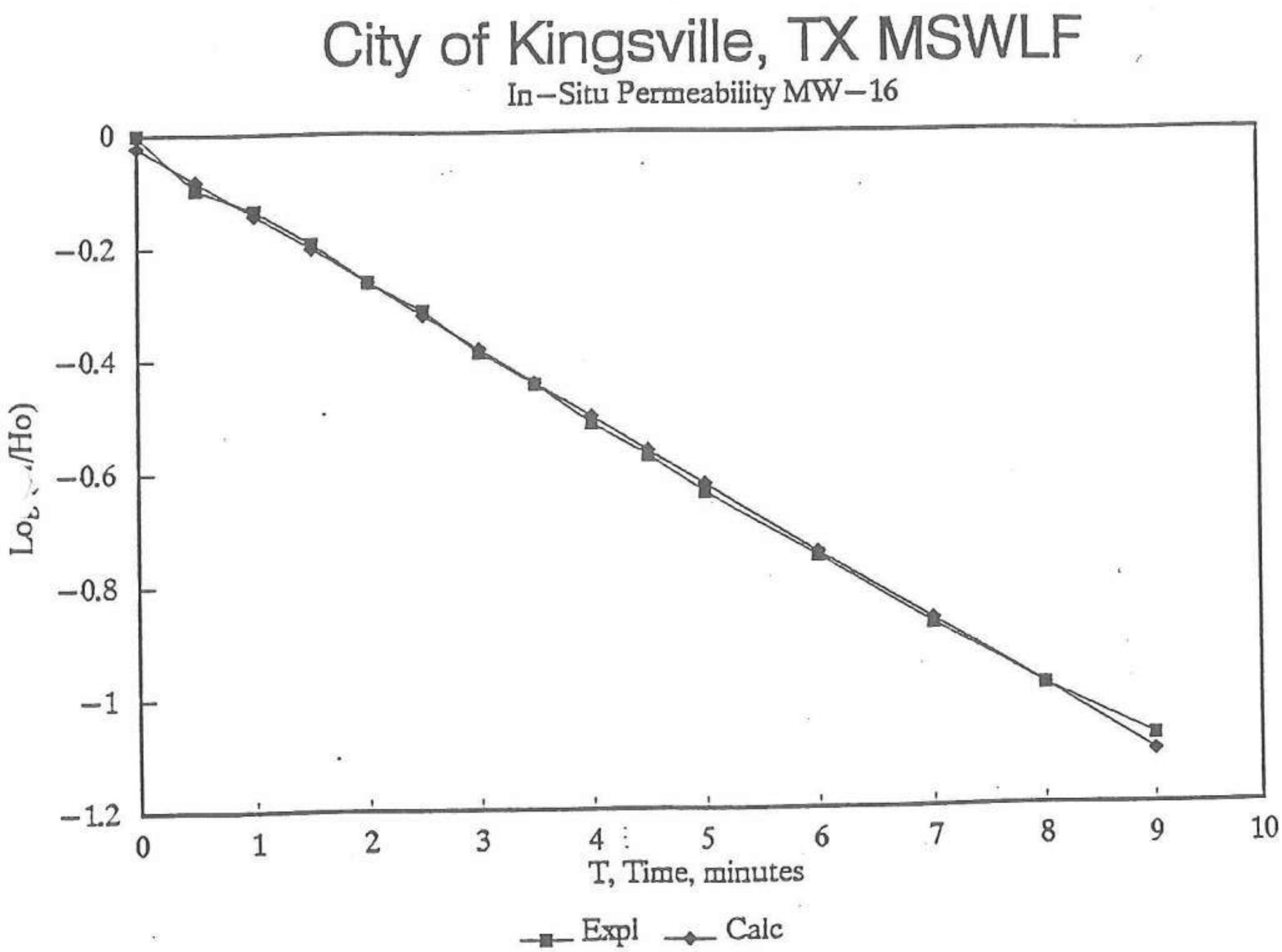
delta= 1587.5
alpha= -35.2406
beta= -191.069

A= -0.0222
B= -0.12036

K= ((r^2*ln(L/R))/(2*L*To))
r= 0.166667 ft
L= 11 ft
R= 0.416667 ft
To= 3.4 min
K= 0.001216 ft/min
0.000618 cm/sec
2E-05 ft/sec
1.750462 ft/day

E-12

FIGURE 11



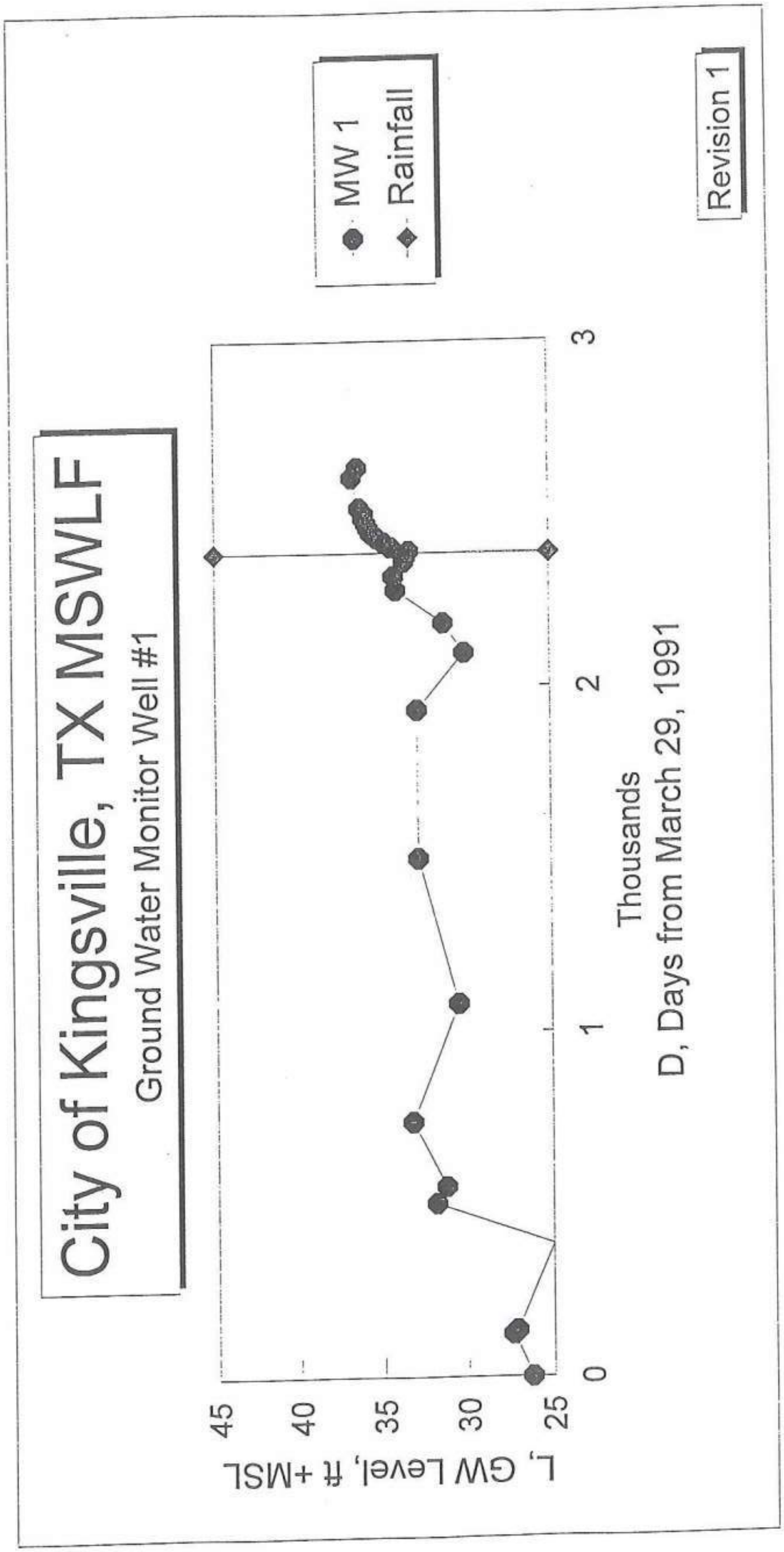
E-13

ATTACHMENT F

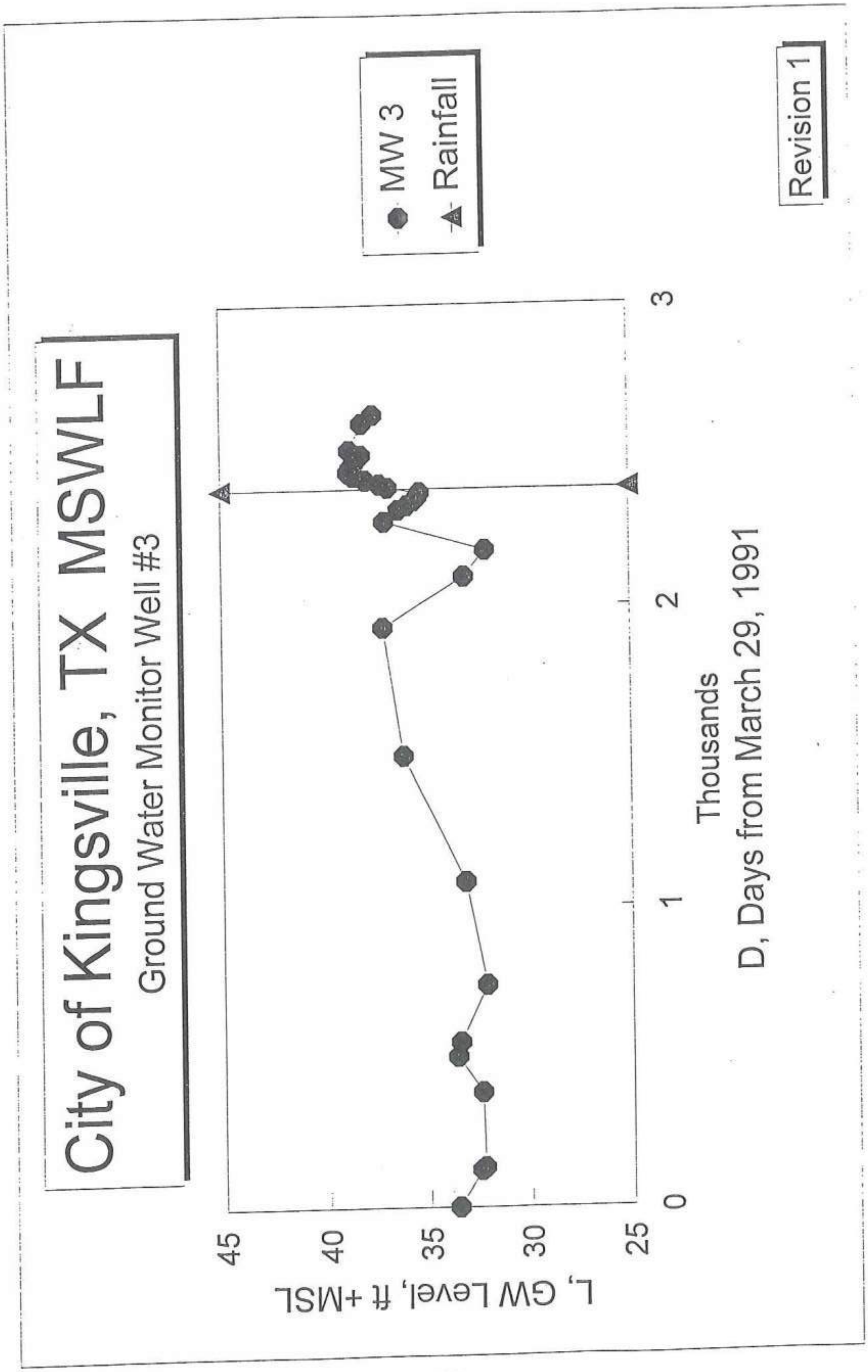
APPENDIX F

HYDROGRAPHS

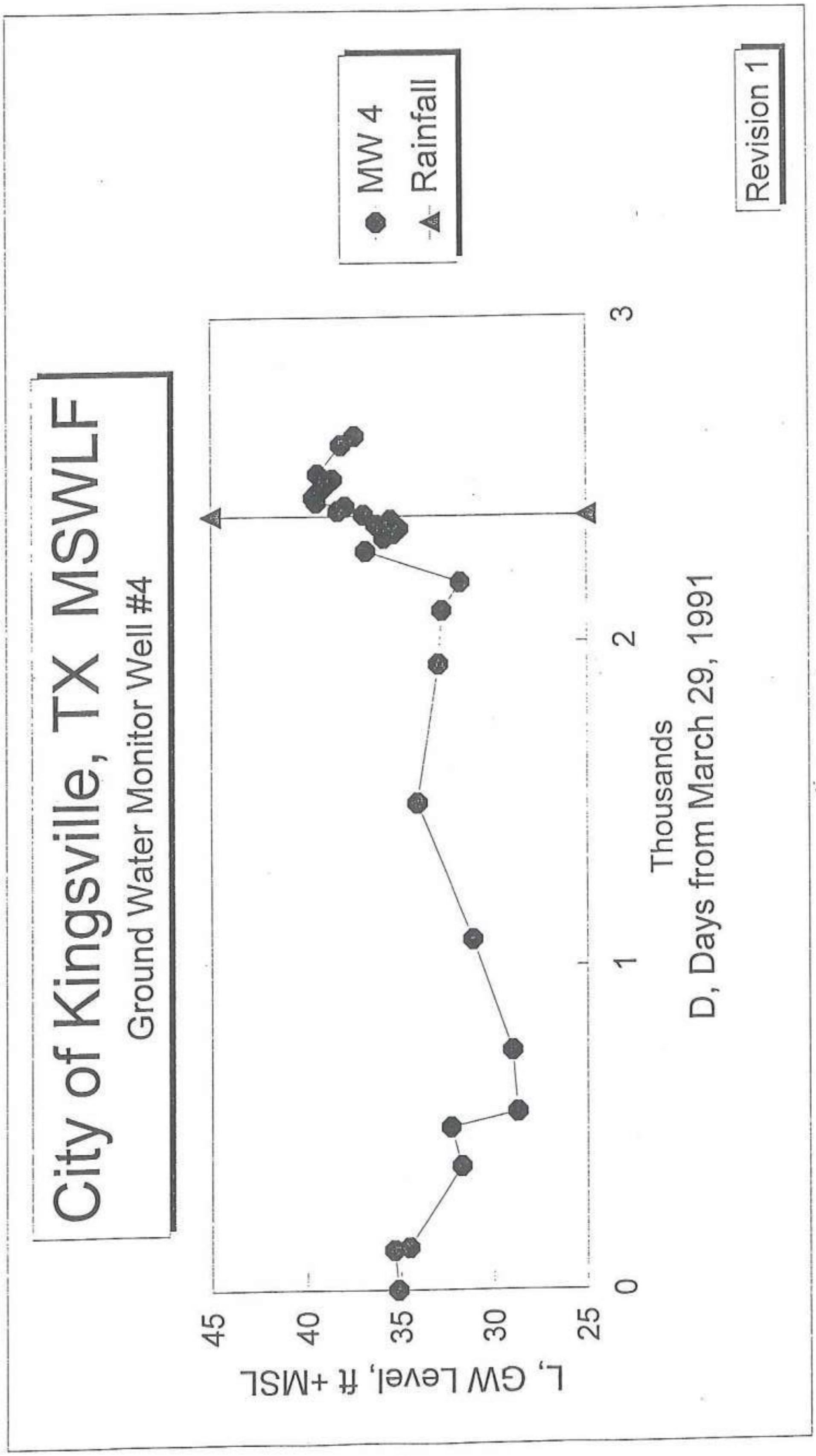
November 1997
Revision 1 - June, 1998


City of Kingsville, TX MSWLF
Ground Water Monitor Well #1
MW 1
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

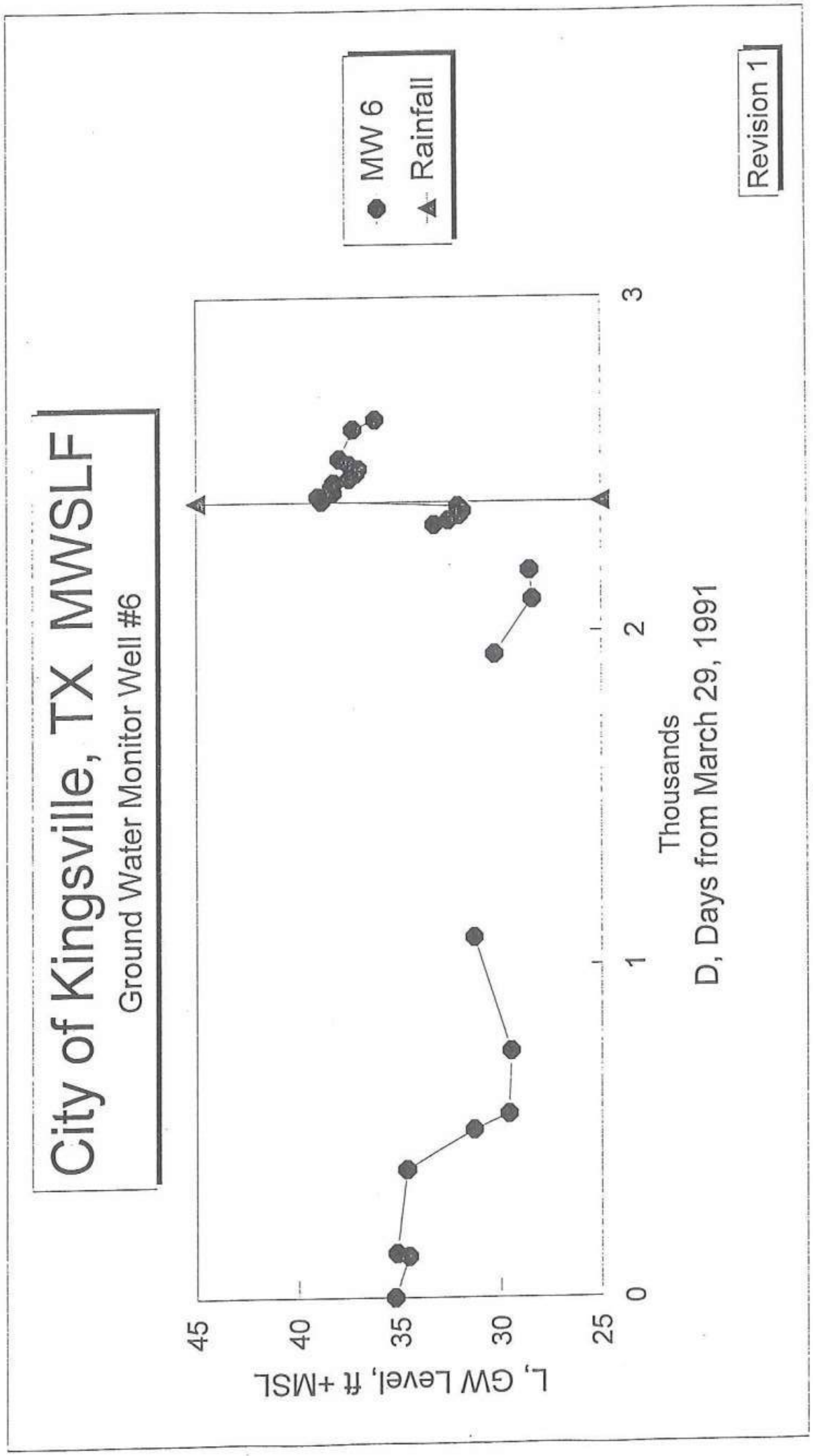
F-1


City of Kingsville, TX MSWLF
Ground Water Monitor Well #3
MW 3
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

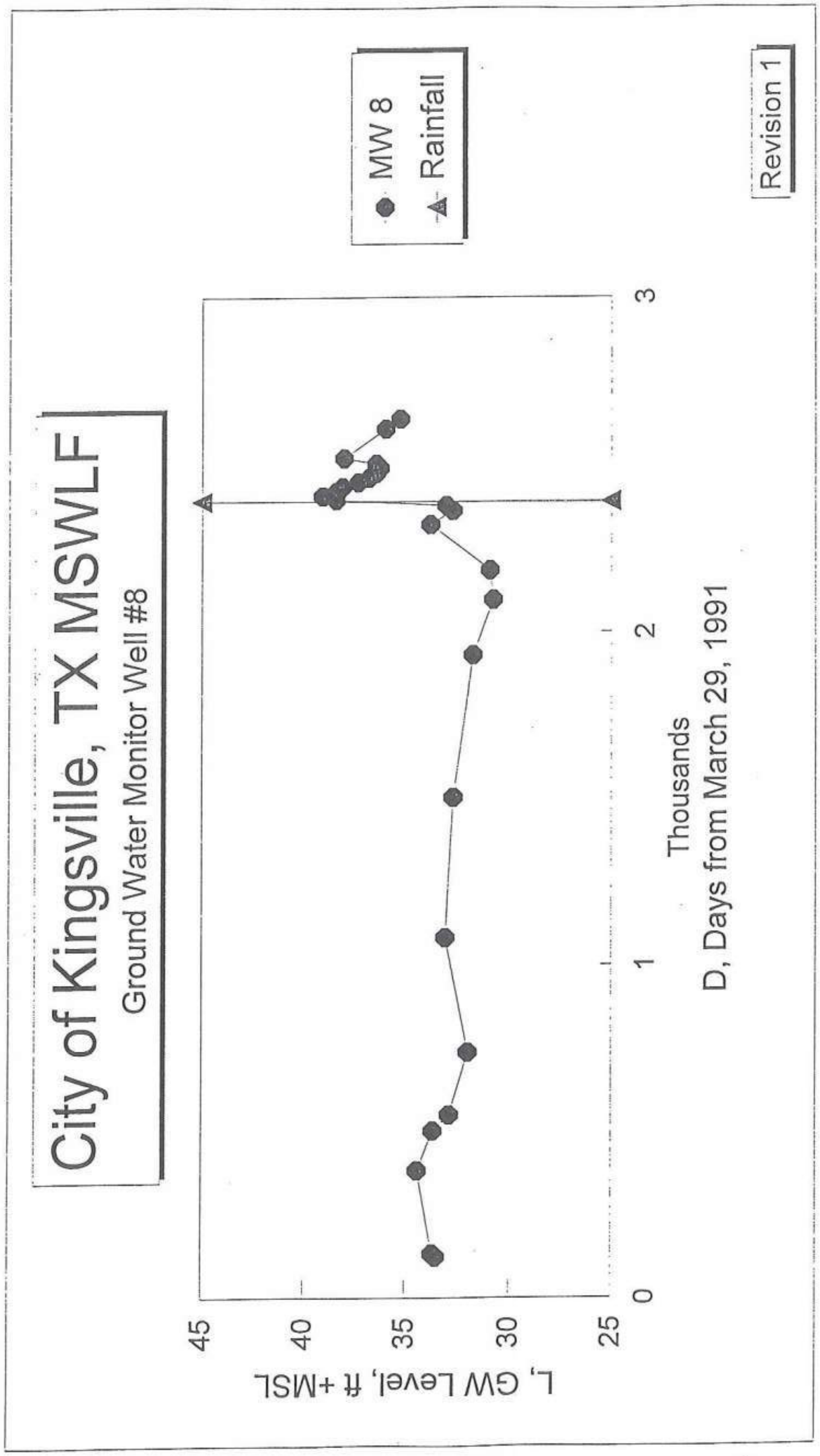
F-2


City of Kingsville, TX MSWLF
Ground Water Monitor Well #4
MW 4
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

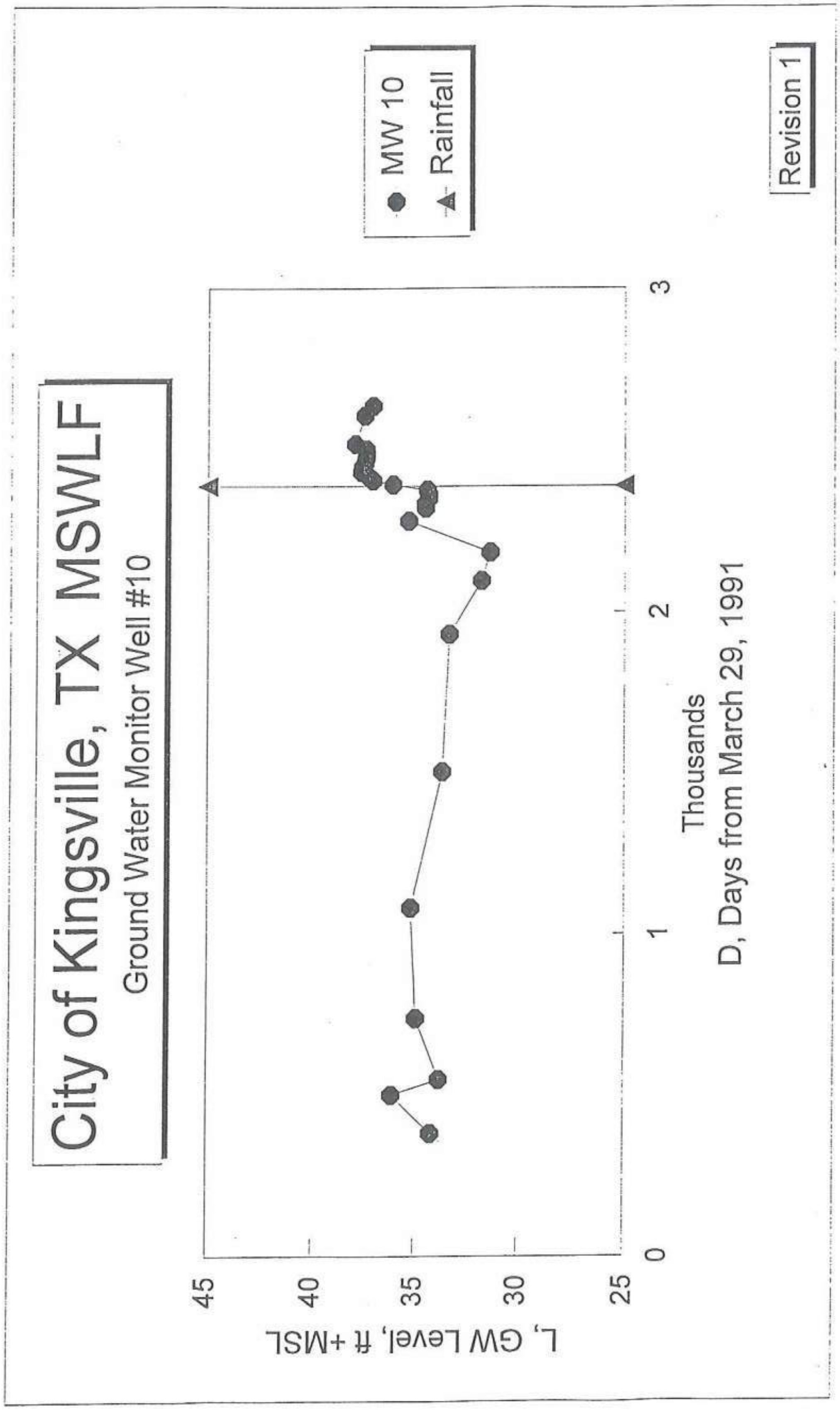
F-3


City of Kingsville, TX MWSLF
Ground Water Monitor Well #6
MW 6
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

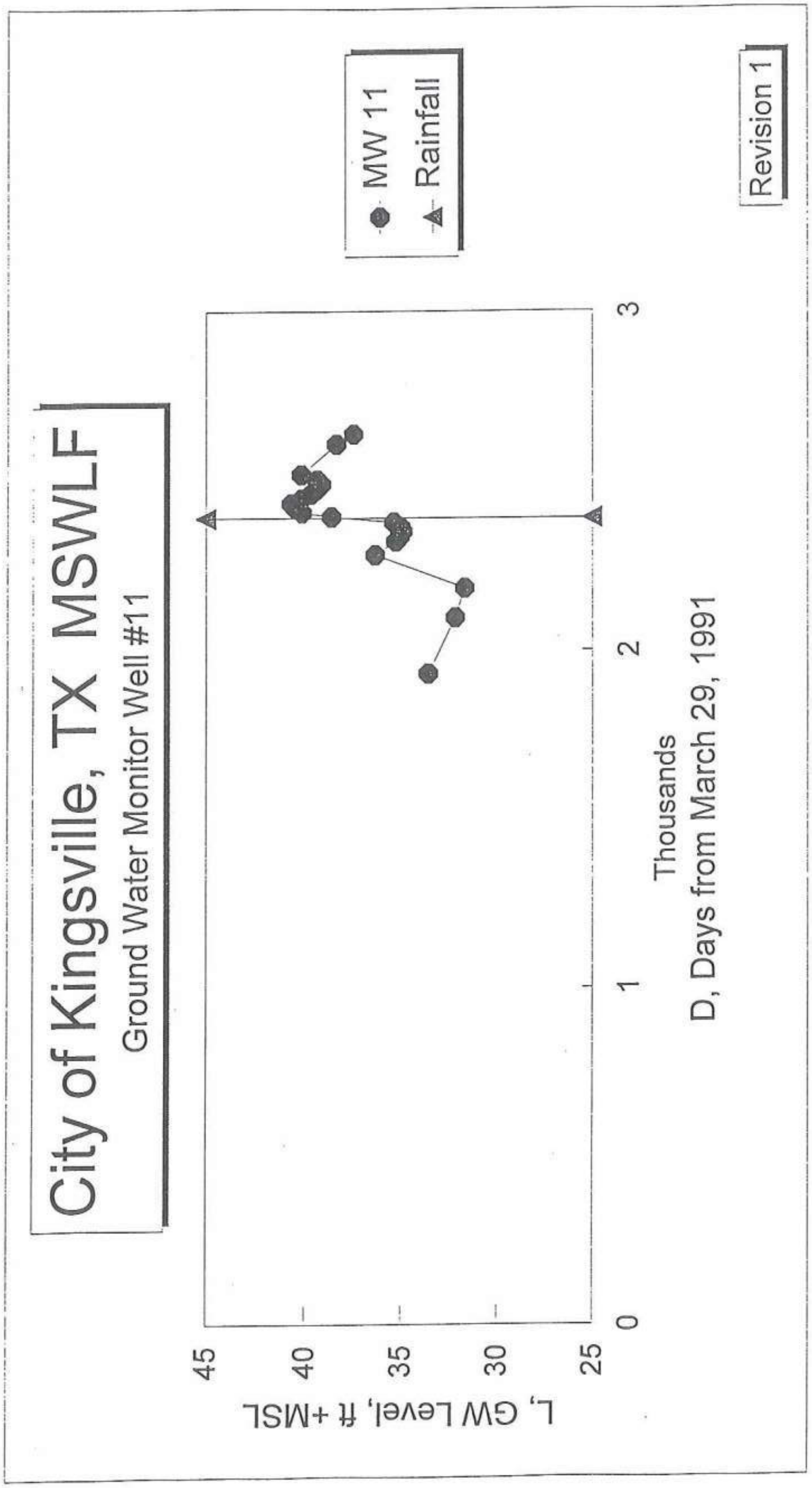
F-4


City of Kingsville, TX MSWLF
Ground Water Monitor Well #8
MW 8
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

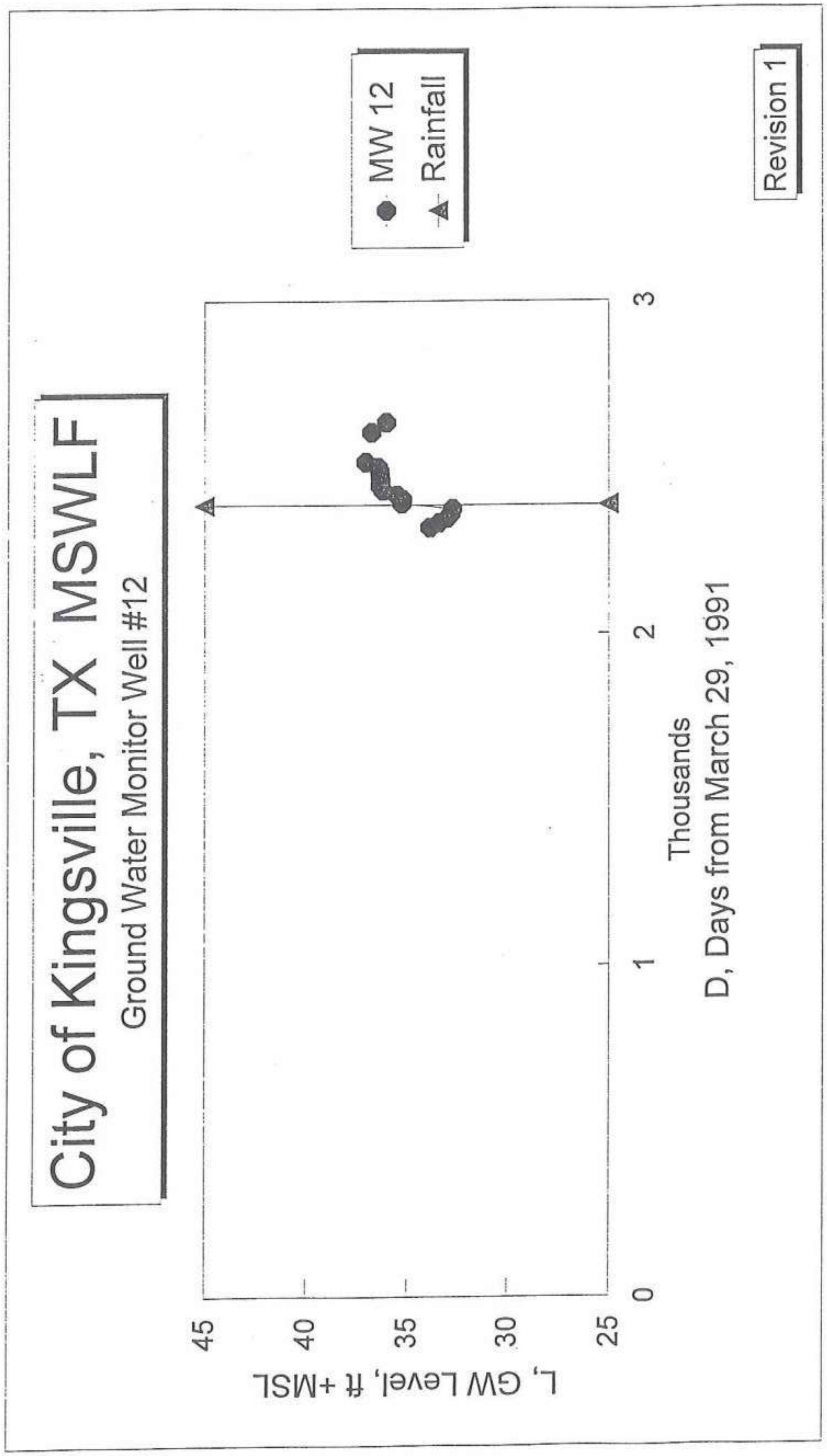
F-5


City of Kingsville, TX MSWLF
Ground Water Monitor Well #10
MW 10
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

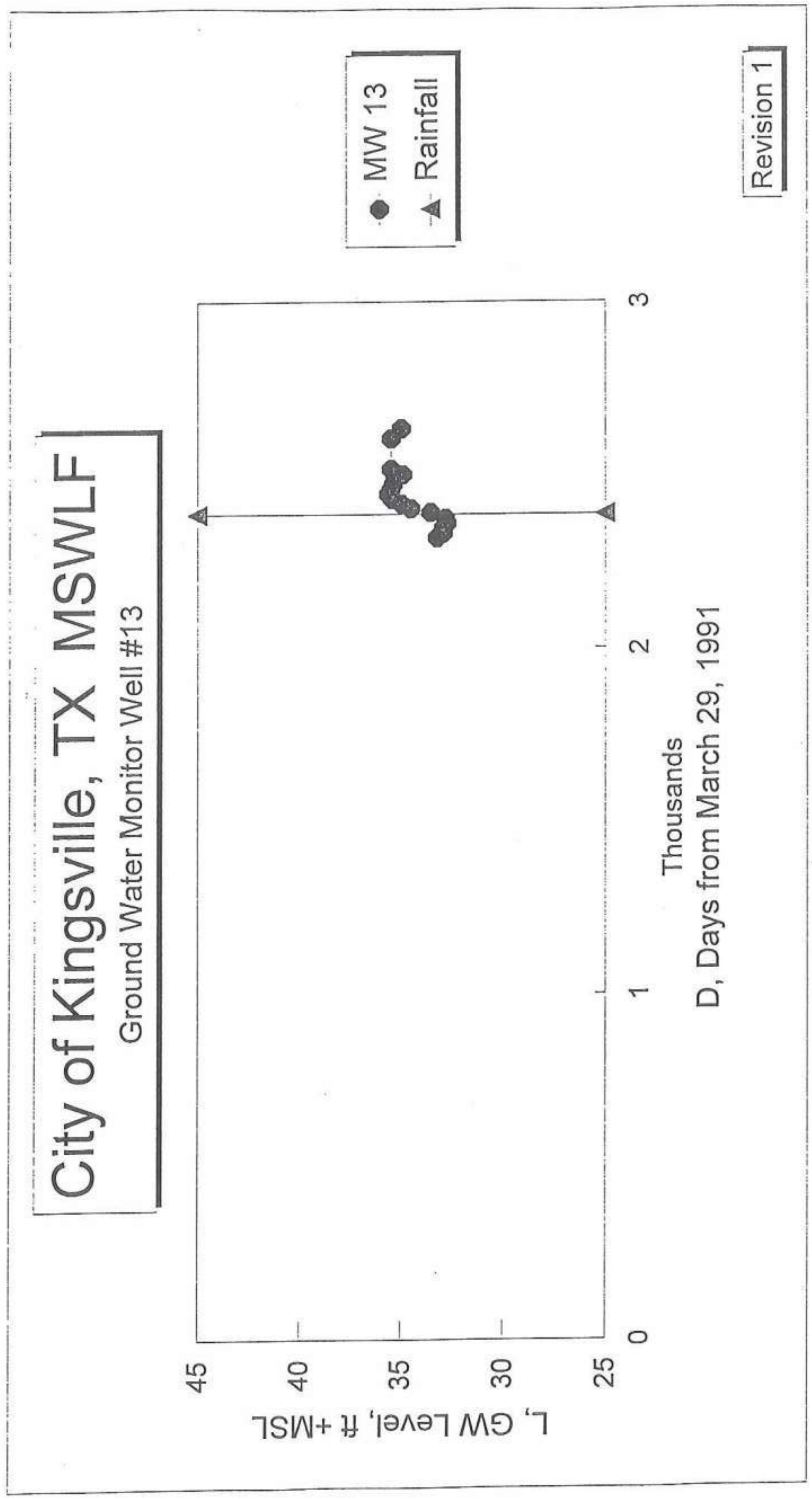
F-6


City of Kingsville, TX MSWLF
Ground Water Monitor Well #11
MW 11
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

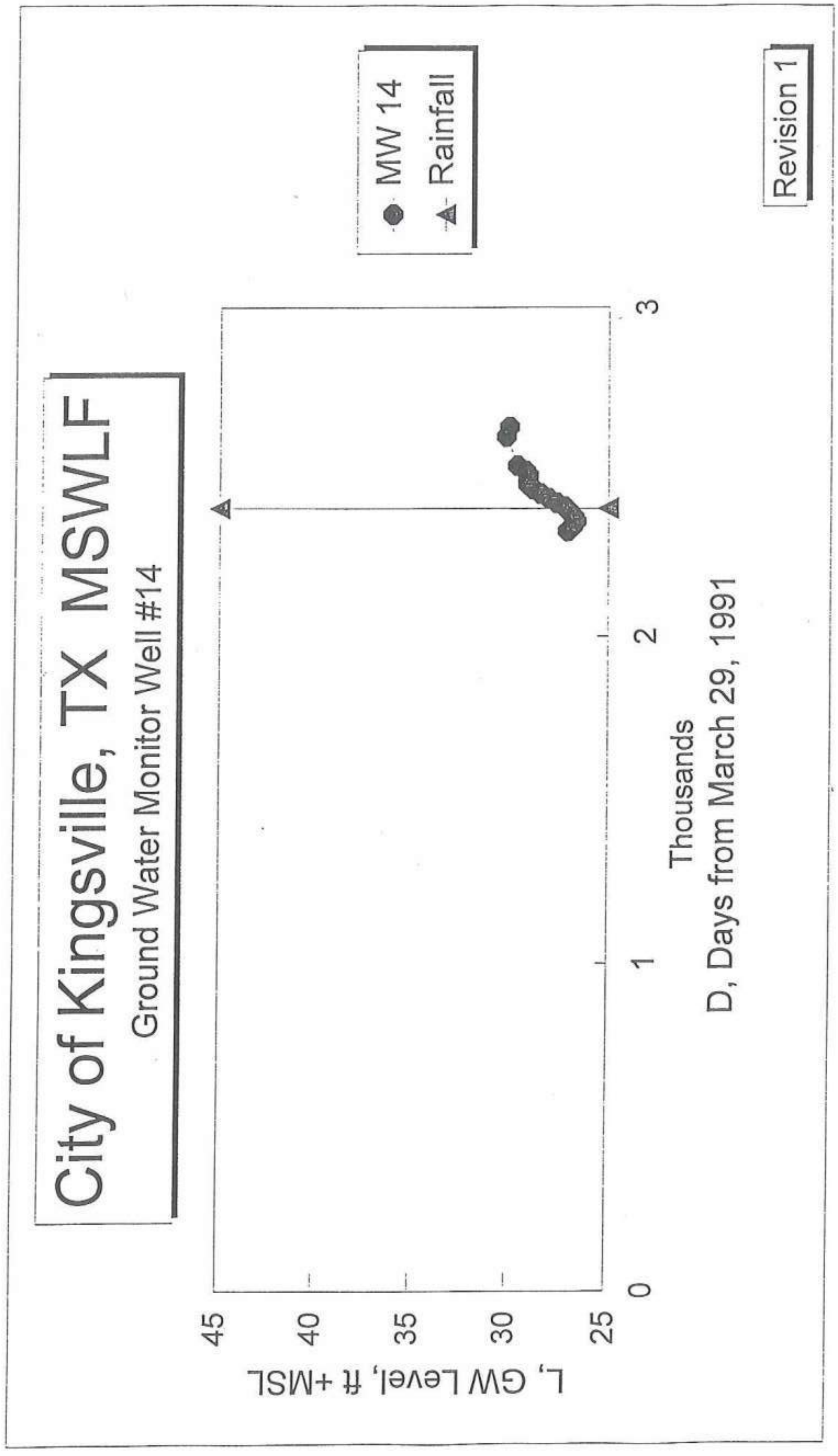
F-7


City of Kingsville, TX MSWLF
Ground Water Monitor Well #12
MW 12
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

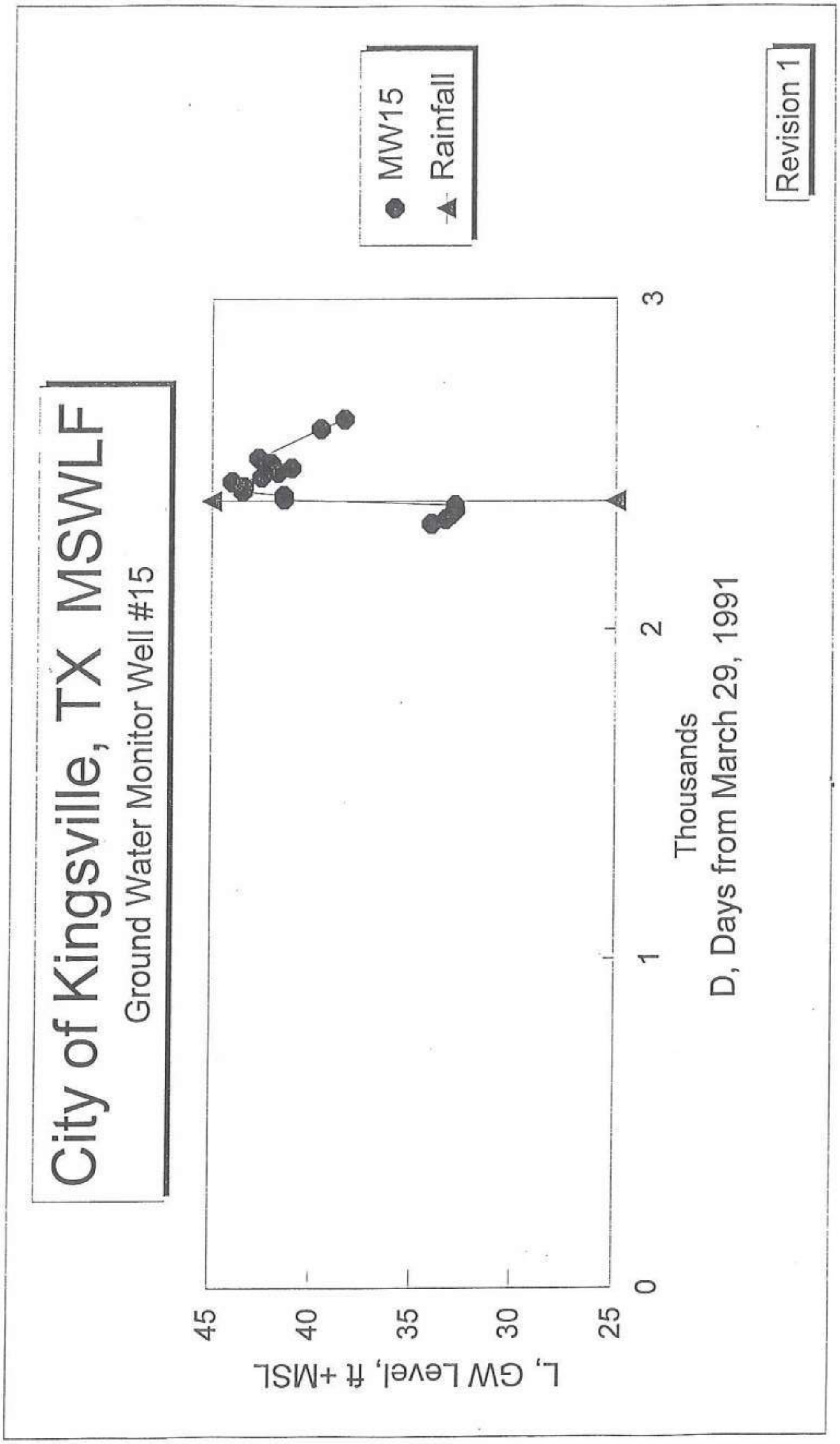
F-8


City of Kingsville, TX MSWLF
Ground Water Monitor Well #13
MW 13
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

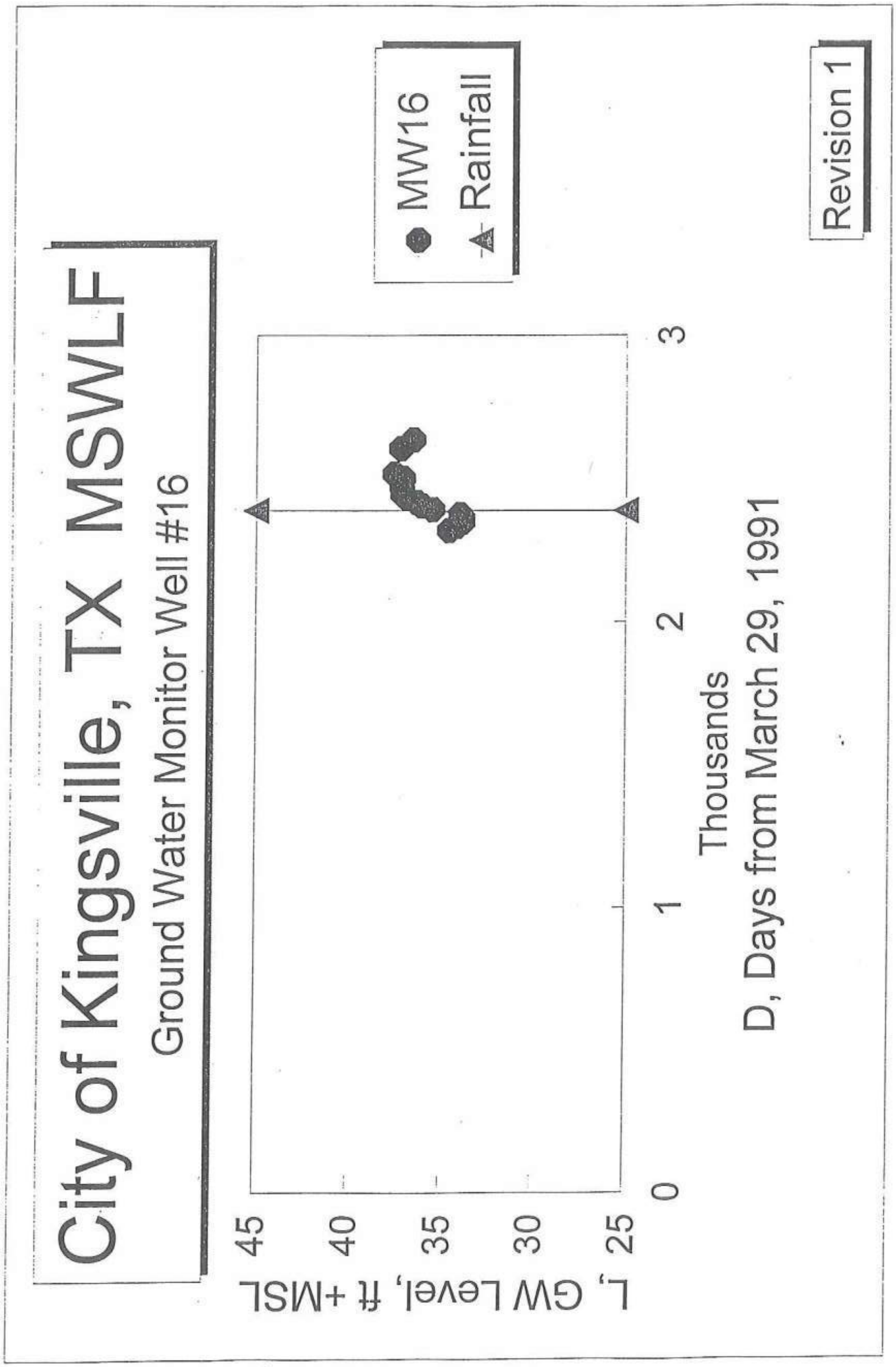
F-9


City of Kingsville, TX MSWLF
Ground Water Monitor Well #14
MW 14
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

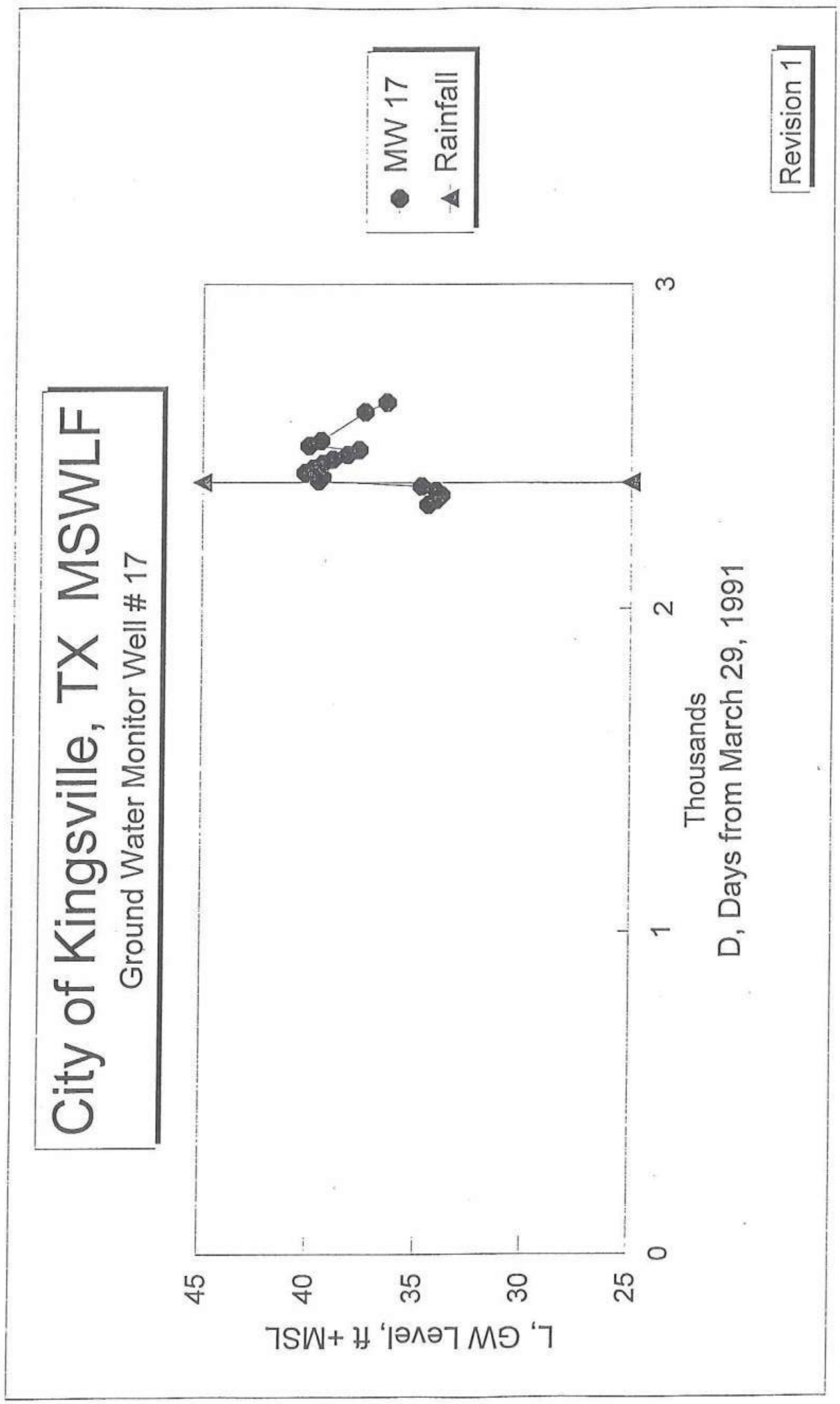
F-10


City of Kingsville, TX MSWLF
Ground Water Monitor Well #15
MW15
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

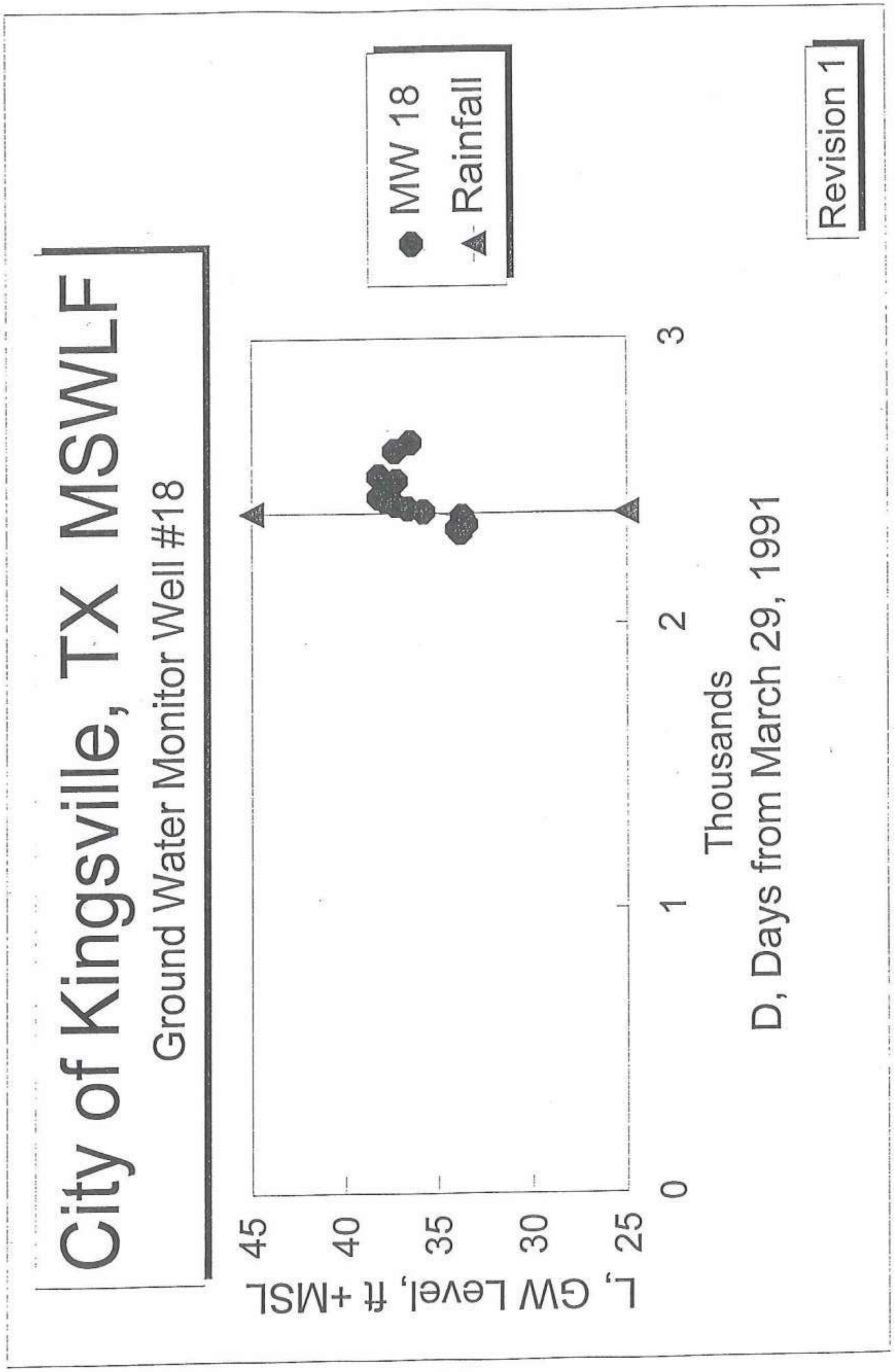
F-11


City of Kingsville, TX MSWLF
Ground Water Monitor Well #16
MW16
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

F-12


City of Kingsville, TX MSWLF
Ground Water Monitor Well # 17
MW 17
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

F-13


City of Kingsville, TX MSWLF
Ground Water Monitor Well #18
MW 18
Rainfall
Revision 1
L, GW Level, ft +MSL
45
40
35
30
25
0
1
2
3
Thousands
D, Days from March 29, 1991

F-14

APPENDIX G

APPENDIX G

GEOTECHNICAL LABORATORY TEST REPORT

November 1997
Revision 1 - June, 1998

G-1

psi Environmental Geotechnical Construction
Consulting • Engineering • Testing

September 2, 1997

Finch Energy & Environmental Services
1204 W. King P.O. Box 73
Kingsville, Texas 78364

Attn: Mr. Allen D. Walzel, M.S., P.E.

Re: Subsurface Exploration and
Laboratory Analysis
Proposed Landfill Expansion
Kingsville, Texas
PSI File Number: 326-72026

Gentlemen:

In compliance with your instructions, we have conducted a subsurface exploration and laboratory analysis for the above referenced project. The results of this investigation, are to be found in the accompanying report, two (2) copies of which are being transmitted herewith.

Often, because of design and construction details which occur on a project, questions arise concerning soil conditions, and PSI would be pleased to continue its role as Geotechnical Engineer during the project implementation.

PSI also has great interest in providing materials testing and inspection services during the construction of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.

STATE OF TEXAS
MARK J. O'CONNOR
79252

Amy R. Rein, E.I.T.
Staff Engineer

Mark J. O'Connor, P.E.
Geotechnical Department Manager

Information To Build On

... TX 78416 • Phone 512/854-4801 • Fax 512/854-6049

psi

G-2

TABLE OF CONTENTS

psi

G-3

SUBSURFACE EXPLORATION AND LABORATORY ANALYSIS FOR THE PROPOSED LANDFILL EXPANSION KINGSVILLE, TEXAS

PREPARED FOR

FINCH ENERGY & ENVIRONMENTAL SERVICES

1204 W. KING P.O. BOX 73

KINGSVILLE, TEXAS 78364

BY

PROFESSIONAL SERVICE INDUSTRIES, INC.

PSI PROJECT NUMBER: 326-72026

INTRODUCTION

Authorization

This report presents the results of a soils exploration and laboratory analysis for the proposed landfill expansion located in Kingsville, Texas. This study was conducted for Mr. Allen D. Walzel, M.S., P.E. of Finch Energy & Environmental Services and for the City of Kingsville.

The work for this project was performed in accordance with our PSI Proposal No. 326-130 dated June 12, 1997. The proposal included a proposed scope of work, estimated cost, unit rates, and PSI's general conditions. The proposal was signed by Mr. Ricardo Guzman, Director of Public Works, representing the City of Kingsville.

Purpose and Scope

The purpose of this exploration was to evaluate the soil and groundwater conditions at the site. The scope of the exploration and analysis included the subsurface exploration, monitor well installation, field and laboratory testing.

FIELD EXPLORATION

Scope

The field exploration to evaluate the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling the test borings, performing standard penetration tests and recovering disturbed split-barrel and relatively undisturbed, thin-wall, Shelby tube samples, and installing monitor wells.

Seven monitor wells were installed. The depths and locations of the monitor wells were specified by Finch Energy & Environmental Services. No boring location sketch was provided to PSI, therefore one is not included in this report. All boring identification numbers and locations were chosen by Finch Energy & Environmental Services.

Drilling and Sampling Procedures

The test borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Representative samples were obtained employing split-barrel sampling procedures in general accordance with the procedures for "Penetration Test and Split-Barrel Sampling of Soils" (ASTM Designation D-1586). Undisturbed samples were obtained using thin-wall sampling procedures in accordance with the procedures for "Thin Walled Tube Sampling of Soils" (ASTM Designation D-1587).

The samples obtained by this procedure were extruded by a hydraulic ram in the field. Samples were identified by Finch Energy & Environmental Services, according to boring number and depth, encased in moisture sealed plastic bags to protect against moisture loss, and transported to the laboratory in special containers.

LABORATORY TESTING PROGRAM

In addition to the field investigation, a supplemental laboratory testing program was conducted to determine additional pertinent engineering characteristics of the subsurface materials. All laboratory tests performed were assigned by Finch Energy & Environmental Services.

The laboratory testing program included supplementary visual classification (ASTM D-2487) on all samples. In addition, selected samples were subjected to water content tests (ASTM D-2216), wet and dry unit weight determinations (ASTM D-2937), unconfined compressive strength tests (ASTM D-2166), Atterberg Limit tests (ASTM D-4318), percent material finer than the #200 sieve (ASTM D-1140), sieve and hydrometer analysis (ASTM D-422), horizontal and vertical permeability tests (ASTM D-5084), organic carbon content tests (ASTM D-2974-87), and unconsolidated undrained triaxial tests (ASTM D-2850).

All phases of the laboratory testing program were conducted in general accordance with applicable ASTM Specifications. The results of these tests are to be found in the data tables and on the boring logs provided in the Appendix.

SUBSURFACE CONDITIONS

Boring Logs

The types of subsurface materials encountered in the test borings have been visually classified. They are described on the boring logs. The results of the field and other laboratory tests are presented on the boring logs and in the data tables provided in the Appendix. Representative samples of the soils were placed in moisture sealed plastic bags and are now stored in the laboratory for further analysis, if desired.

The stratification of the soil as shown on the boring logs represents the soil conditions at the actual boring locations. Variations in the noted soil conditions may exist in areas outside of the boring locations. Lines of demarcation as shown in the description column of the boring logs represent approximate changes in soil conditions. Such soil conditions include the soil type, color, moisture, consistency, relative density and other minor conditions. Dashed lines indicate slight changes in soil conditions whereas solid lines represent distinct changes. Both dashed and solid demarcation lines represent transitions of varying degrees, but the actual transitions may be more or less gradual, or not clearly defined.

It is to be noted that, whereas the test borings are drilled and sampled by experienced drillers, it is sometimes difficult to record changes in stratification within narrow limits. In the absence of foreign substances, it is also difficult to distinguish between discolored soils and clean soil fill.

GENERAL

The appendix attached contains the results of the tests as requested by the client. The boring logs are numbered SB-12 thru SB-18. The remaining tests are identified by plate number. Because some samples were outside ASTM tolerances for size, some slight deviations were noted (see plate 4). In addition, due to the fragile nature of some samples resulting in poor sample condition, some tests were not able to be performed (see plate 5).

In April 1998 deeper borings were tested. The borings are numbered MW-21, MW-23, MW-24, and MW-25. The results of the tests on these borings are attached as well.

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-7

Boring: B-12

Project Name: City of Kingsville Landfill

Date of Boring: July 7, 1997

Site: Kingsville, Texas

Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SILTY CLAY, some sand, dark brown.		S-1				7.2	
SANDY CLAY, brown.		S-2					
	5						
SANDY CLAY, light brown.		S-3				14.1	-#200=60%
SANDY CLAY, light brown, (CL).		S-4				13.6	LL=41% PI=28
	10						
SANDY CLAY, light brown.		S-5					
	15						
CLAYEY SAND, light brown, (SC).		S-6		1.7		19.1	-#200=48% LL=51% PI=28
	20						
CLAYEY SAND, light brown, (SC).		S-7		2.4		23.6	-#200=33% LL=48% PI=26
	25						
SANDY CLAY, light brown.		S-8					
	30						
CLAY, with sand, light brown, (CH).		S-9				24.7	LL=53% PI=29

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-8

Boring: B-12 Page 2

Project Name: City of Kingsville Landfill

Date of Boring: July 7, 1997

Site: Kingsville, Texas

Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
CLAY, with sand, light brown, (CH).	35	S-10				23.2	LL=51% PI=24
CLAY, with sand, light brown and light gray.		S-11				25.2	-#200=51%
	40						
CLAY, with sand, light gray.		S-12					
	45						
CLAY, some sand, light gray.		S-13				29.0	
CLAY, some sand, light gray, (CH).		S-14				30.2	LL=59% PI=25
Total Depth of Boring = 48 Feet.							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-9

Boring: B-13

Project Name: City of Kingsville Landfill   Date of Boring: July 7, 1997

Site: Kingsville, Texas   Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SILTY CLAY, dark brown.		S-1					
SANDY CLAY, brown, (CL).		S-2					LL=30% PI=12
	5						
SANDY CLAY, with sand, light brown.		S-3				8.0	-#200=62%
SANDY CLAY, light brown, (CL).		S-4				9.4	-#200=66% LL=43% PI=26
	10						
SANDY CLAY, light brown.		S-5					
	15						
CLAY, with sand, light brown, (CH).		S-6					LL=59% PI=36
	20						
CLAY, some sand, light gray, (CH).		S-7				21.3	LL=59% PI=29
	25						
CLAY, with sand, light brown.		S-8				21.3	
CLAY, with sand, light brown, (CH).		S-9		2.3		21.6	LL=63% PI=29
CLAYEY SAND, light brown.		S-10				18.6	-#200=48%
	30						

PROFESSIONAL SERVICE INDUSTRIES, INC.
RECORD OF SUBSURFACE EXPLORATION

G-10

Boring: B-13 Page 2

Project Name: City of Kingsville Landfill
Date of Boring: July 7, 1997
Project No.: 326-72026
Site: Kingsville, Texas

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
CLAYEY SAND, light brown, (SC)		S-11		3.2		23.9	-#200=46% LL=59% PI=28
CLAYEY SAND, light brown.	35	S-12				20.3	
CLAYEY SAND, light brown.	40	S-13					
CLAYEY SAND, light brown, (SC).		S-14		0.38		26.9	LL=56% PI=24
FINE SAND, with clay, light brown.	45	S-15				24.7	-#200=30%
FINE SAND, some clay, brown.		S-16				26.7	Non Plastic
Total Depth of Boring = 49.0 Feet.							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-11

Boring: B-14

Project Name: City of Kingsville Landfill

Date of Boring: July 7, 1997

Site: Kingsville, Texas

Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SANDY CLAY, dark brown.		S-1					
	5						
SANDY CLAY, brown, (CL).		S-2				11.5	-#200=56% LL=44% PI=26
SANDY CLAY, light brown.	10	S-3				14.4	-#200=53%
CLAY, with sand, light gray, (CH).		S-4				19.0	LL=63% PI=37
	15						
CLAY, with sand, light gray.		S-5				22.2	
	20						
CLAY, light gray, (CH).		S-6				24.8	LL=58% PI=33
	25						
CLAYEY SAND, light brown.		S-7				28.5	-#200=46%
	30						

PROFESSIONAL SERVICE INDUSTRIES, INC.
RECORD OF SUBSURFACE EXPLORATION

G-12

Boring: B-14 Page 2
Project Name: City of Kingsville Landfill
Date of Boring: July 7, 1997
Site: Kingsville, Texas
Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SANDY CLAY, light brown, (CL).		S-8				29.3	-#200=66% LL=50% PI=27
CLAY, trace sand, brown, (CH).		S-9				25.7	LL=61% PI=33
CLAY, trace sand, brown, (CH).	35	S-10					
CLAY, some sand, light brown, (CH).		S-11				26.0	-#200=85% LL=64% PI=37
SILTY CLAY, some sand, light brown, (CL).	40	S-12				29.5	LL=41% PI=15

Total Depth of Boring = 40.0 Feet.

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-13

Boring: B-15

roject Name: City of Kingsville Landfill

Date of Boring: July 7, 1997

Site: Kingsville, Texas

Project No.: 326-72025

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SILTY CLAY, with sand, dark brown.		S-1					
	5						
CLAYEY SAND, light brown, (SC).		S-2				12.3	-#200=47% LL=30% PI=19
	10						
SANDY CLAY, light brown.		S-3				11.6	-#200=51%
CLAY, some sand, light brown.		S-4				12.9	
CLAY, with sand, light brown, (CH).		S-5				15.3	-#200=55% LL=68% PI=46
CLAY, some sand, light brown, (CH).	15	S-6				15.3	LL=79% PI=56
CLAY, with sand, light gray, (CH).		S-7				15.3	-#200=65% LL=79% PI=56
CLAY, with sand, light brown and light gray, (CH).	20	S-8				21.2	LL=83% PI=60
CLAY, with sand, light brown and light gray.		S-9					
CLAY, with sand, light brown and light gray.		S-10		1.56		20.1	
CLAY, with sand, light brown and light gray, (CH).	25	S-11				21.3	-#200=53% LL=50% PI=32
CLAY, with sand, light brown.		S-12					
CLAY, with sand, light brown, (CH).		S-13				26.5	-#200=58% LL=52% PI=35
CLAY, with sand, brown.	30	S-14				29.0	-#200=66%

PROFESSIONAL SERVICE INDUSTRIES, INC.
RECORD OF SUBSURFACE EXPLORATION

G-14

Boring: B-15 Page 2
Project Name: City of Kingsville Landfill
Date of Boring: July 7, 1997
Site: Kingsville, Texas
Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
CLAYEY SAND, light brown, (SC).	35	S-15					LL=29% PI=8
Total Depth of Boring = 37.0 Feet.							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-15

Boring: B-16

Project Name: City of Kingsville Landfill   Date of Boring: July 7, 1997

Site: Kingsville, Texas   Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SANDY CLAY, dark gray.		S-1					
SANDY CLAY, dark gray.		S-2				9.3	
	5						
CLAYEY SAND, light brown, (SC).		S-3				11.6	-#200=31% LL=45% PI=23
	10						
FINE SAND, some clay, light brown.		S-4					
FINE SAND, some clay, light brown.		S-5					
FINE SAND, with clay, light brown.		S-6					
FINE SAND, with clay, light brown.	15	S-7					
FINE SAND, with clay, light brown.		S-8				27.3	-#200=22% Non Plastic
FINE SAND, with clay, light brown.		S-9				22.3	-#200=24% LL=43% PI=13
	20						
CLAYEY SAND, light brown.		S-10					
CLAYEY SAND, light brown.		S-11					
CLAYEY SAND, light brown.		S-12					
	25						
CLAYEY SAND, light brown.		S-13					
CLAYEY SAND, light brown, (SC).		S-14				24.5	-#200=30% LL=50% PI=29
CLAYEY SAND, light brown.	30	S-15					
CLAYEY SAND, light brown.		S-16					

PROFESSIONAL SERVICE ... RIES, INC.
RECORD OF SUBSURFACE EXPLORATION

G-16

Boring: B-16 Page 2

Project Name: City of Kingsville Landfill Date of Boring: July 7, 1997

Site: Kingsville, Texas Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
CLAYEY SAND, light brown, (SC).		S-17				19.4	-#200=46% LL=41% PI=24
	35						
CLAYEY SAND, light brown.		S-18				21.0	
SANDY CLAY, light brown.		S-19					
SANDY CLAY, light brown.	40	S-20					
CLAY, with sand, light gray.		S-21					
CLAY, some sand, light gray.		S-22					
	45						
CLAY, some sand, light brown, (CH).		S-23				30.6	-#200=83% LL=79% PI=51
Total Depth of Boring = 47.0 Feet.							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-17

Boring: B-17

Project Name: City of Kingsville Landfill

Date of Boring: July 7, 1997

Site: Kingsville, Texas

Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
CLAYEY SAND, light brown.		S-1					
FINE SAND, with clay, light brown.		S-2				21.6	Non Plastic
	5						
FINE SAND, with clay, light brown.		S-3				35.0	-#200=25%
FINE SAND, with clay, light brown.		S-4				31.4	Non Plastic
SANDY CLAY, light brown, (CL).		S-5				32.0	-#200=66% LL=41% PI=19
	10						
CLAY, with sand, light brown.		S-6					
	15						
CLAY, with sand, light brown.		S-7					
CLAY, with sand, light brown, (CH).		S-8				31.5	LL=66% PI=46
	20						
CLAY, with sand, light brown.		S-9					
CLAY, with sand, brown.		S-10					
CLAY, with sand, brown.		S-11					
	25						
CLAY, some sand, light gray, (CH).		S-12				38.0	-#200=83% LL=74% PI=52
CLAY, with sand, light gray.	30	S-13					
CLAY, trace sand, light gray.		S-14				23.0	
CLAY, trace sand, light gray, (CH).		S-15		2.27			LL=62% PI=41
Total Depth of Boring = 33.0 Feet.							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-18

Boring: B-18

Project Name: City of Kingsville Landfill　　Date of Boring: July 7, 1997

Site: Kingsville, Texas　　Project No.: 326-72026

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SILTY CLAY, with sand, dark brown.		S-1					
CLAY, with sand, light brown.		S-2					
	5						
CLAY, with sand, light brown, (CH).		S-3				15.2	-#200=60% LL=59% PI=44
CLAY, some sand, brown.	10	S-4				14.8	
CLAYEY SAND, light gray.		S-5				18.3	-#200=45%
	15						
CLAYEY SAND, light gray.		S-6					
CLAY, with sand, light gray, slightly slickensided (CH).		S-7		4.91		23.8	-#200=57% LL=58% PI=33
CLAY, with sand, light gray.	20	S-8					
CLAY, some clay, light gray.		S-9					
	25						
CLAY, with sand, light gray, (CH).		S-10				26.5	-#200=78% LL=66% PI=47
CLAY, some sand, brown.		S-11				31.9	
	30						
CLAY, with sand, light brown.		S-12					
CLAY, with sand, light gray.		S-13					

...OFESSIONAL SERVICE INDUS...

RECORD OF SUBSURFACE EXPLORATION

G-19

Boring: B-18 Page 2

...ect Name: City of Kingsville Landfill

Date of Boring: July 7, 1997

Project No.: 326-72026

...: Kingsville, Texas

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
CLAY, some sand, light brown, (CH).	35	S-14				34.9	-#200=81% LL=73% PI=48
CLAY, some sand, light brown.	40	S-15				31.1	
Total Depth of Boring = 42.0 Feet.							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-20

Boring: B ~~MW-21~~

Project Name: Kingsville Landfill   Date of Boring: April 27, 1998

Site: Kingsville, Texas   Project No.: 326-82019

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SANDY CLAY, dark brown, hard.		SS-1					
		SS-2			4.5		
becoming silty, turning brown.	5	SS-3			4.5		
SILTY, turning tan.		SS-4			4.5		
		SS-5			4.5		
	10	SS-6			4.5		
SILTY CLAY, with sand, tan, hard.		SS-7			4.5		
	15	SS-8			4.5		
		SS-9			4.5		
More sand, very stiff.		SS-10			2.3		
	20	SS-11			2.3		
		SS-12			3.5		
hard.	25	ST-13			4.5		
less sandy.		ST-14			4.5		
		SS-15			4.5		
	30	SS-16			4.5		

Continued on Next Page

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-21

Boring: ~~MW~~ B-21 (Page 2)

Date of Boring: April 27, 1998

Project Name: Kingsville Landfill

Project No.: 326-82019

: Kingsville, Texas

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
Continued							
SAND, with clay, tan.		SS-17					
	35	SS-18					
		SS-19					
SILTY CLAY, with sand, tan and brown, hard.		SS-20			4.3		
SANDY SILTY CLAY, tan.	40	SS-21					
SAND, some clay, tan.		SS-22					
	45	SS-23					
SILTY CLAY, with sand, tan, hard.		SS-24			4.5		
		SS-25			4.0		
trace sand, brown.	50	SS-26			4.5	37.8	-#200=95% LL=75% PI=40
slickensided.		SS-27			4.5		
	55	SS-28			4.5		
		SS-29			4.5		
very sandy, very stiff.		SS-30			3.8		
less sandy, hard.	60	SS-31			4.5		
Continued on Next Page							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-22

Boring: ~~MW~~ B-21 (Page 3)

Project Name: Kingsville Landfill

Date of Boring: April 27, 1998

: Kingsville, Texas

Project No.: 326-82019

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
Continued							
SILTY CLAY, some sand, grayish tan, hard.		ST-32			4.5	27.7	-#200=86% LL=51% PI=25
tan.	65	ST-33			4.5		
		ST-34			4.5		
		ST-35			4.5		
trace calcareous nodules, very stiff.	70	ST-36			2.5		
		SS-37			3.5		
	75	SS-38			2.8		
		SS-39			3.0		
turning hard.		ST-40			4.0	24.6	-#200=78% LL=62% PI=33
	80	ST-41			4.5		
		ST-42			4.5		
Total Depth of Boring = 84 Feet. No groundwater readings.	85						

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-23

Boring: B ~~MW-23~~
Date of Boring: April 24, 1998
Project Name: Kingsville Landfill
Project No.: 326-82019
e: Kingsville, Texas

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
CLAYEY SAND, dark brown, very dense.		SS-1					
turning brown, trace calcareous nodules.		SS-2			4.5		
	5	SS-3			4.5		
SANDY CLAY, dark brown, trace calcareous nodules, very stiff.		SS-4			2.0		
CLAYEY SAND, dark gray.		SS-5			0.8		
light brown.	10	SS-6			0.5		
becoming silty.		SS-7					
SILTY SAND, with clay, tan.	15	SS-8					
		SS-9					
		SS-10					
SILTY CLAYEY SAND, tan.	20	SS-11					
SILTY SANDY CLAY, tan, very stiff.		SS-12			2.0		
CLAY, with sand, tan, very stiff.	25	SS-13			2.3		
SILTY SANDY CLAY, tan.		SS-14					
		SS-15					
SILTY CLAY, with sand, light brown, hard.	30	SS-16			4.5		

Continued on Next Page

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-24

Boring: B ~~MW~~-23 (Page 2)

...ject Name: Kingsville Landfill   Date of Boring: April 24, 1998

...e: Kingsville, Texas   Project No.: 326-82019

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
Continued							
SILTY SAND, trace clay, tan.		SS-17					
SANDY SILTY CLAY, tan, very stiff.	35	SS-18			3.0		
SILTY CLAY, some sand, tan, very stiff.		SS-19			3.8	36.9	-#200=88% LL=73% PI=37
hard.		SS-20			4.3		
some sand.	40	SS-21			4.5		
trace sand.		SS-22			4.5		
	45	SS-23			4.5		
		SS-24			4.5		
very stiff.		SS-25			3.0		
hard.	50	SS-26			4.0		
slickensided.		SS-27			4.5		
	55	SS-28			4.3		
		SS-29			4.5		
some sand, mottled tan and brown, non-slickensided		SS-30			4.5	27.7	-#200=80% LL=62% PI=32
tan.	60	SS-31			4.5		

Continued on Next Page

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-25

Boring: ~~MW~~ B-23 (Page 3)

Date of Boring: April 24, 1998

Project Name: Kingsville Landfill

Project No.: 326-82019

Location: Kingsville, Texas

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
Continued							
SILTY CLAY, with sand, tan, hard.		SS-32			4.5		
	65	SS-33			4.5		
very stiff.		SS-34			2.8	24.3	-#200=76% LL=59% PI=31
hard.		SS-35			4.0		
very stiff.	70	SS-36			3.3		
very silty.		SS-37			2.5		
hard, less silty.	75	SS-38			4.3		
FINE SAND, some clay, tan.		SS-39					
		SS-40					
	80	SS-41					
CLAY, some sand, tan, hard.		SS-42			4.5		
	85	SS-43			4.5		
Total Depth of Boring = 86 Feet.							
NO GROUNDWATER READINGS							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-26

Boring: B-24 (MW-24 struck through)
Date of Boring: April 28, 1998
Project Name: Kingsville Landfill
Project No.: 326-82019
: Kingsville, Texas

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SANDY CLAY, mottled dark brown and brown, hard.		SS-1			4.5		
dark gray.		SS-2			4.5		
	5	SS-3			4.5		
turning light brown, very stiff.		SS-4			3.0		
becoming silty, calcareous nodules, soft.		SS-5					
	10	SS-6					
		SS-7					
turning tan.	15	SS-8					
		SS-9					
		SS-10					
	20	SS-11			4.5		
SILTY CLAY, with sand, tan, hard.		SS-12			4.3		
	25	ST-13			4.5		
trace sand.		ST-14			4.5		
		ST-15			4.5		
	30	ST-16					

Continued on Next Page

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-27

Boring: B ~~MW~~-24 (Page 2)

Project Name: Kingsville Landfill

Date of Boring: April 28, 1998

e: Kingsville, Texas

Project No.: 326-82019

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
Continued							
CLAY, with sand, tan.		ST-17				36.4	-#200=80% LL=79% PI=38
hard.	35	ST-18			4.3		
CLAY, trace sand, tan, hard.		SS-19			4.5		
		SS-20			4.5		
trace calcareous nodules.	40	ST-21			4.5		
		ST-22			4.5		
becoming very stiff.	45	ST-23			3.5		
becoming hard.		ST-24			4.5		
		ST-25			4.5		
with sand.	50	ST-26			4.5	27.7	-#200=68% LL=71% PI=36
		ST-27			4.5		
becoming silty, less sand.	55	ST-28			4.5		
becoming very stiff.		SS-29			2.3		
becoming hard.		SS-30			4.5		
	60	SS-31			4.3		

Continued on Next Page

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-28

Boring: B ~~MW~~-24 (Page 3)

Project Name: Kingsville Landfill

Date of Boring: April 28, 1998

Project No.: 326-82019

e: Kingsville, Texas

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SILTY CLAY, some sand, tan, stiff.		SS-32			1.8		
becoming hard.	65	SS-33			4.5		
with sand.		SS-34			4.5	17.7	-#200=66% LL=50% PI=30
becoming very stiff.		SS-35			3.5		
	70	SS-36			3.0		
Total Depth of Boring = 72 Feet.							

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-29

Boring: B MW-25
Project Name: Kingsville Landfill
Date of Boring: April 29, 1998
..a: Kingsville, Texas
Project No.: 326-82019

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
SANDY CLAY, light brown, hard.		SS-1			4.5		
		SS-2					
with Caliche.	5	SS-3			4.5		
CALICHE, with sand, silty, hard.		SS-4					
more sand.		SS-5					
	10	SS-6					
		SS-7					
	15	SS-8					
SAND, with clay, light brown.		SS-9					
		SS-10					
	20	SS-11					
		SS-12					
CLAYEY SILTY SAND, light brown.	25	SS-13					
		SS-14					
		SS-15					
SAND, with clay, light brown.	30	SS-16					

Continued on Next Page

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

G-30

Boring: B ~~MW~~-25 (Page 2)

P_ject Name: Kingsville Landfill   Date of Boring: April

_e: Kingsville, Texas   Project No.: 326-82019

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARKS
SURFACE							
Continued							
SILTY CLAY, some sand, tan, very stiff.		SS-17			3.8		
CLAYEY SAND, tan.	35	SS-18					
SANDY CLAY, tan, very stiff.		SS-19			2.8		
		SS-20			8.3		
SILTY CLAY, some sand, very stiff.	40	SS-21			2.5		
becoming hard.		SS-22			4.3		
trace sand.	45	SS-23			4.3		
less silty, becoming very stiff.		SS-24			3.3		
CLAYEY SAND, tan.		SS-25					
SILTY CLAY, trace sand, tan, very stiff.	50	SS-26			3.0		
CLAY, some sand, tan, hard.		ST-27			4.5	31.8	-#200=87% LL=77% PI=43
	55	ST-28			4.5		
		ST-29			4.5		
		ST-30			4.5		
	60	ST-31			4.5		

Continued on Next Page

G-31

PROFESSIONAL SERVICE INDUSTRIES, INC.

RECORD OF SUBSURFACE EXPLORATION

Boring: ~~MW~~ B-25 (Page 3)

Project Name: Kingsville Landfill | Date of Boring: April

Site: Kingsville, Texas | Project No.: 326-82019

DESCRIPTION	DEPTH	SAMPLE	N	Qu	Qp	Mc	REMARK
SURFACE							
CLAY, trace sand, tan, hard.		ST-32			4.5		
	65	ST-33			4.5	30.5	-#200=92% LL=77% PI=39
		ST-34			4.5		
		ST-35			4.5		
	70	ST-36			4.5		
		ST-37			4.5		
	75	ST-38			4.5		
		ST-39			4.5		
some sand.		ST-40			4.5	20.5	-#200=83% LL=58% PI=31
	80	ST-41			4.5		
		ST-42			4.5		
becomes silty.	85	ST-43			4.5		
very stiff.		ST-44			4.5		
Total Depth of Boring = 86 Feet.							
No groundwater readings							

Professional Service Industries

G-32

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classificaton System is used to identify the soil unless otherwise noted.

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split-spoon.

Qu: Unconfined compressive strength, TSF.

Qp: Penetrometer value, unconfined compressive strength, TSF.

Mc: Water content, %.

LL: Liquid limit, %.

PI: Plasticity index, %.

δd: Natural dry density, PCF.

▽: Apparent groundwater level at time noted after completion of boring.

DRILLING AND SAMPLING SYMBOLS

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
AU: Auger Sample.
DB: Diamond Bit.
CB: Carbide Bit.
WS: Washed Sample.

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

TERM (NON-COHESIVE SOILS)	STANDARD PENETRATION RESISTANCE
Very Loose	0-4
Loose	4-10
Medium	10-30
Dense	30-50
Very Dense	Over 50

TERM (COHESIVE SOILS)	Qu - (TSF)
Very Soft	0 - 0.25
Soft	0.25 - 0.50
Firm (Medium)	0.50 - 1.00
Stiff	1.00 - 2.00
Very Stiff	2.00 - 4.00
Hard	4.00+

PARTICLE SIZE

Boulders	8 in.+	Coarse Sand	5mm-0.6mm	Silt	0.074mm-0.005mm
Cobbles	8 in.-3 in.	Medium Sand	0.6mm-0.2mm	Clay	-0.005mm
Gravel	3 in.-5mm	Fine Sand	0.2mm-0.074mm		

G-33

ORGANIC MATTER CONTENT
(ASTM D-2974-87)

Sample	Organic Matter (%)
SB-12 0-2	0.77
SB-15 0-2	1.2
SB-17 0-2	0.52
SB-18 0-2	0.70

PH (ASTM D-4972-89)

Sample	Ph
SB-12 14-19	7.5
SB-12 46-47	7.6
SB-13 8-10	7.4
SB-13 20-25	7.5
SB-13 25-30	8.0
SB-14 10-15	7.5
SB-14 35-37	8.5
SB-15 10-12	7.0
SB-15 23-24	7.5
SB-16 16-18	8.0
SB-16 18-20	8.0
SB-17 0-5	8.0
SB-17 5-10	8.5
SB-17 23-24	8.5
SB-18 10-15	8.0
SB-18 15-17	8.5

G-34

WET AND DRY DENSITY
(ASTM D-2937)

Sample		Wet Density (pcf)	Dry Density (pcf)
SB-12	2-3	114.96	101.2
	7-8	127.53	112.3
	14-19	121.84	102.3
	19-24	118.76	96.1
SB-13	4-8	108.79	100.7
	25-26	114.94	94.8
	26-27	123.27	101.4
	30-35	116.50	94.0
	35-36	112.63	93.6
	40-45	122.92	96.9
SB-14	5-10	116.69	104.7
	10-15	113.11	95.1
	20-25	108.57	86.99
	30-33	114.20	88.3
	33-34	123.86	98.54
	34-35	116.82	92.7
	35-37	104.29	82.1
SB-15	5-10	126.40	112.6
	12-13	113.38	100.4
	14-16	97.04	84.2
	24-25	121.79	100.0
SB-16	1-3	99.59	86.8
	3-5	114.66	104.9
	45-47	110.03	84.3
SB-17	8-9	85.07	64.6
	17-18	95.09	82.7
	23-24	111.74	94.5
	24-29	108.86	78.9
	32-33	115.38	93.8
SB-18	2-5	109.22	99.1
	5-10	97.82	84.9
	9-10	127.25	110.8
	17-18	122.97	99.3
	40-42	106.75	81.4

Information To Build On
Engineering • Consulting • Testing

G-35

DENSITY DETERMINATION TESTS

Tested for: Ray N. Finch, Ph.D, P.E.

Company: Finch Energy & Environmental Services

Results:

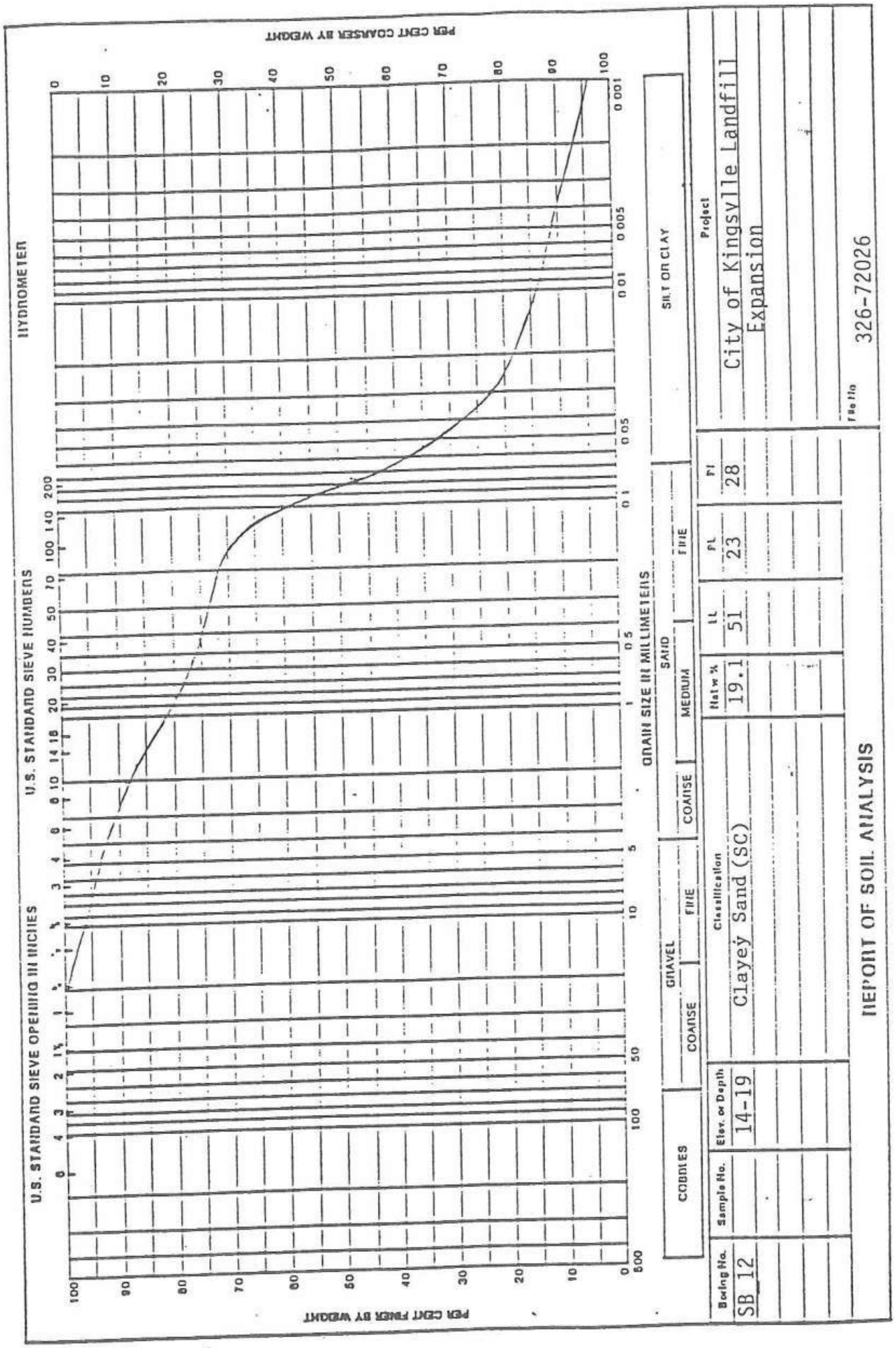
Sample	Depth (ft.)	Wet Density (lbs./ft^3)	Dry Density (lbs./ft^3)
MW-21	64-66	119.8	94.2
MW-23	82-84	125.8	105.3
MW-24	52-54	114.5	86.2
MW-25	58-60	139.0	104.3

Professional Service Industries, Inc. • 810 South Padre Island Drive • Corpus Christi, TX 78416 • Phone 512/854-4801 • Fax 512/854-6049

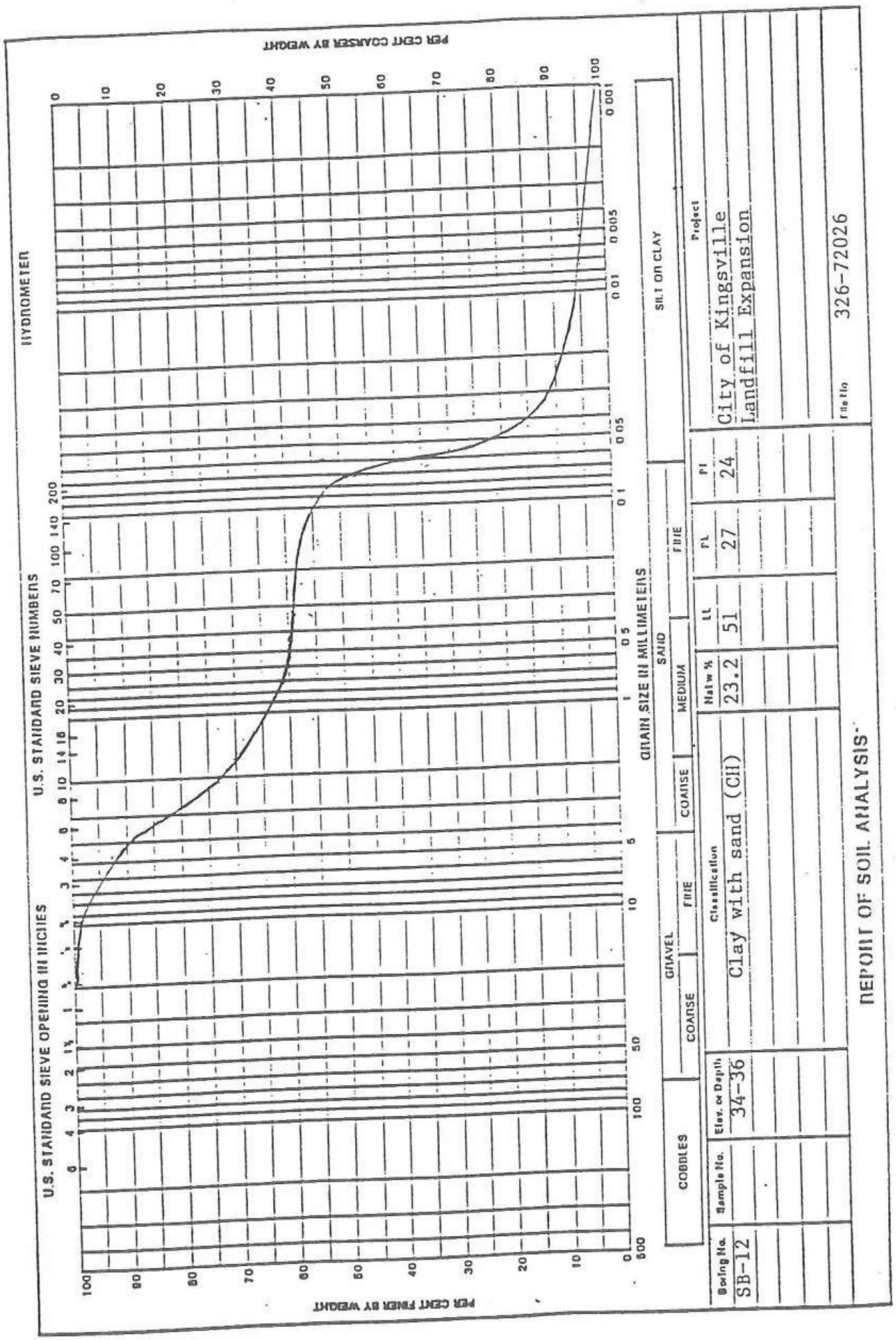
** TOTAL PAGE.02 **

G-1 Grain Size Distribution Curves

G-37


REPORT OF SOIL ANALYSIS
U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB 12
Sample No.
Elev. or Depth
14-19
Classification
Clayey Sand (SC)
Nat w %
19.1
LL
51
PL
23
PI
28
Project
City of Kingsvlle Landfill Expansion
File No.
326-72026

G-38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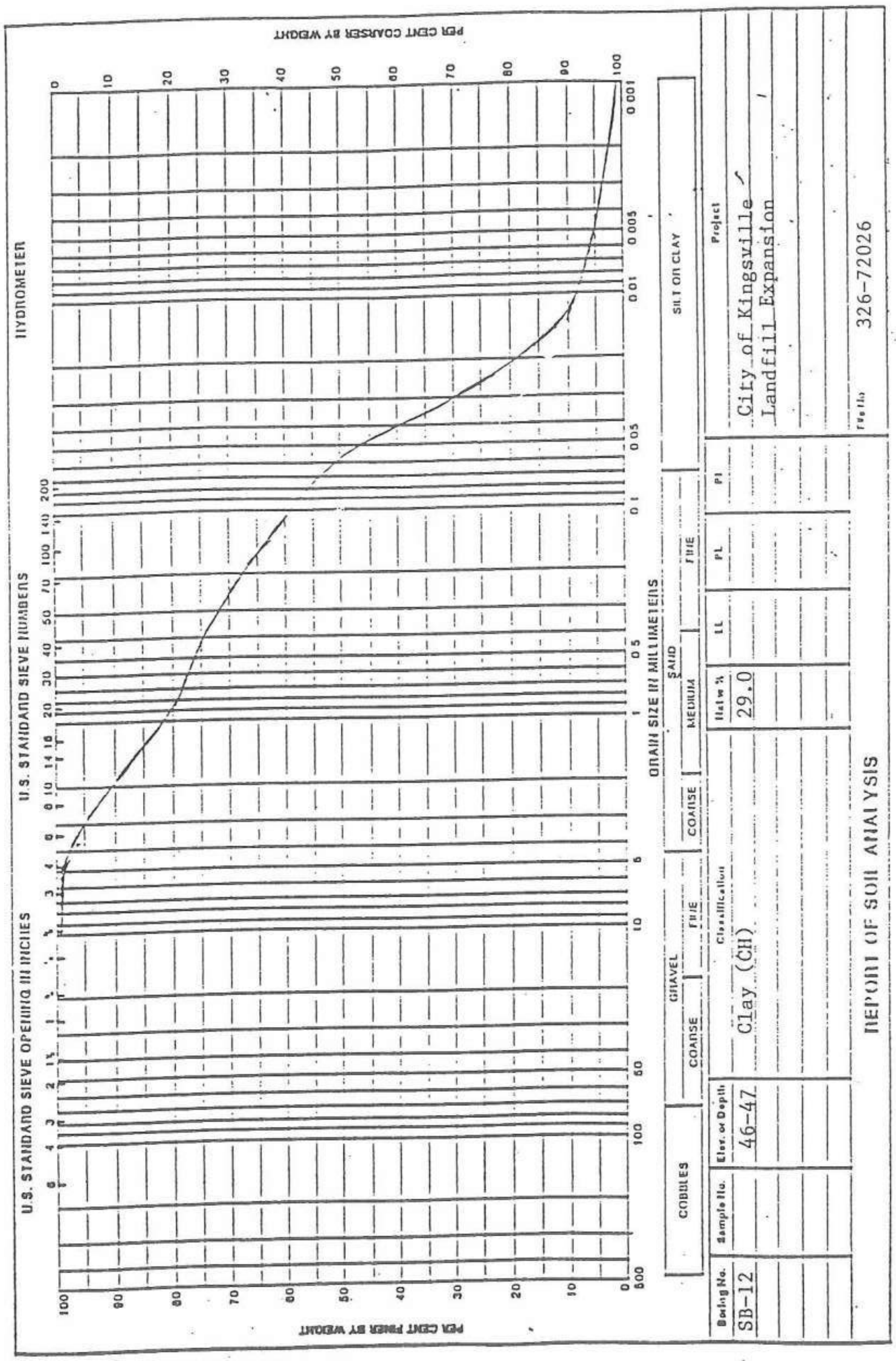
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-12
Sample No.
Elev. or Depth
34-36
Classification
Clay with sand (CH)
Nat w %
23.2
LL
51
PL
27
PI
24
Project
City of Kingsville
Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-39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HYDROMETER
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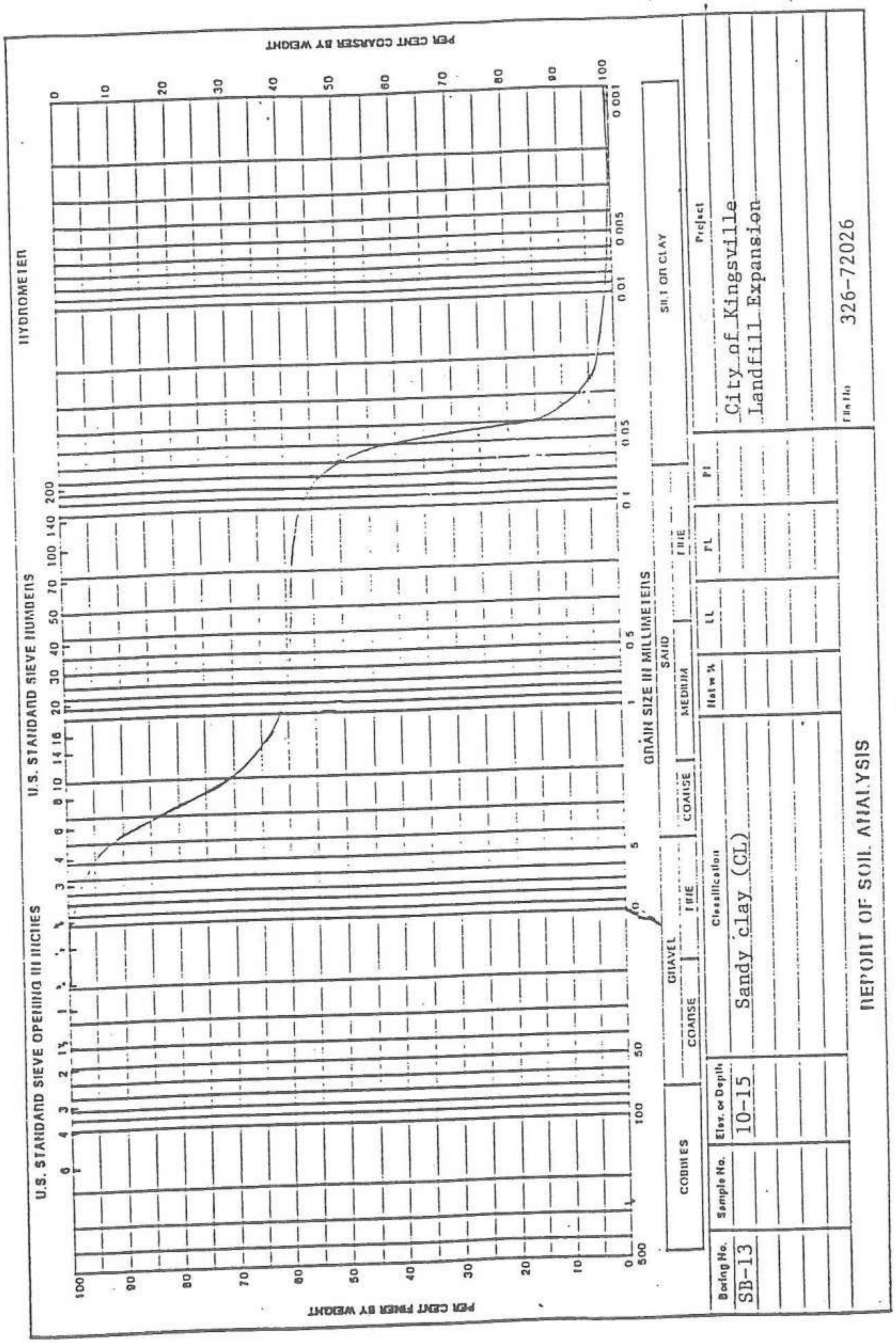
U.S. STANDARD SIEVE OPENING IN INCHES
GRAIN SIZE IN MILLIMETERS
PER CENT FINER BY WEIGHT
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-12
Sample No.
Elev. or Depth
46-47
Classification
Clay (CH)
Nat w %
29.0
LL
PL
PI
Project
City of Kingsville Landfill Expansion
326-72026
REPORT OF SOIL ANALYSIS

G-40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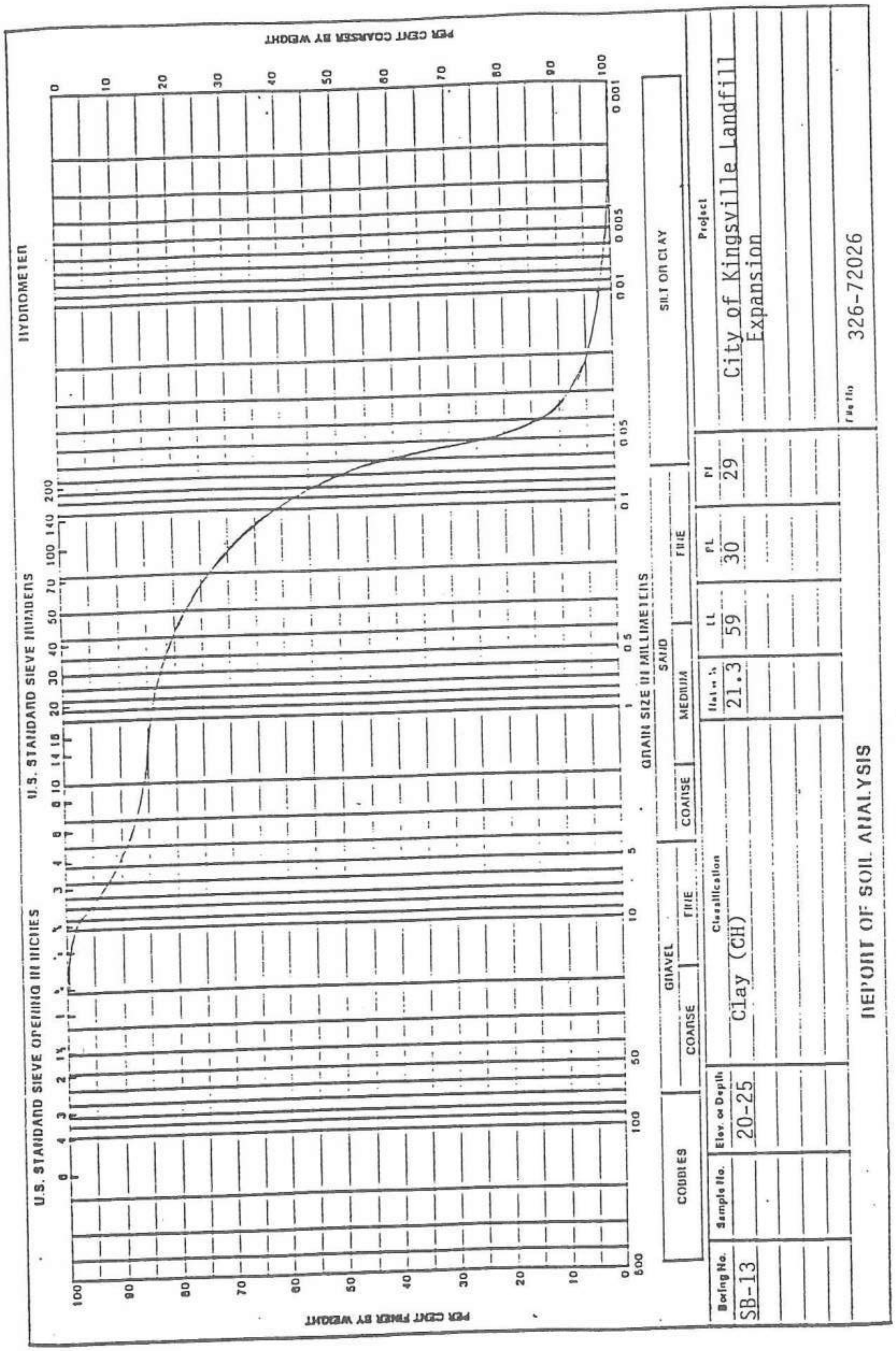
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-13
Sample No.
Elev. or Depth
10-15
Classification
Sandy clay (CL)
Nat w %
LL
PL
PI
Project
City of Kingsville
Landfill Expansion
File No.
326-72026

G-41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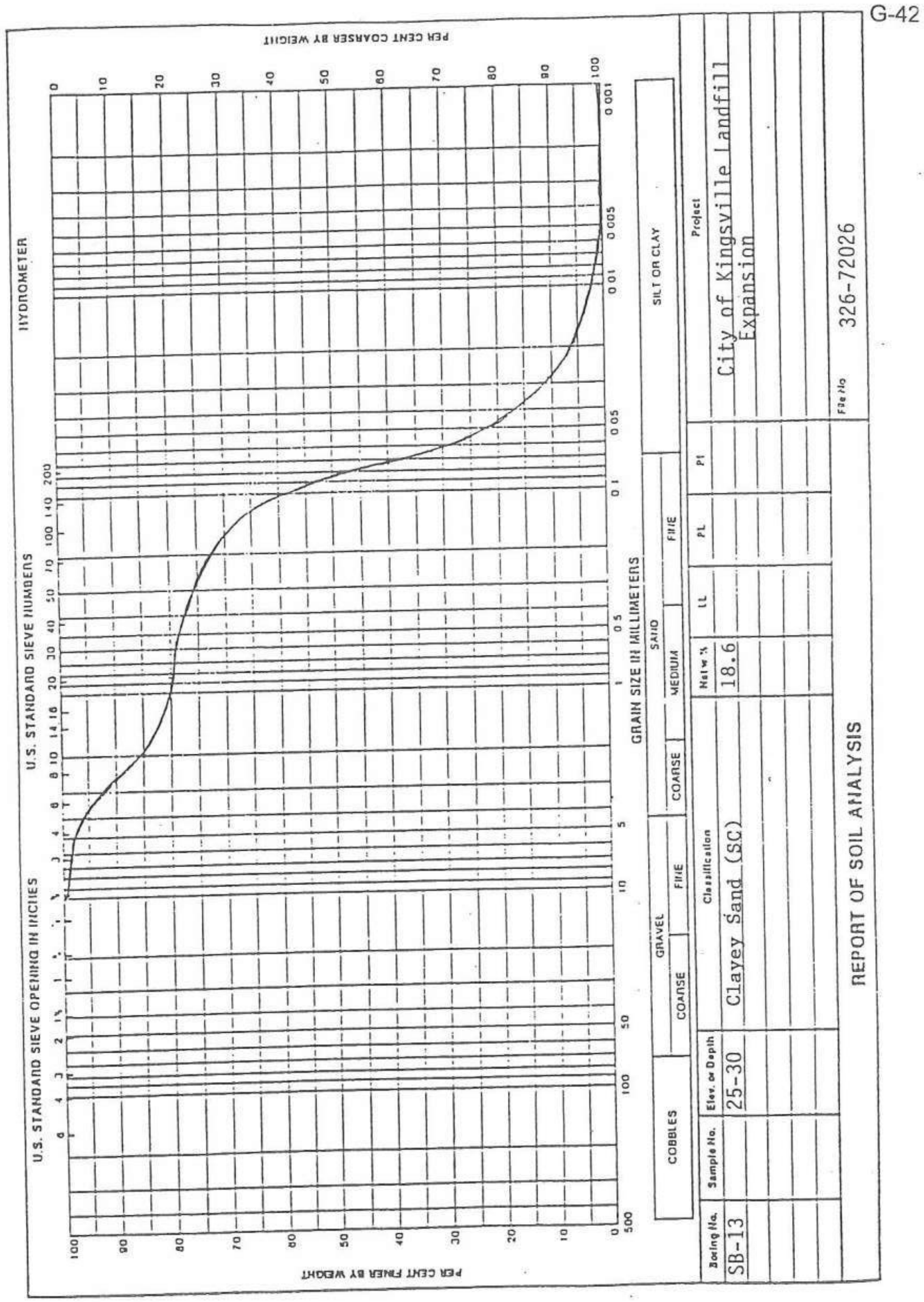
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
GRAIN SIZE IN MILLIMETERS
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-13
Sample No.
Elev. or Depth
20-25
Classification
Clay (CH)
21.3
LL
59
PL
30
PI
29
Project
City of Kingsville Landfill
Expansion
326-72026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REPORT OF SOIL ANALYSIS
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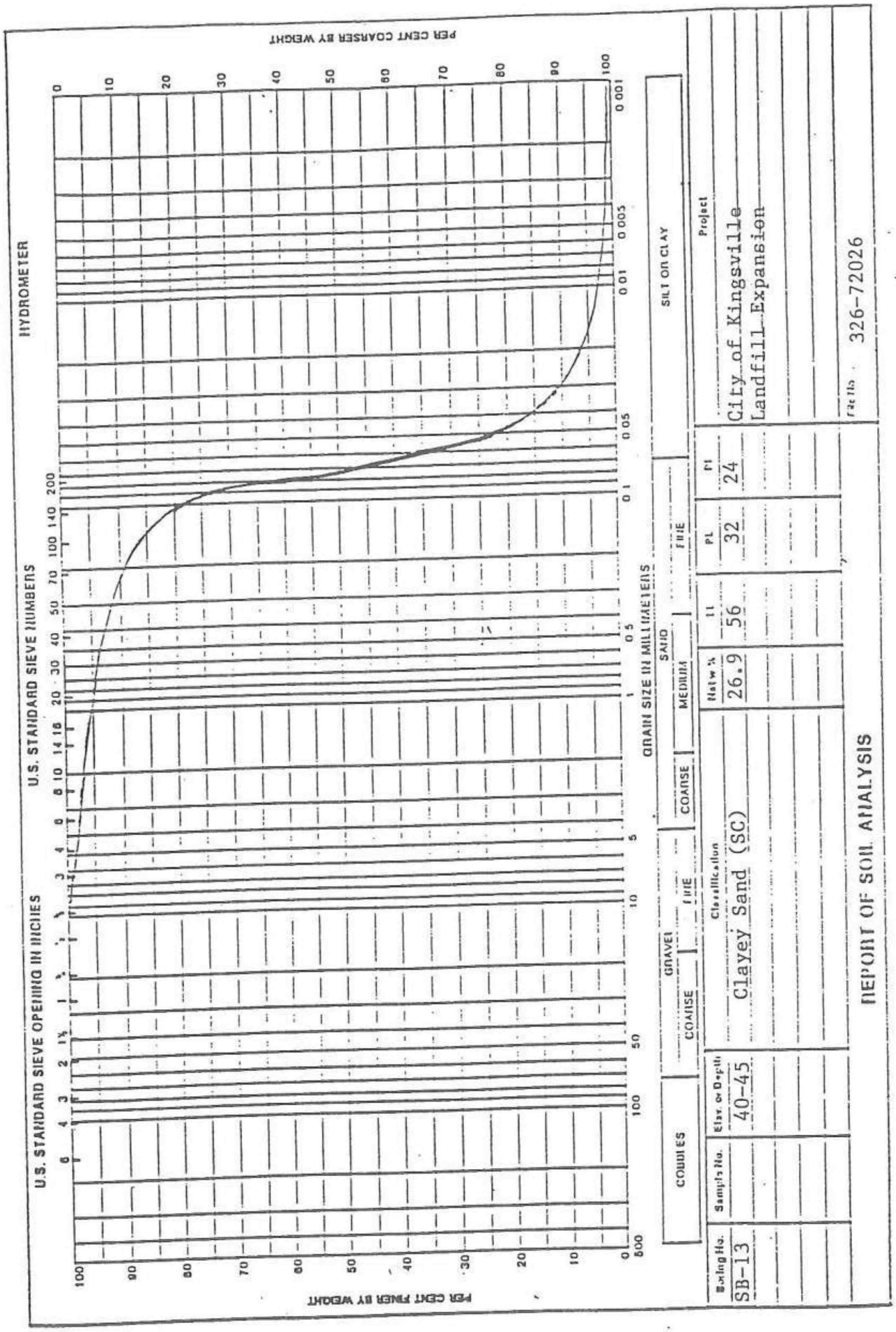
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-13
Sample No.
Elev. or Depth
25-30
Classification
Clayey Sand (SC)
Nat w %
18.6
LL
PL
PI
Project
City of Kingsville Landfill Expansion
File No.
326-72026

G-43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PER CENT FINER BY WEIGHT
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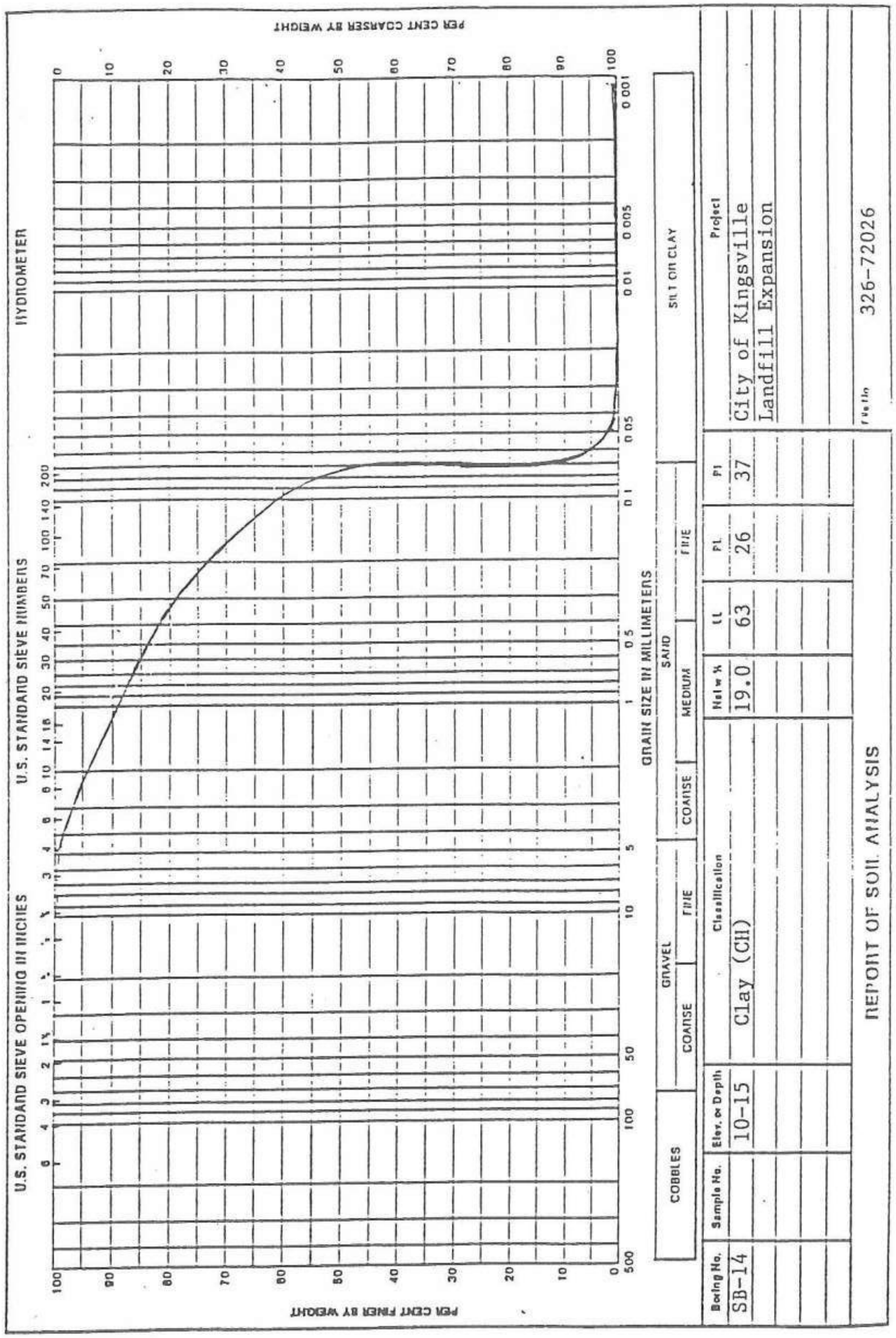
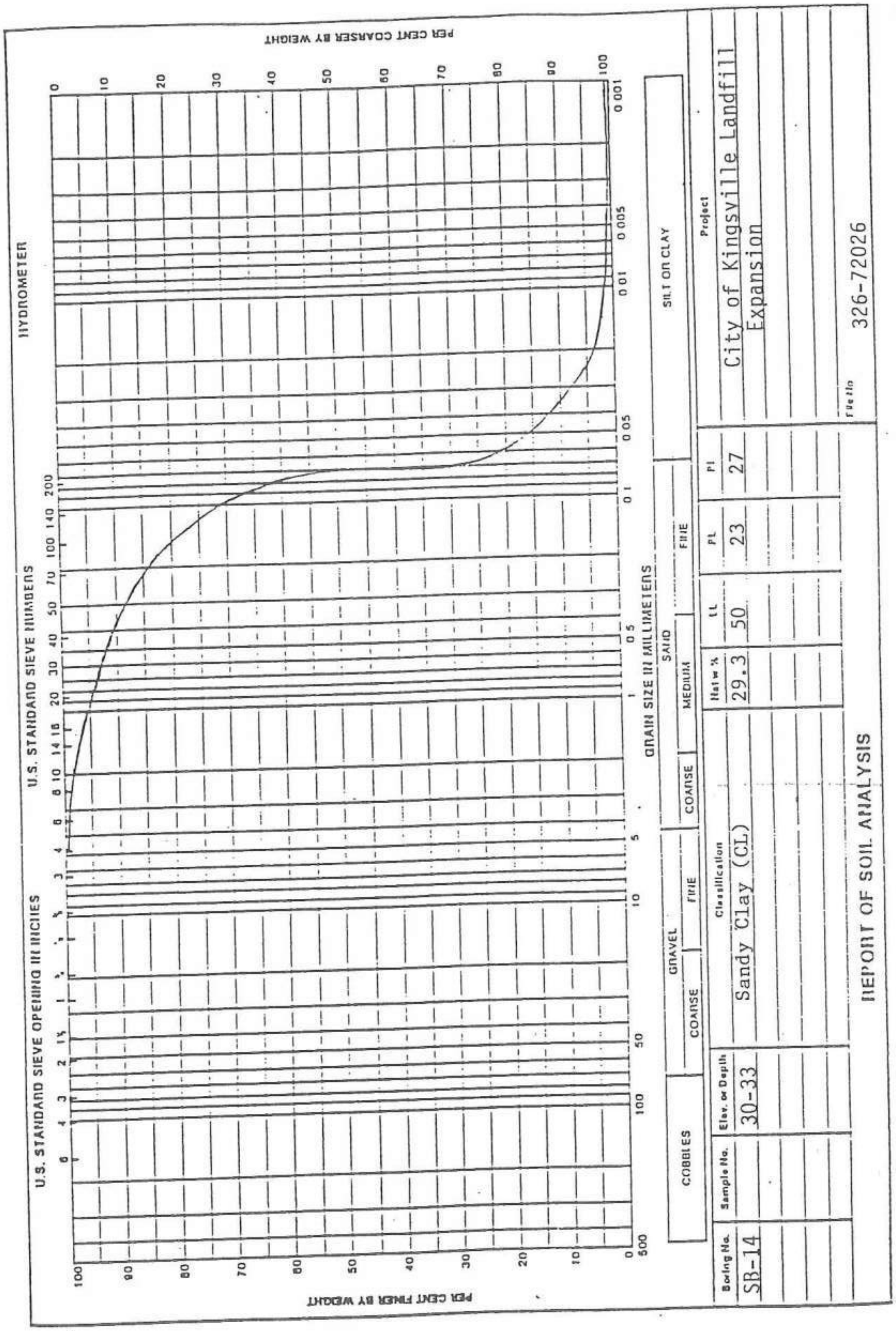
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-13
Sample No.
Elev. or Depth
40-45
Classification
Clayey Sand (SC)
Nat w %
26.9
LL
56
PL
32
PI
24
Project
City of Kingsville Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-44


PER CENT COARSER BY WEIGHT
HYDROMETER
U.S. STANDARD SIEVE NUMBERS
U.S. STANDARD SIEVE OPENING IN INCHES
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
PER CENT FINER BY WEIGHT
Boring No.
SB-14
Sample No.
Elev. or Depth
10-15
Classification
Clay (CH)
Nat w %
19.0
LL
63
PL
26
PI
37
Project
City of Kingsville
Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-45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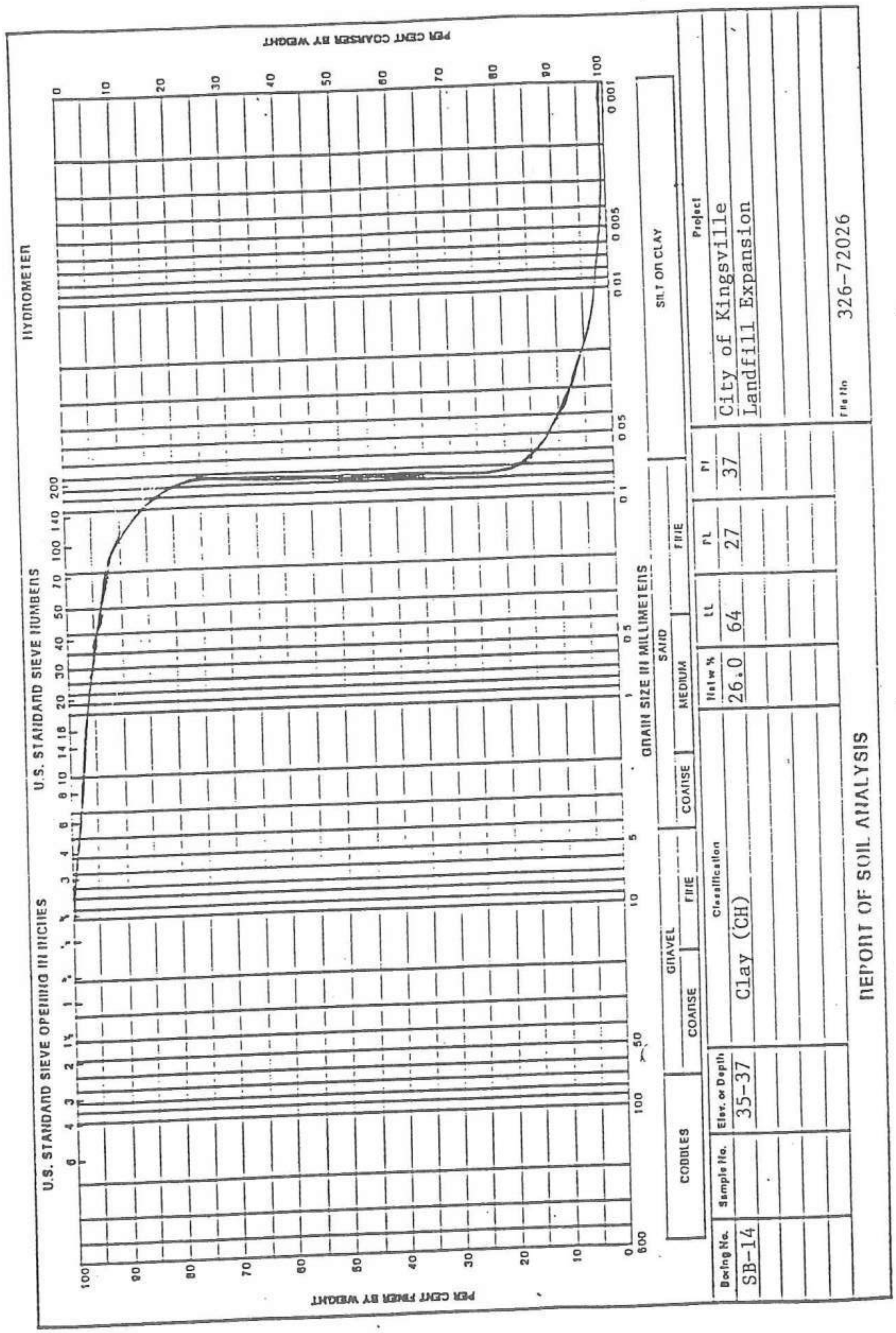
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
MEDIUM
SILT OR CLAY
Boring No.
SB-14
Sample No.
Elev. or Depth
30-33
Classification
Sandy Clay (CL)
Nat w %
29.3
LL
50
PL
23
PI
27
Project
City of Kingsville Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-46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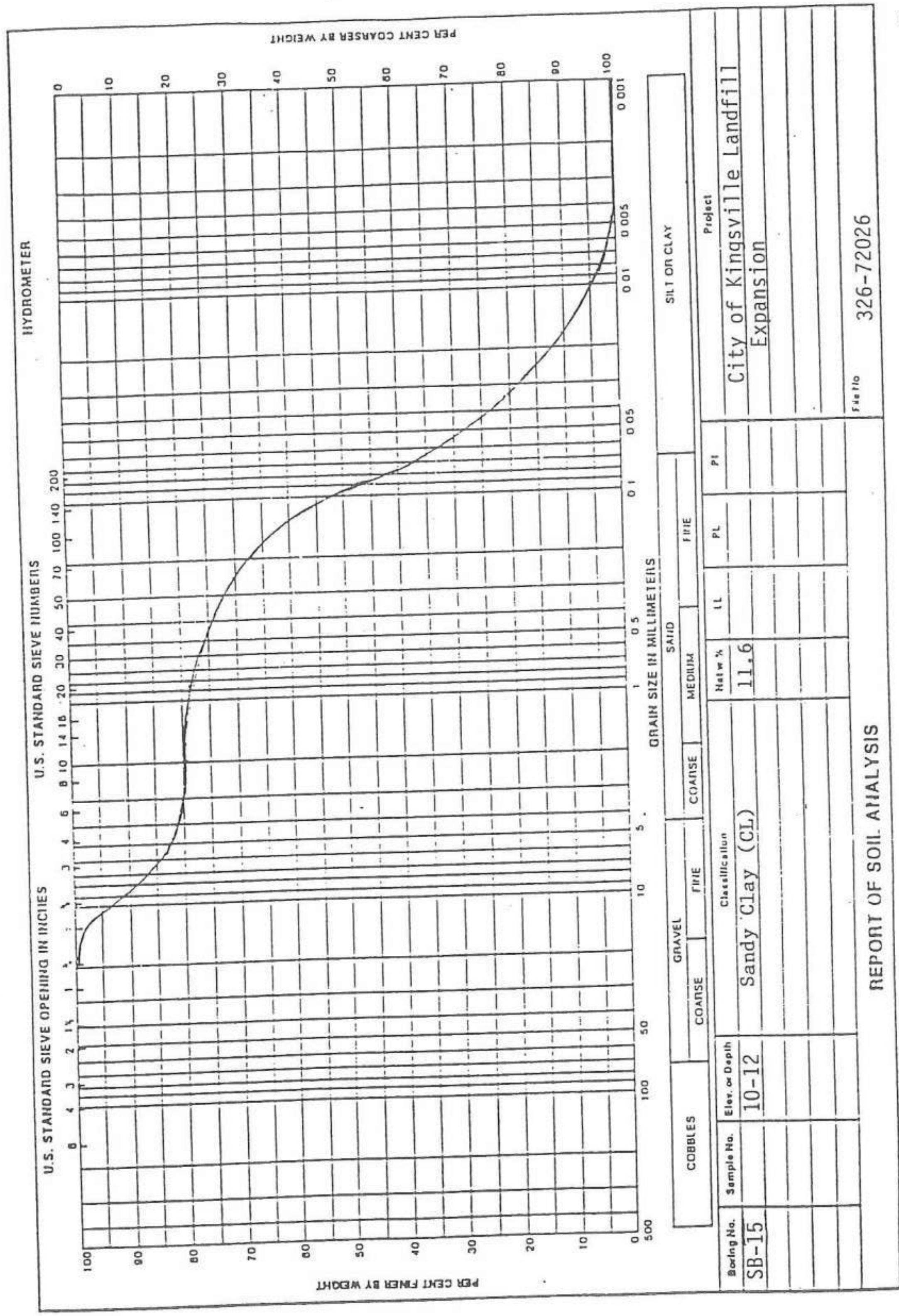
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL COARSE FINE
SAND COARSE MEDIUM FINE
SILT OR CLAY
Boring No. SB-14
Sample No.
Elev. or Depth 35-37
Classification Clay (CH)
Nat w % 26.0
LL 64
PL 27
PI 37
Project City of Kingsville Landfill Expansion
File No. 326-72026

G-47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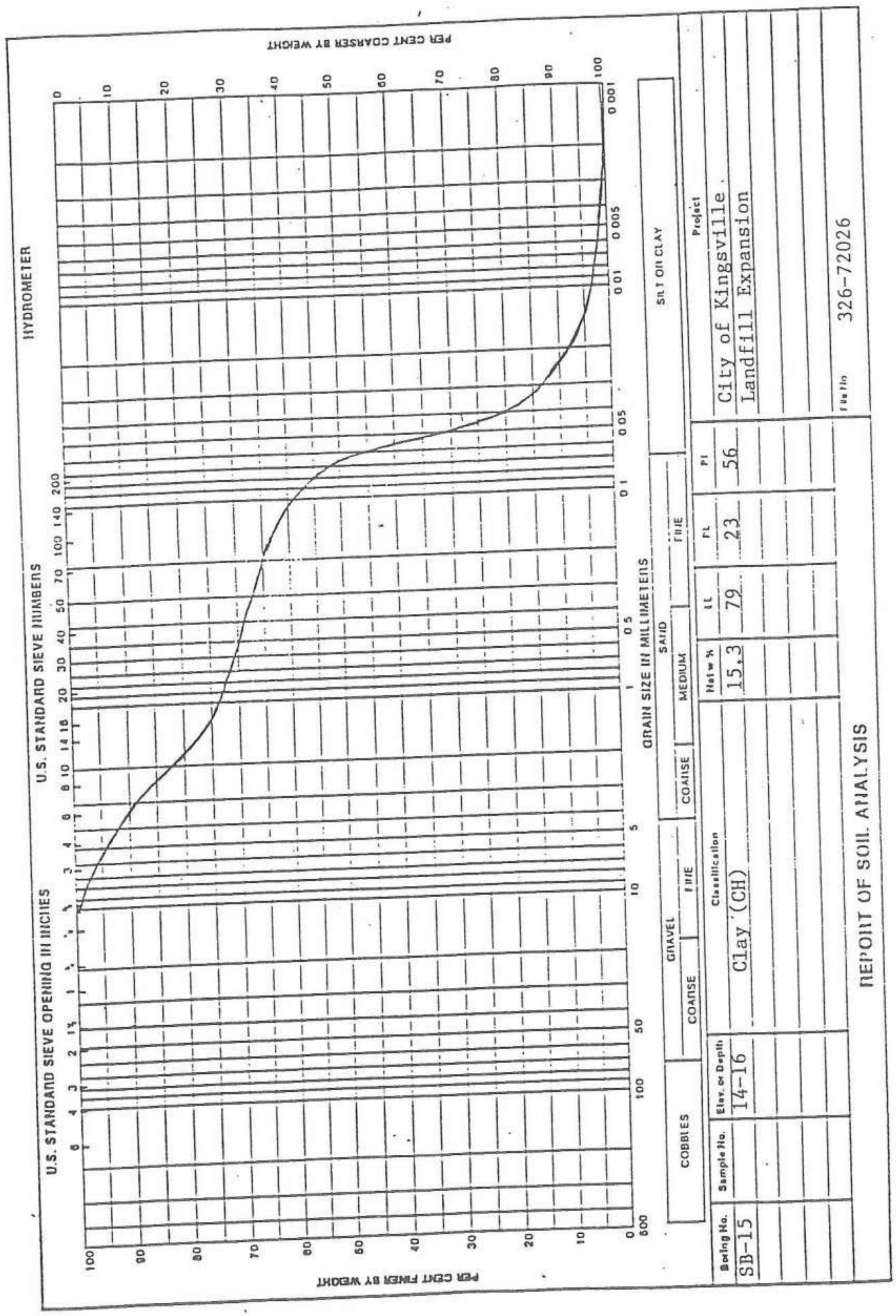
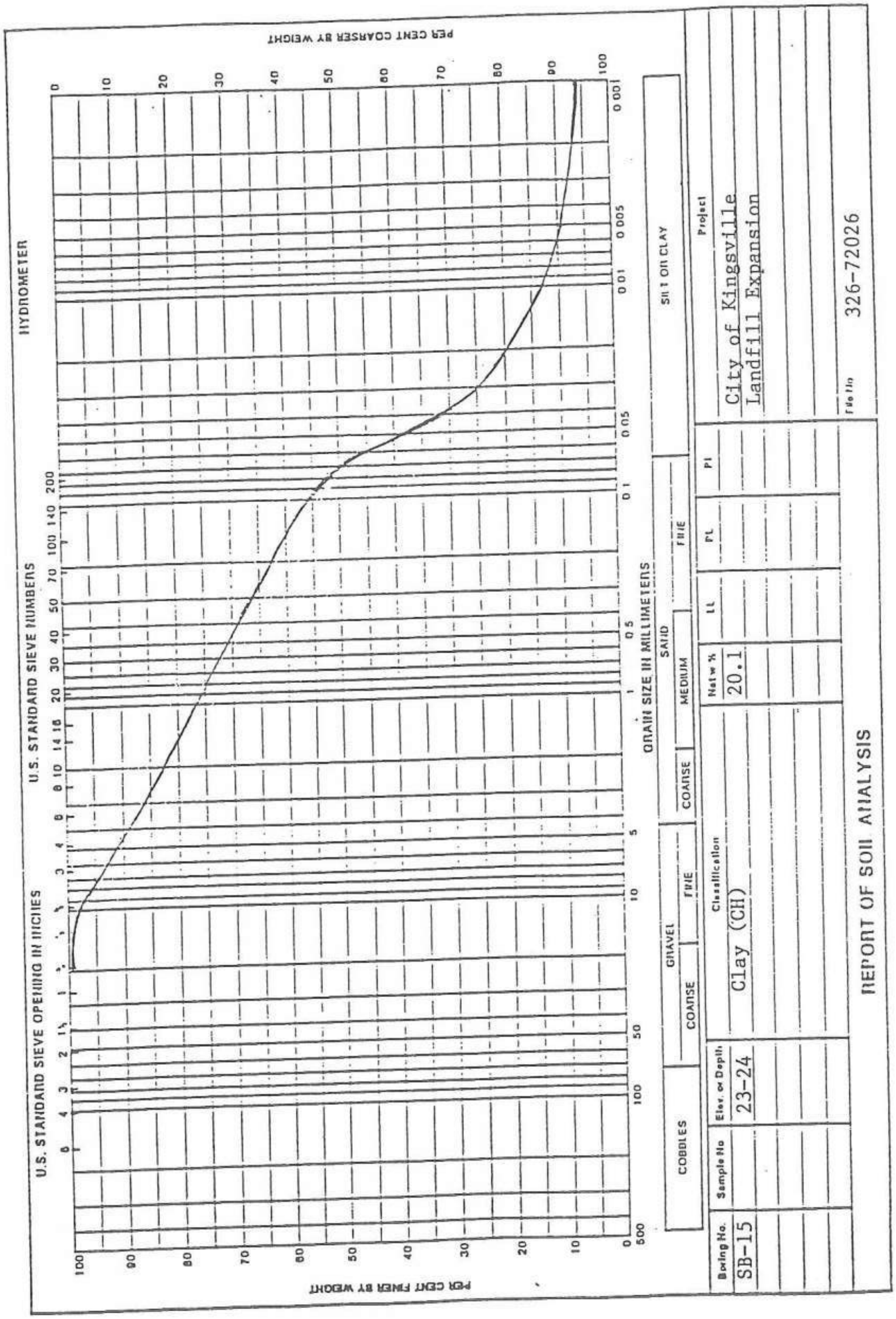
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-15
Elev. or Depth
10-12
Classification
Sandy Clay (CL)
Nat w %
11.6
LL
PL
PI
Project
City of Kingsville Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-48


REPORT OF SOIL ANALYSIS
HYDROMETER
U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
GRAIN SIZE IN MILLIMETERS
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-15
Sample No.
Elev. or Depth
14-16
Classification
Clay (CH)
Nat w %
15.3
LL
79
PL
23
PI
56
Project
City of Kingsville
Landfill Expansion
File No.
326-72026

G-49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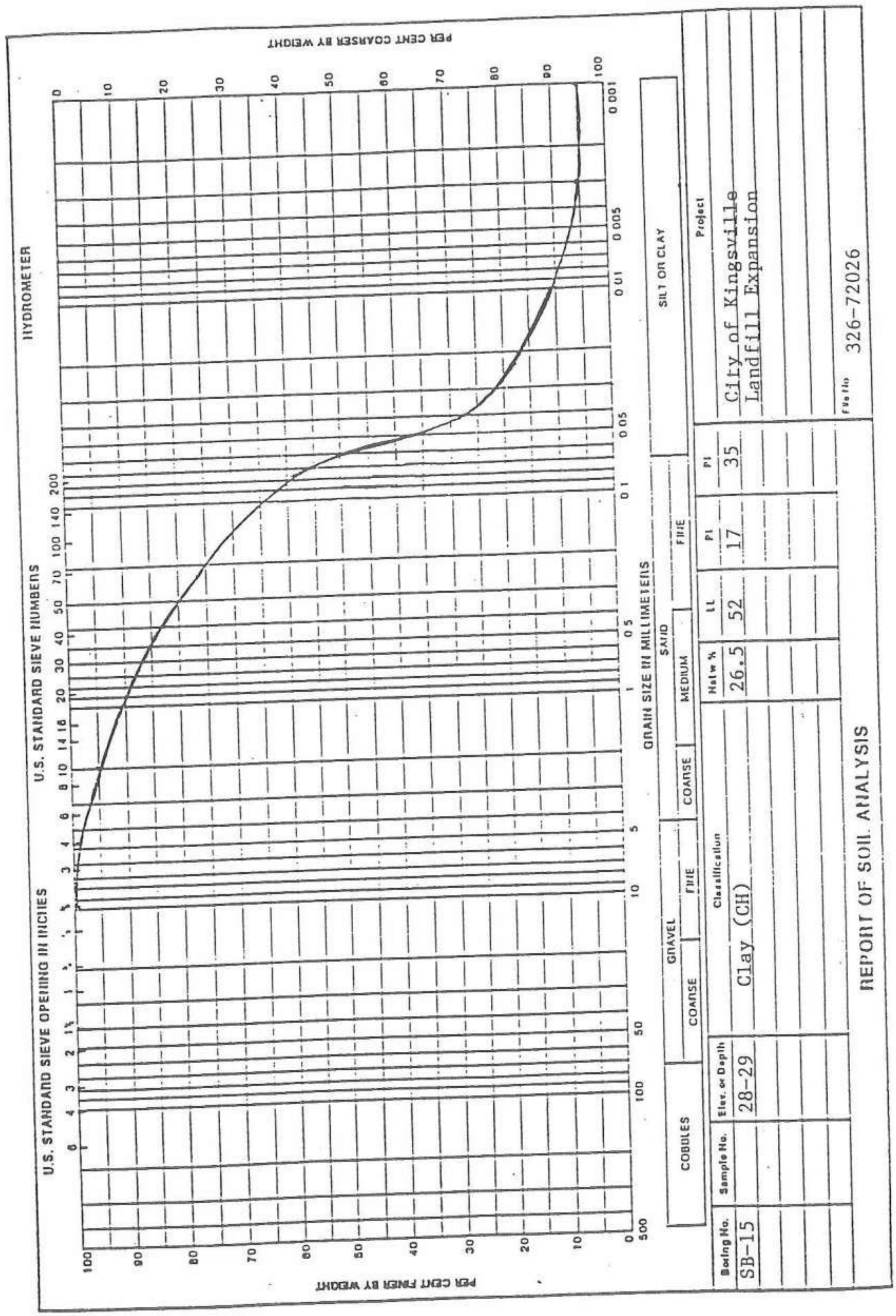
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-15
Sample No.
Elev. or Depth
23-24
Classification
Clay (CH)
Nat w %
20.1
LL
PL
PI
Project
City of Kingsville
Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-50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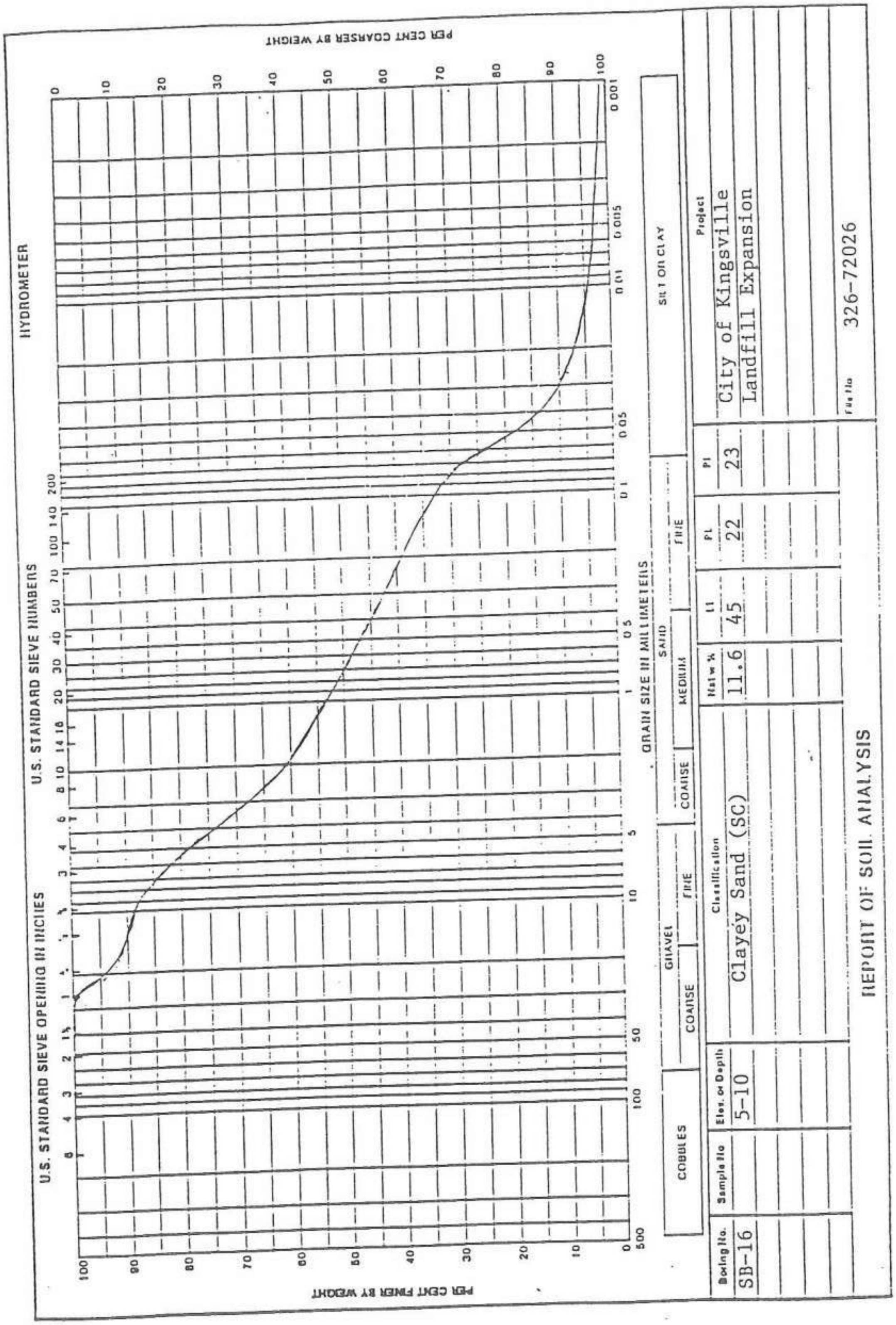
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-15
Sample No.
Elev. or Depth
28-29
Classification
Clay (CH)
Nat w %
26.5
LL
52
PL
17
PI
35
Project
City of Kingsville
Landfill Expansion
File No.
326-72026

G-51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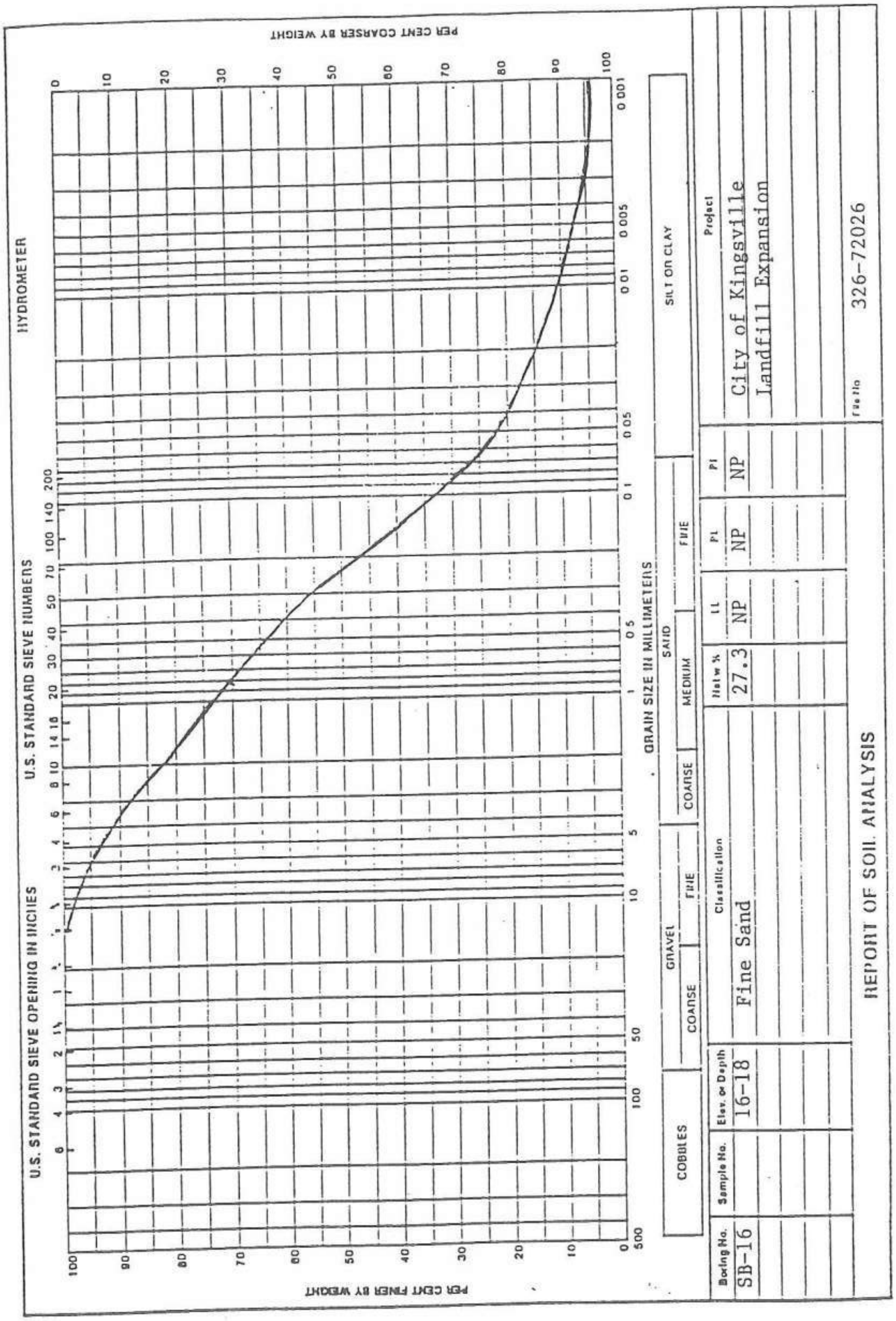
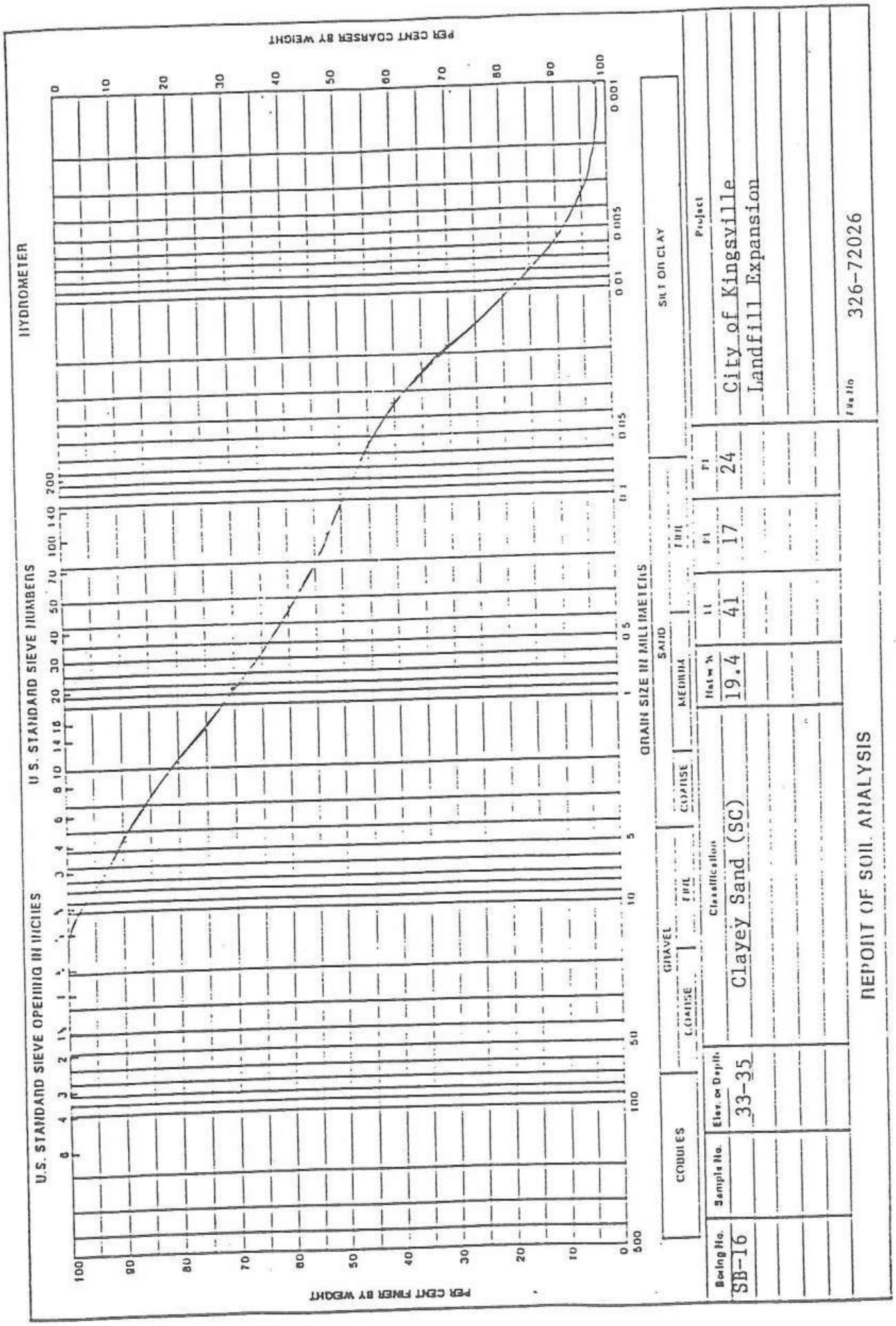
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-16
Elev. or Depth
5-10
Classification
Clayey Sand (SC)
Nat w %
11.6
LL
45
PL
22
PI
23
Project
City of Kingsville
Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-52


REPORT OF SOIL ANALYSIS
U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-16
Sample No.
Elev. or Depth
16-18
Classification
Fine Sand
Nat w %
27.3
LL
NP
PL
NP
PI
NP
Project
City of Kingsville Landfill Expansion
File No.
326-72026

G-53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U.S. STANDARD SIEVE OPENING IN INCHES
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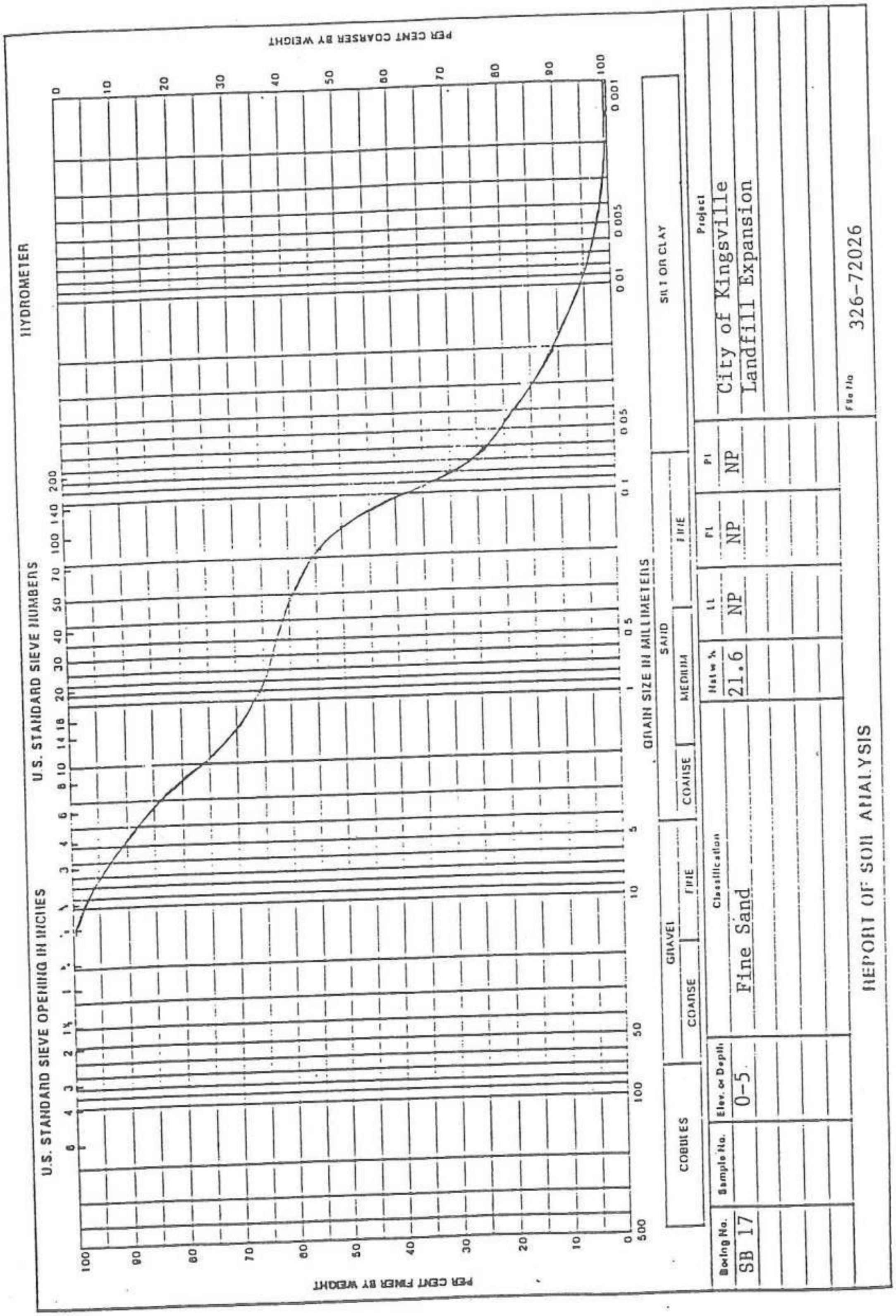
HYDROMETER
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
Boring No. SB-16
Elev. or Depth 33-35
Classification Clayey Sand (SC)
Nat w % 19.4
LL 41
PL 17
PI 24
Project City of Kingsville Landfill Expansion
File No. 326-72026

G-54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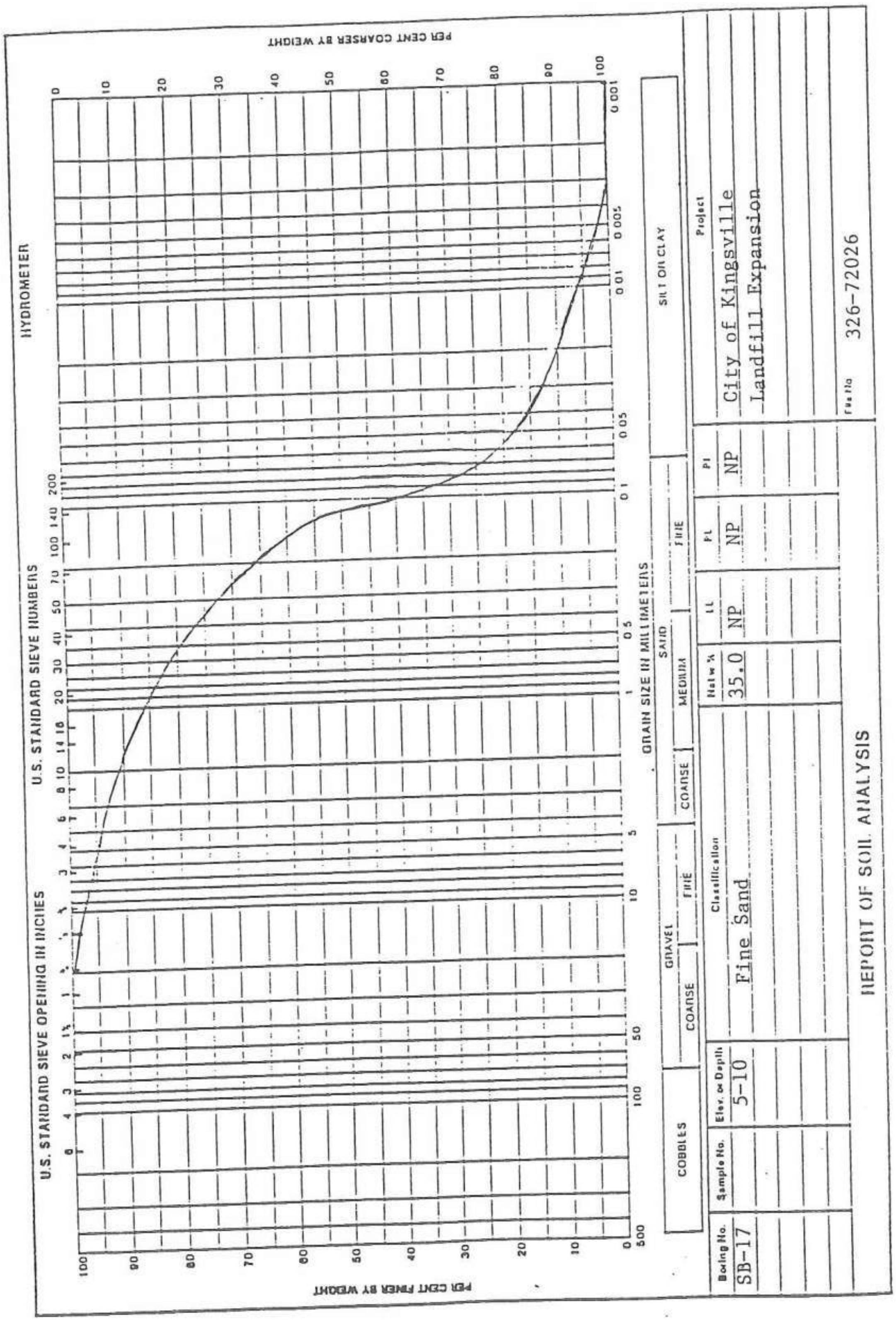
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB 17
Sample No.
Elev. or Depth
0-5
Classification
Fine Sand
Nat w %
21.6
LL
NP
PL
NP
PI
NP
Project
City of Kingsville
Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-55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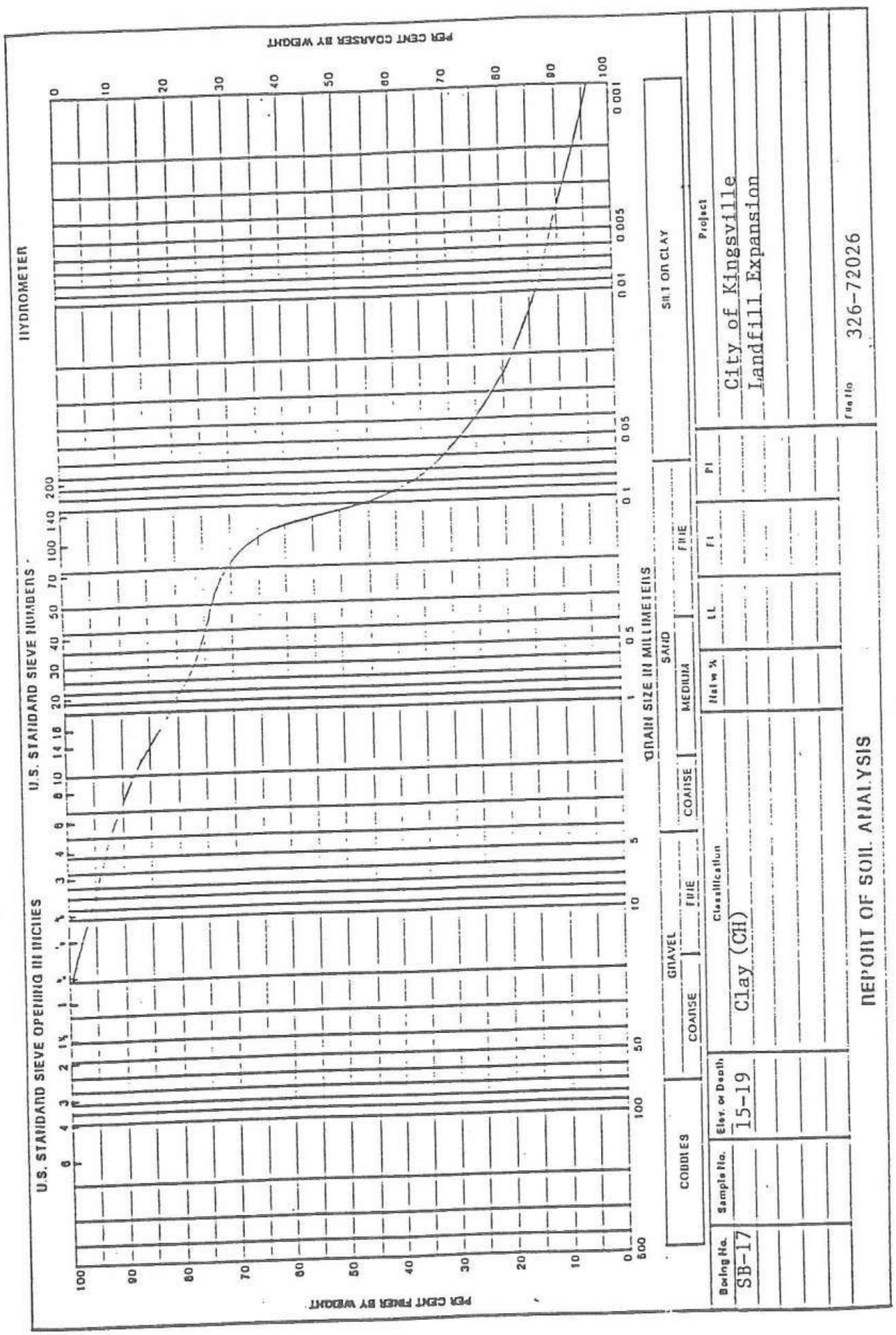
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-17
Sample No.
Elev. or Depth
5-10
Classification
Fine Sand
Nat w %
35.0
LL
NP
PL
NP
PI
NP
Project
City of Kingsville
Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-56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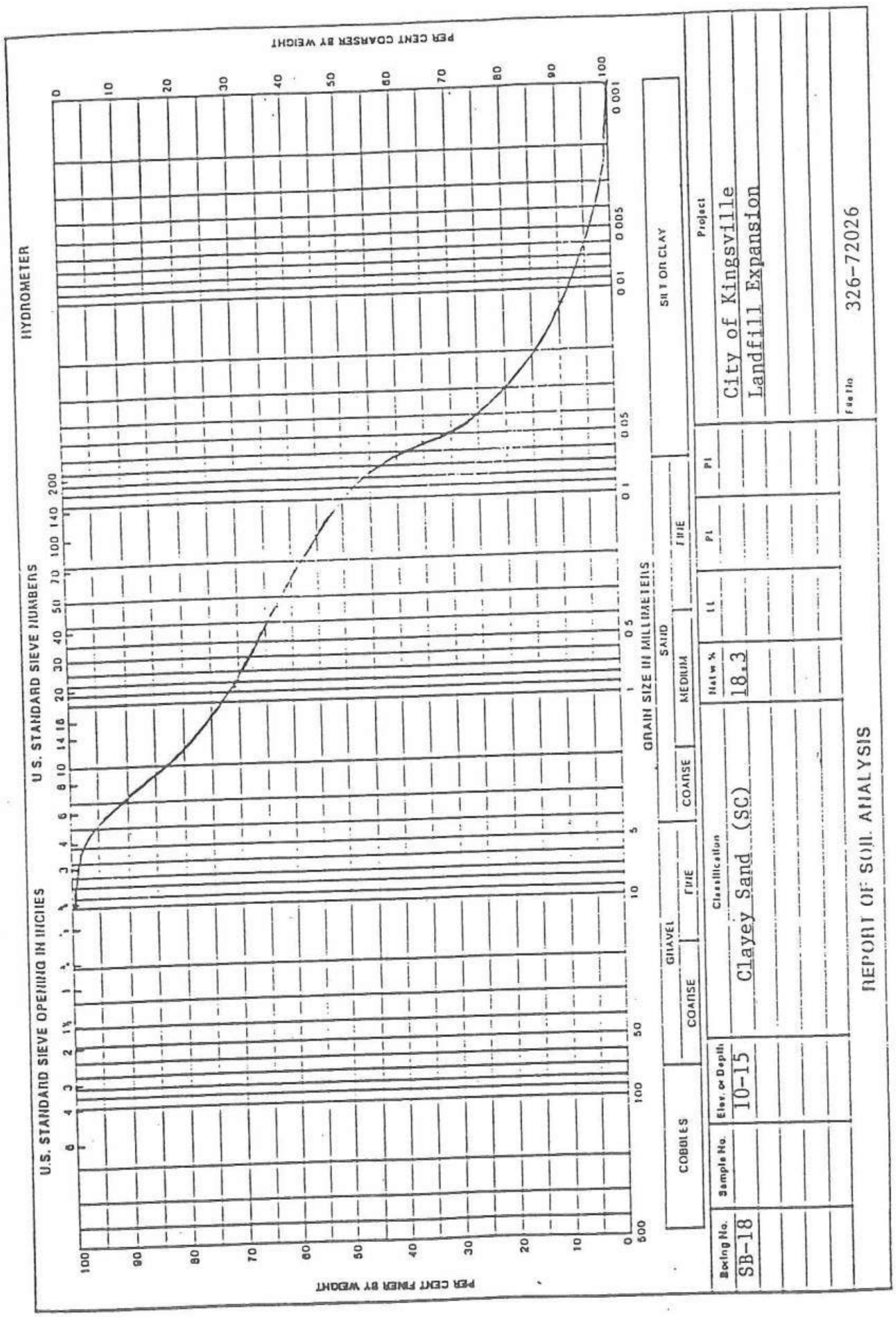
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
Boring No.
SB-17
Sample No.
Elev. or Depth
15-19
Classification
Clay (CH)
Project
City of Kingsville Landfill Expansion
File No.
326-72026

G-57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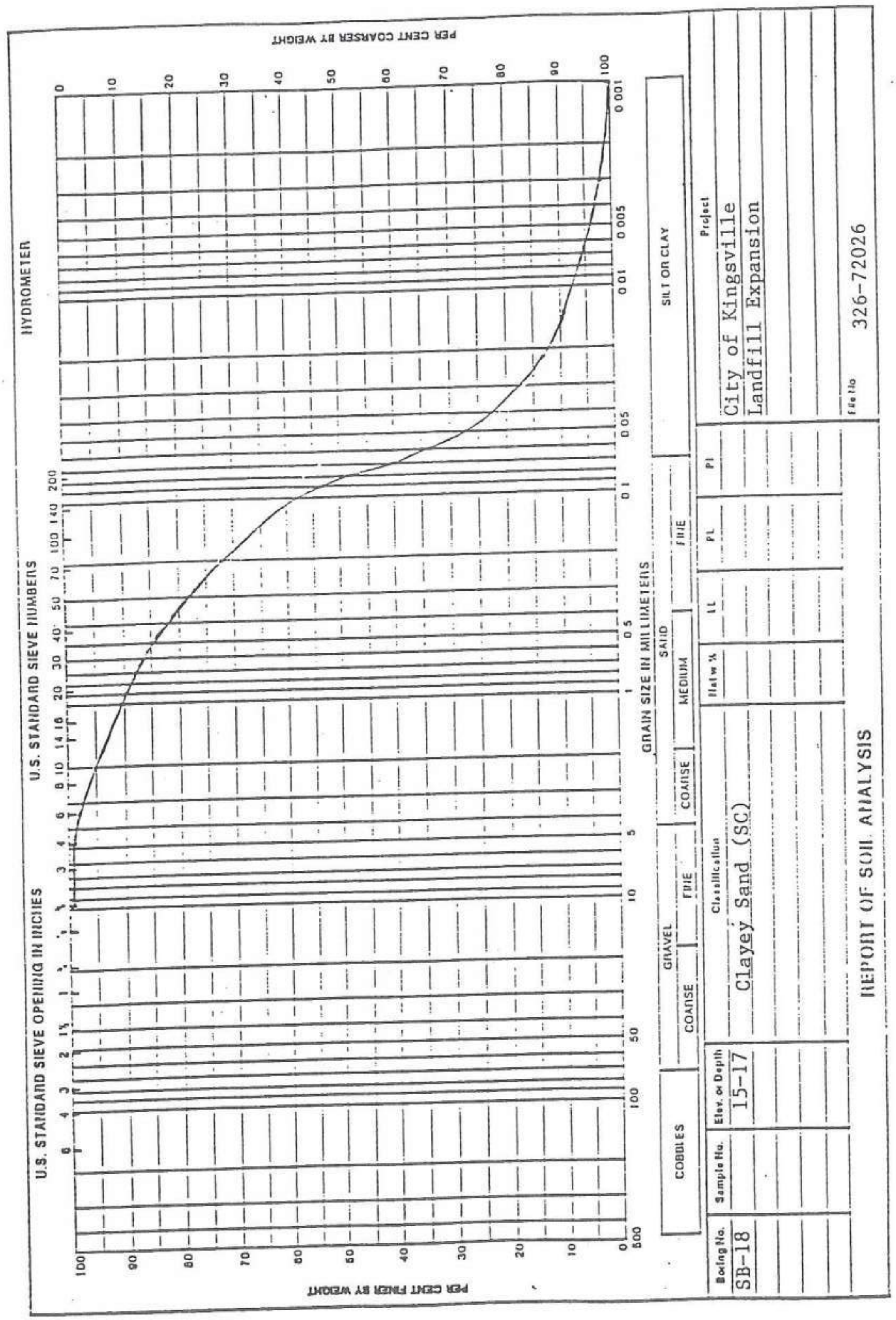
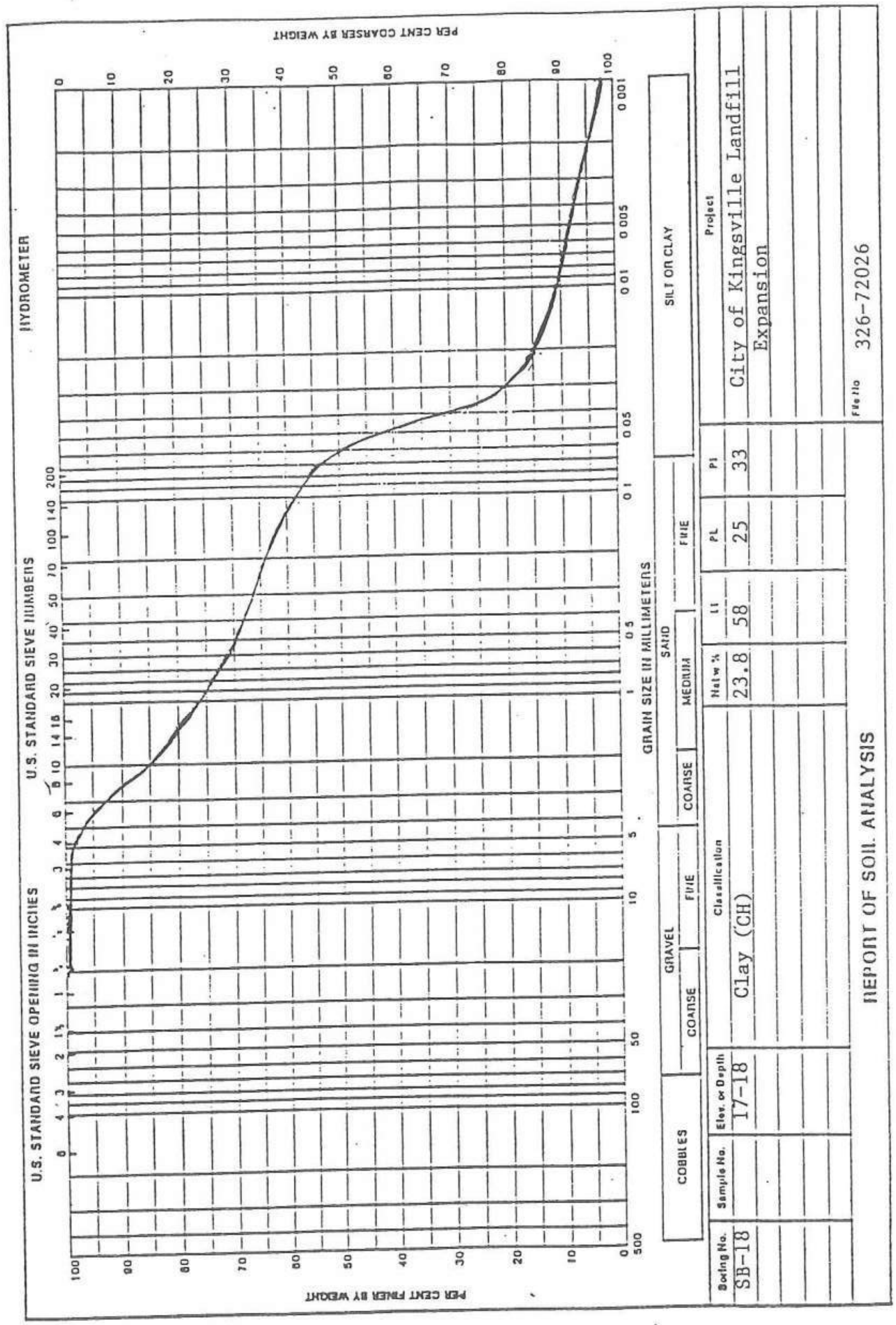
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
MEDIUM
SILT OR CLAY
Boring No.
SB-18
Sample No.
Elev. or Depth
10-15
Classification
Clayey Sand (SC)
Nat w %
18.3
LL
PL
PI
Project
City of Kingsville Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-58


PER CENT COARSER BY WEIGHT
HYDROMETER
U.S. STANDARD SIEVE NUMBERS
U.S. STANDARD SIEVE OPENING IN INCHES
GRAIN SIZE IN MILLIMETERS
PER CENT FINER BY WEIGHT
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-18
Sample No.
Elev. or Depth
15-17
Classification
Clayey Sand (SC)
Nat w %
LL
PL
PI
Project
City of Kingsville
Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-59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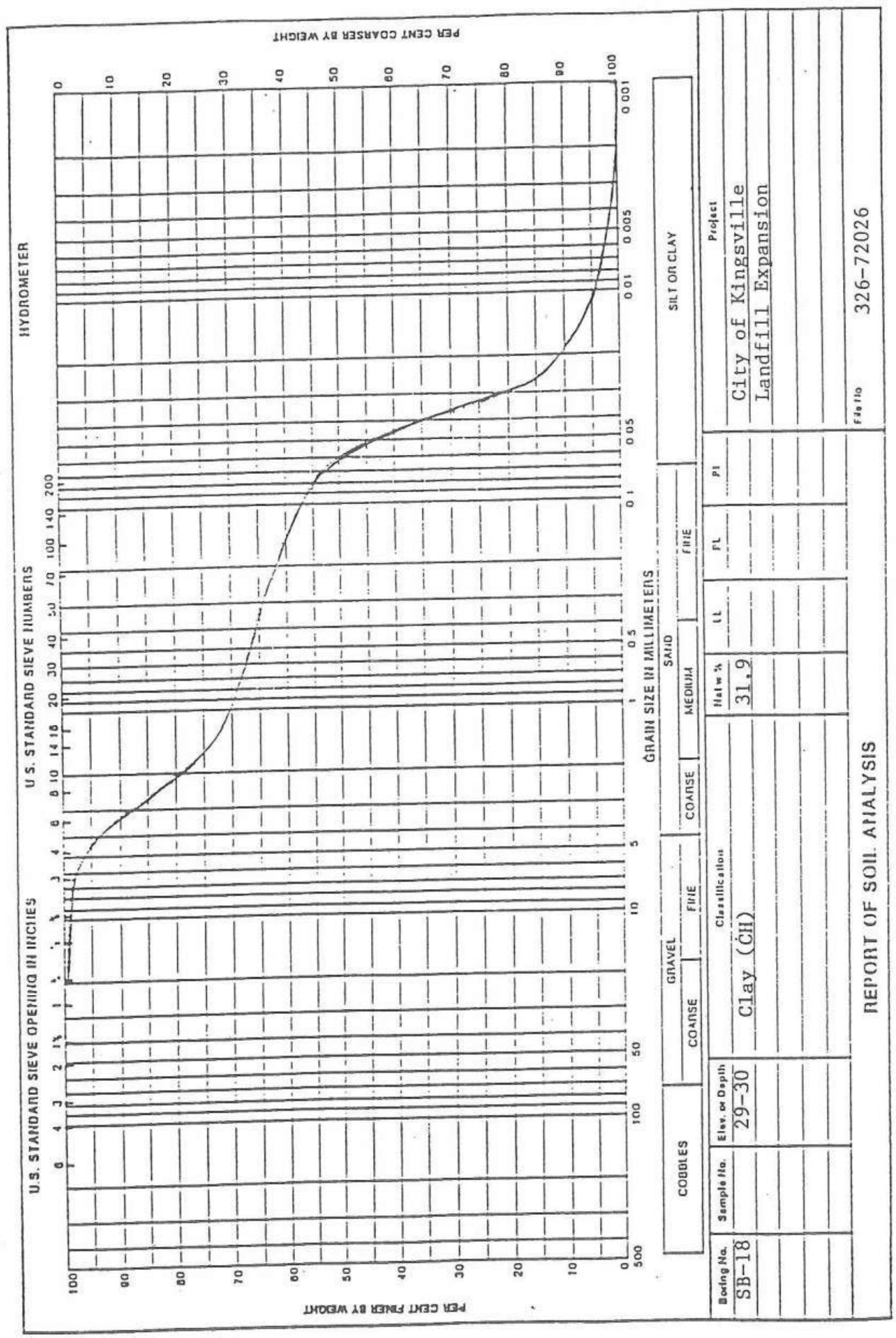
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
Boring No.
SB-18
Sample No.
Elev. or Depth
17-18
Classification
Clay (CH)
Nat w %
23.8
LL
58
PL
25
PI
33
Project
City of Kingsville Landfill Expansion
File No.
326-72026
REPORT OF SOIL ANALYSIS

G-60


REPORT OF SOIL ANALYSIS
U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
MEDIUM
SILT OR CLAY
Boring No.
SB-18
Sample No.
Elev. or Depth
29-30
Classification
Clay (CH)
Nat w %
31.9
LL
PL
PI
Project
City of Kingsville
Landfill Expansion
File No.
326-72026

G-61

City of Kingsville, MSWLF
Hydrogeologic Study
Summary of Test Results

Sample Identification	Classification	Atterberg Limit		Water Content	Finer #200 Sieve
		Liquid Limit	Plastic Index		
B-12; S-1, 0-2	Silty Clay			7.2	
S-3, 5-7	Sandy Clay			14.1	60
S-4, 7-8	Sandy Clay	41	28	13.6	
S-6, 14-19	Clayey Sand	51	28	19.1	48
S-7, 19-24	Clayey Sand	48	26	23.6	33
S-9, 29-34	Clay	53	29	24.7	
S-10, 34-36	Clay	51	24	23.2	
S-11, 36-41	Clay with Sand			25.2	51
S-13, 46-47	Clay, some Sand			29.0	
S-14, 47-48	Clay, some Sand	59	25	30.2	

City of Kingsville, MSWLF
Hydrogeologic Study
Summary of Test Results

Sample Identification	Classification	Atterberg Limit		Water Content	Finer #200 Sieve
		Liquid Limit	Plastic Index		
B-13; S-2, 2-4	Sandy Clay	30	12		
S-3, 5-8	Sandy Clay			8.0	62
S-4, 8-10	Sandy Clay	43	26	9.4	66
S-6, 15-20	Clay with Sand	59	36		
S-7, 20-25	Clay some Sand	59	29	21.3	
S-8, 25-26	Clay with Sand			21.3	
S-9, 26-27	Clay with Sand	63	29	21.6	
S-10, 27-30	Clayey Sand			18.6	48
S-11, 30-35	Clayey Sand	59	28	23.9	46
S-12, 35-36	Clayey Sand			20.3	
S-14, 40-45	Clayey Sand	56	24	26.9	
S-15, 45-46	Fine Sand			24.7	30
S-16, 48-49	Fine Sand		NON	26.7	

City of Kingsville, MSWLF
Hydrogeologic Study
Summary of Test Results

Sample Identification	Classification	Atterberg Limit		Water Content	Finer #200 Sieve
		Liquid Limit	Plastic Index		
B-14; S-2, 5-10	Sandy Clay	44	26	11.5	56
S-3, 10-11	Sandy Clay			14.4	53
S-4, 11-15	Clay with Sand	63	37	19.0	
S-5, 15-20	Clay with Sand			22.2	
S-6, 20-25	Clay	58	33	24.8	
S-7, 25-30	Clayey Sand			28.5	46
S-8, 30-33	Sandy Clay	50	27	29.3	66
S-9, 33-34	Clay, trace Sand	61	33	25.7	
S-11, 35-37	Clay, some Sand	64	37	26.0	85
S-12, 39-40	Silty Clay	41	15	29.5	

City of Kingsville, MSWLF
Hydrogeologic Study
Summary of Test Results

Sample Identification	Classification	Atterberg Limit		Water Content	Finer #200 Sieve
		Liquid Limit	Plastic Index		
B-15; S-2, 5-10	Clayey Sand	30	19	12.3	47
S-3, 10-12	Sandy Clay			11.6	51
S-4, 12-13	Clay, some Sand			12.9	
S-5, 13-14	Clay with Sand	68	46	15.3	55
S-6, 14-16	Clay, some Sand	79	56	15.3	
S-7, 16-19	Clay with Sand	79	56	15.3	65
S-8, 19-22	Clay with Sand	83	60	21.2	
S-10, 23-24	Clay with Sand			20.1	
S-11, 24-25	Clay with Sand	50	32	21.3	53
S-13, 25-28	Clay with Sand	52	35	26.5	58
S-14, 28-29	Clay with Sand			29.0	66
S-15, 30-30	Clayey Sand	29	8		

G-65

City of Kingsville, MSWLF
Hydrogeologic Study
Summary of Test Results

Sample Identification	Classification	Atterberg Limit		Water Content	Finer #200 Sieve
		Liquid Limit	Plastic Index		
B-16; S-2, 3-5	Sandy Clay			9.3	
S-3, 5-10	Clayey Sand	45	23	11.6	31
S-8, 16-18	Fine Sand		NON	27.3	22
S-9, 18-20	Fine Sand	43	13	22.3	24
S-14, 26-29	Clayey Sand	50	29	24.5	30
S-17, 33-35	Clayey Sand	41	24	19.4	46
S-18, 35-37	Clayey Sand			21.0	
S-23, 45-47	Clay, some Sand	79	51	30.6	83

City of Kingsville, MSWLF
Hydrogeologic Study
Summary of Test Results

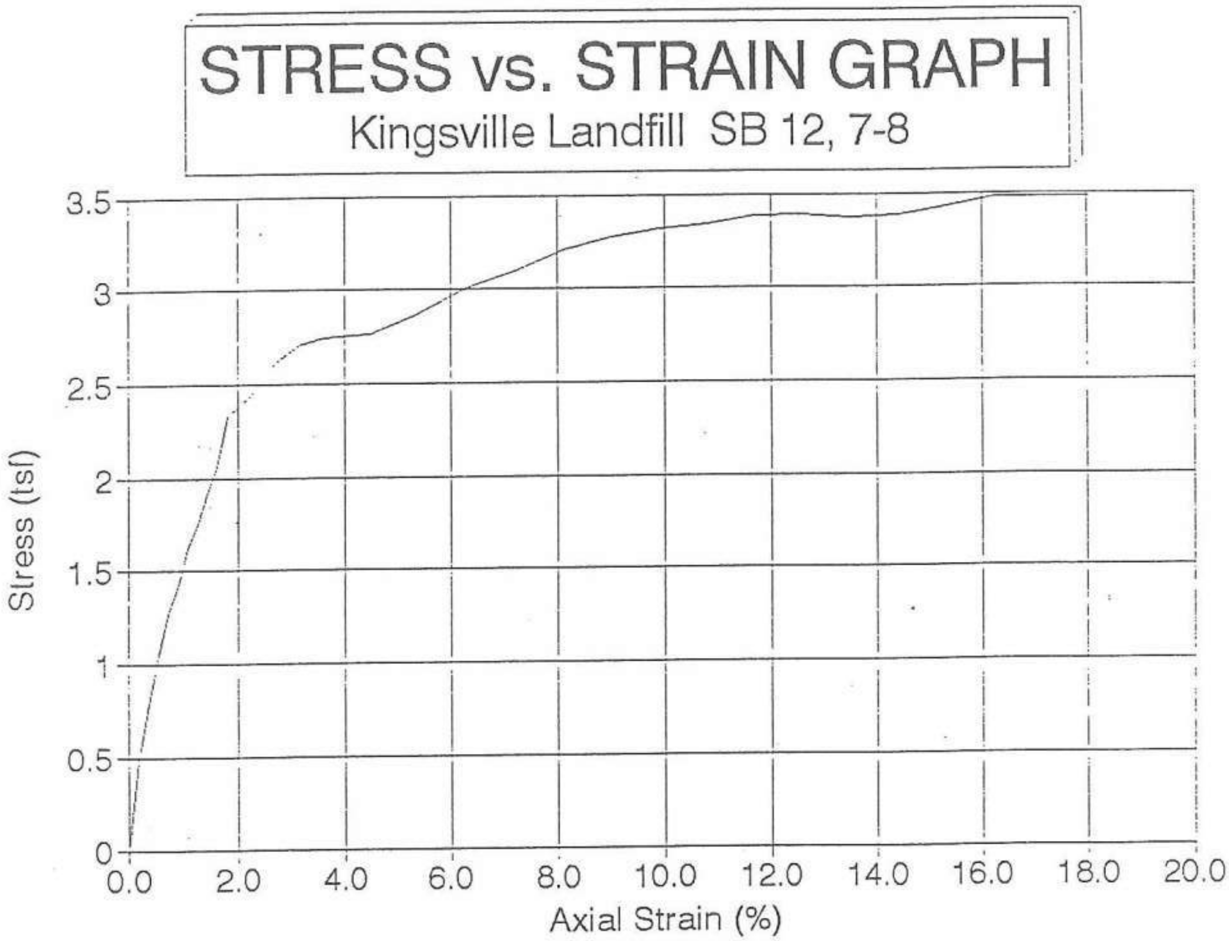
Sample Identification	Classification	Atterberg Limit		Water Content	Finer #200 Sieve
		Liquid Limit	Plastic Index		
B-17; S-2, 2-5	Fine Sand with Clay		NON	21.6	
S-3, 5-8	Fine Sand with Clay			35.0	25
S-4, 8-9	Fine Sand with Clay		NON	31.4	
S-5, 9-10	Sandy Clay	41	19	32.0	66
S-8, 17-18	Clay with Sand	66	46	31.5	
S-12, 24-29	Clay, some Sand	74	52	38.0	83
S-14, 31-32	Clay, trace Sand			23.0	
S-15, 32-33	Clay, trace Sand	62	41		

City of Kingsville, MSWLF
Hydrogeologic Study
Summary of Test Results

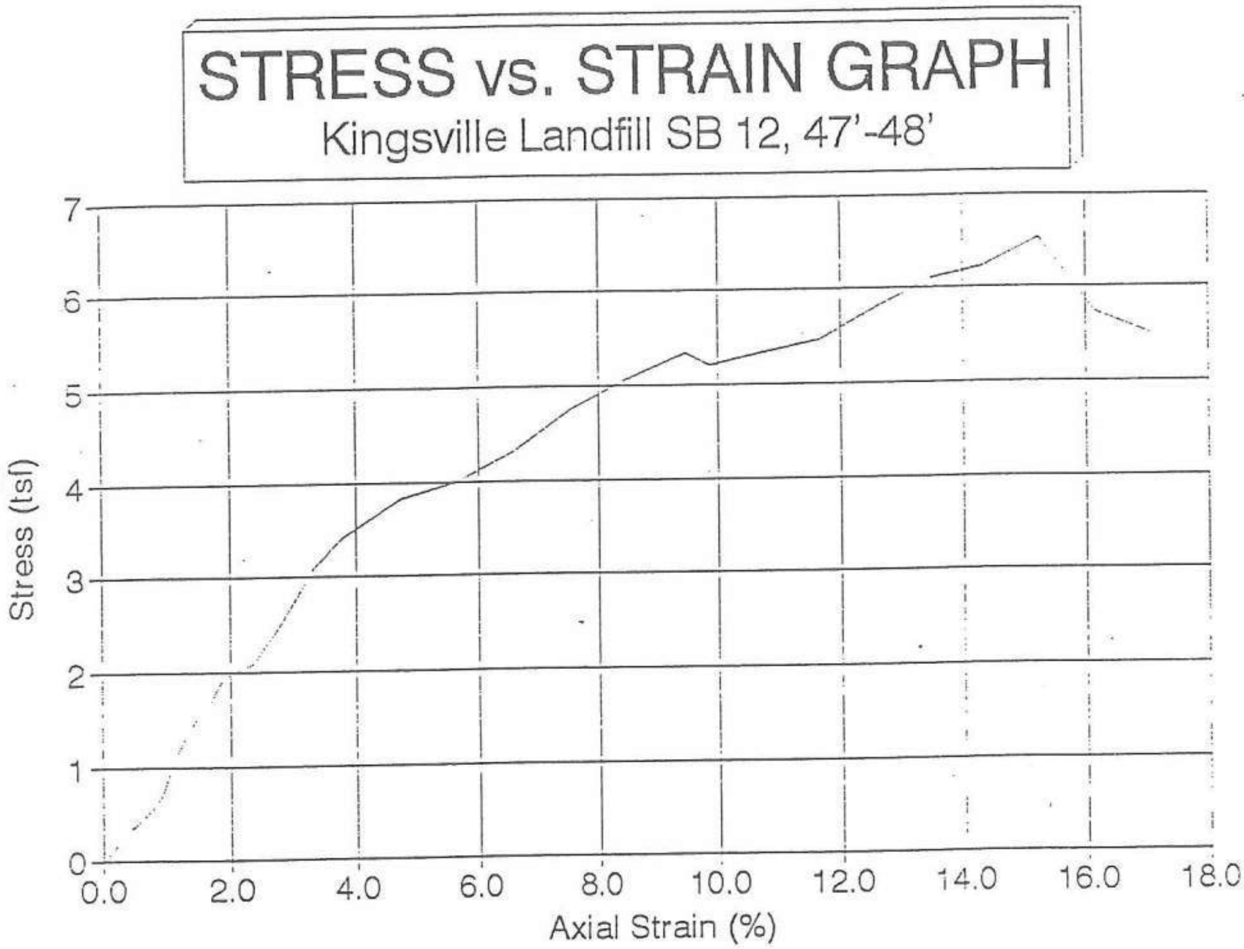
Sample Identification	Classification	Atterberg Limit		Water Content	Finer #200 Sieve
		Liquid Limit	Plastic Index		
B-18; S-3, 5-9	Clay with Sand	59	44	15.2	60
S-4, 9-10	Clay, some Sand			14.8	
S-5, 10-15	Clayey Sand			18.3	45
S-7, 17-18	Clay with Sand	58	33	23.8	57
S-10, 24-29	Clay with Sand	66	47	26.5	78
S-11, 29-30	Clay, some Sand			31.9	
S-14, 34-39	Clay, some Sand	73	48	34.9	81
S-15, 39-42	Clay, some Sand			31.1	

G-2 Compressive Strength Test Results

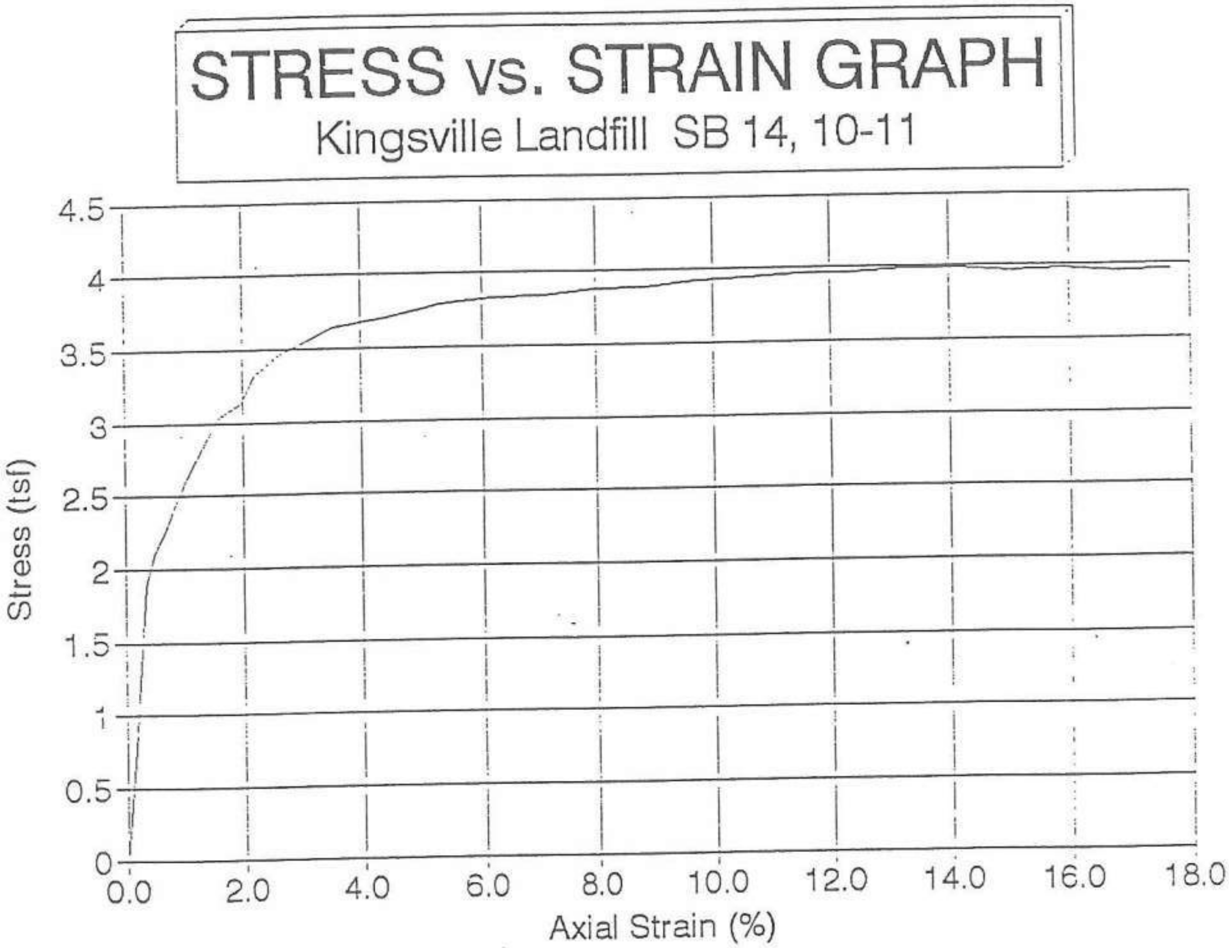
G-69


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 12, 7-8
Stress (tsf)
3.5
3
2.5
2
1.5
1
0.5
0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Axial Strain (%)

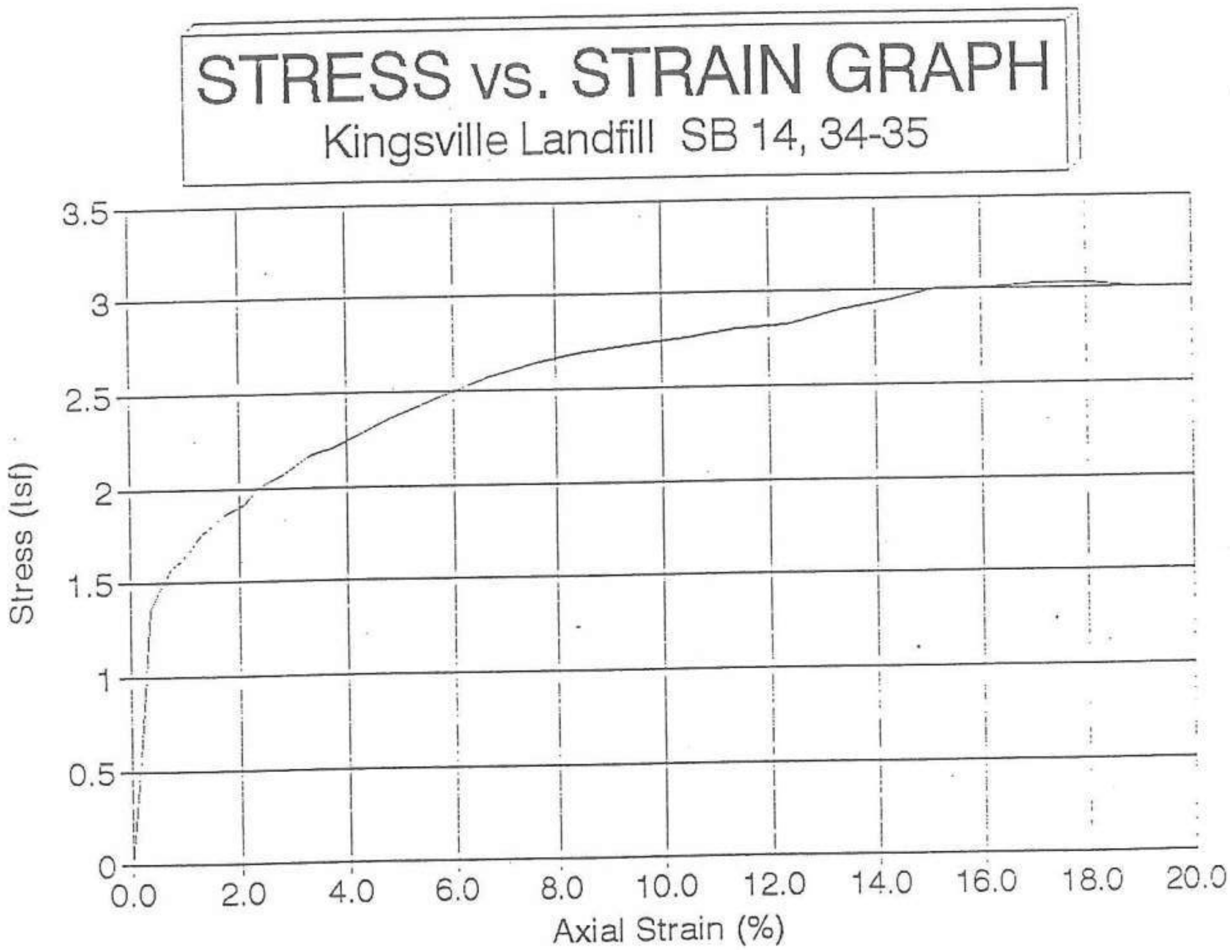
G-70


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 12, 47'-48'
Stress (tsf)
0
1
2
3
4
5
6
7
Axial Strain (%)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0

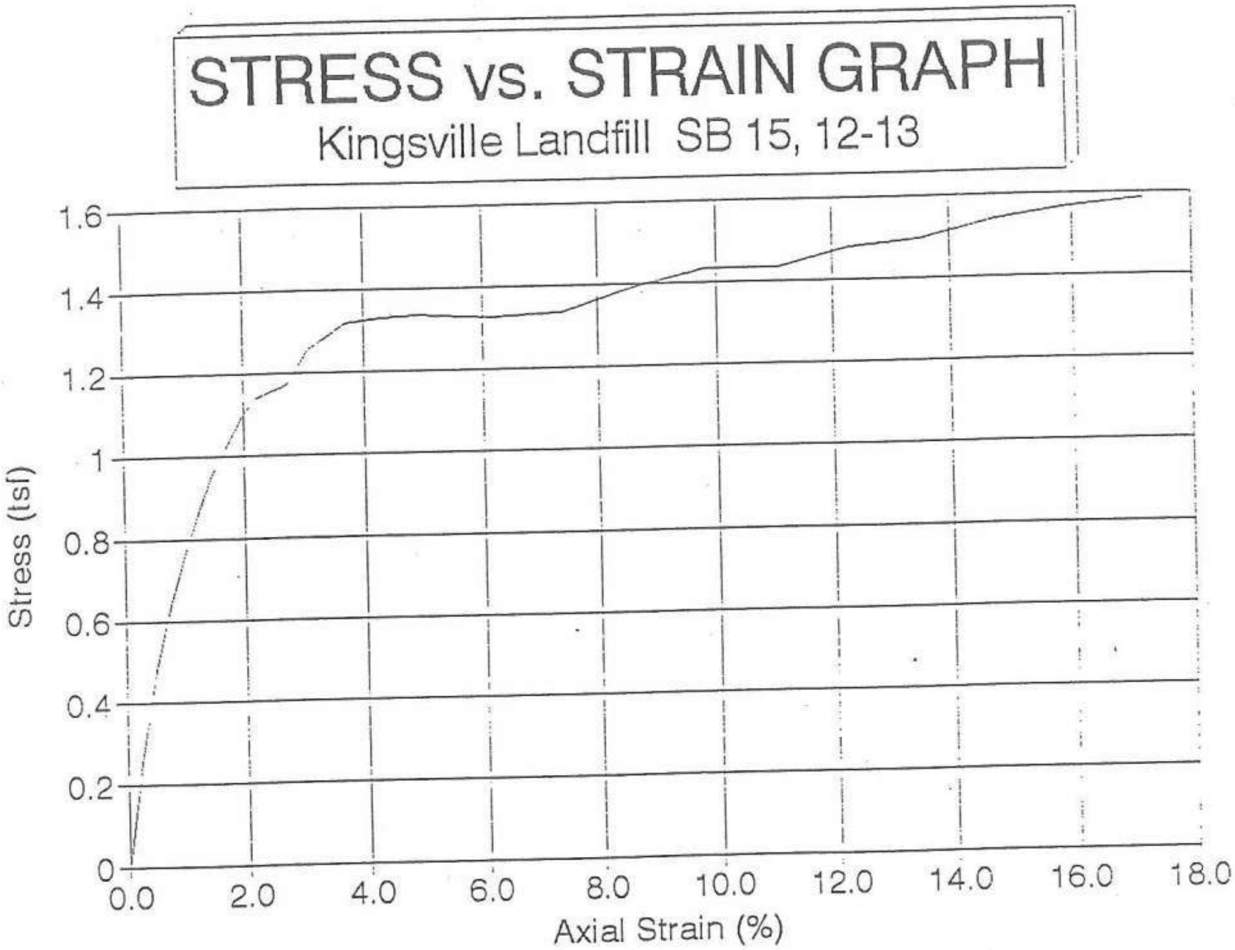
G-71


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 14, 10-11
Stress (tsf)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
Axial Strain (%)

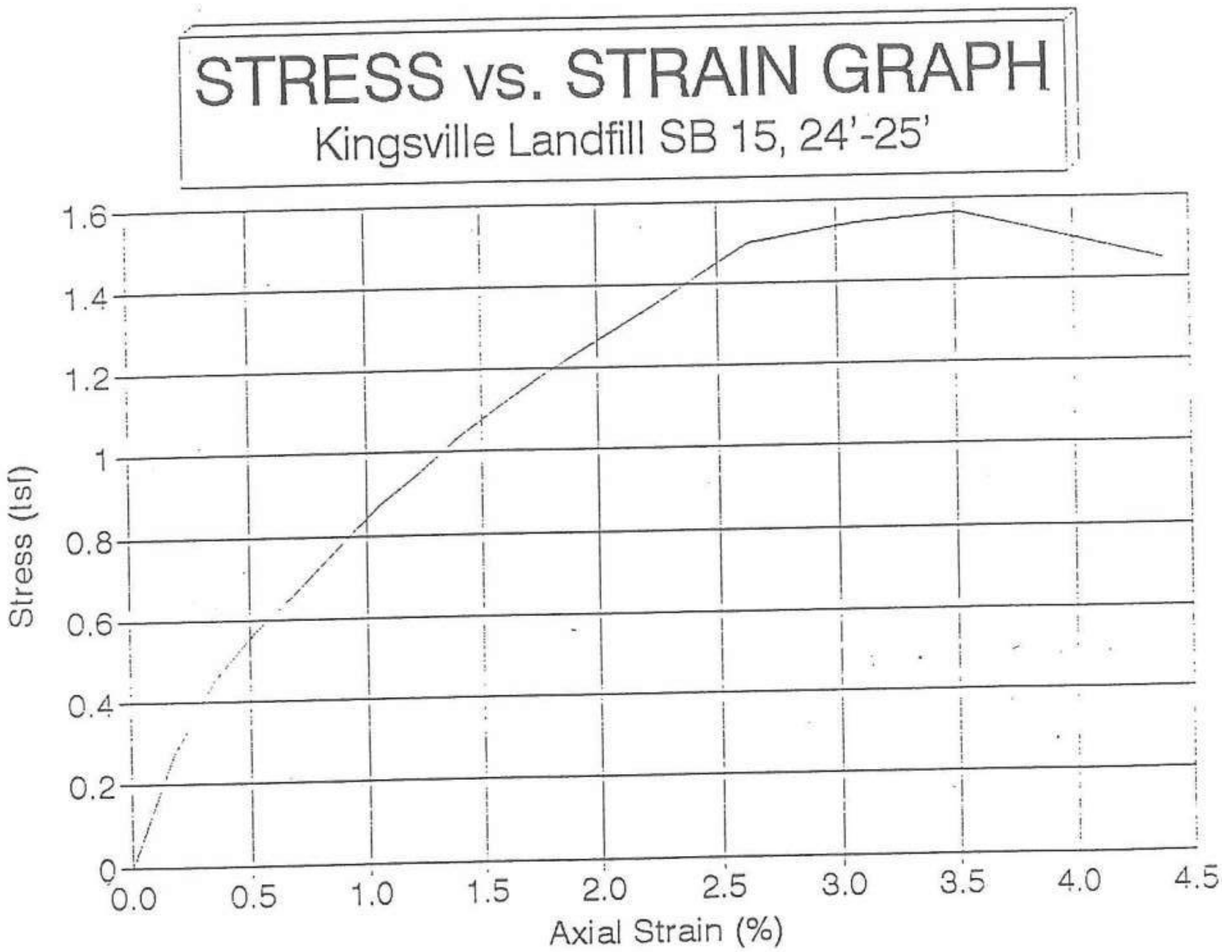
G-72


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 14, 34-35
Stress (tsf)
3.5
3
2.5
2
1.5
1
0.5
0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Axial Strain (%)

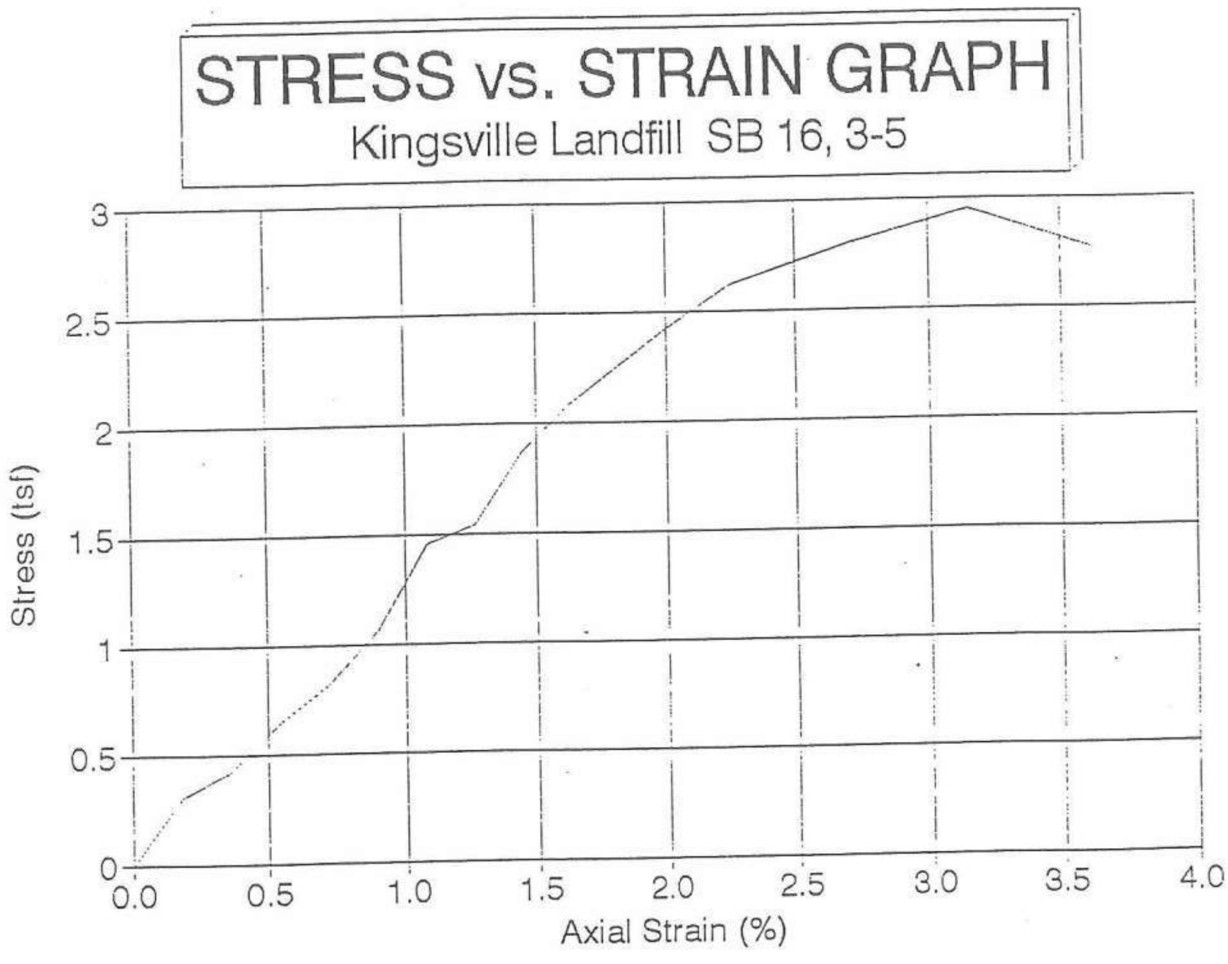
G-73


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 15, 12-13
Stress (tsf)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
Axial Strain (%)

G-74


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 15, 24'-25'
Stress (lsl)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Axial Strain (%)

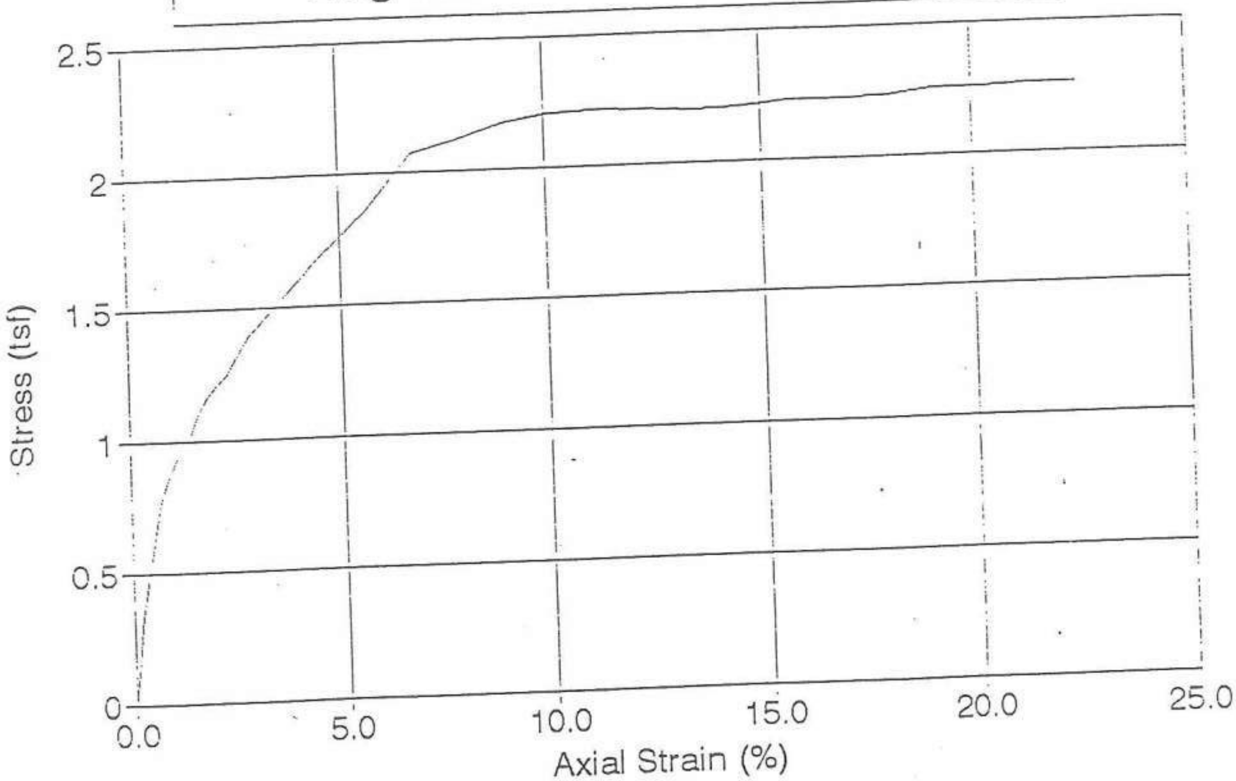
G-75


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 16, 3-5
Stress (tsf)
3
2.5
2
1.5
1
0.5
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Axial Strain (%)

G-76

STRESS vs. STRAIN GRAPH

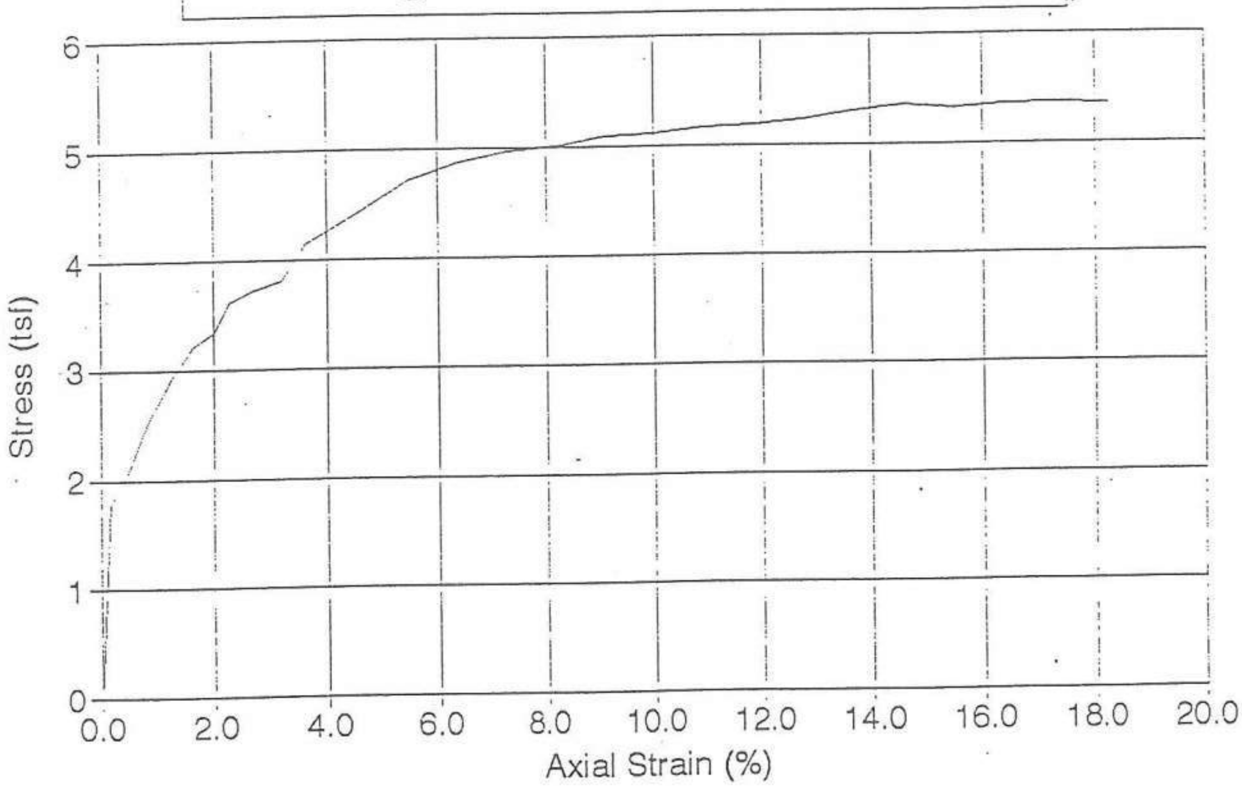
Kingsville Landfill SB 17, 32'-33'



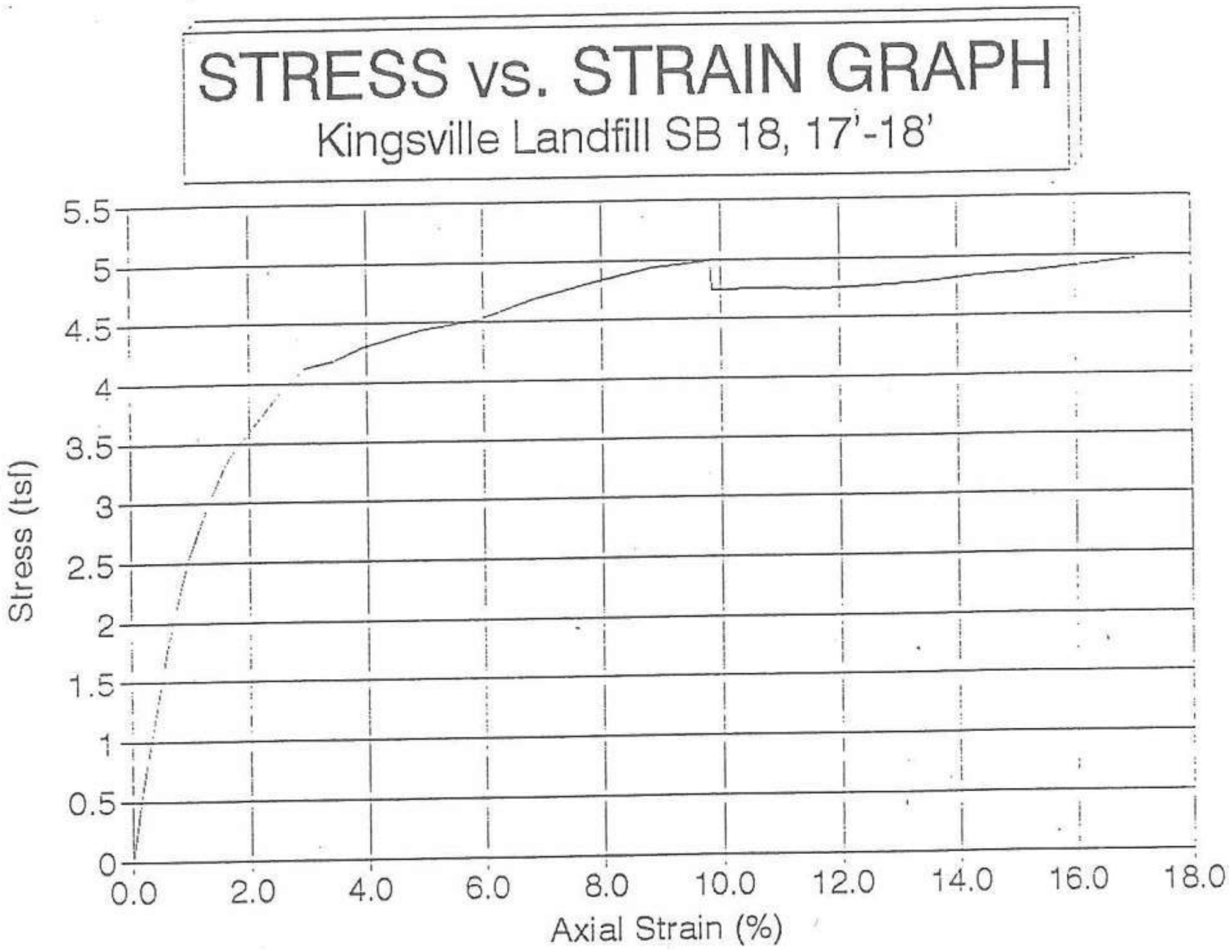
G-77

STRESS vs. STRAIN GRAPH

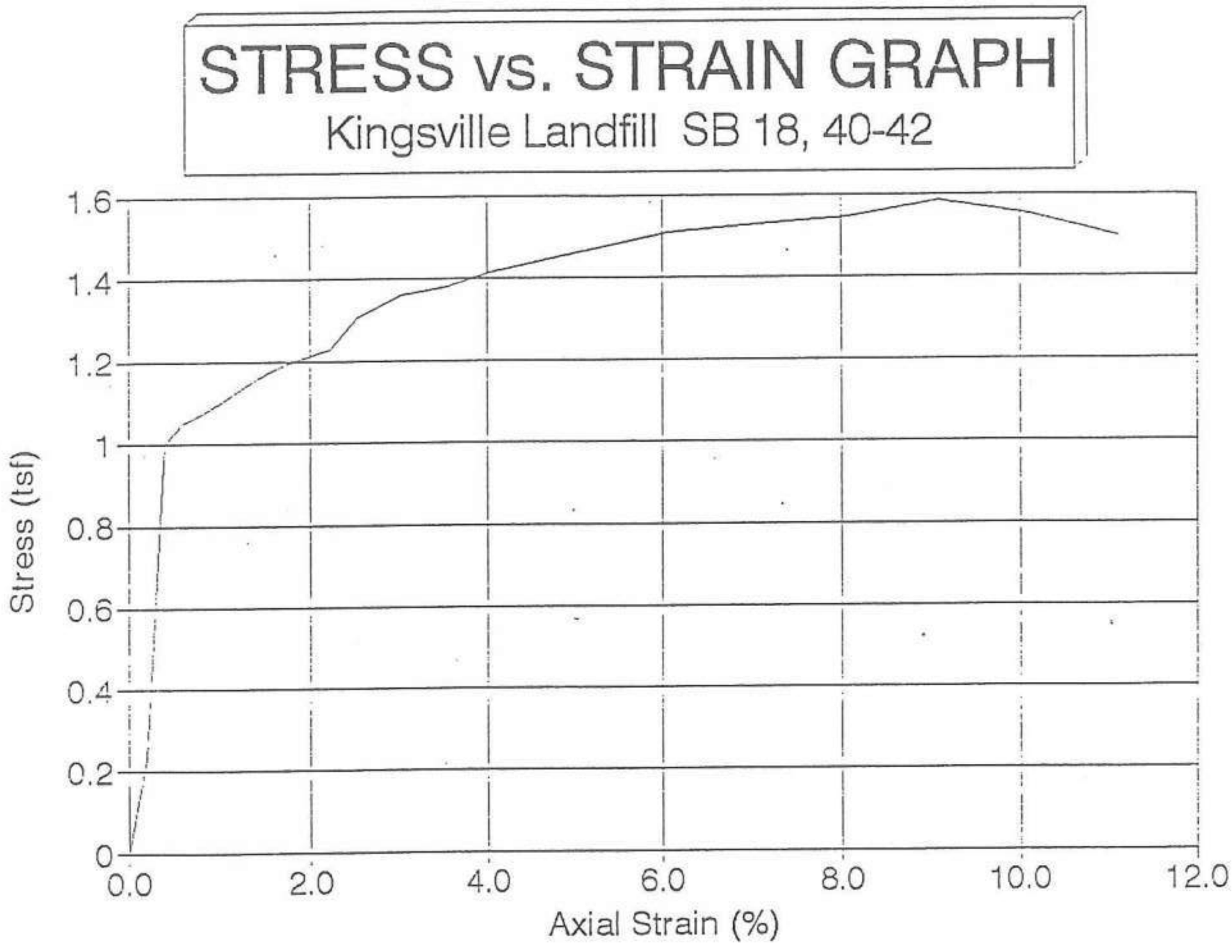
Kingsville Landfill SB 18, 9-10



G-78


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 18, 17'-18'
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Stress (tsf)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
Axial Strain (%)

G-79


STRESS vs. STRAIN GRAPH
Kingsville Landfill SB 18, 40-42
Stress (tsf)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Axial Strain (%)

G-3 Hydraulic Conductivity Test Results

COEFFICIENT OF PERMEABILITY
(ASTM D-5084)

Sample		Average K (cm/s)	
		Vertical	Horizontal
SB-12	2-3		1.6×10^{-4}
	9-14		2.0×10^{-6}
SB-13	0-5		1.0×10^{-4}
	4-8	5.8×10^{-6}	
	25-26	3.4×10^{-7}	5.0×10^{-6}
	35-36	4.6×10^{-4}	3.0×10^{-5}
SB-14	10-15		5.0×10^{-7}
	20-25	6.9×10^{-5}	
	33-34	1.2×10^{-7}	3.0×10^{-6}
SB-15	5-10		5.0×10^{-6}
	13-14	3.0×10^{-7}	
	23-24	2.4×10^{-7}	
SB-16	1-3		6.0×10^{-6}
	33-35	1.2×10^{-5}	
	35-37	4.2×10^{-6}	
SB-17	8-9	1.0×10^{-4}	3.0×10^{-5}
	23-24	9.0×10^{-8}	1.0×10^{-7}
	32-33	6.7×10^{-8}	
SB-18	2-5		1.0×10^{-4}
	29-30	2.3×10^{-8}	

COEFFICIENT OF PERMEABILITY TESTS (ASTM 3-5084)

Tested for: Ray N. Finch, Ph.D, P.E.

Company: Finch Energy & Environmental Services

Results: Vertical Permeabilities of Deep Soil Borings

Sample	Depth (ft.)	Average K
MW-21	50-52	1.99E -09 cm/s
MW-21	62-64	3.00 E -08 cm/s
MW-21	78-80	1.56 E -08 cm/s
MW-23	36-38	4.40 E -08 cm/s
MW-23	46-48	1.60 E -08 cm/s
MW-23	66-68	3.80 E -08 cm/s
MW-24	36-38	1.33 E -09 cm/s
MW-24	50-52	3.28 E -09 cm/s
MW-24	68-70	1.21 E -08 cm/s
MW-25	52-54	2.45 E -08 cm/s
MW-25	64-66	2.30 E -08 cm/s
MW-25	78-80	6.18 E- 09 cm/s

G-4 Cation-Exchange Test Results

City of Kingsville, MSWLF
Cation Exchange Capacity
Summary of Test Results

Soil Sample Identification		Cation Exchange Capacity (meg/100g)
Boring Number	Depth	
SB-12	0 - 2'	11.2
SB-12	19' - 24'	14.8
SB-13	0 - 2'	13.1
SB-13	30' - 35'	21.6
SB-14	0 - 2'	12.9
SB-14	25' - 30'	26.6
SB-15	0 - 2'	22.0
SB-15	25' - 28'	20.7
SB-16	3' - 5'	21.8
SB-16	26' - 29'	8.92
SB-17	0 - 5'	26.0
SB-17	19' - 24'	15.6
SB-18	0 - 2'	16.3
SB-18	5' - 10'	17.2
SB-18	19' - 21'	19.4

TEL. 512-884-0371 PO BOX 2552 784ₒ₃

G-85

JORDAN LABORATORIES, INCORPORATED
ANALYTICAL & ENVIRONMENTAL CHEMISTS
CORPUS CHRISTI, TEXAS
December 9, 1997

F.E.E., INC.
P.O. Box 73
Kingsville, Texas 78364-0073

Report of Analysis

Lab. No.	Identification (Soil Samples)	Cation Exchange Capacity meq/100g
M35-13385	SB12 0'-2'	11.2
M35-13386	SB12 19'-24'	14.8
M35-13387	SB13 0'-2'	13.1
M35-13388	SB13 30'-35'	21.6
M35-13389	SB14 0'-2'	12.9
M35-13390	SB14 25'-30'	26.6
M35-13391	SB15 0'-2'	22.0
M35-13392	SB15 25'-28'	20.7
M35-13393	SB16 3'-5'	21.8
M35-13394	SB16 26'-29'	8.92
M35-13395	SB17 0'-5'	26.0
M35-13396	SB17 19'-24'	15.6
M35-13397	SB18 0'-2'	16.3
M35-13398	SB18 5'-10'	17.2
M35-13399	SB18 19'-21'	19.4

Analysis Date: 12-8-97
Analyst: Nixon
Method AGHB60 (19)

Samples Received 11-21-97

Results on dry basis.

Respectfully Submitted,

Carl F. Crownover, Pres.

G-5 Permeability Calculations

SB-13 4-8

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	12.5	6.5151	5.5372	ERR	0.2706	0.0006480365	ERR	ERR	
0.25	9.3	6.5151	5.5372	3.2	0.2706	0.0006480365	0.083	1.18E-05	
0.5	7.2	6.5151	5.5372	2.1	0.2706	0.0006480365	0.112	1.02E-05	
0.75	5.67	6.5151	5.5372	1.53	0.2706	0.0006480365	0.145	9.53E-06	
1	4.59	6.5151	5.5372	1.08	0.2706	0.0006480365	0.184	8.42E-06	
1.25	3.85	6.5151	5.5372	0.74	0.2706	0.0006480365	0.227	7E-06	-21.3
1.5	3.28	6.5151	5.5372	0.57	0.2706	0.0006480365	0.27	6.38E-06	-10.5
1.75	2.87	6.5151	5.5372	0.41	0.2706	0.0006480365	0.317	5.31E-06	7.9
2	2.57	6.5151	5.5372	0.3	0.2706	0.0006480365	0.363	4.39E-06	23.9

Average K = 5.8E-06 cm/s

Kingsville Landfill

B-13 25-26'

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	17	6.03504	6.56844	-17	0.1781	0.0004265937	ERR		
2	12.2	6.03504	6.56844	4.8	0.1781	0.0004265937	0.061	1.09E-06	
4	10.7	6.03504	6.56844	1.5	0.1781	0.0004265937	0.085	4.29E-07	
6	9.3	6.03504	6.56844	1.4	0.1781	0.0004265937	0.097	4.59E-07	
8	8.1	6.03504	6.56844	1.2	0.1781	0.0004265937	0.112	4.52E-07	
10	7.4	6.03504	6.56844	0.7	0.1781	0.0004265937	0.129	2.96E-07	
12	6.7	6.03504	6.56844	0.7	0.1781	0.0004265937	0.141	3.25E-07	3.6
14	6	6.03504	6.56844	0.7	0.1781	0.0004265937	0.155	3.61E-07	-7.1
16	5.4	6.03504	6.56844	0.6	0.1781	0.0004265937	0.173	3.45E-07	-2.2
18	4.9	6.03504	6.56844	0.5	0.1781	0.0004265937	0.193	3.18E-07	5.7

Average K = 3.4E-07 cm/s

G-89

Kingsville Landfill
SB-14, 20'-25'

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0.00	9	6.2738	6.2992	ERR	0.2013	0.0004821905	ERR	ERR	
0.05	5.8	6.2738	6.2992	3.2	0.2013	0.0004821905	0.116	6.55E-05	5.6
0.10	3.8	6.2738	6.2992	2	0.2013	0.0004821905	0.179	6.3E-05	9.2
0.15	2.2	6.2738	6.2992	1.6	0.2013	0.0004821905	0.274	8.18E-05	-17.8
0.20	1.4	6.2738	6.2992	0.8	0.2013	0.0004821905	0.473	6.74E-05	2.9

Average K 6.9E-05 cm/s

G-90

B-14 33-34'

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	17	6.223	7.0993	-17	0.1572	0.0003765542	ERR		
4	15.5	6.223	7.0993	1.5	0.1572	0.0003765542	0.061	1.33E-07	
8	13.9	6.223	7.0993	1.6	0.1572	0.0003765542	0.067	1.57E-07	
10	13.6	6.223	7.0993	0.3	0.1572	0.0003765542	0.075	6.29E-08	
12	13	6.223	7.0993	0.6	0.1572	0.0003765542	0.077	1.3E-07	
14	12.8	6.223	7.0993	0.2	0.1572	0.0003765542	0.08	4.47E-08	
16	12.2	6.223	7.0993	0.6	0.1572	0.0003765542	0.081	1.38E-07	-19.5
18	11.8	6.223	7.0993	0.4	0.1572	0.0003765542	0.085	9.61E-08	17.0
20	11.4	6.223	7.0993	0.4	0.1572	0.0003765542	0.088	9.94E-08	14.2
22	10.9	6.223	7.0993	0.5	0.1572	0.0003765542	0.091	1.29E-07	-11.7

Average K = 1.2E-07 cm/s

B-15 13-14'

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0.0	11	7.9248	7.0612	-11	0.2024	0.0004847191	ERR		
1.0	9.8	7.9248	7.0612	1.2	0.2024	0.0004847191	0.095	8.59E-07	
2.0	9.3	7.9248	7.0612	0.5	0.2024	0.0004847191	0.106	3.89E-07	
3.0	8.7	7.9248	7.0612	0.6	0.2024	0.0004847191	0.112	4.95E-07	
4.0	8.2	7.9248	7.0612	0.5	0.2024	0.0004847191	0.12	4.4E-07	
5.0	8	7.9248	7.0612	0.2	0.2024	0.0004847191	0.127	1.83E-07	
6.0	7.74	7.9248	7.0612	0.26	0.2024	0.0004847191	0.13	2.45E-07	18.7
7.0	7.4	7.9248	7.0612	0.34	0.2024	0.0004847191	0.134	3.33E-07	-10.6
8.0	7.1	7.9248	7.0612	0.3	0.2024	0.0004847191	0.141	3.07E-07	-1.9
9.0	6.8	7.9248	7.0612	0.3	0.2024	0.0004847191	0.147	3.2E-07	-6.3

Average K = 3E-07 cm/s

Kingsville Landfill
SB-16, 33-35

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0.00	11	6.0706	7.2136	ERR	0.1485	0.0003557839	ERR	ERR	
0.08	8	6.0706	7.2136	3	0.1485	0.0003557839	0.095	2.1E-05	
0.17	6.3	6.0706	7.2136	1.7	0.1485	0.0003557839	0.13	1.57E-05	
0.25	5	6.0706	7.2136	1.3	0.1485	0.0003557839	0.165	1.52E-05	
0.33	4.1	6.0706	7.2136	0.9	0.1485	0.0003557839	0.208	1.3E-05	
0.42	3.4	6.0706	7.2136	0.7	0.1485	0.0003557839	0.254	1.23E-05	-5.1
0.50	2.95	6.0706	7.2136	0.45	0.1485	0.0003557839	0.306	9.3E-06	20.4
0.58	2.5	6.0706	7.2136	0.45	0.1485	0.0003557839	0.353	1.09E-05	7.2
0.67	2.01	6.0706	7.2136	0.49	0.1485	0.0003557839	0.416	1.43E-05	-22.5

Average K 1.2E-05 cm/s

SB-16 35-37

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	13.5	5.03936	4.05384	-13.5	0.3904	0.0009351924	ERR	ERR	
0.25	10.99	5.03936	4.05384	2.51	0.3904	0.0009351924	0.077	1.18E-05	
0.5	9.05	5.03936	4.05384	1.94	0.3904	0.0009351924	0.095	1.12E-05	
0.75	7.6	5.03936	4.05384	1.45	0.3904	0.0009351924	0.115	1E-05	
1	6.4	5.03936	4.05384	1.2	0.3904	0.0009351924	0.137	9.87E-06	
1.25	5.48	5.03936	4.05384	0.92	0.3904	0.0009351924	0.163	8.91E-06	
1.5	4.75	5.03936	4.05384	0.73	0.3904	0.0009351924	0.19	8.21E-06	
1.75	4.19	5.03936	4.05384	0.56	0.3904	0.0009351924	0.219	7.2E-06	
2	3.7	5.03936	4.05384	0.49	0.3904	0.0009351924	0.248	7.14E-06	
2.5	3.02	5.03936	4.05384	0.68	0.3904	0.0009351924	0.281	5.84E-06	
2.75	2.77	5.03936	4.05384	0.25	0.3904	0.0009351924	0.345	4.95E-06	-17.5
3	2.58	5.03936	4.05384	0.19	0.3904	0.0009351924	0.376	4.07E-06	3.4
3.25	2.39	5.03936	4.05384	0.19	0.3904	0.0009351924	0.403	4.39E-06	-4.0
3.5	2.25	5.03936	4.05384	0.14	0.3904	0.0009351924	0.436	3.46E-06	18.0

Average K = 4.2E-06 cm/s

B-17 32-33'

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0.0	13	9.1186	7.08406	-13	0.2314	0.0005541438	ERR		
20.0	9.6	9.1186	7.08406	3.4	0.2314	0.0005541438	0.08	1.29E-07	
22.0	9.35	9.1186	7.08406	0.25	0.2314	0.0005541438	0.108	1.12E-07	
24.0	9.2	9.1186	7.08406	0.15	0.2314	0.0005541438	0.111	6.86E-08	
26.0	9.05	9.1186	7.08406	0.15	0.2314	0.0005541438	0.113	6.97E-08	
28.0	8.95	9.1186	7.08406	0.1	0.2314	0.0005541438	0.115	4.71E-08	
30.0	8.8	9.1186	7.08406	0.15	0.2314	0.0005541438	0.116	7.17E-08	-6.6
32.0	8.68	9.1186	7.08406	0.12	0.2314	0.0005541438	0.118	5.82E-08	13.4
34.0	8.55	9.1186	7.08406	0.13	0.2314	0.0005541438	0.12	6.4E-08	4.8
36.0	8.4	9.1186	7.08406	0.15	0.2314	0.0005541438	0.122	7.51E-08	-11.6

Average K = 6.7E-08 cm/s

** TOTAL PAGE.10 **

Kingsville Landfill
SB-18, 29-30

Time	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0.00	15	7.2898	7.239	-15	0.1771	0.0004242455	ERR		
5.00	13.9	7.2898	7.239	-13.9	0.1771	0.0004242455	0.069	-8.4E-07	
20.00	12.92	7.2898	7.239	-12.92	0.1771	0.0004242455	0.075	-2.1E-07	
25.00	12.65	7.2898	7.239	-12.65	0.1771	0.0004242455	0.081	-1.8E-07	
30.00	12 41	7.2898	7.239	2.59	0.1771	0.0004242455	0.069	4.12E-08	
35.00	12.2	7.2898	7.239	0.21	0.1771	0.0004242455	0.084	2.22E-08	
40.00	11.98	7.2898	7.239	0.22	0.1771	0.0004242455	0.085	2.36E-08	
45.00	11.71	7.2898	7.239	0.27	0.1771	0.0004242455	0.087	2.96E-08	
50.00	11.53	7.2898	7.239	0.18	0.1771	0.0004242455	0.089	2.01E-08	
55.00	11.32	7.2898	7.239	0.21	0.1771	0.0004242455	0.09	2.39E-08	-5.0
60.00	11.1	7.2898	7.239	0.22	0.1771	0.0004242455	0.092	2.55E-08	-12.1
65.00	10.92	7.2898	7.239	0.18	0.1771	0.0004242455	0.094	2.12E-08	6.6
70.00	10.75	7.2898	7.239	0.17	0.1771	0.0004242455	0.095	2.04E-08	10.4

Average K 2.3E-08 cm/s

G-96

City of Kingsville MW-21 DEPTH 50'-52'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	14.4	6.985	7.0358	-14.4	0.1797	0.00043033	ERR		
30	14.2	6.985	7.0358	0.2	0.1797	0.00043033	0.072	3.1E-09	
90	13.85	6.985	7.0358	0.35	0.1797	0.00043033	0.073	2.7E-09	
150	13.6	6.985	7.0358	0.25	0.1797	0.00043033	0.075	2E-09	
1015	10.75	6.985	7.0358	2.85	0.1797	0.00043033	0.077	1.8E-09	
1075	10.55	6.985	7.0358	0.2	0.1797	0.00043033	0.097	2.1E-09	
1135	10.38	6.985	7.0358	0.17	0.1797	0.00043033	0.099	1.8E-09	10.6
1195	10.2	6.985	7.0358	0.18	0.1797	0.00043033	0.1	1.9E-09	3.7
1255	10	6.985	7.0358	0.2	0.1797	0.00043033	0.102	2.2E-09	-9.0
1285	9.9	6.985	7.0358	0.1	0.1797	0.00043033	0.104	2.2E-09	-10.6

AVERAGE K= 1.99457803E-09 cm/s

City of Kingsville MW21 DEPTH 62'-64'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	12.4	7.0612	7.0866	-12.4	0.179	0.00042881	ERR		
1	12.2	7.0612	7.0866	0.2	0.179	0.00042881	0.084	1.067E-07	
2	12	7.0612	7.0866	0.2	0.179	0.00042881	0.085	1.085E-07	
3	11.9	7.0612	7.0866	0.1	0.179	0.00042881	0.087	5.492E-08	
4	11.75	7.0612	7.0866	0.15	0.179	0.00042881	0.087	8.325E-08	
5	11.7	7.0612	7.0866	0.05	0.179	0.00042881	0.089	2.798E-08	
20	10.75	7.0612	7.0866	0.95	0.179	0.00042881	0.089	3.711E-08	-23.9
35	10.2	7.0612	7.0866	0.55	0.179	0.00042881	0.097	2.3E-08	23.2
50	9.4	7.0612	7.0866	0.8	0.179	0.00042881	0.102	3.579E-08	-19.5
65	8.9	7.0612	7.0866	0.5	0.179	0.00042881	0.111	2.394E-08	20.1

AVERAGE K= 2.99575674E-08 cm/s

G-98

City of Kingsville MW21 78'-80'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	14	7.0104	7.0358	-14	0.1803	0.00043189	ERR		
30	13	7.0104	7.0358	1	0.1803	0.00043189	0.074	1.635E-08	
60	12.3	7.0104	7.0358	0.7	0.1803	0.00043189	0.08	1.221E-08	
90	11.35	7.0104	7.0358	0.95	0.1803	0.00043189	0.085	1.774E-08	
120	10.65	7.0104	7.0358	0.7	0.1803	0.00043189	0.092	1.404E-08	
150	9.95	7.0104	7.0358	0.7	0.1803	0.00043189	0.098	1.5E-08	
180	9.3	7.0104	7.0358	0.65	0.1803	0.00043189	0.105	1.49E-08	4.4
210	8.7	7.0104	7.0358	0.6	0.1803	0.00043189	0.112	1.471E-08	5.6
240	8.1	7.0104	7.0358	0.6	0.1803	0.00043189	0.12	1.576E-08	-1.1
270	7.5	7.0104	7.0358	0.6	0.1803	0.00043189	0.129	1.698E-08	-8.9

AVERAGE K= 1.55899395E-08 cm/s

MAY 29 '98 12:45 FR PSI-CHEMISTRY 412 922 4043 TO 15128546049--812 P.03/05

G-99

Professional Service Industries, Inc.
850 Poplar Street, Pittsburgh, PA 15220 (412) 922-4000

Project Number: 326-82019
Project Name: KINGSVILLE LANDFILL
Client: FINCH ENG.

PERMEABILITY TEST REPORT

SAMPLE DATA

Boring Number: 23		Sample Number:	Depth (ft): 36-38	
Sample Description:	LIGHT BROWN FAT CLAY			
Sample Type:	SPLIT SPOON	LL: --	%<#200: ---	
Sample Condition:	UNDISTURBED	PI: --	Specific Gravity:	2.70
	INITIAL	FINAL	Specification: ASTM D 5084	
Height (in):	3.030	2.958	Test Type: Falling Head with Rising Tailwater	
Diameter (in):	1.408	1.408		
Weight (g):	135.47	138.42	Confining pressure:	5.0 psi
Wet Density (pcf):	109.4	114.5	Initial Porosity:	0.524
Moisture Content:	36.4	51.6	Initial Dial Rdng.:	0.000 in
Dry Density (pcf):	80.2	75.5	Dial after Sat.:	0.072 in
Percent Saturation:	89	113	Change in Ht.:	0.072 in
Void Ratio:	1.101	1.231	Corrected Ht.:	2.958 in

TEST DATA

	Determination No.:	1	2	3	4
Lower Burrette	Pressure (psi)	105.0	105.0	105.0	105.0
	Initial Reading	4.4	4.8	6.1	3.5
	Final Reading	4.8	6.1	6.2	4.4
Upper Burrette	Pressure (psi)	101.0	101.0	101.0	101.0
	Initial Reading	34.1	33.7	32.4	35.2
	Final Reading	33.7	32.4	32.3	34.1
	Elapsed Time (sec)	19500	66900	7200	53700
	Temperature(C)	21.0	20.0	20.0	20.0
	Ratio Flow In/Flow Out	1.00	1.00	1.00	0.82
	Initial Gradient	40.9	40.8	40.5	41.1
	Final Gradient	40.8	40.5	40.5	40.9
Coefficient of Permeability (k), (cm/sec)		4.9E-08	4.8E-08	3.4E-08	4.5E-08

Average Coefficient of Permeability(cm/sec): 4.4E-08

MAY 29 '98 12:45 FR PSI-CHEMISTRY 412 922 4043 TO 15128546049--812 P.04/05

G-100

Professional Service Industries, Inc.

850 Poplar Street, Pittsburgh, PA 15220 (412) 922-4000

Project Number: 326-82019
Project Name: KINGSVILLE LANDFILL
Client: FINCH ENG.

PERMEABILITY TEST REPORT

SAMPLE DATA

Boring Number: 23		Sample Number:		Depth (ft): 46-48
Sample Description:	LIGHT BROWN FAT CLAY			
Sample Type:	SPLIT SPOON	LL: --		%<#200: ---
Sample Condition:	UNDISTURBED	PI: --		Specific Gravity: 2.70
	INITIAL	FINAL		Specification: ASTM D 5084
Height (in):	2.792	2.741		Test Type: Falling Head
Diameter (in):	1.380	1.380		with Rising Tailwater
Weight (g):	126.00	131.87	Confining pressure:	5.0 psi
Wet Density (pcf):	115.0	122.6	Initial Porosity:	0.463
Moisture Content:	27.0	45.0	Initial Dial Rdng.:	0.000 in
Dry Density (pcf):	90.5	84.5	Dial after Sat.:	0.051 in
Percent Saturation:	85	122	Change in Ht.:	0.051 in
Void Ratio:	0.861	0.993	Corrected Ht.:	2.741 in

TEST DATA

	Determination No.:	1	2	3	4
Lower Burrette	Pressure (psi)	105.0	105.0	105.0	105.0
	Initial Reading	1.3	1.4	1.7	2.1
	Final Reading	1.4	1.7	1.8	2.2
Upper Burrette	Pressure (psi)	101.0	101.0	101.0	101.0
	Initial Reading	39.9	39.7	39.3	38.8
	Final Reading	39.8	39.3	39.2	38.7
	Elapsed Time (sec)	11400	55800	11700	18600
	Temperature(C)	20.0	21.5	21.0	20.0
	Ratio Flow In/Flow Out	1.00	0.75	1.00	1.00
	Initial Gradient	45.3	45.2	45.1	45.0
	Final Gradient	45.2	45.1	45.1	45.0
Coefficient of Permeability (k), (cm/sec)		2.0E-08	1.4E-08	1.9E-08	1.2E-08
Average Coefficient of Permeability(cm/sec):			1.6E-08		

MAY 29 '98 12:45 FR PSI-CHEMISTRY 412 922 4043 TO 15128546049--812 P.05/05

G-101

Professional Service Industries, Inc.
850 Poplar Street, Pittsburgh, PA 15220 (412) 922-4000

Project Number: 326-82019
Project Name: KINGSVILLE LANDFILL
Client: FINCH ENG.

PERMEABILITY TEST REPORT

SAMPLE DATA

Boring Number: 23		Sample Number:		Depth (ft): 66-68
Sample Description:	LIGHT BROWN FAT CLAY			
Sample Type:	SPLIT SPOON	LL: --		%<#200: ---
Sample Condition:	UNDISTURBED	PI: --		Specific Gravity: 2.70
	INITIAL	FINAL		Specification: ASTM D 5084
Height (in):	3.104	3.039		Test Type: Falling Head
Diameter (in):	1.412	1.445		with Rising Tailwater
Weight (g):	159.47	163.84	Confining pressure:	5.0 psi
Wet Density (pcf):	125.0	125.3	Initial Porosity:	0.377
Moisture Content:	19.0	25.2	Initial Dial Rdng.:	0.000 in
Dry Density (pcf):	105.0	100.0	Dial after Sat.:	0.065 in
Percent Saturation:	85	99	Change in Ht.:	0.065 in
Void Ratio:	0.604	0.684	Corrected Ht.:	3.039 in

TEST DATA

		1	2	3	4
	Determination No.:	1	2	3	4
Lower Burrette	Pressure (psi)	105.0	105.0	105.0	105.0
	Initial Reading	3.8	1.7	3.3	3.7
	Final Reading	4.5	2.2	3.7	3.8
Upper Burrette	Pressure (psi)	101.0	101.0	101.0	101.0
	Initial Reading	37.0	39.9	37.6	37.2
	Final Reading	36.3	39.4	37.2	37.1
	Elapsed Time (sec)	57000	26100	22800	6000
	Temperature(C)	20.0	21.0	21.5	21.0
	Ratio Flow In/Flow Out	1.00	1.00	1.00	1.00
	Initial Gradient	40.2	40.8	40.3	40.2
	Final Gradient	40.1	40.7	40.3	40.2
Coefficient of Permeability (k), (cm/sec)		2.9E-08	4.4E-08	4.0E-08	3.8E-08
Average Coefficient of Permeability (cm/sec):			3.8E-08		

** TOTAL PAGE 05 **

G-102

City of Kingsville MW-24 36'-38'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	12.7	3.8354	3.68808	-12.7	0.359	0.00085994	ERR		
1	12.6	3.8354	3.68808	0.1	0.359	0.00085994	0.082	1E-07	
2	12.5	3.8354	3.68808	0.1	0.359	0.00085994	0.083	1E-07	
3	12.45	3.8354	3.68808	0.05	0.359	0.00085994	0.083	5.3E-08	
4	12.4	3.8354	3.68808	0.05	0.359	0.00085994	0.084	5.3E-08	
5	12.35	3.8354	3.68808	0.05	0.359	0.00085994	0.084	5.3E-08	
36	12.31	3.8354	3.68808	0.04	0.359	0.00085994	0.084	1.4E-09	-3.6
66	12.28	3.8354	3.68808	0.03	0.359	0.00085994	0.085	1.1E-09	19.5
96	12.24	3.8354	3.68808	0.04	0.359	0.00085994	0.085	1.4E-09	-7.7
126	12.2	3.8354	3.68808	0.04	0.359	0.00085994	0.085	1.4E-09	-8.0

AVERAGE K= 1.32896172E-09 cm/s

G-103

City of Kingsville   MW 24   Depth 50'-52'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	10	7.0612	7.0612	-10	0.1803	0.0004319	ERR		
2	9.75	7.0612	7.0612	0.25	0.1803	0.0004319	0.104	8.4E-08	
7	9.5	7.0612	7.0612	0.25	0.1803	0.0004319	0.107	3.4E-08	
20	9.2	7.0612	7.0612	0.3	0.1803	0.0004319	0.11	1.6E-08	
40	8.9	7.0612	7.0612	0.3	0.1803	0.0004319	0.113	1.1E-08	
55	8.7	7.0612	7.0612	0.2	0.1803	0.0004319	0.117	1E-08	
1050	5.25	7.0612	7.0612	3.45	0.1803	0.0004319	0.12	3.4E-09	-3.7
1110	5.13	7.0612	7.0612	0.12	0.1803	0.0004319	0.198	2.5E-09	22.2
1170	5.01	7.0612	7.0612	0.12	0.1803	0.0004319	0.203	2.6E-09	20.4
1230	4.89	7.0612	7.0612	0.12	0.1803	0.0004319	0.208	2.7E-09	18.5

AVERAGE K= 3.27611861E-09 cm/s

G-104

City of Kingsville MW-24 68'-70'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	10.5	3.79984	3.81254	-10.5	0.3328	0.00079725	ERR		
20	10.2	3.79984	3.81254	0.3	0.3328	0.00079725	0.099	1.8E-08	
50	9.85	3.79984	3.81254	0.35	0.3328	0.00079725	0.102	1.4E-08	
80	9.5	3.79984	3.81254	0.35	0.3328	0.00079725	0.106	1.5E-08	
110	9.2	3.79984	3.81254	0.3	0.3328	0.00079725	0.11	1.3E-08	
140	8.9	3.79984	3.81254	0.3	0.3328	0.00079725	0.113	1.3E-08	
170	8.6	3.79984	3.81254	0.3	0.3328	0.00079725	0.117	1.4E-08	-15.1
200	8.3	3.79984	3.81254	0.3	0.3328	0.00079725	0.121	1.4E-08	-19.2
230	8.1	3.79984	3.81254	0.2	0.3328	0.00079725	0.125	9.9E-09	18.2
260	7.9	3.79984	3.81254	0.2	0.3328	0.00079725	0.129	1E-08	16.1

AVERAGE K= 1.21241225E-08 cm/s

G-105

City of Kingsville MW25 DEPTH 52'-54'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	10.1	6.7056	7.0104	-10.1	0.1737	0.00041611	ERR		
3	9.75	6.7056	7.0104	0.35	0.1737	0.00041611	0.103	7.5E-08	
6	9.5	6.7056	7.0104	0.25	0.1737	0.00041611	0.107	5.5E-08	
11	9.2	6.7056	7.0104	0.3	0.1737	0.00041611	0.11	4.1E-08	
21	8.75	6.7056	7.0104	0.45	0.1737	0.00041611	0.113	3.2E-08	
31	8.3	6.7056	7.0104	0.45	0.1737	0.00041611	0.119	3.4E-08	
51	7.7	6.7056	7.0104	0.6	0.1737	0.00041611	0.125	2.4E-08	2.3
61	7.4	6.7056	7.0104	0.3	0.1737	0.00041611	0.135	2.5E-08	-3.5
71	7.1	6.7056	7.0104	0.3	0.1737	0.00041611	0.141	2.6E-08	-7.7
81	6.85	6.7056	7.0104	0.25	0.1737	0.00041611	0.147	2.3E-08	6.7

AVERAGE K= 2.44774432E-08 cm/s

G-106

City of Kingsville MW25 DEPTH 64'-66'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	10.5	6.7564	6.7564	-10.5	0.1884	0.00045138	ERR		
5	10.3	6.7564	6.7564	0.2	0.1884	0.00045138	0.099	2.7E-08	
10	10	6.7564	6.7564	0.3	0.1884	0.00045138	0.101	4.1E-08	
25	9.3	6.7564	6.7564	0.7	0.1884	0.00045138	0.104	3.3E-08	
40	8.8	6.7564	6.7564	0.5	0.1884	0.00045138	0.112	2.5E-08	
55	8.3	6.7564	6.7564	0.5	0.1884	0.00045138	0.118	2.7E-08	
70	7.85	6.7564	6.7564	0.45	0.1884	0.00045138	0.125	2.6E-08	-11.9
85	7.5	6.7564	6.7564	0.35	0.1884	0.00045138	0.133	2.1E-08	8.5
100	7.2	6.7564	6.7564	0.3	0.1884	0.00045138	0.139	1.9E-08	18.1
115	6.8	6.7564	6.7564	0.4	0.1884	0.00045138	0.145	2.6E-08	-14.7

AVERAGE K= 2.29697766E-08 cm/s

** TOTAL PAGE.14 **

G-107

City of Kingsville MW25 78-80'

TIME	Reading	Length	Diameter	dZout	L/A	C	T	K	from Average K
0	10.6	7.0358	7.0612	-10.6	0.1797	0.00043034	ERR		
2	10.4	7.0358	7.0612	0.2	0.1797	0.00043034	0.098	6.3E-08	
7	10.2	7.0358	7.0612	0.2	0.1797	0.00043034	0.1	2.6E-08	
17	10.1	7.0358	7.0612	0.1	0.1797	0.00043034	0.102	6.5E-09	
47	9.73	7.0358	7.0612	0.37	0.1797	0.00043034	0.103	8.2E-09	
77	9.4	7.0358	7.0612	0.33	0.1797	0.00043034	0.107	7.6E-09	
107	9.1	7.0358	7.0612	0.3	0.1797	0.00043034	0.111	7.1E-09	-15.4
137	8.85	7.0358	7.0612	0.25	0.1797	0.00043034	0.114	6.1E-09	0.9
167	8.6	7.0358	7.0612	0.25	0.1797	0.00043034	0.118	6.3E-09	-1.9
197	8.4	7.0358	7.0612	0.2	0.1797	0.00043034	0.121	5.2E-09	16.3

AVERAGE K= 6.17565979E-09 cm/s

G-108

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G-6 Effective Cohesion/Angle of Internal Friction

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G-110

psi Environmental Geotechnical Construction
Consulting • Engineering • Testing

September 25, 1997

Finch Energy & Environmental Services
P.O. Box 73
Kingsville, Texas 78364

Re: Subsurface Exploration and
Laboratory Analysis
Proposed Landfill Expansion
Kingsville, Texas
PSI File Number: 326-72026
Addendum

Gentlemen:

It was requested that PSI provide ϕ′ and c′ values for the samples on which we performed unconsolidated undrained triaxial tests. These values are provided in the following table.

Soil Identification	Effective Cohesion, c′ (psf)	Effective Angle of internal Friction, ϕ′
SB-12, 7' - 8'	200	26
SB-12, 47' - 48'	200	26
SB-14, 10' - 11'	200	26
SB-14, 34' - 35'	200	24
SB-15, 12' - 13'	200	21
SB-15, 24' - 25'	200	24
SB-16, 3' - 5'	200	26
SB-17, 32' - 33'	200	24
SB-18, 9' - 10'	200	21
SB-18, 17' - 18'	200	24
SB-18, 40' - 42'	200	24

PSI • 810 South Padre Island Drive • Corpus Christi, TX 78416 • Phone 512/854-4801 • Fax 512/854-6049

Please call should you have any questions or if we could be or further assistance.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.

Amy R. Rein, E.I.T.
Staff Engineer

STATE OF TEXAS
MARK J. O'CONNOR
79252
REGISTERED
PROFESSIONAL ENGINEER

Mark J. O'Connor, P.E.
Geotechnical Department Manager

psi

GEOTECHNICAL DATA
P.S.I. Laboratory, ASTM D-3080
Light Olive Green Clay (Aquiclude)

Lt. Olive Green Clay Geotechnical Properties					
Soil Boring	Depth,	C',Cohesion Coefficient	Psi, Angle of Int. Friction	W_m	Rho,
Number	ft (bgs)	Lbf/ft^2	degrees	wt %	Lbm/ft^3
21	64' - 66'	1100	26.3	20	108
23	82' - 84'	700	19.4	28	90
24	52' - 54'	560	35.0	28	89.6
25	58' - 60'	940	26.6	30	85.3
Avg.	65'	825	26.8	26.5	93.2
Max.	84'	1100	35.0	30	108
Min.	52'	560	19.4	20	85.3

November 1997
Revision 1- June 1998

ATTACHMENT H

APPENDIX H

ENGINEERING DESIGN CALCULATIONS and ANALYSES

November 1997
Revision 1
June 1998

APPENDIX H.1

SLOPE STABILITY ANALYSIS

Revision 1

June 1998

City of Kingsville, Texas Municipal Solid Waste Landfill Permit
Application 235-B

ATTACHMENT 4 – GEOLOGY REPORT

APPENDIX H.1
Slope Stability Analysis

STATE OF TEXAS
JOSEPH O. SAI
70926
REGISTERED
PROFESSIONAL ENGINEER

Joe Sai
6/22/98

THIS CERTIFICATION IS INTENDED FOR PERMITTING PURPOSES ONLY AND INCLUDES PAGES 1 THROUGH 131.

Revision 1 6/22/98

H-1

Summary of Slope Stability Analysis Cases

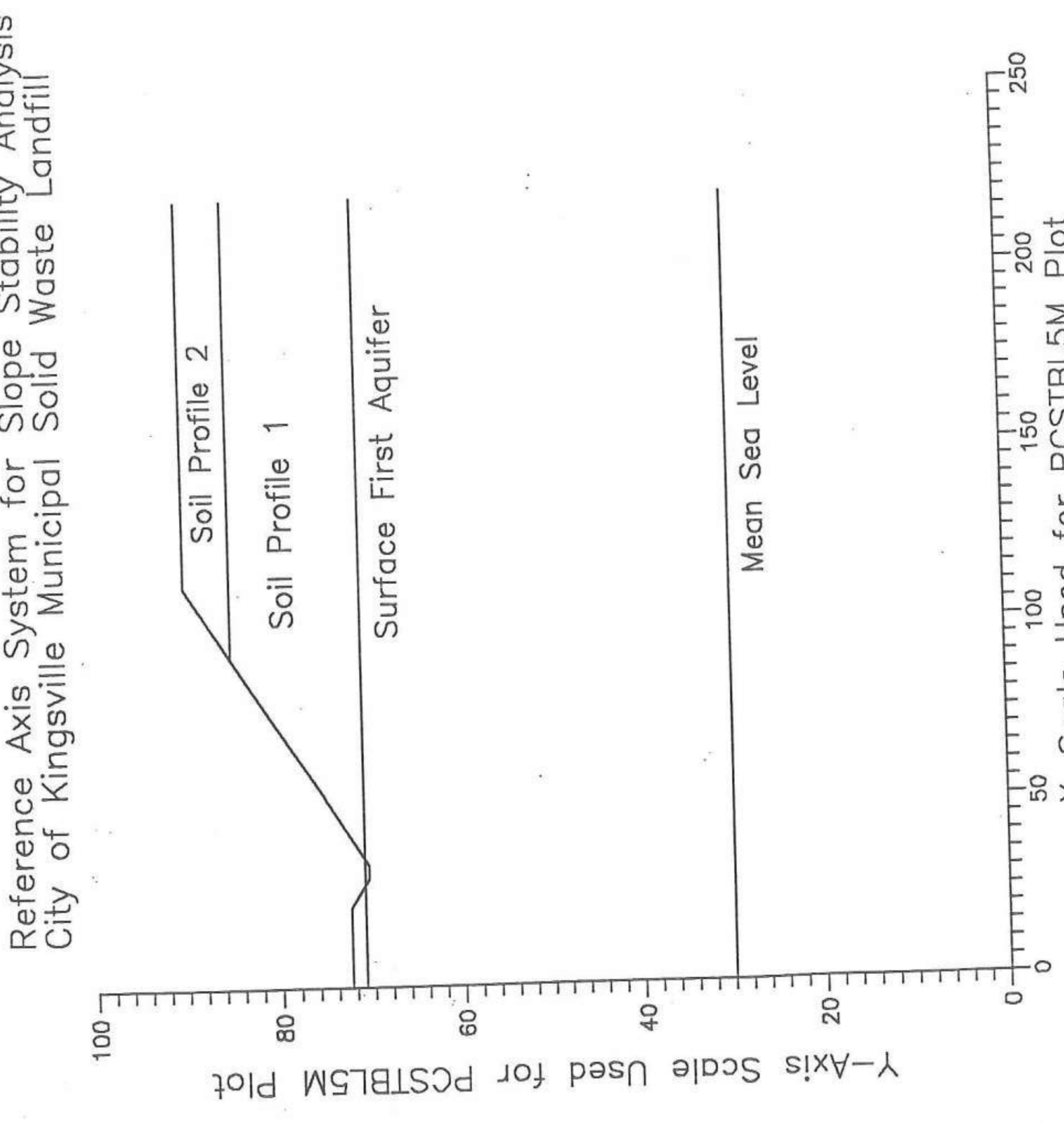
Friction angle(ϕ)	# of Boundaries	Soil Types	Slope Type	Type of Failure Analysis	Minimum Factor of safety
Base of Landfill					
21°	8	2	4:1	CIRCL2*	2.53
21°	8	2	3:1	CIRCL2*	2.57
24°	8	2	3:1	RANDOM**	2.67
21°	8	2	3:1	BLOCK***	2.44
Waste on Top of Landfill					
a	12	4	4:1	CICLE#	4.77
@	12	4	4:1	CICLE#	4.49
a	12	4	4:1	BLOCK***	4.63
b	10	3	4:1	CICLE#	5.05

Note:
* Factors of Safety were calculated using the Modified Bishop Method and a Circular surface search method
** Factors of Safety were calculated using the Modified Janbu Method and Irregular surface searching method
*** Factors of safety were calculated using Modified Janbu Method and Block surface search method
\# Factors of Safety were calculated using the Modified Janbu Method and a Random Circular surface search method

a 24, 21, & 20 degrees for soil type 2, 3 and 4 respectively
b 21 and 20 degrees for soil type 2, and 3 respectively
@ 21, 10, and 20 for soil type 2, 3, and 4 respectively

Surface of first aquifer was at 41 feet above mean sea level

3/124


Reference Axis System for Slope Stability Analysis
City of Kingsville Municipal Solid Waste Landfill
Soil Profile 2
Soil Profile 1
Surface First Aquifer
Mean Sea Level
X–Scale Used for PCSTBL5M Plot
Y–Axis Scale Used for PCSTBL5M Plot
0
50
100
150
200
250
20
40
60
80
100

H-3

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PSI Environmental Geotechnical Construction
Consulting • Engineering • Testing

4/129

September 25, 1997

Finch Energy & Environmental Services
P.O. Box 73
Kingsville, Texas 78364

Re: Subsurface Exploration and
Laboratory Analysis
Proposed Landfill Expansion
Kingsville, Texas
PSI File Number: 326-72026
Addendum

6

Gentlemen:

It was requested that PSI provide ϕ' and c' values for the samples on which we performed unconsolidated undrained triaxial tests. These values are provided in the following table.

Soil Identification	Effective Cohesion, c′ (psf)	Effective Angle of internal Friction, ϕ′
SB-12, 7' - 8'	200	26
SB-12, 47' - 48'	200	26
SB-14, 10' - 11'	200	26
SB-14, 34' - 35'	200	24
SB-15, 12' - 13'	200	21
SB-15, 24' - 25'	200	24
SB-16, 3' - 5'	200	26
SB-17, 32' - 33'	200	24
SB-18, 9' - 10'	200	21
SB-18, 17' - 18'	200	24
SB-18, 40' - 42'	200	24

H-4

PSI • 810 South Padre Island Drive • Corpus Christi, TX 78416 • Phone 512/854-4801 • Fax 512/854-6049

5/129

Please call should you have any questions or if we could be or further assistance.

Respectfully submitted,

PROFESSIONAL SERVICE INDUSTRIES, INC.

Amy R. Rein, E.I.T.
Staff Engineer

STATE OF TEXAS
MARK J. O'CONNOR
79252
REGISTERED PROFESSIONAL ENGINEER

Mark J. O'Connor, P.E.
Geotechnical Department Manager

psi

H-5

6/129

** PCSTABL5M **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	6/21/98
Time of Run:	3
Run By:	jos
Input Data Filename:	kmsw14.in
Output Filename:	kmsw14.out
Unit:	ENGLISH

City of Kingsville, Texas Municipal Solid Waste Landfill Permit Application 235-B
[Slope Stability Analysis (4:1 slope)]

BOUNDARY COORDINATES

7 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	72.50	22.00	72.50	1
2	22.00	72.50	30.00	70.50	1
3	30.00	70.50	34.00	70.50	1
4	34.00	70.50	42.00	72.50	1
5	42.00	72.50	92.00	85.00	1
6	92.00	85.00	112.00	90.00	2
7	112.00	90.00	220.00	90.00	2
8	92.00	85.00	220.00	85.00	1

7/129

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	94.5	112.1	200.0	21.0	.00	.0	1
2	86.8	99.6	.0	.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	71.00
2	220.00	71.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

900 Trial Surfaces Have Been Generated.

30 Surfaces Initiate From Each Of 30 Points Equally Spaced Along The Ground Surface Between X = .00 ft. and X = 80.00 ft.

Each Surface Terminates Between X = 110.00 ft. and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

H-7

6X

8/129

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.83	71.79
2	27.35	70.17
3	29.95	68.67
4	32.61	67.28
5	35.32	66.00
6	38.09	64.85
7	40.91	63.82
8	43.77	62.92
9	46.67	62.14
10	49.60	61.49
11	52.55	60.97
12	55.53	60.58
13	58.52	60.32
14	61.51	60.19
15	64.51	60.20
16	67.51	60.33
17	70.50	60.60
18	73.47	61.00
19	76.42	61.52
20	79.35	62.18
21	82.25	62.97
22	85.10	63.88
23	87.92	64.91
24	90.69	66.07
25	93.40	67.35
26	96.06	68.75
27	98.65	70.26
28	101.17	71.89
29	103.62	73.62
30	105.99	75.46
31	108.27	77.40
32	110.47	79.44
33	112.58	81.58
34	114.59	83.81
35	116.50	86.12
36	118.31	88.51
37	119.34	90.00

Circle Center At X = 62.9 ; Y = 128.5 and Radius, 68.3

*** 2.534 ***

H-8

9/129

Individual data on the 44 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.2	28.3	.0	.0	.0	.0	.0	.0	.0
2	1.3	98.9	.0	39.4	.0	.0	.0	.0	.0
3	2.6	411.8	27.2	295.5	.0	.0	.0	.0	.0
4	.1	10.7	1.6	8.5	.0	.0	.0	.0	.0
5	2.6	742.4	81.3	558.2	.0	.0	.0	.0	.0
6	1.4	554.3	43.5	388.7	.0	.0	.0	.0	.0
7	1.3	645.4	28.5	427.2	.0	.0	.0	.0	.0
8	2.8	1776.2	.0	1042.9	.0	.0	.0	.0	.0
9	2.8	2337.5	.0	1247.1	.0	.0	.0	.0	.0
10	1.1	1037.2	.0	523.6	.0	.0	.0	.0	.0
11	1.8	1837.5	.0	904.5	.0	.0	.0	.0	.0
12	2.9	3382.1	.0	1585.6	.0	.0	.0	.0	.0
13	2.9	3854.7	.0	1719.3	.0	.0	.0	.0	.0
14	3.0	4287.8	.0	1828.8	.0	.0	.0	.0	.0
15	3.0	4677.1	.0	1914.2	.0	.0	.0	.0	.0
16	3.0	5019.0	.0	1975.0	.0	.0	.0	.0	.0
17	3.0	5310.4	.0	2011.3	.0	.0	.0	.0	.0
18	3.0	5548.6	.0	2022.9	.0	.0	.0	.0	.0
19	3.0	5731.9	.0	2009.9	.0	.0	.0	.0	.0
20	3.0	5858.8	.0	1972.2	.0	.0	.0	.0	.0
21	3.0	5928.8	.0	1910.0	.0	.0	.0	.0	.0
22	3.0	5941.7	.0	1823.3	.0	.0	.0	.0	.0
23	2.9	5898.1	.0	1712.3	.0	.0	.0	.0	.0
24	2.9	5799.3	.0	1577.3	.0	.0	.0	.0	.0
25	2.9	5647.0	.0	1418.5	.0	.0	.0	.0	.0
26	2.8	5443.7	.0	1236.2	.0	.0	.0	.0	.0
27	2.8	5192.5	.0	1030.7	.0	.0	.0	.0	.0
28	1.3	2395.5	.0	418.1	.0	.0	.0	.0	.0
29	1.4	2499.3	.0	384.4	.0	.0	.0	.0	.0
30	2.7	4546.8	.0	551.9	.0	.0	.0	.0	.0
31	2.6	4162.2	.0	279.6	.0	.0	.0	.0	.0
32	1.1	1740.1	.0	31.3	.0	.0	.0	.0	.0
33	1.4	2018.5	.0	.0	.0	.0	.0	.0	.0
34	2.4	3384.9	.0	.0	.0	.0	.0	.0	.0
35	2.4	3000.1	.0	.0	.0	.0	.0	.0	.0
36	2.3	2601.8	.0	.0	.0	.0	.0	.0	.0
37	2.2	2195.4	.0	.0	.0	.0	.0	.0	.0
38	1.5	1328.7	.0	.0	.0	.0	.0	.0	.0
39	.6	454.2	.0	.0	.0	.0	.0	.0	.0
40	2.0	1311.5	.0	.0	.0	.0	.0	.0	.0
41	1.0	484.3	.0	.0	.0	.0	.0	.0	.0
42	.9	356.3	.0	.0	.0	.0	.0	.0	.0
43	1.8	421.5	.0	.0	.0	.0	.0	.0	.0
44	1.0	66.2	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 37 Coordinate Points

8

10/129

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.83	71.79
2	27.34	70.15
3	29.92	68.63
4	32.58	67.22
5	35.29	65.94
6	38.05	64.78
7	40.87	63.75
8	43.73	62.84
9	46.63	62.07
10	49.56	61.42
11	52.51	60.92
12	55.49	60.54
13	58.48	60.30
14	61.48	60.20
15	64.48	60.23
16	67.48	60.39
17	70.46	60.70
18	73.43	61.13
19	76.37	61.70
20	79.29	62.41
21	82.17	63.24
22	85.01	64.21
23	87.81	65.30
24	90.55	66.51
25	93.23	67.85
26	95.85	69.31
27	98.41	70.89
28	100.88	72.58
29	103.28	74.38
30	105.60	76.29
31	107.82	78.30
32	109.96	80.41
33	111.99	82.62
34	113.93	84.91
35	115.75	87.29
36	117.47	89.75
37	117.63	90.00

Circle Center At X = 62.3 ; Y = 126.5 and Radius, 66.3

*** 2.537 ***

H-10

9X 11/129

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.35	70.50
2	32.90	68.92
3	35.52	67.46
4	38.20	66.11
5	40.93	64.88
6	43.72	63.78
7	46.56	62.80
8	49.43	61.94
9	52.34	61.21
10	55.28	60.60
11	58.24	60.13
12	61.22	59.79
13	64.22	59.58
14	67.21	59.50
15	70.21	59.55
16	73.21	59.74
17	76.19	60.05
18	79.16	60.50
19	82.10	61.08
20	85.02	61.78
21	87.90	62.61
22	90.74	63.57
23	93.54	64.65
24	96.29	65.86
25	98.98	67.18
26	101.61	68.62
27	104.18	70.17
28	106.67	71.84
29	109.09	73.61
30	111.43	75.49
31	113.69	77.47
32	115.85	79.55
33	117.93	81.72
34	119.90	83.97
35	121.78	86.32
36	123.54	88.74
37	124.38	90.00

Circle Center At X = 67.5 ; Y = 127.8 and Radius, 68.3

*** 2.537 ***

1X 12/129

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.83	71.79
2	27.36	70.19
3	29.96	68.69
4	32.63	67.31
5	35.34	66.04
6	38.11	64.88
7	40.92	63.84
8	43.78	62.92
9	46.67	62.12
10	49.59	61.44
11	52.54	60.88
12	55.51	60.45
13	58.49	60.15
14	61.49	59.96
15	64.49	59.91
16	67.49	59.98
17	70.48	60.17
18	73.46	60.49
19	76.43	60.94
20	79.38	61.51
21	82.29	62.20
22	85.18	63.02
23	88.03	63.95
24	90.84	65.01
25	93.60	66.18
26	96.31	67.46
27	98.97	68.86
28	101.56	70.37
29	104.09	71.98
30	106.55	73.70
31	108.93	75.52
32	111.24	77.44
33	113.46	79.46
34	115.60	81.56
35	117.64	83.76
36	119.60	86.03
37	121.45	88.39
38	122.61	90.00

Circle Center At X = 64.3 ; Y = 131.4 and Radius, 71.5

*** 2.538 ***

N/ 13/129

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.35	70.50
2	32.88	68.89
3	35.48	67.39
4	38.14	66.02
5	40.86	64.76
6	43.64	63.62
7	46.47	62.61
8	49.33	61.73
9	52.24	60.97
10	55.17	60.35
11	58.13	59.85
12	61.11	59.49
13	64.10	59.26
14	67.10	59.17
15	70.10	59.21
16	73.09	59.38
17	76.08	59.69
18	79.04	60.13
19	81.99	60.70
20	84.91	61.40
21	87.79	62.23
22	90.63	63.19
23	93.43	64.28
24	96.17	65.49
25	98.86	66.82
26	101.49	68.27
27	104.05	69.83
28	106.54	71.51
29	108.95	73.29
30	111.28	75.18
31	113.52	77.18
32	115.67	79.27
33	117.72	81.45
34	119.68	83.73
35	121.53	86.09
36	123.28	88.53
37	124.23	90.00

Circle Center At X = 67.7 ; Y = 126.4 and Radius, 67.3

*** 2.538 ***

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.83	71.79
2	27.38	70.22
3	30.00	68.75
4	32.67	67.39
5	35.40	66.14
6	38.18	65.01
7	41.00	63.99
8	43.86	63.09
9	46.76	62.31
10	49.68	61.65
11	52.63	61.11
12	55.61	60.69
13	58.59	60.40
14	61.59	60.23
15	64.59	60.18
16	67.58	60.26
17	70.58	60.47
18	73.56	60.79
19	76.53	61.24
20	79.47	61.81
21	82.39	62.51
22	85.28	63.32
23	88.13	64.25
24	90.94	65.30
25	93.70	66.47
26	96.42	67.74
27	99.08	69.13
28	101.68	70.63
29	104.21	72.24
30	106.68	73.94
31	109.07	75.75
32	111.39	77.66
33	113.62	79.66
34	115.78	81.75
35	117.84	83.93
36	119.81	86.19
37	121.69	88.53
38	122.77	90.00

Circle Center At X = 64.2 ; Y = 132.7 and Radius, 72.5

*** 2.541 ***

13/
15/129

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.59	71.10
2	30.20	69.64
3	32.88	68.28
4	35.61	67.03
5	38.38	65.89
6	41.20	64.86
7	44.05	63.94
8	46.95	63.14
9	49.87	62.46
10	52.81	61.89
11	55.78	61.44
12	58.76	61.11
13	61.75	60.90
14	64.75	60.81
15	67.75	60.84
16	70.75	60.99
17	73.74	61.26
18	76.71	61.65
19	79.67	62.16
20	82.60	62.79
21	85.51	63.53
22	88.38	64.39
23	91.22	65.37
24	94.02	66.45
25	96.77	67.65
26	99.47	68.96
27	102.11	70.37
28	104.70	71.89
29	107.22	73.51
30	109.68	75.23
31	112.07	77.05
32	114.38	78.96
33	116.61	80.96
34	118.76	83.06
35	120.83	85.23
36	122.81	87.49
37	124.69	89.82
38	124.83	90.00

Circle Center At X = 65.5 ; Y = 135.7 and Radius, 74.9

*** 2.543 ***

H-15

17X
16/129

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.59	71.10
2	30.02	69.35
3	32.53	67.70
4	35.11	66.17
5	37.75	64.75
6	40.46	63.46
7	43.22	62.29
8	46.04	61.25
9	48.89	60.34
10	51.79	59.55
11	54.72	58.90
12	57.67	58.38
13	60.65	57.99
14	63.64	57.74
15	66.63	57.63
16	69.63	57.65
17	72.63	57.80
18	75.61	58.09
19	78.58	58.52
20	81.53	59.08
21	84.45	59.77
22	87.34	60.59
23	90.18	61.54
24	92.98	62.62
25	95.73	63.83
26	98.42	65.16
27	101.05	66.60
28	103.60	68.17
29	106.09	69.85
30	108.50	71.64
31	110.82	73.53
32	113.06	75.53
33	115.20	77.63
34	117.25	79.83
35	119.19	82.11
36	121.03	84.48
37	122.77	86.93
38	124.38	89.46
39	124.70	90.00

Circle Center At X = 67.7 ; Y = 124.0 and Radius, 66.4

*** 2.546 ***

H-16

15/
17/129

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.35	70.50
2	33.08	69.27
3	35.86	68.14
4	38.68	67.13
5	41.54	66.22
6	44.44	65.43
7	47.36	64.76
8	50.31	64.20
9	53.28	63.76
10	56.26	63.43
11	59.25	63.23
12	62.25	63.14
13	65.25	63.17
14	68.25	63.32
15	71.24	63.59
16	74.21	63.97
17	77.17	64.47
18	80.10	65.09
19	83.01	65.82
20	85.89	66.67
21	88.73	67.63
22	91.53	68.70
23	94.29	69.88
24	97.00	71.17
25	99.66	72.57
26	102.26	74.07
27	104.79	75.67
28	107.27	77.37
29	109.67	79.16
30	112.00	81.05
31	114.25	83.03
32	116.43	85.10
33	118.52	87.25
34	120.52	89.48
35	120.96	90.00

Circle Center At X = 63.0 ; Y = 139.2 and Radius, 76.0

*** 2.549 ***

18/129

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.83	71.79
2	27.20	69.95
3	29.65	68.22
4	32.18	66.61
5	34.77	65.10
6	37.44	63.72
7	40.16	62.46
8	42.93	61.32
9	45.76	60.31
10	48.62	59.43
11	51.53	58.68
12	54.46	58.06
13	57.42	57.57
14	60.40	57.22
15	63.40	57.00
16	66.39	56.92
17	69.39	56.97
18	72.39	57.16
19	75.37	57.48
20	78.34	57.94
21	81.28	58.53
22	84.19	59.25
23	87.06	60.10
24	89.90	61.08
25	92.69	62.19
26	95.42	63.43
27	98.10	64.78
28	100.71	66.26
29	103.25	67.85
30	105.72	69.55
31	108.11	71.37
32	110.41	73.29
33	112.63	75.31
34	114.75	77.43
35	116.78	79.65
36	118.70	81.95
37	120.52	84.34
38	122.22	86.80
39	123.82	89.35
40	124.19	90.00

Circle Center At X = 66.7 ; Y = 123.3 and Radius, 66.4

*** 2.553 ***

19/129

```
                 Y           A     X     I     S            F     T

                .00     27.50     55.00     82.50    110.00    137.50

X        .00 +---------+---------+-----*---+---------+---------+
             -                        ...
             -                       ....
             -                      .....
             -                     ......
             -                    ......*
       27.50 +                   ......01
             -                   .....11*
             -                  .....013.
             -                  ....013.*
             -                 .....819...
             -                 ....013....
A      55.00 +                 ....817.....
             -                .....819.....
             -                .....819......
             -                .....819......
             -                .....819......
             -                .....8119......
X      82.50 +                 ....8319......
             -                 .....3119.....
             -                 .....8312.....*
             -                  .....8312.....
             -                  ......3319.....
             -                   ......5312....
I     110.00 +                   .......83112..*
             -                    .......833112.
             -                     ........83311
             -                      .........333
             -                       ...........
             -                        ..........
S     137.50 +                         .........
             -                           .......
             -                              ....
             -                                ..
             -
             -
      165.00 +
             -
             -
             -
             -
             -
F     192.50 +
             -
             -
             -
             -
             -
T     220.00 +                           W    * *
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H-19

NS/ 20/129

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	6/21/98
Time of Run:	3
Run By:	jos
Input Data Filename:	kmsw13.in
Output Filename:	kmsw13.out
Unit:	ENGLISH

City of Kingsville, Texas Municipal Solid Waste Landfill Permit Application 235-B
[Slope Stability Analysis (3:1 slope)]

BOUNDARY COORDINATES

7 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	72.50	22.00	72.50	1
2	22.00	72.50	28.00	70.50	1
3	28.00	70.50	32.00	70.50	1
4	32.00	70.50	38.00	72.50	1
5	38.00	72.50	75.50	85.00	1
6	75.50	85.00	90.50	90.00	2
7	90.50	90.00	220.00	90.00	2
8	75.50	85.00	220.00	85.00	1

1X 21/129

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	94.5	112.1	200.0	21.0	.00	.0	1
2	86.8	99.6	.0	.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	71.00
2	220.00	71.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

25 Trial Surfaces Have Been Generated.

5 Surfaces Initiate From Each Of 5 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 80.00 ft.

Each Surface Terminates Between X = 110.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

28/ 22/129

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	.00	72.50
2	2.26	70.53
3	4.60	68.65
4	7.01	66.86
5	9.49	65.18
6	12.04	63.59
7	14.65	62.11
8	17.31	60.74
9	20.04	59.47
10	22.80	58.32
11	25.62	57.28
12	28.47	56.35
13	31.36	55.54
14	34.28	54.84
15	37.22	54.27
16	40.19	53.81
17	43.17	53.47
18	46.16	53.26
19	49.16	53.16
20	52.16	53.19
21	55.15	53.34
22	58.14	53.60
23	61.12	53.99
24	64.07	54.50
25	67.01	55.12
26	69.91	55.87
27	72.79	56.73
28	75.62	57.71
29	78.42	58.80
30	81.17	60.00
31	83.87	61.31
32	86.51	62.73
33	89.09	64.25
34	91.61	65.88
35	94.07	67.61
36	96.45	69.43
37	98.75	71.35
38	100.98	73.37
39	103.12	75.47
40	105.18	77.65
41	107.14	79.92
42	109.02	82.26
43	110.79	84.68
44	112.47	87.16
45	114.05	89.71
46	114.21	90.00

Circle Center At X = 50.0 ; Y = 127.5 and Radius, 74.3

*** 2.570 ***

2X 23/129

Individual data on the 54 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.7	121.8	.0	.0	.0	.0	.0	.0	.0
2	.5	91.2	.0	10.6	.0	.0	.0	.0	.0
3	2.3	701.7	.0	264.6	.0	.0	.0	.0	.0
4	2.4	1219.3	.0	607.6	.0	.0	.0	.0	.0
5	2.5	1737.4	.0	932.4	.0	.0	.0	.0	.0
6	2.5	2250.5	.0	1238.5	.0	.0	.0	.0	.0
7	2.6	2753.3	.0	1525.4	.0	.0	.0	.0	.0
8	2.7	3240.7	.0	1792.5	.0	.0	.0	.0	.0
9	2.7	3707.8	.0	2039.5	.0	.0	.0	.0	.0
10	2.0	2907.9	.0	1585.7	.0	.0	.0	.0	.0
11	.8	1231.8	.0	680.3	.0	.0	.0	.0	.0
12	2.8	4366.6	.0	2471.5	.0	.0	.0	.0	.0
13	2.4	3741.2	16.1	2205.9	.0	.0	.0	.0	.0
14	.5	742.3	14.7	449.9	.0	.0	.0	.0	.0
15	2.9	4712.8	90.1	2818.5	.0	.0	.0	.0	.0
16	.6	1081.1	20.0	639.2	.0	.0	.0	.0	.0
17	2.3	4024.5	18.0	2320.3	.0	.0	.0	.0	.0
18	2.9	5635.9	.0	3078.4	.0	.0	.0	.0	.0
19	.8	1566.4	.0	825.4	.0	.0	.0	.0	.0
20	2.2	4557.0	.0	2349.6	.0	.0	.0	.0	.0
21	3.0	6568.2	.0	3249.3	.0	.0	.0	.0	.0
22	3.0	6967.1	.0	3301.1	.0	.0	.0	.0	.0
23	3.0	7317.0	.0	3330.2	.0	.0	.0	.0	.0
24	3.0	7615.5	.0	3336.7	.0	.0	.0	.0	.0
25	3.0	7860.7	.0	3320.6	.0	.0	.0	.0	.0
26	3.0	8051.1	.0	3281.8	.0	.0	.0	.0	.0
27	3.0	8185.6	.0	3220.5	.0	.0	.0	.0	.0
28	3.0	8263.7	.0	3136.7	.0	.0	.0	.0	.0
29	2.9	8285.5	.0	3030.6	.0	.0	.0	.0	.0
30	2.9	8251.5	.0	2902.3	.0	.0	.0	.0	.0
31	2.9	8162.6	.0	2752.0	.0	.0	.0	.0	.0
32	2.7	7668.6	.0	2470.4	.0	.0	.0	.0	.0
33	.1	351.8	.0	109.7	.0	.0	.0	.0	.0
34	2.8	7815.9	.0	2386.8	.0	.0	.0	.0	.0
35	2.7	7554.0	.0	2172.3	.0	.0	.0	.0	.0
36	2.7	7247.2	.0	1937.1	.0	.0	.0	.0	.0
37	2.6	6898.9	.0	1681.4	.0	.0	.0	.0	.0
38	2.6	6512.8	.0	1405.9	.0	.0	.0	.0	.0
39	1.4	3434.7	.0	657.5	.0	.0	.0	.0	.0
40	1.1	2640.6	.0	453.3	.0	.0	.0	.0	.0
41	2.5	5478.6	.0	796.7	.0	.0	.0	.0	.0
42	2.4	4844.2	.0	464.1	.0	.0	.0	.0	.0
43	1.9	3468.4	.0	119.6	.0	.0	.0	.0	.0
44	.4	739.4	.0	.0	.0	.0	.0	.0	.0
45	2.2	3624.5	.0	.0	.0	.0	.0	.0	.0
46	2.1	3073.1	.0	.0	.0	.0	.0	.0	.0
47	2.1	2532.9	.0	.0	.0	.0	.0	.0	.0
48	2.0	2008.8	.0	.0	.0	.0	.0	.0	.0
49	1.9	1505.8	.0	.0	.0	.0	.0	.0	.0
50	1.8	1028.9	.0	.0	.0	.0	.0	.0	.0

51	.2	98.5	.0	.0	.0	.0	.0	.0	.0
52	1.5	496.4	.0	.0	.0	.0	.0	.0	.0
53	1.6	213.8	.0	.0	.0	.0	.0	.0	.0
54	.2	2.0	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.00	72.50
2	22.59	70.99
3	25.24	69.57
4	27.93	68.25
5	30.66	67.01
6	33.43	65.86
7	36.24	64.82
8	39.09	63.86
9	41.96	63.00
10	44.87	62.24
11	47.79	61.58
12	50.74	61.02
13	53.70	60.56
14	56.68	60.20
15	59.67	59.94
16	62.67	59.78
17	65.67	59.72
18	68.67	59.77
19	71.66	59.91
20	74.65	60.16
21	77.63	60.50
22	80.60	60.95
23	83.55	61.50
24	86.48	62.15
25	89.38	62.89
26	92.26	63.74
27	95.11	64.68
28	97.93	65.71
29	100.70	66.84
30	103.44	68.07
31	106.14	69.39
32	108.79	70.79
33	111.39	72.29
34	113.94	73.87
35	116.43	75.54
36	118.87	77.29
37	121.24	79.12
38	123.56	81.03
39	125.80	83.02
40	127.98	85.08
41	130.09	87.22
42	132.12	89.42
43	132.62	90.00

Circle Center At X = 65.9 ; Y = 148.5 and Radius, 88.7

*** 2.709 ***

Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.00	72.50
2	22.12	70.38
3	24.33	68.35
4	26.63	66.43
5	29.02	64.60
6	31.48	62.89
7	34.01	61.28
8	36.61	59.79
9	39.28	58.41
10	42.00	57.16
11	44.78	56.02
12	47.61	55.01
13	50.47	54.12
14	53.37	53.36
15	56.31	52.73
16	59.26	52.23
17	62.24	51.86
18	65.23	51.62
19	68.23	51.52
20	71.23	51.54
21	74.23	51.70
22	77.21	51.99
23	80.18	52.42
24	83.13	52.97
25	86.05	53.65
26	88.94	54.46
27	91.79	55.40
28	94.60	56.46
29	97.35	57.64
30	100.05	58.95
31	102.69	60.37
32	105.27	61.91
33	107.78	63.56
34	110.21	65.32
35	112.56	67.18
36	114.82	69.15
37	117.00	71.21
38	119.08	73.37
39	121.07	75.62
40	122.96	77.95
41	124.74	80.37
42	126.41	82.86
43	127.97	85.42
44	129.42	88.05
45	130.38	90.00

Circle Center At X = 69.1 ; Y = 119.5 and Radius, 68.0

*** 2.754 ***

H-25

~~24~~ 26/129

Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	40.00	73.17
2	42.52	71.53
3	45.12	70.04
4	47.80	68.69
5	50.55	67.50
6	53.36	66.45
7	56.23	65.56
8	59.14	64.83
9	62.08	64.25
10	65.05	63.84
11	68.04	63.60
12	71.04	63.51
13	74.04	63.60
14	77.03	63.84
15	80.00	64.25
16	82.95	64.82
17	85.86	65.55
18	88.72	66.44
19	91.53	67.49
20	94.28	68.68
21	96.97	70.03
22	99.57	71.52
23	102.09	73.15
24	104.51	74.92
25	106.84	76.82
26	109.05	78.84
27	111.15	80.98
28	113.14	83.23
29	114.99	85.59
30	116.72	88.04
31	117.94	90.00

Circle Center At X = 71.1 ; Y = 118.3 and Radius, 54.8

*** 2.869 ***

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.00	72.50
2	22.87	71.62
3	25.76	70.81
4	28.66	70.06
5	31.59	69.39
6	34.53	68.80
7	37.48	68.27
8	40.45	67.81
9	43.42	67.43
10	46.40	67.12
11	49.40	66.88
12	52.39	66.72
13	55.39	66.63
14	58.39	66.61
15	61.39	66.67
16	64.39	66.79
17	67.38	67.00
18	70.37	67.27
19	73.35	67.62
20	76.32	68.04
21	79.28	68.53
22	82.22	69.09
23	85.16	69.73
24	88.07	70.43
25	90.97	71.21
26	93.85	72.06
27	96.70	72.98
28	99.54	73.96
29	102.34	75.02
30	105.12	76.14
31	107.88	77.34
32	110.60	78.59
33	113.29	79.92
34	115.95	81.31
35	118.58	82.76
36	121.16	84.28
37	123.71	85.86
38	126.23	87.50
39	128.70	89.20
40	129.79	90.00

Circle Center At X = 57.6 ; Y = 189.6 and Radius, 123.0

*** 2.869 ***

Failure Surface Specified By 56 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	.00	72.50
2	2.20	70.46
3	4.46	68.49
4	6.79	66.59
5	9.17	64.78
6	11.62	63.04
7	14.12	61.38
8	16.67	59.80
9	19.27	58.30
10	21.92	56.89
11	24.61	55.57
12	27.34	54.34
13	30.12	53.19
14	32.93	52.14
15	35.77	51.17
16	38.64	50.30
17	41.54	49.53
18	44.46	48.85
19	47.40	48.26
20	50.36	47.77
21	53.33	47.37
22	56.32	47.07
23	59.31	46.87
24	62.31	46.77
25	65.31	46.76
26	68.31	46.85
27	71.30	47.04
28	74.29	47.33
29	77.26	47.71
30	80.23	48.19
31	83.17	48.76
32	86.09	49.43
33	89.00	50.19
34	91.87	51.05
35	94.72	52.00
36	97.53	53.04
37	100.31	54.17
38	103.05	55.40
39	105.75	56.71
40	108.40	58.10
41	111.01	59.59
42	113.57	61.15
43	116.07	62.80
44	118.53	64.53
45	120.92	66.34
46	123.25	68.22
47	125.53	70.18
48	127.73	72.21
49	129.87	74.32
50	131.94	76.49
51	133.94	78.72

52	135.87	81.03
53	137.72	83.39
54	139.49	85.81
55	141.18	88.28
56	142.28	90.00

Circle Center At X = 64.0 ; Y = 139.2 and Radius, 92.4

*** 2.926 ***

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	.00	72.50
2	2.85	71.57
3	5.73	70.71
4	8.61	69.90
5	11.52	69.15
6	14.44	68.46
7	17.37	67.83
8	20.32	67.26
9	23.27	66.75
10	26.24	66.30
11	29.22	65.91
12	32.20	65.59
13	35.19	65.32
14	38.18	65.11
15	41.18	64.97
16	44.17	64.89
17	47.17	64.87
18	50.17	64.91
19	53.17	65.01
20	56.17	65.17
21	59.16	65.39
22	62.15	65.68
23	65.13	66.02
24	68.10	66.43
25	71.06	66.90
26	74.01	67.42
27	76.96	68.01
28	79.89	68.66
29	82.80	69.37
30	85.70	70.13
31	88.59	70.96
32	91.45	71.84
33	94.30	72.79
34	97.13	73.79
35	99.93	74.85
36	102.72	75.96
37	105.48	77.14
38	108.22	78.37
39	110.93	79.65

40	113.61	80.99
41	116.27	82.38
42	118.90	83.83
43	121.49	85.33
44	124.06	86.89
45	126.59	88.49
46	128.86	90.00

Circle Center At X = 46.7 ; Y = 211.6 and Radius, 146.8

*** 2.987 ***

Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.00	72.50
2	22.33	70.61
3	24.72	68.80
4	27.18	67.08
5	29.70	65.44
6	32.27	63.90
7	34.89	62.44
8	37.56	61.08
9	40.28	59.81
10	43.04	58.64
11	45.85	57.57
12	48.68	56.59
13	51.55	55.72
14	54.45	54.94
15	57.37	54.27
16	60.32	53.70
17	63.28	53.24
18	66.26	52.88
19	69.25	52.62
20	72.25	52.47
21	75.25	52.42
22	78.25	52.48
23	81.24	52.65
24	84.23	52.92
25	87.21	53.29
26	90.17	53.77
27	93.11	54.35
28	96.03	55.03
29	98.93	55.82
30	101.79	56.71
31	104.63	57.69
32	107.42	58.78
33	110.18	59.96
34	112.89	61.24
35	115.56	62.61
36	118.18	64.08
37	120.74	65.64

31/1

38	123.25	67.28
39	125.70	69.02
40	128.09	70.83
41	130.41	72.73
42	132.66	74.71
43	134.84	76.77
44	136.95	78.91
45	138.99	81.11
46	140.94	83.39
47	142.81	85.73
48	144.60	88.14
49	145.89	90.00

Circle Center At X = 75.1 ; Y = 138.0 and Radius, 85.6

*** 3.020 ***

Failure Surface Specified By 59 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	.00	72.50
2	2.17	70.43
3	4.41	68.43
4	6.70	66.50
5	9.06	64.64
6	11.47	62.86
7	13.94	61.15
8	16.46	59.52
9	19.03	57.98
10	21.65	56.51
11	24.31	55.12
12	27.01	53.82
13	29.75	52.60
14	32.53	51.47
15	35.34	50.43
16	38.19	49.48
17	41.06	48.61
18	43.96	47.84
19	46.88	47.15
20	49.82	46.56
21	52.78	46.06
22	55.75	45.65
23	58.73	45.34
24	61.73	45.11
25	64.72	44.99
26	67.72	44.95
27	70.72	45.01
28	73.72	45.17
29	76.71	45.41
30	79.69	45.75
31	82.66	46.19

32	85.61	46.71
33	88.55	47.33
34	91.46	48.04
35	94.35	48.84
36	97.22	49.73
37	100.05	50.71
38	102.86	51.78
39	105.63	52.93
40	108.36	54.17
41	111.05	55.49
42	113.70	56.90
43	116.30	58.39
44	118.86	59.96
45	121.36	61.61
46	123.82	63.34
47	126.21	65.15
48	128.55	67.02
49	130.83	68.97
50	133.05	70.99
51	135.21	73.08
52	137.29	75.23
53	139.31	77.45
54	141.26	79.73
55	143.14	82.07
56	144.94	84.47
57	146.67	86.93
58	148.32	89.43
59	148.67	90.00

Circle Center At X = 67.3 ; Y = 141.0 and Radius, 96.0

*** 3.045 ***

Failure Surface Specified By 52 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.00	72.50
2	22.20	70.46
3	24.48	68.51
4	26.82	66.64
5	29.23	64.85
6	31.70	63.15
7	34.23	61.54
8	36.82	60.02
9	39.46	58.59
10	42.15	57.26
11	44.88	56.03
12	47.66	54.89
13	50.48	53.86
14	53.33	52.92

33/129

15	56.21	52.09
16	59.12	51.37
17	62.06	50.74
18	65.01	50.23
19	67.98	49.81
20	70.97	49.51
21	73.96	49.31
22	76.96	49.22
23	79.96	49.24
24	82.96	49.36
25	85.95	49.59
26	88.93	49.93
27	91.90	50.37
28	94.85	50.92
29	97.77	51.58
30	100.67	52.34
31	103.55	53.20
32	106.39	54.17
33	109.19	55.23
34	111.96	56.40
35	114.68	57.66
36	117.35	59.02
37	119.98	60.48
38	122.55	62.02
39	125.06	63.66
40	127.51	65.39
41	129.90	67.20
42	132.22	69.10
43	134.48	71.08
44	136.66	73.14
45	138.76	75.28
46	140.79	77.49
47	142.74	79.77
48	144.61	82.12
49	146.39	84.54
50	148.08	87.01
51	149.68	89.55
52	149.95	90.00

Circle Center At X = 78.0 ; Y = 133.1 and Radius, 83.9

*** 3.164 ***

34/129

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           Y            A     X     I     S            F     T

            .00     27.50     55.00     82.50    110.00    137.50

X       .00 +---------+---------+-----*---+---------+---------+
           -                       617
           -                       17.
           -                     61 7.
           -                    61 772
           -                   61  73*
      27.50 +                  911 332*
           -                  61 3325*
           -                 661 3825*
           -                 6113827544
           -                961382254 .
           -                6 1382.54 .
A     55.00 +                6 18 2.4 ..
           -               96 11 2.4 .. .
           -               96031.245 ...
           -               96031.245 ...
           -               9603.12475...  *
           -                603.124 5.... .
X     82.50 +                963. 1 45......
           -                9683 .1455 . ..
           -                9063 .2145 ...  *
           -                 9683..2175...
           -                 99633.2.117...
           -                  906 3.2.411...
I    110.00 +                   96633 2 5411..
           -                    96633 2.54411
           -                    0966.332255.4
           -                      9866.32257.
           -                       9 66..3223
           -                        99866.. 2
S    137.50 +                          99666..
           -                           098866
           -                             0988
           -                                0
           -
           -
     165.00 +
           -
           -
           -
           -
           -
F    192.50 +
           -
           -
           -
           -
           -
T    220.00 +                         W    * *
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H-34

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	6/22/98
Time of Run:	3
Run By:	jos
Input Data Filename:	kmsw13fa.in
Output Filename:	kmsw13r.out
Unit:	ENGLISH

City of Kingsville, Texas Municipal Solid Waste Landfill
Permit Application 235-B
[Slope Stability Analysis (3:1 slope)]
Random Failure Surface Analysis

BOUNDARY COORDINATES

7 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	72.50	22.00	72.50	1
2	22.00	72.50	28.00	70.50	1
3	28.00	70.50	32.00	70.50	1
4	32.00	70.50	38.00	72.50	1
5	38.00	72.50	75.50	85.00	1
6	75.50	85.00	90.50	90.00	2
7	90.50	90.00	220.00	90.00	2
8	75.50	85.00	220.00	85.00	1

36/129

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	94.5	112.1	200.0	24.0	.00	.0	1
2	86.8	99.6	.0	.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	71.00
2	220.00	71.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Irregular Surfaces, Has Been Specified.

Janbus Empirical Coef. is being used for the case of c & phi both > 0
100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = .00 ft.
and X = 80.00 ft.

Each Surface Terminates Between X = 110.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

37/129

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.78	72.50
2	20.70	71.84
3	23.61	71.09
4	25.97	69.23
5	28.25	67.29
6	30.56	65.37
7	32.69	63.26
8	35.01	61.36
9	37.79	60.23
10	40.74	60.75
11	43.74	60.88
12	46.70	61.40
13	49.68	61.68
14	52.67	61.92
15	55.63	61.39
16	58.28	60.00
17	61.24	60.53
18	64.10	61.42
19	65.80	63.89
20	68.36	65.45
21	71.27	66.19
22	74.12	67.11
23	77.06	67.72
24	78.81	70.15
25	81.29	71.84
26	82.48	74.59
27	84.23	77.03
28	86.78	78.61
29	88.39	81.14
30	90.42	83.35
31	93.15	84.60
32	95.79	86.01
33	98.79	86.23
34	101.63	85.26
35	104.46	84.27
36	107.20	85.50
37	110.20	85.52
38	112.59	87.33
39	114.73	89.43
40	115.07	90.00

*** 2.668 ***

Individual data on the 50 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.9	91.2	.0	.0	.0	.0	.0	.0	.0
2	1.3	101.3	.0	.0	.0	.0	.0	.0	.0
3	1.6	142.3	.0	.0	.0	.0	.0	.0	.0
4	.1	9.5	.0	.0	.0	.0	.0	.0	.0
5	2.2	339.7	.0	157.6	.0	.0	.0	.0	.0
6	2.0	563.3	21.5	438.5	.0	.0	.0	.0	.0
7	.3	87.6	7.9	74.3	.0	.0	.0	.0	.0
8	2.3	1079.4	72.1	873.9	.0	.0	.0	.0	.0
9	1.4	941.9	44.9	804.0	.0	.0	.0	.0	.0
10	.7	539.2	17.4	447.3	.0	.0	.0	.0	.0
11	2.3	2290.7	.0	1627.2	.0	.0	.0	.0	.0
12	2.8	3433.9	.0	1910.2	.0	.0	.0	.0	.0
13	.2	281.9	.0	142.9	.0	.0	.0	.0	.0
14	2.7	3735.5	.0	1824.3	.0	.0	.0	.0	.0
15	3.0	4247.9	.0	1906.7	.0	.0	.0	.0	.0
16	3.0	4357.8	.0	1846.4	.0	.0	.0	.0	.0
17	3.0	4549.4	.0	1771.2	.0	.0	.0	.0	.0
18	3.0	4749.5	.0	1722.2	.0	.0	.0	.0	.0
19	3.0	5015.0	.0	1749.1	.0	.0	.0	.0	.0
20	2.7	5030.6	.0	1928.8	.0	.0	.0	.0	.0
21	3.0	5994.6	.0	2009.4	.0	.0	.0	.0	.0
22	2.9	5856.8	.0	1876.9	.0	.0	.0	.0	.0
23	1.7	3261.8	.0	1562.5	.0	.0	.0	.0	.0
24	2.6	4526.0	.0	1184.5	.0	.0	.0	.0	.0
25	2.9	5012.5	.0	969.0	.0	.0	.0	.0	.0
26	2.9	4919.7	.0	814.1	.0	.0	.0	.0	.0
27	1.4	2372.0	.0	329.1	.0	.0	.0	.0	.0
28	1.6	2701.3	.0	342.4	.0	.0	.0	.0	.0
29	1.7	2843.4	.0	386.5	.0	.0	.0	.0	.0
30	1.3	1855.7	.0	39.9	.0	.0	.0	.0	.0
31	1.2	1768.7	.0	.0	.0	.0	.0	.0	.0
32	1.2	1536.7	.0	.0	.0	.0	.0	.0	.0
33	1.8	1919.7	.0	.0	.0	.0	.0	.0	.0
34	2.5	2463.7	.0	.0	.0	.0	.0	.0	.0
35	1.6	1348.0	.0	.0	.0	.0	.0	.0	.0
36	2.0	1343.7	.0	.0	.0	.0	.0	.0	.0
37	.1	46.8	.0	.0	.0	.0	.0	.0	.0
38	2.6	1401.8	.0	.0	.0	.0	.0	.0	.0
39	.8	340.1	.0	.0	.0	.0	.0	.0	.0
40	1.9	738.8	.0	.0	.0	.0	.0	.0	.0
41	3.0	1007.4	.0	.0	.0	.0	.0	.0	.0
42	2.8	1048.7	.0	.0	.0	.0	.0	.0	.0
43	.8	318.5	.0	.0	.0	.0	.0	.0	.0
44	2.1	973.0	.0	.0	.0	.0	.0	.0	.0
45	1.6	762.4	.0	.0	.0	.0	.0	.0	.0
46	1.1	458.2	.0	.0	.0	.0	.0	.0	.0
47	3.0	1169.6	.0	.0	.0	.0	.0	.0	.0
48	2.4	741.1	.0	.0	.0	.0	.0	.0	.0
49	2.1	300.6	.0	.0	.0	.0	.0	.0	.0
50	.3	8.3	.0	.0	.0	.0	.0	.0	.0

39/129

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.78	72.50
2	20.70	71.84
3	23.61	71.09
4	25.97	69.23
5	28.25	67.29
6	30.56	65.37
7	32.69	63.26
8	35.01	61.36
9	37.79	60.23
10	40.74	60.75
11	43.74	60.88
12	46.70	61.40
13	49.68	61.68
14	52.67	61.92
15	55.63	61.39
16	58.28	60.00
17	61.24	60.53
18	64.10	61.42
19	65.80	63.89
20	68.36	65.45
21	71.27	66.19
22	74.12	67.11
23	77.06	67.72
24	78.81	70.15
25	81.29	71.84
26	82.48	74.59
27	84.23	77.03
28	86.78	78.61
29	88.39	81.14
30	90.42	83.35
31	93.15	84.60
32	95.79	86.01
33	98.79	86.23
34	101.63	85.26
35	104.46	84.27
36	107.20	85.50
37	110.20	85.52
38	112.59	87.33
39	114.73	89.43
40	115.07	90.00

*** 2.668 ***

40/129

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.78	72.50
2	20.70	71.84
3	23.61	71.09
4	25.97	69.23
5	28.25	67.29
6	30.56	65.37
7	32.69	63.26
8	35.01	61.36
9	37.79	60.23
10	40.74	60.75
11	43.74	60.88
12	46.70	61.40
13	49.68	61.68
14	52.67	61.92
15	55.63	61.39
16	58.28	60.00
17	61.24	60.53
18	64.10	61.42
19	65.80	63.89
20	68.36	65.45
21	71.27	66.19
22	74.12	67.11
23	77.06	67.72
24	78.81	70.15
25	81.29	71.84
26	82.48	74.59
27	84.23	77.03
28	86.78	78.61
29	88.39	81.14
30	90.42	83.35
31	93.15	84.60
32	95.79	86.01
33	98.79	86.23
34	101.63	85.26
35	104.46	84.27
36	107.20	85.50
37	110.20	85.52
38	112.59	87.33
39	114.73	89.43
40	115.07	90.00

*** 2.668 ***

41/124

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	35.56	71.69
2	37.90	69.81
3	40.78	68.96
4	43.03	66.97
5	45.56	65.36
6	48.43	64.51
7	50.99	62.93
8	53.76	61.80
9	56.72	62.31
10	59.51	63.42
11	62.50	63.70
12	65.40	64.45
13	68.31	65.17
14	71.28	65.59
15	74.28	65.47
16	77.24	64.96
17	80.13	64.17
18	83.13	64.08
19	86.13	64.10
20	88.50	65.94
21	90.99	67.61
22	92.51	70.20
23	95.09	71.72
24	98.08	72.00
25	100.69	73.49
26	103.39	74.79
27	105.92	76.40
28	106.99	79.20
29	109.08	81.35
30	109.10	84.35
31	110.05	87.20
32	111.69	89.71
33	111.73	90.00

*** 3.419 ***

42/129

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	35.56	71.69
2	37.90	69.81
3	40.78	68.96
4	43.03	66.97
5	45.56	65.36
6	48.43	64.51
7	50.99	62.93
8	53.76	61.80
9	56.72	62.31
10	59.51	63.42
11	62.50	63.70
12	65.40	64.45
13	68.31	65.17
14	71.28	65.59
15	74.28	65.47
16	77.24	64.96
17	80.13	64.17
18	83.13	64.08
19	86.13	64.10
20	88.50	65.94
21	90.99	67.61
22	92.51	70.20
23	95.09	71.72
24	98.08	72.00
25	100.69	73.49
26	103.39	74.79
27	105.92	76.40
28	106.99	79.20
29	109.08	81.35
30	109.10	84.35
31	110.05	87.20
32	111.69	89.71
33	111.73	90.00

*** 3.419 ***

43/120

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.44	74.65
2	47.25	73.58
3	49.73	71.90
4	52.68	71.34
5	55.55	70.47
6	58.13	68.94
7	61.08	68.38
8	63.80	67.11
9	66.16	65.26
10	68.53	63.43
11	71.51	63.06
12	74.09	64.58
13	77.07	64.96
14	80.07	64.93
15	83.05	65.31
16	85.51	67.02
17	88.05	68.61
18	90.54	70.29
19	93.47	70.94
20	95.50	73.15
21	97.82	75.06
22	98.47	77.98
23	99.95	80.59
24	102.22	82.55
25	104.93	83.83
26	107.48	85.42
27	110.44	85.90
28	113.30	86.80
29	116.00	88.11
30	118.95	88.66
31	121.78	89.66
32	123.96	90.00

*** 3.465 ***

44/129

Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.67	70.94
2	28.81	68.85
3	31.52	67.55
4	33.99	65.85
5	36.22	63.84
6	38.41	61.79
7	41.07	60.41
8	43.92	59.48
9	46.55	58.03
10	48.92	56.20
11	51.18	54.21
12	53.38	52.18
13	56.38	52.21
14	59.35	52.67
15	62.34	52.86
16	65.04	54.17
17	67.96	54.86
18	70.83	54.00
19	73.47	52.57
20	76.36	51.75
21	79.26	51.01
22	82.18	51.69
23	84.98	50.61
24	87.97	50.29
25	90.68	49.01
26	93.68	48.87
27	96.67	48.70
28	99.35	50.05
29	101.82	51.76
30	103.47	54.26
31	105.53	56.45
32	108.24	57.72
33	109.91	60.22
34	112.71	61.28
35	115.71	61.45
36	118.04	63.34
37	119.75	65.80
38	121.83	67.97
39	123.16	70.65
40	124.19	73.47
41	126.29	75.61
42	129.11	76.65
43	130.64	79.23
44	131.81	82.00
45	133.83	84.21
46	136.78	84.78
47	139.45	86.14
48	141.05	88.68
49	142.49	90.00

*** 3.822 ***

45/129

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.33	77.61
2	55.87	76.01
3	58.37	74.35
4	61.26	73.56
5	63.47	71.53
6	66.09	70.07
7	68.33	68.07
8	71.06	66.82
9	73.66	65.32
10	76.61	64.79
11	79.61	64.74
12	82.42	65.79
13	85.22	66.87
14	88.21	66.63
15	91.00	67.75
16	92.35	70.43
17	94.71	72.28
18	96.32	74.81
19	98.09	77.23
20	100.49	79.04
21	102.23	81.48
22	103.96	83.93
23	106.58	85.40
24	109.58	85.45
25	112.29	86.73
26	114.94	88.14
27	117.69	89.35
28	118.09	90.00

*** 3.943 ***

46/124

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.44	74.65
2	46.62	72.58
3	49.62	72.58
4	51.87	74.56
5	54.61	75.79
6	57.58	76.17
7	60.58	76.09
8	63.48	75.30
9	66.45	74.89
10	69.20	73.68
11	71.95	72.49
12	74.91	72.02
13	77.83	72.71
14	80.76	73.35
15	83.76	73.17
16	86.66	72.40
17	89.65	72.47
18	92.15	74.13
19	94.16	76.36
20	96.72	77.92
21	99.62	78.68
22	102.35	79.94
23	104.47	82.06
24	107.13	83.45
25	109.87	84.67
26	112.64	85.84
27	114.98	87.71
28	117.70	88.97
29	120.65	89.54
30	123.64	89.78
31	126.58	89.19
32	129.57	88.93
33	131.73	90.00

*** 4.041 ***

47/129

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.67	70.94
2	28.86	68.90
3	31.32	67.18
4	34.27	66.63
5	37.18	65.91
6	40.07	66.74
7	43.06	66.62
8	45.96	65.84
9	48.43	64.14
10	50.60	62.07
11	53.14	60.46
12	56.13	60.31
13	58.93	59.23
14	61.08	57.13
15	63.90	56.11
16	66.88	56.48
17	69.87	56.28
18	72.83	56.80
19	75.73	56.06
20	78.67	55.44
21	81.62	55.96
22	84.52	55.19
23	87.51	55.47
24	89.66	57.56
25	92.44	58.67
26	95.44	58.52
27	98.36	59.21
28	101.30	58.60
29	104.03	59.85
30	106.44	61.63
31	108.00	64.19
32	108.70	67.11
33	109.17	70.08
34	110.83	72.57
35	111.06	75.56
36	112.26	78.32
37	112.67	81.29
38	114.14	83.91
39	115.97	86.29
40	117.70	88.74
41	119.46	90.00

*** 4.290 ***

48/129

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            Y           A     X     I     S            F     T

              .00    27.50    55.00    82.50   110.00   137.50

 X      .00 +---------+---------+-----*---+---------+---------+
            -                         ..
            -                        .  .
            -                        . .
            -                        . .1
            -                        . .*
      27.50 +                       ..11*
            -                       .117*
            -                       1704*
            -                       1.44.
            -                      71.4.96
            -                     7.11..69.
 A    55.00 +                    7 .14..6.8
            -                    7.014.6.89
            -                    77.116889..
            -                   ..70.618.9...
            -                   .7.0.61.9....*
            -                 ...70..4411.....
 X    82.50 +                ... 70..46.111...
            -                . .7.0..4469..11.
            -                . .7..0...449..11 *
            -                 ..7..00...466..1
            -                   77.0.....4.661
            -                     .770....44461
 I   110.00 +                    ..77000000.4144
            -                        .7.. ....0911
            -                        ..77.......68
            -                        ....777.....6
            -                        ......77...9.
            -                          .......777.9
 S   137.50 +                            .......7..
            -                              .....77
            -                                 ....
            -
            -
            -
     165.00 +
            -
            -
            -
            -
            -
 F   192.50 +
            -
            -
            -
            -
            -
 T   220.00 +                          W      * *
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H-48

49/424

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	6/23/98
Time of Run:	3
Run By:	JOS
Input Data Filename:	kmswl3fb.in
Output Filename:	kmswl3fb.out
Unit:	ENGLISH

City of Kingsville, Texas Municipal Solid Waste Landfill
Permit Application 235-B
[Slope Stability Analysis (3:1 slope at ϕ = 21°]

BOUNDARY COORDINATES

7 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	72.50	22.00	72.50	1
2	22.00	72.50	28.00	70.50	1
3	28.00	70.50	32.00	70.50	1
4	32.00	70.50	38.00	72.50	1
5	38.00	72.50	75.50	85.00	1
6	75.50	85.00	90.50	90.00	2
7	90.50	90.00	220.00	90.00	2
8	75.50	85.00	220.00	85.00	1

50/29

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	94.5	112.1	200.0	21.0	.00	.0	1
2	86.8	99.6	.0	.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	71.00
2	220.00	71.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Irregular Surfaces, Has Been Specified.

Janbus Empirical Coef. is being used for the case of c & phi both > 0
100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 80.00 ft.

Each Surface Terminates Between X = 110.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.78	72.50
2	20.70	71.84
3	23.61	71.09
4	25.97	69.23
5	28.25	67.29
6	30.56	65.37
7	32.69	63.26
8	35.01	61.36
9	37.79	60.23
10	40.74	60.75
11	43.74	60.88
12	46.70	61.40
13	49.68	61.68
14	52.67	61.92
15	55.63	61.39
16	58.28	60.00
17	61.24	60.53
18	64.10	61.42
19	65.80	63.89
20	68.36	65.45
21	71.27	66.19
22	74.12	67.11
23	77.06	67.72
24	78.81	70.15
25	81.29	71.84
26	82.48	74.59
27	84.23	77.03
28	86.78	78.61
29	88.39	81.14
30	90.42	83.35
31	93.15	84.60
32	95.79	86.01
33	98.79	86.23
34	101.63	85.26
35	104.46	84.27
36	107.20	85.50
37	110.20	85.52
38	112.59	87.33
39	114.73	89.43
40	115.07	90.00

*** 2.435 ***

Individual data on the 50 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.9	91.2	.0	.0	.0	.0	.0	.0	.0
2	1.3	101.3	.0	.0	.0	.0	.0	.0	.0
3	1.6	142.3	.0	.0	.0	.0	.0	.0	.0
4	.1	9.5	.0	.0	.0	.0	.0	.0	.0
5	2.2	339.7	.0	157.6	.0	.0	.0	.0	.0
6	2.0	563.3	21.5	438.5	.0	.0	.0	.0	.0
7	.3	87.6	7.9	74.3	.0	.0	.0	.0	.0
8	2.3	1079.4	72.1	873.9	.0	.0	.0	.0	.0
9	1.4	941.9	44.9	804.0	.0	.0	.0	.0	.0
10	.7	539.2	17.4	447.3	.0	.0	.0	.0	.0
11	2.3	2290.7	.0	1627.2	.0	.0	.0	.0	.0
12	2.8	3433.9	.0	1910.2	.0	.0	.0	.0	.0
13	.2	281.9	.0	142.9	.0	.0	.0	.0	.0
14	2.7	3735.5	.0	1824.3	.0	.0	.0	.0	.0
15	3.0	4247.9	.0	1906.7	.0	.0	.0	.0	.0
16	3.0	4357.8	.0	1846.4	.0	.0	.0	.0	.0
17	3.0	4549.4	.0	1771.2	.0	.0	.0	.0	.0
18	3.0	4749.5	.0	1722.2	.0	.0	.0	.0	.0
19	3.0	5015.0	.0	1749.1	.0	.0	.0	.0	.0
20	2.7	5030.6	.0	1928.8	.0	.0	.0	.0	.0
21	3.0	5994.6	.0	2009.4	.0	.0	.0	.0	.0
22	2.9	5856.8	.0	1876.9	.0	.0	.0	.0	.0
23	1.7	3261.8	.0	1562.5	.0	.0	.0	.0	.0
24	2.6	4526.0	.0	1184.5	.0	.0	.0	.0	.0
25	2.9	5012.5	.0	969.0	.0	.0	.0	.0	.0
26	2.9	4919.7	.0	814.1	.0	.0	.0	.0	.0
27	1.4	2372.0	.0	329.1	.0	.0	.0	.0	.0
28	1.6	2701.3	.0	342.4	.0	.0	.0	.0	.0
29	1.7	2843.4	.0	386.5	.0	.0	.0	.0	.0
30	1.3	1855.7	.0	39.9	.0	.0	.0	.0	.0
31	1.2	1768.7	.0	.0	.0	.0	.0	.0	.0
32	1.2	1536.7	.0	.0	.0	.0	.0	.0	.0
33	1.8	1919.7	.0	.0	.0	.0	.0	.0	.0
34	2.5	2463.7	.0	.0	.0	.0	.0	.0	.0
35	1.6	1348.0	.0	.0	.0	.0	.0	.0	.0
36	2.0	1343.7	.0	.0	.0	.0	.0	.0	.0
37	.1	46.8	.0	.0	.0	.0	.0	.0	.0
38	2.6	1401.8	.0	.0	.0	.0	.0	.0	.0
39	.8	340.1	.0	.0	.0	.0	.0	.0	.0
40	1.9	738.8	.0	.0	.0	.0	.0	.0	.0
41	3.0	1007.4	.0	.0	.0	.0	.0	.0	.0
42	2.8	1048.7	.0	.0	.0	.0	.0	.0	.0
43	.8	318.5	.0	.0	.0	.0	.0	.0	.0
44	2.1	973.0	.0	.0	.0	.0	.0	.0	.0
45	1.6	762.4	.0	.0	.0	.0	.0	.0	.0
46	1.1	458.2	.0	.0	.0	.0	.0	.0	.0
47	3.0	1169.6	.0	.0	.0	.0	.0	.0	.0
48	2.4	741.1	.0	.0	.0	.0	.0	.0	.0
49	2.1	300.6	.0	.0	.0	.0	.0	.0	.0

50	.3	8.3	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.78	72.50
2	20.70	71.84
3	23.61	71.09
4	25.97	69.23
5	28.25	67.29
6	30.56	65.37
7	32.69	63.26
8	35.01	61.36
9	37.79	60.23
10	40.74	60.75
11	43.74	60.88
12	46.70	61.40
13	49.68	61.68
14	52.67	61.92
15	55.63	61.39
16	58.28	60.00
17	61.24	60.53
18	64.10	61.42
19	65.80	63.89
20	68.36	65.45
21	71.27	66.19
22	74.12	67.11
23	77.06	67.72
24	78.81	70.15
25	81.29	71.84
26	82.48	74.59
27	84.23	77.03
28	86.78	78.61
29	88.39	81.14
30	90.42	83.35
31	93.15	84.60
32	95.79	86.01
33	98.79	86.23
34	101.63	85.26
35	104.46	84.27
36	107.20	85.50
37	110.20	85.52
38	112.59	87.33
39	114.73	89.43
40	115.07	90.00

*** 2.435 ***

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.78	72.50
2	20.70	71.84
3	23.61	71.09
4	25.97	69.23
5	28.25	67.29
6	30.56	65.37
7	32.69	63.26
8	35.01	61.36
9	37.79	60.23
10	40.74	60.75
11	43.74	60.88
12	46.70	61.40
13	49.68	61.68
14	52.67	61.92
15	55.63	61.39
16	58.28	60.00
17	61.24	60.53
18	64.10	61.42
19	65.80	63.89
20	68.36	65.45
21	71.27	66.19
22	74.12	67.11
23	77.06	67.72
24	78.81	70.15
25	81.29	71.84
26	82.48	74.59
27	84.23	77.03
28	86.78	78.61
29	88.39	81.14
30	90.42	83.35
31	93.15	84.60
32	95.79	86.01
33	98.79	86.23
34	101.63	85.26
35	104.46	84.27
36	107.20	85.50
37	110.20	85.52
38	112.59	87.33
39	114.73	89.43
40	115.07	90.00

*** 2.435 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	35.56	71.69
2	37.90	69.81
3	40.78	68.96
4	43.03	66.97
5	45.56	65.36
6	48.43	64.51
7	50.99	62.93
8	53.76	61.80
9	56.72	62.31
10	59.51	63.42
11	62.50	63.70
12	65.40	64.45
13	68.31	65.17
14	71.28	65.59
15	74.28	65.47
16	77.24	64.96
17	80.13	64.17
18	83.13	64.08
19	86.13	64.10
20	88.50	65.94
21	90.99	67.61
22	92.51	70.20
23	95.09	71.72
24	98.08	72.00
25	100.69	73.49
26	103.39	74.79
27	105.92	76.40
28	106.99	79.20
29	109.08	81.35
30	109.10	84.35
31	110.05	87.20
32	111.69	89.71
33	111.73	90.00

*** 3.107 ***

56/129

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	35.56	71.69
2	37.90	69.81
3	40.78	68.96
4	43.03	66.97
5	45.56	65.36
6	48.43	64.51
7	50.99	62.93
8	53.76	61.80
9	56.72	62.31
10	59.51	63.42
11	62.50	63.70
12	65.40	64.45
13	68.31	65.17
14	71.28	65.59
15	74.28	65.47
16	77.24	64.96
17	80.13	64.17
18	83.13	64.08
19	86.13	64.10
20	88.50	65.94
21	90.99	67.61
22	92.51	70.20
23	95.09	71.72
24	98.08	72.00
25	100.69	73.49
26	103.39	74.79
27	105.92	76.40
28	106.99	79.20
29	109.08	81.35
30	109.10	84.35
31	110.05	87.20
32	111.69	89.71
33	111.73	90.00

*** 3.107 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.44	74.65
2	47.25	73.58
3	49.73	71.90
4	52.68	71.34
5	55.55	70.47
6	58.13	68.94
7	61.08	68.38
8	63.80	67.11
9	66.16	65.26
10	68.53	63.43
11	71.51	63.06
12	74.09	64.58
13	77.07	64.96
14	80.07	64.93
15	83.05	65.31
16	85.51	67.02
17	88.05	68.61
18	90.54	70.29
19	93.47	70.94
20	95.50	73.15
21	97.82	75.06
22	98.47	77.98
23	99.95	80.59
24	102.22	82.55
25	104.93	83.83
26	107.48	85.42
27	110.44	85.90
28	113.30	86.80
29	116.00	88.11
30	118.95	88.66
31	121.78	89.66
32	123.96	90.00

*** 3.128 ***

58/129

Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.67	70.94
2	28.81	68.85
3	31.52	67.55
4	33.99	65.85
5	36.22	63.84
6	38.41	61.79
7	41.07	60.41
8	43.92	59.48
9	46.55	58.03
10	48.92	56.20
11	51.18	54.21
12	53.38	52.18
13	56.38	52.21
14	59.35	52.67
15	62.34	52.86
16	65.04	54.17
17	67.96	54.86
18	70.83	54.00
19	73.47	52.57
20	76.36	51.75
21	79.26	51.01
22	82.18	51.69
23	84.98	50.61
24	87.97	50.29
25	90.68	49.01
26	93.68	48.87
27	96.67	48.70
28	99.35	50.05
29	101.82	51.76
30	103.47	54.26
31	105.53	56.45
32	108.24	57.72
33	109.91	60.22
34	112.71	61.28
35	115.71	61.45
36	118.04	63.34
37	119.75	65.80
38	121.83	67.97
39	123.16	70.65
40	124.19	73.47
41	126.29	75.61
42	129.11	76.65
43	130.64	79.23
44	131.81	82.00
45	133.83	84.21
46	136.78	84.78
47	139.45	86.14
48	141.05	88.68
49	142.49	90.00

*** 3.413 ***

H-58

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.33	77.61
2	55.87	76.01
3	58.37	74.35
4	61.26	73.56
5	63.47	71.53
6	66.09	70.07
7	68.33	68.07
8	71.06	66.82
9	73.66	65.32
10	76.61	64.79
11	79.61	64.74
12	82.42	65.79
13	85.22	66.87
14	88.21	66.63
15	91.00	67.75
16	92.35	70.43
17	94.71	72.28
18	96.32	74.81
19	98.09	77.23
20	100.49	79.04
21	102.23	81.48
22	103.96	83.93
23	106.58	85.40
24	109.58	85.45
25	112.29	86.73
26	114.94	88.14
27	117.69	89.35
28	118.09	90.00

*** 3.553 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.44	74.65
2	46.62	72.58
3	49.62	72.58
4	51.87	74.56
5	54.61	75.79
6	57.58	76.17
7	60.58	76.09
8	63.48	75.30
9	66.45	74.89
10	69.20	73.68
11	71.95	72.49
12	74.91	72.02
13	77.83	72.71
14	80.76	73.35
15	83.76	73.17
16	86.66	72.40
17	89.65	72.47
18	92.15	74.13
19	94.16	76.36
20	96.72	77.92
21	99.62	78.68
22	102.35	79.94
23	104.47	82.06
24	107.13	83.45
25	109.87	84.67
26	112.64	85.84
27	114.98	87.71
28	117.70	88.97
29	120.65	89.54
30	123.64	89.78
31	126.58	89.19
32	129.57	88.93
33	131.73	90.00

*** 3.684 ***

61/129

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.67	70.94
2	28.86	68.90
3	31.32	67.18
4	34.27	66.63
5	37.18	65.91
6	40.07	66.74
7	43.06	66.62
8	45.96	65.84
9	48.43	64.14
10	50.60	62.07
11	53.14	60.46
12	56.13	60.31
13	58.93	59.23
14	61.08	57.13
15	63.90	56.11
16	66.88	56.48
17	69.87	56.28
18	72.83	56.80
19	75.73	56.06
20	78.67	55.44
21	81.62	55.96
22	84.52	55.19
23	87.51	55.47
24	89.66	57.56
25	92.44	58.67
26	95.44	58.52
27	98.36	59.21
28	101.30	58.60
29	104.03	59.85
30	106.44	61.63
31	108.00	64.19
32	108.70	67.11
33	109.17	70.08
34	110.83	72.57
35	111.06	75.56
36	112.26	78.32
37	112.67	81.29
38	114.14	83.91
39	115.97	86.29
40	117.70	88.74
41	119.46	90.00

*** 3.863 ***

62/129

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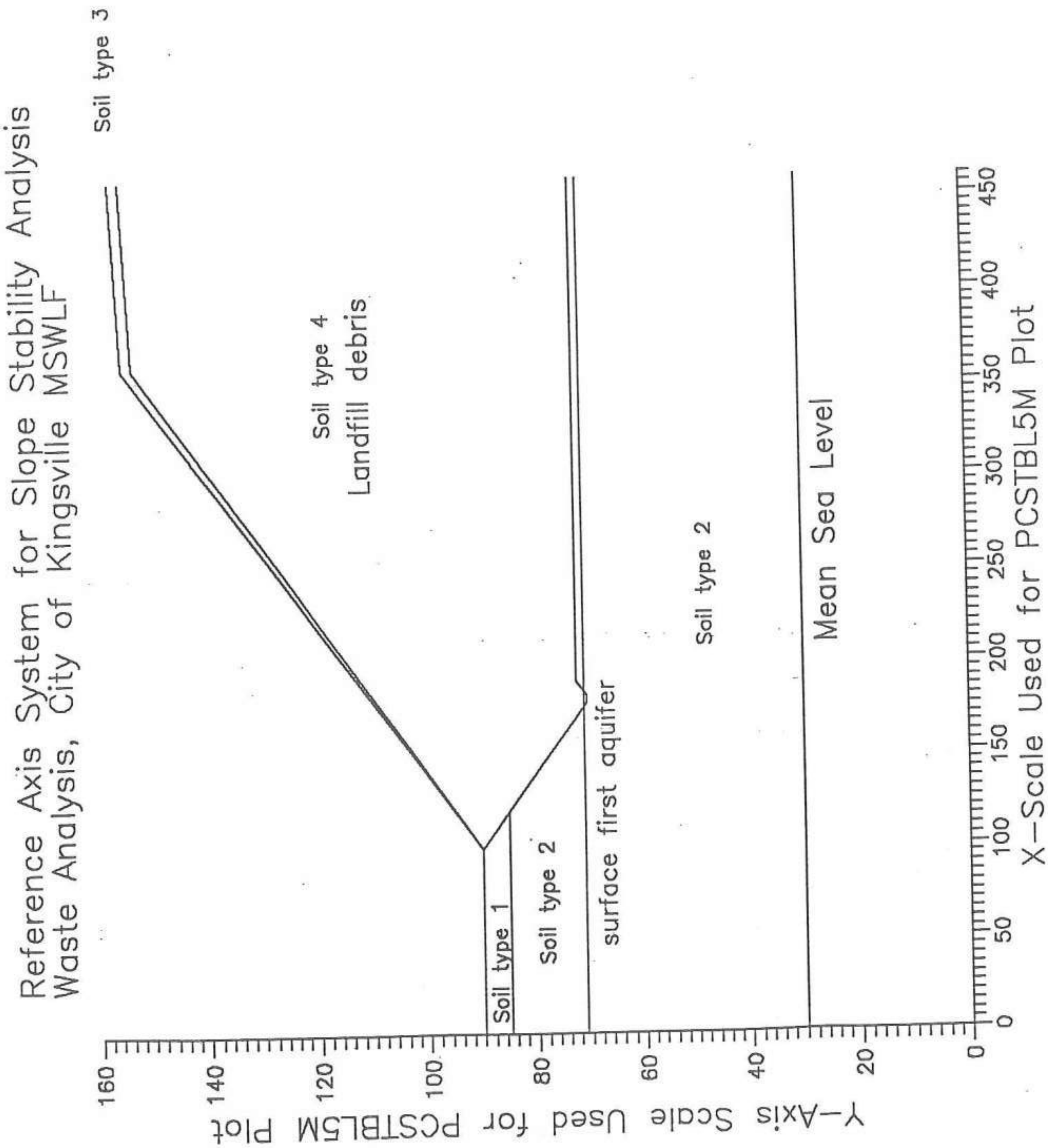
              Y          A     X     I     S          F     T

                .00    27.50    55.00    82.50   110.00   137.50

X     .00 +---------+---------+-----*---+---------+---------+
          -                          ..
          -                          .  .
          -                          . .
          -                          . .1
          -                          . .*
    27.50 +                         ..11*
          -                         .117*
          -                         1704*
          -                         1.44.
          -                        71.4.96
          -                       7.11..69.
A   55.00 +                      7 .14..6.8
          -                      7.014.6.89
          -                      77.116889..
          -                     ..70.618.9...
          -                     .7.0.61.9....*
          -                   ...70..4411.....
X   82.50 +                  ... 70..46.111...
          -                  . .7.0..4469..11.
          -                  . .7..0...449..11 *
          -                   ..7..00...466..1
          -                     77.0.....4.661
          -                      .770....44461
I  110.00 +                      ..77000000.4144
          -                        .7.. ....0911
          -                        ..77.......68
          -                        ....777.....6
          -                        ......77...9.
          -                          ......777.9
S  137.50 +                            ......7..
          -                              .....77
          -                                 ....
          -
          -
          -
  165.00 +
          -
          -
          -
          -
          -
F  192.50 +
          -
          -
          -
          -
          -
T  220.00 +                           W    * *
```

H-62


Reference Axis System for Slope Stability Analysis
Waste Analysis, City of Kingsville MSWLF
Soil type 3
Soil type 4
Landfill debris
Soil type 2
Mean Sea Level
Soil type 1
Soil type 2
surface first aquifer
X–Scale Used for PCSTBL5M Plot
Y–Axis Scale Used for PCSTBL5M Plot
0
50
100
150
200
250
300
350
400
450
0
20
40
60
80
100
120
140
160

H-63

64/129

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	6/23/98
Time of Run:	3
Run By:	JOS
Input Data Filename:	kmsw24.in
Output Filename:	kmsw24.out
Unit:	ENGLISH

City of Kingsville, Texas Municipal Solid Waste Landfill
Permit Application 235-B
[Slope Stability Analysis (4:1 slope)]
Landfill (with Cover) Slope Stability Analysis

BOUNDARY COORDINATES

3 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	90.00	100.00	90.00	1
2	100.00	90.00	360.00	155.00	3
3	360.00	155.00	460.00	157.00	3
4	100.00	90.00	360.00	153.00	4
5	360.00	153.00	460.00	155.00	4
6	100.00	90.00	120.00	85.00	1
7	.00	85.00	120.00	85.00	2
8	120.00	85.00	170.00	72.50	2
9	170.00	72.50	178.00	70.50	2
10	178.00	70.50	182.00	70.50	2
11	182.00	70.50	190.00	72.50	2
12	190.00	72.50	460.00	72.50	2

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	86.8	99.6	.0	.0	.00	.0	1
2	94.5	112.1	200.0	24.0	.00	.0	1
3	90.0	105.0	200.0	21.0	.00	.0	1
4	30.0	32.0	1000.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	71.00
2	460.00	71.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

Janbus Empirical Coef. is being used for the case of c & phi both > 0
900 Trial Surfaces Have Been Generated.

30 Surfaces Initiate From Each Of 30 Points Equally Spaced
Along The Ground Surface Between X = .00 ft.
and X = 150.00 ft.

Each Surface Terminates Between X = 200.00 ft.
and X = 460.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 72 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.86
2	107.60	88.07
3	111.81	85.37
4	116.08	82.77
5	120.41	80.28
6	124.80	77.88
7	129.24	75.59
8	133.74	73.40
9	138.28	71.31
10	142.87	69.33
11	147.51	67.46
12	152.19	65.70
13	156.91	64.05
14	161.66	62.50
15	166.45	61.07
16	171.28	59.75
17	176.13	58.54
18	181.01	57.45
19	185.91	56.47
20	190.83	55.60
21	195.78	54.85
22	200.74	54.21
23	205.71	53.69
24	210.69	53.29
25	215.68	53.00
26	220.68	52.83
27	225.68	52.77
28	230.68	52.83
29	235.68	53.00
30	240.67	53.30
31	245.65	53.70
32	250.63	54.23
33	255.58	54.87
34	260.53	55.62
35	265.45	56.49
36	270.35	57.47
37	275.23	58.57
38	280.08	59.78
39	284.90	61.10
40	289.69	62.54

41	294.45	64.09
42	299.17	65.74
43	303.85	67.51
44	308.48	69.38
45	313.07	71.36
46	317.62	73.45
47	322.11	75.64
48	326.55	77.94
49	330.94	80.33
50	335.27	82.83
51	339.54	85.43
52	343.75	88.13
53	347.89	90.93
54	351.97	93.82
55	355.98	96.81
56	359.92	99.88
57	363.79	103.05
58	367.58	106.31
59	371.30	109.66
60	374.94	113.09
61	378.49	116.60
62	381.97	120.20
63	385.36	123.87
64	388.66	127.63
65	391.87	131.46
66	395.00	135.36
67	398.03	139.34
68	400.97	143.38
69	403.82	147.49
70	406.56	151.67
71	409.21	155.91
72	409.26	155.99

*** 4.769 ***

Individual data on the 86 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	4.0	239.7	.0	.0	.0	.0	.0	.0	.0
3	.1	9.1	.0	.0	.0	.0	.0	.0	.0
4	4.2	943.8	.0	.0	.0	.0	.0	.0	.0
5	.6	209.5	.0	.0	.0	.0	.0	.0	.0
6	3.7	1648.1	.0	.0	.0	.0	.0	.0	.0
7	3.9	2504.5	.0	.0	.0	.0	.0	.0	.0
8	.4	304.4	.0	.0	.0	.0	.0	.0	.0
9	4.4	3719.4	.0	.0	.0	.0	.0	.0	.0
10	4.4	4590.0	.0	.0	.0	.0	.0	.0	.0
11	4.5	5432.1	.0	.0	.0	.0	.0	.0	.0
12	4.5	6242.3	.0	.0	.0	.0	.0	.0	.0
13	.7	1063.3	.0	.0	.0	.0	.0	.0	.0

14	3.9	6010.8	.0	218.8	.0	.0	.0	.0	.0
15	4.6	7966.7	.0	811.5	.0	.0	.0	.0	.0
16	4.7	8814.3	.0	1378.4	.0	.0	.0	.0	.0
17	4.7	9611.6	.0	1911.2	.0	.0	.0	.0	.0
18	4.8	10355.4	.0	2409.8	.0	.0	.0	.0	.0
19	4.8	11043.0	.0	2874.0	.0	.0	.0	.0	.0
20	3.5	8531.1	.0	2388.9	.0	.0	.0	.0	.0
21	1.3	3140.4	.0	914.5	.0	.0	.0	.0	.0
22	4.7	11908.5	.0	3594.9	.0	.0	.0	.0	.0
23	.1	330.0	.0	102.8	.0	.0	.0	.0	.0
24	1.9	4832.3	.0	1515.9	.0	.0	.0	.0	.0
25	3.0	7951.2	.0	2540.9	.0	.0	.0	.0	.0
26	1.0	2689.5	.0	862.3	.0	.0	.0	.0	.0
27	2.0	5548.8	.0	1775.3	.0	.0	.0	.0	.0
28	1.9	5480.4	.0	1743.0	.0	.0	.0	.0	.0
29	4.1	12283.2	.0	3858.6	.0	.0	.0	.0	.0
30	.8	2590.3	.0	810.1	.0	.0	.0	.0	.0
31	4.9	15708.2	.0	4921.2	.0	.0	.0	.0	.0
32	5.0	16340.9	.0	5137.8	.0	.0	.0	.0	.0
33	5.0	16904.5	.0	5318.3	.0	.0	.0	.0	.0
34	5.0	17397.4	.0	5462.8	.0	.0	.0	.0	.0
35	5.0	17818.1	.0	5571.2	.0	.0	.0	.0	.0
36	5.0	18165.5	.0	5643.3	.0	.0	.0	.0	.0
37	5.0	18438.6	.0	5679.1	.0	.0	.0	.0	.0
38	5.0	18636.7	.0	5678.7	.0	.0	.0	.0	.0
39	5.0	18759.4	.0	5642.0	.0	.0	.0	.0	.0
40	5.0	18806.6	.0	5569.0	.0	.0	.0	.0	.0
41	5.0	18778.3	.0	5459.8	.0	.0	.0	.0	.0
42	5.0	18674.9	.0	5314.5	.0	.0	.0	.0	.0
43	5.0	18496.9	.0	5133.1	.0	.0	.0	.0	.0
44	4.9	18245.2	.0	4915.7	.0	.0	.0	.0	.0
45	4.9	17920.8	.0	4662.4	.0	.0	.0	.0	.0
46	4.9	17525.0	.0	4373.4	.0	.0	.0	.0	.0
47	4.9	17059.6	.0	4048.8	.0	.0	.0	.0	.0
48	4.9	16526.1	.0	3688.8	.0	.0	.0	.0	.0
49	4.8	15926.8	.0	3293.6	.0	.0	.0	.0	.0
50	4.8	15263.9	.0	2863.5	.0	.0	.0	.0	.0
51	4.8	14539.7	.0	2398.5	.0	.0	.0	.0	.0
52	4.7	13757.2	.0	1899.1	.0	.0	.0	.0	.0
53	4.7	12919.2	.0	1365.4	.0	.0	.0	.0	.0
54	4.6	12028.7	.0	797.8	.0	.0	.0	.0	.0
55	3.8	9135.2	.0	206.8	.0	.0	.0	.0	.0
56	.8	1956.8	.0	.0	.0	.0	.0	.0	.0
57	2.5	5669.7	.0	.0	.0	.0	.0	.0	.0
58	2.1	4609.9	.0	.0	.0	.0	.0	.0	.0
59	4.5	9950.1	.0	.0	.0	.0	.0	.0	.0
60	4.4	9693.4	.0	.0	.0	.0	.0	.0	.0
61	4.4	9419.5	.0	.0	.0	.0	.0	.0	.0
62	4.3	9129.3	.0	.0	.0	.0	.0	.0	.0
63	4.3	8823.7	.0	.0	.0	.0	.0	.0	.0
64	4.2	8503.9	.0	.0	.0	.0	.0	.0	.0
65	4.1	8171.0	.0	.0	.0	.0	.0	.0	.0
66	4.1	7826.1	.0	.0	.0	.0	.0	.0	.0
67	4.0	7470.6	.0	.0	.0	.0	.0	.0	.0
68	3.9	7105.6	.0	.0	.0	.0	.0	.0	.0
69	.1	135.6	.0	.0	.0	.0	.0	.0	.0
70	3.8	6543.8	.0	.0	.0	.0	.0	.0	.0

71	3.8	6193.4	.0	.0	.0	.0	.0	.0	.0
72	3.7	5708.3	.0	.0	.0	.0	.0	.0	.0
73	3.6	5225.6	.0	.0	.0	.0	.0	.0	.0
74	3.6	4746.7	.0	.0	.0	.0	.0	.0	.0
75	3.5	4273.1	.0	.0	.0	.0	.0	.0	.0
76	3.4	3806.4	.0	.0	.0	.0	.0	.0	.0
77	3.3	3347.8	.0	.0	.0	.0	.0	.0	.0
78	3.2	2899.0	.0	.0	.0	.0	.0	.0	.0
79	3.1	2461.4	.0	.0	.0	.0	.0	.0	.0
80	3.0	2036.4	.0	.0	.0	.0	.0	.0	.0
81	2.9	1625.4	.0	.0	.0	.0	.0	.0	.0
82	2.8	1229.9	.0	.0	.0	.0	.0	.0	.0
83	2.7	851.1	.0	.0	.0	.0	.0	.0	.0
84	1.4	306.3	.0	.0	.0	.0	.0	.0	.0
85	1.2	113.8	.0	.0	.0	.0	.0	.0	.0
86	.0	.2	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 77 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.86
2	107.49	87.92
3	111.60	85.08
4	115.77	82.32
5	120.01	79.65
6	124.29	77.08
7	128.64	74.61
8	133.03	72.23
9	137.48	69.94
10	141.98	67.76
11	146.52	65.67
12	151.11	63.69
13	155.75	61.81
14	160.42	60.02
15	165.13	58.35
16	169.87	56.77
17	174.65	55.30
18	179.46	53.94
19	184.30	52.68
20	189.17	51.53
21	194.06	50.49
22	198.97	49.55
23	203.90	48.73
24	208.85	48.01
25	213.81	47.40
26	218.79	46.90
27	223.77	46.51
28	228.76	46.23
29	233.76	46.05
30	238.76	45.99
31	243.76	46.04
32	248.76	46.20
33	253.75	46.47
34	258.74	46.85

76/124

35	263.71	47.34
36	268.68	47.93
37	273.63	48.64
38	278.56	49.45
39	283.47	50.38
40	288.37	51.41
41	293.24	52.55
42	298.08	53.79
43	302.89	55.14
44	307.67	56.60
45	312.42	58.16
46	317.14	59.83
47	321.82	61.60
48	326.45	63.47
49	331.05	65.44
50	335.60	67.51
51	340.10	69.69
52	344.55	71.96
53	348.96	74.33
54	353.31	76.79
55	357.60	79.35
56	361.84	82.01
57	366.02	84.75
58	370.13	87.59
59	374.19	90.52
60	378.17	93.54
61	382.09	96.64
62	385.95	99.83
63	389.73	103.10
64	393.43	106.45
65	397.07	109.89
66	400.62	113.41
67	404.10	117.00
68	407.50	120.67
69	410.82	124.41
70	414.05	128.22
71	417.20	132.10
72	420.26	136.06
73	423.24	140.07
74	426.12	144.16
75	428.92	148.30
76	431.62	152.51
77	434.05	156.48

*** 4.901 ***

Failure Surface Specified By 82 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.86
2	107.65	88.15
3	111.90	85.52
4	116.20	82.97
5	120.55	80.50
6	124.95	78.12
7	129.39	75.82
8	133.87	73.61
9	138.40	71.48
10	142.96	69.45
11	147.57	67.49
12	152.21	65.63
13	156.88	63.86
14	161.59	62.17
15	166.33	60.58
16	171.10	59.07
17	175.89	57.66
18	180.72	56.34
19	185.56	55.12
20	190.43	53.98
21	195.32	52.94
22	200.23	51.99
23	205.16	51.14
24	210.10	50.38
25	215.06	49.72
26	220.02	49.15
27	225.00	48.68
28	229.99	48.30
29	234.98	48.02
30	239.98	47.83
31	244.98	47.74
32	249.98	47.74
33	254.97	47.84
34	259.97	48.04
35	264.96	48.33
36	269.95	48.71
37	274.92	49.20
38	279.89	49.77
39	284.85	50.45
40	289.79	51.21
41	294.71	52.07
42	299.62	53.03
43	304.51	54.08
44	309.38	55.22
45	314.22	56.45
46	319.04	57.78
47	323.84	59.20
48	328.60	60.71
49	333.34	62.31
50	338.04	64.01
51	342.72	65.79

52	347.35	67.66
53	351.95	69.62
54	356.51	71.67
55	361.04	73.80
56	365.52	76.02
57	369.95	78.32
58	374.34	80.71
59	378.69	83.19
60	382.99	85.74
61	387.23	88.38
62	391.43	91.10
63	395.57	93.90
64	399.66	96.78
65	403.70	99.73
66	407.67	102.76
67	411.59	105.87
68	415.45	109.05
69	419.24	112.31
70	422.98	115.63
71	426.64	119.03
72	430.25	122.50
73	433.78	126.03
74	437.25	129.64
75	440.65	133.30
76	443.97	137.04
77	447.23	140.83
78	450.41	144.69
79	453.52	148.61
80	456.55	152.58
81	459.50	156.62
82	459.77	157.00

*** 4.942 ***

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	113.79	93.45
2	118.23	91.13
3	122.71	88.91
4	127.23	86.79
5	131.80	84.76
6	136.41	82.82
7	141.06	80.99
8	145.75	79.25
9	150.47	77.61
10	155.23	76.07
11	160.02	74.63
12	164.84	73.29
13	169.68	72.05
14	174.55	70.91
15	179.44	69.88

73/129

16	184.35	68.95
17	189.28	68.12
18	194.23	67.40
19	199.19	66.78
20	204.17	66.26
21	209.15	65.85
22	214.14	65.54
23	219.14	65.34
24	224.14	65.25
25	229.14	65.25
26	234.13	65.37
27	239.13	65.58
28	244.12	65.91
29	249.10	66.33
30	254.07	66.86
31	259.03	67.50
32	263.98	68.24
33	268.91	69.08
34	273.81	70.03
35	278.70	71.08
36	283.57	72.23
37	288.41	73.48
38	293.22	74.84
39	298.01	76.29
40	302.76	77.85
41	307.48	79.50
42	312.16	81.26
43	316.80	83.11
44	321.41	85.06
45	325.97	87.10
46	330.49	89.24
47	334.96	91.48
48	339.39	93.80
49	343.76	96.22
50	348.09	98.73
51	352.36	101.34
52	356.57	104.03
53	360.73	106.80
54	364.83	109.67
55	368.86	112.62
56	372.84	115.65
57	376.75	118.77
58	380.59	121.97
59	384.37	125.25
60	388.07	128.60
61	391.71	132.04
62	395.27	135.55
63	398.75	139.13
64	402.17	142.78
65	405.50	146.51
66	408.75	150.31
67	411.93	154.17
68	413.42	156.07

*** 4.942 ***

H-73

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.97	94.74
2	122.55	91.25
3	126.23	87.87
4	130.02	84.60
5	133.90	81.45
6	137.87	78.42
7	141.94	75.51
8	146.09	72.73
9	150.33	70.07
10	154.64	67.54
11	159.03	65.14
12	163.49	62.88
13	168.01	60.76
14	172.60	58.77
15	177.25	56.92
16	181.95	55.21
17	186.70	53.65
18	191.49	52.23
19	196.33	50.96
20	201.20	49.83
21	206.10	48.85
22	211.03	48.02
23	215.99	47.34
24	220.96	46.82
25	225.94	46.44
26	230.94	46.21
27	235.94	46.14
28	240.94	46.21
29	245.93	46.44
30	250.92	46.82
31	255.89	47.35
32	260.84	48.03
33	265.77	48.86
34	270.68	49.84
35	275.55	50.97
36	280.38	52.24
37	285.18	53.66
38	289.93	55.23
39	294.62	56.94
40	299.27	58.79
41	303.86	60.77
42	308.38	62.90
43	312.84	65.17
44	317.23	67.56
45	321.54	70.09
46	325.77	72.75
47	329.93	75.54
48	333.99	78.45
49	337.97	81.48
50	341.85	84.63

75/129

51	345.63	87.90
52	349.32	91.28
53	352.90	94.77
54	356.37	98.37
55	359.73	102.07
56	362.98	105.88
57	366.11	109.77
58	369.12	113.77
59	372.01	117.85
60	374.77	122.01
61	377.41	126.26
62	379.92	130.59
63	382.29	134.99
64	384.53	139.46
65	386.63	143.99
66	388.60	148.59
67	390.42	153.25
68	391.28	155.63

*** 4.954 ***

Failure Surface Specified By 80 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	93.10	90.00
2	97.42	87.48
3	101.79	85.05
4	106.20	82.69
5	110.65	80.42
6	115.15	78.23
7	119.68	76.12
8	124.25	74.10
9	128.86	72.16
10	133.51	70.31
11	138.19	68.54
12	142.90	66.86
13	147.64	65.27
14	152.41	63.77
15	157.20	62.35
16	162.02	61.03
17	166.87	59.79
18	171.73	58.65
19	176.62	57.59
20	181.53	56.63
21	186.45	55.76
22	191.39	54.97
23	196.34	54.28
24	201.31	53.69
25	206.28	53.18
26	211.26	52.77

76/129

27	216.25	52.44
28	221.25	52.21
29	226.25	52.08
30	231.25	52.03
31	236.24	52.08
32	241.24	52.22
33	246.24	52.46
34	251.23	52.79
35	256.21	53.20
36	261.18	53.72
37	266.15	54.32
38	271.10	55.01
39	276.04	55.80
40	280.96	56.68
41	285.86	57.65
42	290.75	58.71
43	295.62	59.86
44	300.46	61.10
45	305.28	62.43
46	310.07	63.85
47	314.84	65.36
48	319.58	66.95
49	324.29	68.63
50	328.96	70.40
51	333.61	72.26
52	338.21	74.20
53	342.78	76.23
54	347.32	78.34
55	351.81	80.54
56	356.26	82.82
57	360.67	85.18
58	365.03	87.62
59	369.35	90.14
60	373.62	92.74
61	377.84	95.42
62	382.01	98.18
63	386.13	101.01
64	390.19	103.92
65	394.20	106.91
66	398.16	109.97
67	402.06	113.10
68	405.90	116.31
69	409.67	119.58
70	413.39	122.92
71	417.05	126.34
72	420.64	129.81
73	424.16	133.36
74	427.62	136.97
75	431.02	140.64
76	434.34	144.38
77	437.59	148.17
78	440.78	152.03
79	443.89	155.95
80	444.45	156.69

*** 4.955 ***

77/129

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	108.62	92.16
2	112.40	88.88
3	116.26	85.71
4	120.22	82.65
5	124.26	79.71
6	128.39	76.89
7	132.60	74.18
8	136.88	71.60
9	141.23	69.15
10	145.66	66.82
11	150.15	64.61
12	154.70	62.54
13	159.31	60.60
14	163.97	58.80
15	168.68	57.13
16	173.44	55.59
17	178.24	54.20
18	183.08	52.94
19	187.95	51.82
20	192.86	50.85
21	197.79	50.01
22	202.74	49.32
23	207.71	48.77
24	212.69	48.36
25	217.69	48.10
26	222.69	47.98
27	227.69	48.01
28	232.68	48.18
29	237.67	48.49
30	242.65	48.95
31	247.62	49.55
32	252.56	50.29
33	257.48	51.18
34	262.37	52.21
35	267.24	53.37
36	272.06	54.68
37	276.85	56.13
38	281.59	57.71
39	286.29	59.43
40	290.93	61.28
41	295.52	63.27
42	300.05	65.39
43	304.51	67.64
44	308.91	70.01
45	313.24	72.51
46	317.50	75.14
47	321.68	77.88
48	325.77	80.75
49	329.79	83.73

50	333.71	86.83
51	337.55	90.04
52	341.29	93.36
53	344.93	96.78
54	348.47	100.31
55	351.91	103.94
56	355.25	107.66
57	358.47	111.48
58	361.59	115.40
59	364.59	119.40
60	367.47	123.48
61	370.23	127.65
62	372.88	131.89
63	375.40	136.21
64	377.79	140.60
65	380.06	145.06
66	382.20	149.58
67	384.20	154.16
68	384.74	155.49

*** 4.959 ***

Failure Surface Specified By 67 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	129.31	97.33
2	132.90	93.85
3	136.60	90.48
4	140.39	87.23
5	144.29	84.09
6	148.28	81.08
7	152.36	78.18
8	156.52	75.42
9	160.77	72.78
10	165.09	70.27
11	169.50	67.90
12	173.97	65.66
13	178.50	63.56
14	183.10	61.60
15	187.76	59.78
16	192.47	58.10
17	197.23	56.57
18	202.03	55.19
19	206.88	53.95
20	211.76	52.86
21	216.67	51.92
22	221.61	51.13
23	226.57	50.49
24	231.54	50.00
25	236.53	49.67

79/129

26	241.53	49.49
27	246.53	49.46
28	251.53	49.58
29	256.52	49.86
30	261.50	50.29
31	266.47	50.87
32	271.41	51.60
33	276.33	52.48
34	281.23	53.51
35	286.08	54.69
36	290.90	56.02
37	295.68	57.50
38	300.41	59.12
39	305.09	60.89
40	309.71	62.79
41	314.27	64.84
42	318.77	67.02
43	323.20	69.35
44	327.55	71.80
45	331.83	74.39
46	336.03	77.11
47	340.14	79.95
48	344.17	82.92
49	348.10	86.01
50	351.93	89.22
51	355.67	92.54
52	359.30	95.98
53	362.82	99.53
54	366.24	103.18
55	369.54	106.93
56	372.73	110.79
57	375.79	114.74
58	378.74	118.78
59	381.56	122.91
60	384.25	127.12
61	386.81	131.41
62	389.24	135.78
63	391.54	140.22
64	393.69	144.73
65	395.71	149.31
66	397.59	153.94
67	398.27	155.77

*** 4.965 ***

80/129

Failure Surface Specified By 76 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	113.79	93.45
2	118.22	91.13
3	122.70	88.90
4	127.21	86.74
5	131.76	84.67
6	136.35	82.68
7	140.97	80.78
8	145.63	78.96
9	150.32	77.22
10	155.04	75.57
11	159.79	74.01
12	164.56	72.53
13	169.36	71.14
14	174.19	69.83
15	179.04	68.62
16	183.91	67.49
17	188.80	66.45
18	193.71	65.50
19	198.64	64.64
20	203.58	63.87
21	208.53	63.18
22	213.50	62.59
23	218.47	62.09
24	223.45	61.68
25	228.44	61.36
26	233.44	61.13
27	238.44	60.99
28	243.44	60.94
29	248.44	60.98
30	253.43	61.11
31	258.43	61.34
32	263.42	61.65
33	268.40	62.06
34	273.38	62.55
35	278.34	63.14
36	283.30	63.81
37	288.24	64.57
38	293.17	65.43
39	298.08	66.37
40	302.97	67.40
41	307.84	68.53
42	312.69	69.74
43	317.52	71.03
44	322.33	72.42
45	327.10	73.89
46	331.86	75.45
47	336.58	77.09
48	341.27	78.82
49	345.93	80.63
50	350.55	82.53
51	355.14	84.51

81/129

52	359.70	86.58
53	364.21	88.73
54	368.69	90.95
55	373.12	93.26
56	377.52	95.65
57	381.86	98.12
58	386.17	100.67
59	390.42	103.30
60	394.63	106.00
61	398.79	108.78
62	402.89	111.63
63	406.95	114.56
64	410.95	117.56
65	414.89	120.63
66	418.78	123.77
67	422.61	126.98
68	426.38	130.27
69	430.09	133.62
70	433.74	137.03
71	437.33	140.52
72	440.86	144.06
73	444.31	147.67
74	447.71	151.35
75	451.03	155.08
76	452.56	156.85

*** 4.966 ***

Failure Surface Specified By 67 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.97	94.74
2	123.27	92.20
3	127.64	89.77
4	132.06	87.43
5	136.54	85.20
6	141.06	83.07
7	145.63	81.05
8	150.25	79.13
9	154.91	77.33
10	159.61	75.62
11	164.35	74.03
12	169.13	72.55
13	173.94	71.18
14	178.78	69.92
15	183.64	68.77
16	188.54	67.74
17	193.45	66.82
18	198.38	66.01
19	203.34	65.32
20	208.30	64.74

82/129

21	213.28	64.27
22	218.27	63.93
23	223.26	63.69
24	228.26	63.58
25	233.26	63.58
26	238.26	63.69
27	243.26	63.92
28	248.24	64.26
29	253.22	64.72
30	258.19	65.30
31	263.14	65.99
32	268.08	66.79
33	272.99	67.71
34	277.88	68.74
35	282.75	69.89
36	287.59	71.14
37	292.40	72.51
38	297.18	73.99
39	301.92	75.58
40	306.62	77.28
41	311.28	79.08
42	315.90	81.00
43	320.48	83.02
44	325.00	85.14
45	329.48	87.37
46	333.90	89.70
47	338.27	92.14
48	342.58	94.67
49	346.83	97.30
50	351.02	100.03
51	355.14	102.86
52	359.20	105.78
53	363.19	108.79
54	367.11	111.90
55	370.95	115.10
56	374.72	118.38
57	378.42	121.75
58	382.03	125.20
59	385.57	128.74
60	389.02	132.36
61	392.39	136.05
62	395.67	139.83
63	398.86	143.68
64	401.96	147.60
65	404.97	151.59
66	407.89	155.65
67	408.10	155.96

*** 4.983 ***

83/129

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                  Y          A    X    I    S       F    T

                 .00    57.50  115.00   172.50   230.00   287.50

X        .00 +---------+-W--**---+---------+---------+---------+
             -            ...
             -          .....
             -         ......
             -        .......
             -       ........
      57.50  +      .........
             -     ..........
             -    ...........
             -    ...........
             -   ...........6*
             -  ...........611
A    115.00  +  ..........6114
             - ...........11*58
             - ..........11448.
             - .........21548...
             - .........1548....
             - .........2184.....
X    172.50  + .........154*......
             -.........218*.......
             -.........2194*.......
             -........21894........
             -........21.4..........
             -........21.4..........
I    230.00  +........21.4...........
             - .......21.4...........
             - .......21.94..........
             - .......26194...........
             -  ......25194...........
             -  ......22194............
S    287.50  +  .......25104...........
             -   ......25194...........
             -   .....325104...........
             -    .....25114...........
             -     ....3251144.:........
             -     .....226114..........
     345.00  +      ....3326114.........
             -       ....32291147........
             -        ....322911447.....*
             -         ....3226.114577...
             -          ...33.26..1155577
             -           ....3.22..111855
F    402.50  +            ....3.62...1118
             -              ...33922...41
             -               ....3.6222..
             -                 ...3396622
             -                   ...33966
             -                      .3339
T    460.00  +          W*             .*
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** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	6/22/98
Time of Run:	3
Run By:	JOS
Input Data Filename:	kmsw23.in
Output Filename:	kmsw23f.out
Unit:	ENGLISH

City of Kingsville, Texas Municipal Solid Waste Landfill
Permit Application 235-B
[Slope Stability Analysis (4:1 slope) ϕ = 10°]
Landfill (with Cover) Slope Stability Analysis

BOUNDARY COORDINATES

3 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	90.00	100.00	90.00	1
2	100.00	90.00	360.00	155.00	3
3	360.00	155.00	460.00	157.00	3
4	100.00	90.00	360.00	153.00	4
5	360.00	153.00	460.00	155.00	4
6	100.00	90.00	120.00	85.00	1
7	.00	85.00	120.00	85.00	2
8	120.00	85.00	170.50	72.50	2
9	170.50	72.50	178.00	70.50	2
10	178.00	70.50	182.00	70.50	2
11	182.00	70.50	190.00	72.50	2
12	190.00	72.50	460.00	72.50	2

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	86.8	99.6	.0	.0	.00	.0	1
2	94.5	112.1	200.0	21.0	.00	.0	1
3	90.0	105.0	200.0	10.0	.00	.0	1
4	30.0	32.0	1000.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	71.00
2	460.00	71.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

Janbus Empirical Coef. is being used for the case of c & phi both > 0
900 Trial Surfaces Have Been Generated.

30 Surfaces Initiate From Each Of 30 Points Equally Spaced Along The Ground Surface Between X = .00 ft.
and X = 150.00 ft.

Each Surface Terminates Between X = 200.00 ft.
and X = 460.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 72 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.86
2	107.60	88.07
3	111.81	85.37
4	116.08	82.77
5	120.41	80.28
6	124.80	77.88
7	129.24	75.59
8	133.74	73.40
9	138.28	71.31
10	142.87	69.33
11	147.51	67.46
12	152.19	65.70
13	156.91	64.05
14	161.66	62.50
15	166.45	61.07
16	171.28	59.75
17	176.13	58.54
18	181.01	57.45
19	185.91	56.47
20	190.83	55.60
21	195.78	54.85
22	200.74	54.21
23	205.71	53.69
24	210.69	53.29
25	215.68	53.00
26	220.68	52.83
27	225.68	52.77
28	230.68	52.83
29	235.68	53.00
30	240.67	53.30
31	245.65	53.70
32	250.63	54.23
33	255.58	54.87
34	260.53	55.62
35	265.45	56.49
36	270.35	57.47
37	275.23	58.57
38	280.08	59.78
39	284.90	61.10
40	289.69	62.54
41	294.45	64.09
42	299.17	65.74
43	303.85	67.51
44	308.48	69.38
45	313.07	71.36
46	317.62	73.45
47	322.11	75.64

48	326.55	77.94
49	330.94	80.33
50	335.27	82.83
51	339.54	85.43
52	343.75	88.13
53	347.89	90.93
54	351.97	93.82
55	355.98	96.81
56	359.92	99.88
57	363.79	103.05
58	367.58	106.31
59	371.30	109.66
60	374.94	113.09
61	378.49	116.60
62	381.97	120.20
63	385.36	123.87
64	388.66	127.63
65	391.87	131.46
66	395.00	135.36
67	398.03	139.34
68	400.97	143.38
69	403.82	147.49
70	406.56	151.67
71	409.21	155.91
72	409.26	155.99

*** 4.490 ***

Individual data on the 86 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	.0	.0	.0	.0	.0	.0	.0	.0	.0
2	4.0	239.7	.0	.0	.0	.0	.0	.0	.0
3	.1	9.1	.0	.0	.0	.0	.0	.0	.0
4	4.2	943.8	.0	.0	.0	.0	.0	.0	.0
5	.6	209.5	.0	.0	.0	.0	.0	.0	.0
6	3.7	1648.1	.0	.0	.0	.0	.0	.0	.0
7	3.9	2504.5	.0	.0	.0	.0	.0	.0	.0
8	.4	304.4	.0	.0	.0	.0	.0	.0	.0
9	4.4	3721.2	.0	.0	.0	.0	.0	.0	.0
10	4.4	4595.0	.0	.0	.0	.0	.0	.0	.0
11	4.5	5440.3	.0	.0	.0	.0	.0	.0	.0
12	4.5	6253.9	.0	.0	.0	.0	.0	.0	.0
13	.7	1065.4	.0	.0	.0	.0	.0	.0	.0
14	3.9	6023.8	.0	218.8	.0	.0	.0	.0	.0
15	4.6	7985.4	.0	811.5	.0	.0	.0	.0	.0
16	4.7	8836.6	.0	1378.4	.0	.0	.0	.0	.0
17	4.7	9637.6	.0	1911.2	.0	.0	.0	.0	.0
18	4.8	10385.3	.0	2409.8	.0	.0	.0	.0	.0
19	4.8	11076.7	.0	2874.0	.0	.0	.0	.0	.0
20	4.0	9788.1	.0	2743.6	.0	.0	.0	.0	.0
21	.8	1920.6	.0	559.7	.0	.0	.0	.0	.0

22	4.8	12252.0	.0	3694.9	.0	.0	.0	.0	.0
23	.0	8.9	.0	2.8	.0	.0	.0	.0	.0
24	1.9	4834.7	.0	1515.9	.0	.0	.0	.0	.0
25	3.0	7951.2	.0	2540.9	.0	.0	.0	.0	.0
26	1.0	2689.5	.0	862.3	.0	.0	.0	.0	.0
27	2.0	5548.8	.0	1775.3	.0	.0	.0	.0	.0
28	1.9	5480.4	.0	1743.0	.0	.0	.0	.0	.0
29	4.1	12283.2	.0	3858.6	.0	.0	.0	.0	.0
30	.8	2590.3	.0	810.1	.0	.0	.0	.0	.0
31	4.9	15708.2	.0	4921.2	.0	.0	.0	.0	.0
32	5.0	16340.9	.0	5137.8	.0	.0	.0	.0	.0
33	5.0	16904.5	.0	5318.3	.0	.0	.0	.0	.0
34	5.0	17397.4	.0	5462.8	.0	.0	.0	.0	.0
35	5.0	17818.1	.0	5571.2	.0	.0	.0	.0	.0
36	5.0	18165.5	.0	5643.3	.0	.0	.0	.0	.0
37	5.0	18438.6	.0	5679.1	.0	.0	.0	.0	.0
38	5.0	18636.7	.0	5678.7	.0	.0	.0	.0	.0
39	5.0	18759.4	.0	5642.0	.0	.0	.0	.0	.0
40	5.0	18806.6	.0	5569.0	.0	.0	.0	.0	.0
41	5.0	18778.3	.0	5459.8	.0	.0	.0	.0	.0
42	5.0	18674.9	.0	5314.5	.0	.0	.0	.0	.0
43	5.0	18496.9	.0	5133.1	.0	.0	.0	.0	.0
44	4.9	18245.2	.0	4915.7	.0	.0	.0	.0	.0
45	4.9	17920.8	.0	4662.4	.0	.0	.0	.0	.0
46	4.9	17525.0	.0	4373.4	.0	.0	.0	.0	.0
47	4.9	17059.6	.0	4048.8	.0	.0	.0	.0	.0
48	4.9	16526.1	.0	3688.8	.0	.0	.0	.0	.0
49	4.8	15926.8	.0	3293.6	.0	.0	.0	.0	.0
50	4.8	15263.9	.0	2863.5	.0	.0	.0	.0	.0
51	4.8	14539.7	.0	2398.5	.0	.0	.0	.0	.0
52	4.7	13757.2	.0	1899.1	.0	.0	.0	.0	.0
53	4.7	12919.2	.0	1365.4	.0	.0	.0	.0	.0
54	4.6	12028.7	.0	797.8	.0	.0	.0	.0	.0
55	3.8	9135.2	.0	206.8	.0	.0	.0	.0	.0
56	.8	1956.8	.0	.0	.0	.0	.0	.0	.0
57	2.5	5669.7	.0	.0	.0	.0	.0	.0	.0
58	2.1	4609.9	.0	.0	.0	.0	.0	.0	.0
59	4.5	9950.1	.0	.0	.0	.0	.0	.0	.0
60	4.4	9693.4	.0	.0	.0	.0	.0	.0	.0
61	4.4	9419.5	.0	.0	.0	.0	.0	.0	.0
62	4.3	9129.3	.0	.0	.0	.0	.0	.0	.0
63	4.3	8823.7	.0	.0	.0	.0	.0	.0	.0
64	4.2	8503.9	.0	.0	.0	.0	.0	.0	.0
65	4.1	8171.0	.0	.0	.0	.0	.0	.0	.0
66	4.1	7826.1	.0	.0	.0	.0	.0	.0	.0
67	4.0	7470.6	.0	.0	.0	.0	.0	.0	.0
68	3.9	7105.6	.0	.0	.0	.0	.0	.0	.0
69	.1	135.6	.0	.0	.0	.0	.0	.0	.0
70	3.8	6543.8	.0	.0	.0	.0	.0	.0	.0
71	3.8	6193.4	.0	.0	.0	.0	.0	.0	.0
72	3.7	5708.3	.0	.0	.0	.0	.0	.0	.0
73	3.6	5225.6	.0	.0	.0	.0	.0	.0	.0
74	3.6	4746.7	.0	.0	.0	.0	.0	.0	.0
75	3.5	4273.1	.0	.0	.0	.0	.0	.0	.0
76	3.4	3806.4	.0	.0	.0	.0	.0	.0	.0
77	3.3	3347.8	.0	.0	.0	.0	.0	.0	.0
78	3.2	2899.0	.0	.0	.0	.0	.0	.0	.0

79	3.1	2461.4	.0	.0	.0	.0	.0	.0	.0
80	3.0	2036.4	.0	.0	.0	.0	.0	.0	.0
81	2.9	1625.4	.0	.0	.0	.0	.0	.0	.0
82	2.8	1229.9	.0	.0	.0	.0	.0	.0	.0
83	2.7	851.1	.0	.0	.0	.0	.0	.0	.0
84	1.4	306.3	.0	.0	.0	.0	.0	.0	.0
85	1.2	113.8	.0	.0	.0	.0	.0	.0	.0
86	.0	.2	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 77 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.86
2	107.49	87.92
3	111.60	85.08
4	115.77	82.32
5	120.01	79.65
6	124.29	77.08
7	128.64	74.61
8	133.03	72.23
9	137.48	69.94
10	141.98	67.76
11	146.52	65.67
12	151.11	63.69
13	155.75	61.81
14	160.42	60.02
15	165.13	58.35
16	169.87	56.77
17	174.65	55.30
18	179.46	53.94
19	184.30	52.68
20	189.17	51.53
21	194.06	50.49
22	198.97	49.55
23	203.90	48.73
24	208.85	48.01
25	213.81	47.40
26	218.79	46.90
27	223.77	46.51
28	228.76	46.23
29	233.76	46.05
30	238.76	45.99
31	243.76	46.04
32	248.76	46.20
33	253.75	46.47
34	258.74	46.85
35	263.71	47.34
36	268.68	47.93
37	273.63	48.64
38	278.56	49.45
39	283.47	50.38
40	288.37	51.41
41	293.24	52.55
42	298.08	53.79

43	302.89	55.14
44	307.67	56.60
45	312.42	58.16
46	317.14	59.83
47	321.82	61.60
48	326.45	63.47
49	331.05	65.44
50	335.60	67.51
51	340.10	69.69
52	344.55	71.96
53	348.96	74.33
54	353.31	76.79
55	357.60	79.35
56	361.84	82.01
57	366.02	84.75
58	370.13	87.59
59	374.19	90.52
60	378.17	93.54
61	382.09	96.64
62	385.95	99.83
63	389.73	103.10
64	393.43	106.45
65	397.07	109.89
66	400.62	113.41
67	404.10	117.00
68	407.50	120.67
69	410.82	124.41
70	414.05	128.22
71	417.20	132.10
72	420.26	136.06
73	423.24	140.07
74	426.12	144.16
75	428.92	148.30
76	431.62	152.51
77	434.05	156.48

*** 4.568 ***

Failure Surface Specified By 82 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.86
2	107.65	88.15
3	111.90	85.52
4	116.20	82.97
5	120.55	80.50
6	124.95	78.12
7	129.39	75.82
8	133.87	73.61
9	138.40	71.48
10	142.96	69.45
11	147.57	67.49

H-90

12	152.21	65.63
13	156.88	63.86
14	161.59	62.17
15	166.33	60.58
16	171.10	59.07
17	175.89	57.66
18	180.72	56.34
19	185.56	55.12
20	190.43	53.98
21	195.32	52.94
22	200.23	51.99
23	205.16	51.14
24	210.10	50.38
25	215.06	49.72
26	220.02	49.15
27	225.00	48.68
28	229.99	48.30
29	234.98	48.02
30	239.98	47.83
31	244.98	47.74
32	249.98	47.74
33	254.97	47.84
34	259.97	48.04
35	264.96	48.33
36	269.95	48.71
37	274.92	49.20
38	279.89	49.77
39	284.85	50.45
40	289.79	51.21
41	294.71	52.07
42	299.62	53.03
43	304.51	54.08
44	309.38	55.22
45	314.22	56.45
46	319.04	57.78
47	323.84	59.20
48	328.60	60.71
49	333.34	62.31
50	338.04	64.01
51	342.72	65.79
52	347.35	67.66
53	351.95	69.62
54	356.51	71.67
55	361.04	73.80
56	365.52	76.02
57	369.95	78.32
58	374.34	80.71
59	378.69	83.19
60	382.99	85.74
61	387.23	88.38
62	391.43	91.10
63	395.57	93.90
64	399.66	96.78
65	403.70	99.73
66	407.67	102.76
67	411.59	105.87
68	415.45	109.05

69	419.24	112.31
70	422.98	115.63
71	426.64	119.03
72	430.25	122.50
73	433.78	126.03
74	437.25	129.64
75	440.65	133.30
76	443.97	137.04
77	447.23	140.83
78	450.41	144.69
79	453.52	148.61
80	456.55	152.58
81	459.50	156.62
82	459.77	157.00

*** 4.610 ***

Failure Surface Specified By 80 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	93.10	90.00
2	97.42	87.48
3	101.79	85.05
4	106.20	82.69
5	110.65	80.42
6	115.15	78.23
7	119.68	76.12
8	124.25	74.10
9	128.86	72.16
10	133.51	70.31
11	138.19	68.54
12	142.90	66.86
13	147.64	65.27
14	152.41	63.77
15	157.20	62.35
16	162.02	61.03
17	166.87	59.79
18	171.73	58.65
19	176.62	57.59
20	181.53	56.63
21	186.45	55.76
22	191.39	54.97
23	196.34	54.28
24	201.31	53.69
25	206.28	53.18
26	211.26	52.77
27	216.25	52.44
28	221.25	52.21
29	226.25	52.08
30	231.25	52.03
31	236.24	52.08
32	241.24	52.22

33	246.24	52.46
34	251.23	52.79
35	256.21	53.20
36	261.18	53.72
37	266.15	54.32
38	271.10	55.01
39	276.04	55.80
40	280.96	56.68
41	285.86	57.65
42	290.75	58.71
43	295.62	59.86
44	300.46	61.10
45	305.28	62.43
46	310.07	63.85
47	314.84	65.36
48	319.58	66.95
49	324.29	68.63
50	328.96	70.40
51	333.61	72.26
52	338.21	74.20
53	342.78	76.23
54	347.32	78.34
55	351.81	80.54
56	356.26	82.82
57	360.67	85.18
58	365.03	87.62
59	369.35	90.14
60	373.62	92.74
61	377.84	95.42
62	382.01	98.18
63	386.13	101.01
64	390.19	103.92
65	394.20	106.91
66	398.16	109.97
67	402.06	113.10
68	405.90	116.31
69	409.67	119.58
70	413.39	122.92
71	417.05	126.34
72	420.64	129.81
73	424.16	133.36
74	427.62	136.97
75	431.02	140.64
76	434.34	144.38
77	437.59	148.17
78	440.78	152.03
79	443.89	155.95
80	444.45	156.69

*** 4.646 ***

Failure Surface Specified By 77 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	113.79	93.45
2	117.51	90.11
3	121.32	86.86
4	125.20	83.71
5	129.16	80.66
6	133.19	77.71
7	137.30	74.85
8	141.48	72.11
9	145.72	69.46
10	150.03	66.92
11	154.40	64.50
12	158.83	62.18
13	163.32	59.97
14	167.86	57.87
15	172.45	55.89
16	177.09	54.02
17	181.77	52.27
18	186.49	50.64
19	191.26	49.13
20	196.06	47.73
21	200.90	46.45
22	205.76	45.30
23	210.65	44.27
24	215.57	43.36
25	220.51	42.57
26	225.46	41.90
27	230.43	41.36
28	235.42	40.94
29	240.41	40.65
30	245.40	40.48
31	250.40	40.44
32	255.40	40.52
33	260.40	40.73
34	265.39	41.06
35	270.37	41.51
36	275.33	42.09
37	280.28	42.79
38	285.22	43.62
39	290.12	44.56
40	295.01	45.63
41	299.87	46.82
42	304.69	48.14
43	309.48	49.57
44	314.23	51.12
45	318.95	52.79
46	323.62	54.57
47	328.24	56.47
48	332.82	58.49
49	337.34	60.62
50	341.81	62.86
51	346.22	65.21
52	350.58	67.67
53	354.87	70.24
54	359.09	72.92

55	363.25	75.70
56	367.33	78.58
57	371.34	81.56
58	375.28	84.64
59	379.14	87.82
60	382.92	91.10
61	386.61	94.46
62	390.23	97.92
63	393.75	101.47
64	397.18	105.11
65	400.52	108.82
66	403.77	112.63
67	406.93	116.51
68	409.98	120.46
69	412.94	124.50
70	415.79	128.60
71	418.54	132.78
72	421.19	137.02
73	423.73	141.33
74	426.16	145.70
75	428.48	150.13
76	430.69	154.61
77	431.53	156.43

*** 4.655 ***

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.97	94.74
2	122.55	91.25
3	126.23	87.87
4	130.02	84.60
5	133.90	81.45
6	137.87	78.42
7	141.94	75.51
8	146.09	72.73
9	150.33	70.07
10	154.64	67.54
11	159.03	65.14
12	163.49	62.88
13	168.01	60.76
14	172.60	58.77
15	177.25	56.92
16	181.95	55.21
17	186.70	53.65
18	191.49	52.23
19	196.33	50.96
20	201.20	49.83
21	206.10	48.85
22	211.03	48.02

23	215.99	47.34
24	220.96	46.82
25	225.94	46.44
26	230.94	46.21
27	235.94	46.14
28	240.94	46.21
29	245.93	46.44
30	250.92	46.82
31	255.89	47.35
32	260.84	48.03
33	265.77	48.86
34	270.68	49.84
35	275.55	50.97
36	280.38	52.24
37	285.18	53.66
38	289.93	55.23
39	294.62	56.94
40	299.27	58.79
41	303.86	60.77
42	308.38	62.90
43	312.84	65.17
44	317.23	67.56
45	321.54	70.09
46	325.77	72.75
47	329.93	75.54
48	333.99	78.45
49	337.97	81.48
50	341.85	84.63
51	345.63	87.90
52	349.32	91.28
53	352.90	94.77
54	356.37	98.37
55	359.73	102.07
56	362.98	105.88
57	366.11	109.77
58	369.12	113.77
59	372.01	117.85
60	374.77	122.01
61	377.41	126.26
62	379.92	130.59
63	382.29	134.99
64	384.53	139.46
65	386.63	143.99
66	388.60	148.59
67	390.42	153.25
68	391.28	155.63

*** 4.657 ***

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	108.62	92.16
2	112.40	88.88
3	116.26	85.71
4	120.22	82.65
5	124.26	79.71
6	128.39	76.89
7	132.60	74.18
8	136.88	71.60
9	141.23	69.15
10	145.66	66.82
11	150.15	64.61
12	154.70	62.54
13	159.31	60.60
14	163.97	58.80
15	168.68	57.13
16	173.44	55.59
17	178.24	54.20
18	183.08	52.94
19	187.95	51.82
20	192.86	50.85
21	197.79	50.01
22	202.74	49.32
23	207.71	48.77
24	212.69	48.36
25	217.69	48.10
26	222.69	47.98
27	227.69	48.01
28	232.68	48.18
29	237.67	48.49
30	242.65	48.95
31	247.62	49.55
32	252.56	50.29
33	257.48	51.18
34	262.37	52.21
35	267.24	53.37
36	272.06	54.68
37	276.85	56.13
38	281.59	57.71
39	286.29	59.43
40	290.93	61.28
41	295.52	63.27
42	300.05	65.39
43	304.51	67.64
44	308.91	70.01
45	313.24	72.51
46	317.50	75.14
47	321.68	77.88
48	325.77	80.75
49	329.79	83.73
50	333.71	86.83
51	337.55	90.04

52	341.29	93.36
53	344.93	96.78
54	348.47	100.31
55	351.91	103.94
56	355.25	107.66
57	358.47	111.48
58	361.59	115.40
59	364.59	119.40
60	367.47	123.48
61	370.23	127.65
62	372.88	131.89
63	375.40	136.21
64	377.79	140.60
65	380.06	145.06
66	382.20	149.58
67	384.20	154.16
68	384.74	155.49

*** 4.658 ***

Failure Surface Specified By 82 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	108.62	92.16
2	112.63	89.17
3	116.70	86.26
4	120.83	83.44
5	125.01	80.70
6	129.25	78.06
7	133.55	75.50
8	137.90	73.03
9	142.30	70.65
10	146.74	68.37
11	151.24	66.18
12	155.78	64.08
13	160.36	62.07
14	164.98	60.16
15	169.64	58.35
16	174.34	56.64
17	179.07	55.02
18	183.83	53.50
19	188.63	52.08
20	193.45	50.77
21	198.30	49.55
22	203.17	48.43
23	208.07	47.42
24	212.98	46.50
25	217.92	45.69
26	222.87	44.98
27	227.83	44.38
28	232.80	43.87
29	237.79	43.48

30	242.78	43.18
31	247.78	42.99
32	252.77	42.90
33	257.77	42.92
34	262.77	43.04
35	267.77	43.26
36	272.76	43.59
37	277.74	44.02
38	282.71	44.56
39	287.67	45.20
40	292.61	45.94
41	297.54	46.78
42	302.45	47.73
43	307.34	48.78
44	312.21	49.92
45	317.05	51.17
46	321.86	52.53
47	326.65	53.98
48	331.40	55.52
49	336.12	57.17
50	340.81	58.92
51	345.46	60.76
52	350.06	62.70
53	354.63	64.73
54	359.16	66.86
55	363.63	69.08
56	368.07	71.40
57	372.45	73.81
58	376.78	76.30
59	381.06	78.89
60	385.28	81.56
61	389.45	84.33
62	393.56	87.17
63	397.61	90.11
64	401.60	93.12
65	405.52	96.22
66	409.38	99.40
67	413.17	102.66
68	416.90	106.00
69	420.55	109.41
70	424.13	112.90
71	427.64	116.46
72	431.07	120.10
73	434.43	123.80
74	437.71	127.58
75	440.91	131.42
76	444.03	135.33
77	447.07	139.30
78	450.02	143.33
79	452.89	147.43
80	455.68	151.58
81	458.38	155.79
82	459.11	156.98

*** 4.667 ***

Failure Surface Specified By 67 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	129.31	97.33
2	132.90	93.85
3	136.60	90.48
4	140.39	87.23
5	144.29	84.09
6	148.28	81.08
7	152.36	78.18
8	156.52	75.42
9	160.77	72.78
10	165.09	70.27
11	169.50	67.90
12	173.97	65.66
13	178.50	63.56
14	183.10	61.60
15	187.76	59.78
16	192.47	58.10
17	197.23	56.57
18	202.03	55.19
19	206.88	53.95
20	211.76	52.86
21	216.67	51.92
22	221.61	51.13
23	226.57	50.49
24	231.54	50.00
25	236.53	49.67
26	241.53	49.49
27	246.53	49.46
28	251.53	49.58
29	256.52	49.86
30	261.50	50.29
31	266.47	50.87
32	271.41	51.60
33	276.33	52.48
34	281.23	53.51
35	286.08	54.69
36	290.90	56.02
37	295.68	57.50
38	300.41	59.12
39	305.09	60.89
40	309.71	62.79
41	314.27	64.84
42	318.77	67.02
43	323.20	69.35
44	327.55	71.80
45	331.83	74.39
46	336.03	77.11
47	340.14	79.95
48	344.17	82.92
49	348.10	86.01
50	351.93	89.22
51	355.67	92.54
52	359.30	95.98

53	362.82	99.53
54	366.24	103.18
55	369.54	106.93
56	372.73	110.79
57	375.79	114.74
58	378.74	118.78
59	381.56	122.91
60	384.25	127.12
61	386.81	131.41
62	389.24	135.78
63	391.54	140.22
64	393.69	144.73
65	395.71	149.31
66	397.59	153.94
67	398.27	155.77

*** 4.695 ***

Failure Surface Specified By 80 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.97	94.74
2	122.87	91.62
3	126.84	88.58
4	130.88	85.63
5	134.98	82.77
6	139.14	80.00
7	143.36	77.32
8	147.64	74.74
9	151.98	72.25
10	156.37	69.86
11	160.82	67.57
12	165.31	65.37
13	169.85	63.28
14	174.43	61.28
15	179.06	59.39
16	183.73	57.60
17	188.44	55.92
18	193.18	54.34
19	197.96	52.86
20	202.77	51.49
21	207.61	50.23
22	212.47	49.07
23	217.36	48.03
24	222.27	47.09
25	227.20	46.26
26	232.15	45.53
27	237.11	44.92
28	242.09	44.42
29	247.07	44.03
30	252.06	43.75
31	257.06	43.57
32	262.06	43.51

33	267.06	43.56
34	272.06	43.72
35	277.05	43.99
36	282.04	44.38
37	287.01	44.87
38	291.97	45.47
39	296.92	46.18
40	301.86	47.00
41	306.77	47.93
42	311.66	48.96
43	316.53	50.11
44	321.37	51.36
45	326.18	52.72
46	330.96	54.19
47	335.71	55.76
48	340.42	57.43
49	345.09	59.21
50	349.72	61.09
51	354.31	63.07
52	358.86	65.16
53	363.36	67.34
54	367.80	69.63
55	372.20	72.01
56	376.54	74.49
57	380.83	77.06
58	385.06	79.73
59	389.23	82.49
60	393.34	85.34
61	397.38	88.28
62	401.36	91.31
63	405.27	94.43
64	409.11	97.63
65	412.87	100.92
66	416.57	104.29
67	420.18	107.74
68	423.73	111.27
69	427.19	114.87
70	430.57	118.56
71	433.87	122.31
72	437.09	126.14
73	440.22	130.04
74	443.26	134.01
75	446.21	138.04
76	449.08	142.14
77	451.85	146.30
78	454.53	150.52
79	457.12	154.80
80	458.37	156.97

*** 4.699 ***

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                 Y            A     X     I     S         F     T

                .00      57.50    115.00    172.50    230.00    287.50

X          .00 +---------+-W--**---+---------+---------+---------+
               -             ...
               -           .....
               -          ......
               -         .......
               -        ........
         57.50 +       .........
               -      ..........
               -     ...........
               -     ...........
               -    ...........4*
               -   ..........411
A       115.00 +   .........4115
               -  ..........11*69
               -  .........11569.
               - .........21599...
               - .........1599....
               - ........2199.....
X       172.50 + .......5169*......
               -........219*.......
               -.......521..*.......
               -.......219..........
               -.......21............
               -......521............
I       230.00 +......521.............
               - .....521.............
               - .....521.............
               - .....5241.............
               -  ....5241.............
               -  ....5221..............
S       287.50 +  .....5241.............
               -   ....5241.............
               -   ....53241.............
               -    ....52411............
               -     ...5324117...........
               -     ...05224117..........
        345.00 +      ...83324117.........
               -       ...8322.1177........
               -        ...8322.11677.....*
               -         ...83224.116677...
               -          ..033524..1166677
               -           ..083522..111966
F       402.50 +            ...83.42...1119
               -              ..833.22....1
               -               ..883.4222..
               -                 ..833.4422
               -                   ..833.44
               -                      .333.
T       460.00 +           W*            8*
```

84

H-103

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	6/23/98
Time of Run:	3
Run By:	JOS
Input Data Filename:	kmsw24b.in
Output Filename:	kmsw24b.out
Unit:	ENGLISH

City of Kingsville, Texas Municipal Solid Waste Landfill
Permit Application 235-B
[Slope Stability Analysis (4:1 slope)]
Landfill (with Cover) Sliding Block Analysis

BOUNDARY COORDINATES

3 Top Boundaries
12 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	90.00	100.00	90.00	1
2	100.00	90.00	360.00	155.00	3
3	360.00	155.00	460.00	157.00	3
4	100.00	90.00	360.00	153.00	4
5	360.00	153.00	460.00	155.00	4
6	100.00	90.00	120.00	85.00	1
7	.00	85.00	120.00	85.00	2
8	120.00	85.00	170.00	72.50	2
9	170.00	72.50	178.00	70.50	2
10	178.00	70.50	182.00	70.50	2
11	182.00	70.50	190.00	72.50	2
12	190.00	72.50	460.00	72.50	2

H-104

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	86.8	99.6	.0	.0	.00	.0	1
2	94.5	112.1	200.0	24.0	.00	.0	1
3	90.0	105.0	200.0	21.0	.00	.0	1
4	30.0	32.0	1000.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	71.00
2	460.00	71.00

Janbus Empirical Coef is being used for the case of c & phi both > 0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

17 Trial Surfaces Have Been Generated.

6 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 20.0

H-105

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	107.60	88.07	152.19	65.70	2.00
2	195.78	54.85	260.53	55.62	2.00
3	289.69	62.54	299.17	65.74	2.00
4	303.85	67.51	351.97	93.82	2.00
5	378.49	116.60	395.00	135.36	2.00
6	403.82	147.49	409.26	155.99	2.00

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	92.25	90.00
2	94.46	87.80
3	113.67	82.22
4	132.72	76.14
5	228.81	55.88
6	294.28	63.15
7	343.77	90.21
8	389.05	129.13
9	407.94	153.90
10	409.93	156.00

*** 4.626 ***

Individual data on the 23 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.2	211.7	.0	.0	.0	.0	.0	.0	.0
2	5.5	1446.9	.0	.0	.0	.0	.0	.0	.0
3	4.1	1509.4	.0	.0	.0	.0	.0	.0	.0
4	9.6	4890.6	.0	.0	.0	.0	.0	.0	.0
5	6.3	4354.1	.0	.0	.0	.0	.0	.0	.0
6	12.7	11485.6	.0	.0	.0	.0	.0	.0	.0

7	24.4	28918.6	.0	.0	.0	.0	.0	.0	.0
8	12.9	18421.4	.0	1117.3	.0	.0	.0	.0	.0
9	6.0	9451.3	.0	1282.2	.0	.0	.0	.0	.0
10	2.0	3266.4	.0	535.0	.0	.0	.0	.0	.0
11	4.0	6832.0	.0	1231.3	.0	.0	.0	.0	.0
12	2.0	3645.6	.0	696.4	.0	.0	.0	.0	.0
13	6.0	12105.7	.0	2411.8	.0	.0	.0	.0	.0
14	38.8	107676.4	.0	27299.0	.0	.0	.0	.0	.0
15	65.5	212152.0	.0	47214.3	.0	.0	.0	.0	.0
16	14.4	38925.3	.0	4010.1	.0	.0	.0	.0	.0
17	2.7	6220.1	.0	.0	.0	.0	.0	.0	.0
18	32.4	67072.8	.0	.0	.0	.0	.0	.0	.0
19	16.2	29053.4	.0	.0	.0	.0	.0	.0	.0
20	29.0	37163.6	.0	.0	.0	.0	.0	.0	.0
21	18.9	10349.2	.0	.0	.0	.0	.0	.0	.0
22	.1	11.0	.0	.0	.0	.0	.0	.0	.0
23	1.9	172.9	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	107.74	91.93
2	117.84	82.70
3	215.93	55.94
4	291.45	62.44
5	343.40	89.46
6	393.99	134.78
7	403.84	147.78
8	412.09	156.04

*** 4.631 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.31	90.83
2	107.81	90.06
3	124.83	79.55
4	257.70	54.74
5	295.38	65.33
6	329.70	82.60
7	390.64	130.99
8	408.80	155.73
9	408.86	155.98

*** 4.660 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	104.41	91.10
2	107.71	87.80
3	125.54	78.75
4	242.16	56.08
5	292.01	62.35
6	343.91	90.05
7	379.68	118.92
8	405.50	151.05
9	406.28	155.93

*** 4.704 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	101.61	90.40
2	105.77	87.26
3	125.63	84.88
4	141.03	72.12
5	234.68	54.48
6	297.05	65.71
7	327.64	79.60
8	390.45	129.72
9	404.83	149.78
10	410.28	156.01

*** 4.715 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	109.48	92.37
2	117.11	86.01
3	134.23	75.67
4	259.58	56.25
5	297.34	64.48
6	335.43	85.30
7	392.96	132.14
8	406.87	151.76
9	409.93	156.00

*** 4.720 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	110.43	92.61
2	115.75	87.32
3	131.91	75.53
4	231.80	55.69
5	290.15	63.11
6	327.38	80.22
7	380.11	118.83
8	408.41	153.91
9	410.09	156.00

*** 4.756 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	114.82	93.70
2	120.03	88.84
3	134.65	75.19
4	237.30	54.90
5	295.32	63.49
6	324.70	79.25
7	392.99	133.20
8	405.98	151.45
9	409.99	156.00

*** 4.798 ***

Failure Surface Specified By 8 Coordinate Points

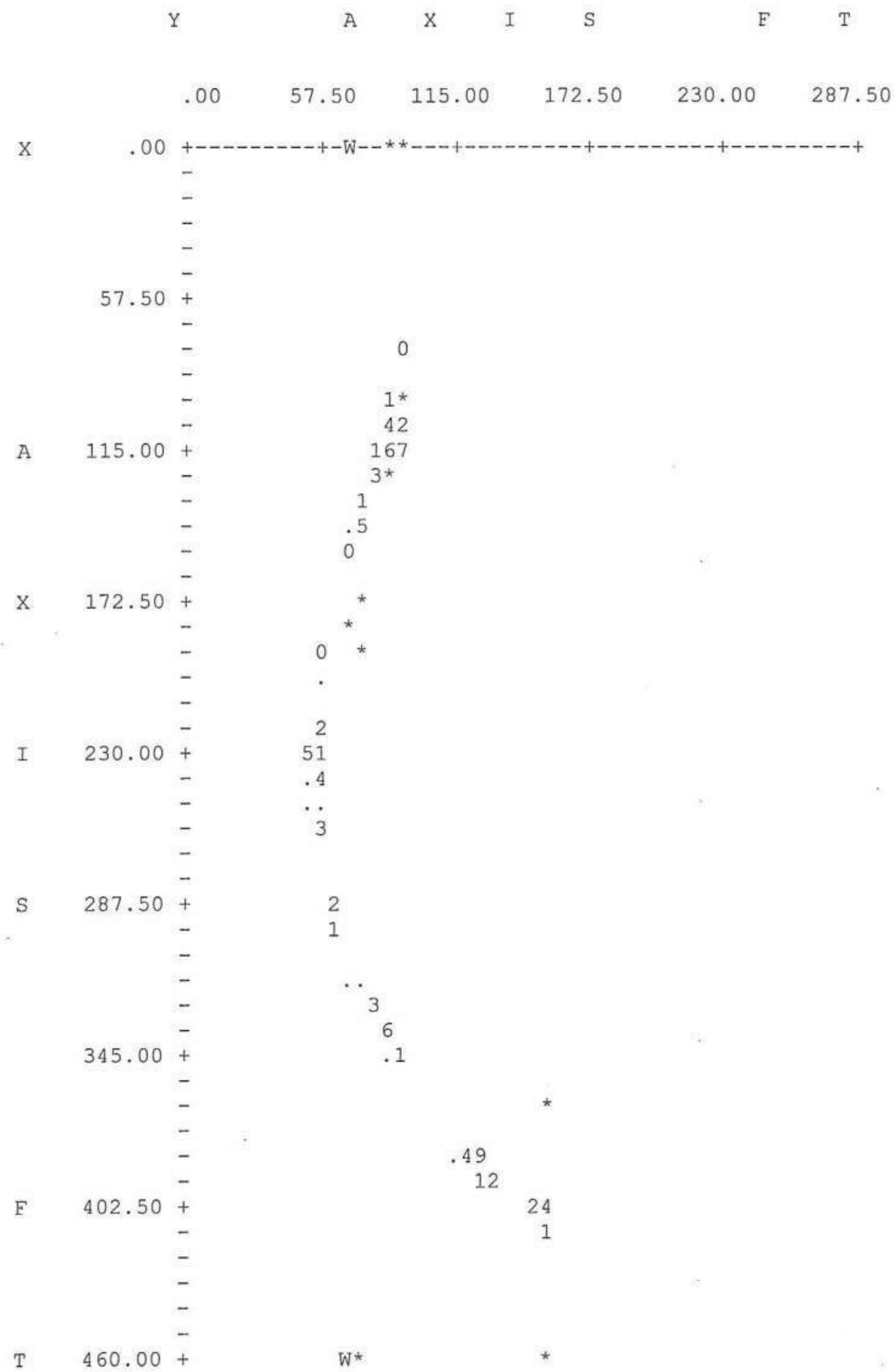
Point No.	X-Surf (ft)	Y-Surf (ft)
1	106.40	91.60
2	116.16	82.90
3	255.74	56.49
4	297.24	64.12
5	329.00	81.39
6	387.95	127.76
7	404.72	148.45
8	406.12	155.92

*** 4.820 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	80.15	90.00
2	91.75	85.91
3	110.22	78.24
4	129.98	75.13
5	148.73	68.16
6	196.16	55.85
7	297.61	65.62
8	328.14	80.19
9	392.65	132.62
10	406.48	151.05
11	411.05	156.02

*** 4.843 ***


Y AXIS FT
.00
57.50
115.00
172.50
230.00
287.50
X AXIS FT
.00
57.50
115.00
172.50
230.00
287.50
345.00
402.50
460.00

** PCSTABL5M **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	6/23/98
Time of Run:	3
Run By:	JOS
Input Data Filename:	kmsw24nc.in
Output Filename:	kmsw24nc.out
Unit:	ENGLISH

City of Kingsville, Texas Municipal Solid Waste Landfill
Permit Application 235-B
[Slope Stability Analysis (4:1 slope)]
Landfill without Cover

BOUNDARY COORDINATES

3 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	90.00	100.00	90.00	1
2	100.00	90.00	360.00	153.00	3
3	360.00	153.00	460.00	155.00	3
4	100.00	90.00	120.00	85.00	1
5	.00	85.00	120.00	85.00	2
6	120.00	85.00	170.00	72.50	2
7	170.00	72.50	178.00	70.50	2
8	178.00	70.50	182.00	70.50	2
9	182.00	70.50	190.00	72.50	2
10	190.00	72.50	460.00	72.50	2

H-112

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	86.8	99.6	.0	.0	.00	.0	1
2	94.5	112.1	200.0	21.0	.00	.0	1
3	30.0	32.0	1000.0	20.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	71.00
2	460.00	71.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

Janbus Empirical Coef. is being used for the case of c & phi both > 0
900 Trial Surfaces Have Been Generated.

30 Surfaces Initiate From Each Of 30 Points Equally Spaced Along The Ground Surface Between X = .00 ft. and X = 150.00 ft.

Each Surface Terminates Between X = 200.00 ft. and X = 460.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 71 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.84
2	107.59	88.04
3	111.80	85.33
4	116.07	82.73
5	120.39	80.22
6	124.78	77.82
7	129.22	75.52
8	133.71	73.32
9	138.25	71.23
10	142.84	69.24
11	147.47	67.36
12	152.14	65.58
13	156.86	63.92
14	161.61	62.37
15	166.40	60.92
16	171.22	59.59
17	176.07	58.37
18	180.94	57.26
19	185.84	56.27
20	190.76	55.39
21	195.71	54.63
22	200.66	53.97
23	205.63	53.44
24	210.62	53.02
25	215.61	52.71
26	220.60	52.53
27	225.60	52.45
28	230.60	52.50
29	235.60	52.65
30	240.59	52.93
31	245.58	53.32
32	250.55	53.83
33	255.51	54.45
34	260.46	55.18
35	265.39	56.03
36	270.29	57.00
37	275.17	58.08
38	280.03	59.27
39	284.86	60.57
40	289.65	61.99
41	294.41	63.51
42	299.14	65.15
43	303.82	66.89
44	308.47	68.75

45	313.07	70.71
46	317.62	72.77
47	322.13	74.94
48	326.58	77.22
49	330.98	79.60
50	335.32	82.08
51	339.60	84.66
52	343.82	87.33
53	347.98	90.11
54	352.08	92.98
55	356.10	95.94
56	360.06	99.00
57	363.94	102.15
58	367.75	105.39
59	371.49	108.71
60	375.14	112.12
61	378.72	115.62
62	382.21	119.19
63	385.62	122.85
64	388.95	126.59
65	392.18	130.40
66	395.33	134.28
67	398.39	138.24
68	401.35	142.27
69	404.22	146.36
70	407.00	150.52
71	409.19	153.98

*** 5.046 ***

Individual data on the 83 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.0	218.9	.0	.0	.0	.0	.0	.0	.0
2	.2	17.7	.0	.0	.0	.0	.0	.0	.0
3	4.2	927.9	.0	.0	.0	.0	.0	.0	.0
4	.5	183.2	.0	.0	.0	.0	.0	.0	.0
5	3.7	1648.6	.0	.0	.0	.0	.0	.0	.0
6	3.9	2483.7	.0	.0	.0	.0	.0	.0	.0
7	.4	288.6	.0	.0	.0	.0	.0	.0	.0
8	4.4	3671.7	.0	.0	.0	.0	.0	.0	.0
9	4.4	4530.9	.0	.0	.0	.0	.0	.0	.0
10	4.5	5361.4	.0	.0	.0	.0	.0	.0	.0
11	4.5	6160.0	.0	.0	.0	.0	.0	.0	.0
12	.5	752.9	.0	.0	.0	.0	.0	.0	.0
13	4.1	6233.6	.0	243.6	.0	.0	.0	.0	.0
14	4.6	7869.0	.0	843.0	.0	.0	.0	.0	.0
15	4.7	8705.7	.0	1412.9	.0	.0	.0	.0	.0
16	4.7	9492.0	.0	1949.0	.0	.0	.0	.0	.0
17	4.8	10225.1	.0	2451.0	.0	.0	.0	.0	.0
18	4.8	10901.9	.0	2918.6	.0	.0	.0	.0	.0

H-115

19	3.6	8561.7	.0	2465.8	.0	.0	.0	.0	.0
20	1.2	2958.2	.0	885.8	.0	.0	.0	.0	.0
21	4.8	11908.8	.0	3696.0	.0	.0	.0	.0	.0
22	.1	167.8	.0	53.7	.0	.0	.0	.0	.0
23	1.9	4930.4	.0	1589.8	.0	.0	.0	.0	.0
24	2.9	7678.6	.0	2522.9	.0	.0	.0	.0	.0
25	1.1	2828.9	.0	932.5	.0	.0	.0	.0	.0
26	2.0	5479.7	.0	1802.2	.0	.0	.0	.0	.0
27	1.8	5218.0	.0	1705.8	.0	.0	.0	.0	.0
28	4.2	12328.3	.0	3979.9	.0	.0	.0	.0	.0
29	.8	2343.1	.0	752.9	.0	.0	.0	.0	.0
30	4.9	15501.0	.0	4989.5	.0	.0	.0	.0	.0
31	5.0	16124.5	.0	5210.4	.0	.0	.0	.0	.0
32	5.0	16679.1	.0	5395.5	.0	.0	.0	.0	.0
33	5.0	17163.5	.0	5544.6	.0	.0	.0	.0	.0
34	5.0	17576.1	.0	5657.7	.0	.0	.0	.0	.0
35	5.0	17915.8	.0	5734.6	.0	.0	.0	.0	.0
36	5.0	18181.6	.0	5775.5	.0	.0	.0	.0	.0
37	5.0	18372.9	.0	5780.1	.0	.0	.0	.0	.0
38	5.0	18489.2	.0	5748.6	.0	.0	.0	.0	.0
39	5.0	18530.5	.0	5680.9	.0	.0	.0	.0	.0
40	5.0	18496.7	.0	5577.1	.0	.0	.0	.0	.0
41	5.0	18388.2	.0	5437.2	.0	.0	.0	.0	.0
42	5.0	18205.6	.0	5261.3	.0	.0	.0	.0	.0
43	4.9	17949.7	.0	5049.6	.0	.0	.0	.0	.0
44	4.9	17621.5	.0	4802.1	.0	.0	.0	.0	.0
45	4.9	17222.3	.0	4518.9	.0	.0	.0	.0	.0
46	4.9	16753.9	.0	4200.2	.0	.0	.0	.0	.0
47	4.9	16217.8	.0	3846.2	.0	.0	.0	.0	.0
48	4.8	15616.2	.0	3457.1	.0	.0	.0	.0	.0
49	4.8	14951.3	.0	3033.0	.0	.0	.0	.0	.0
50	4.8	14225.5	.0	2574.3	.0	.0	.0	.0	.0
51	4.7	13441.7	.0	2081.1	.0	.0	.0	.0	.0
52	4.7	12602.6	.0	1553.7	.0	.0	.0	.0	.0
53	4.6	11711.3	.0	992.4	.0	.0	.0	.0	.0
54	4.6	10771.2	.0	397.5	.0	.0	.0	.0	.0
55	.6	1447.6	.0	6.5	.0	.0	.0	.0	.0
56	3.3	7143.7	.0	.0	.0	.0	.0	.0	.0
57	.6	1260.6	.0	.0	.0	.0	.0	.0	.0
58	4.5	9379.6	.0	.0	.0	.0	.0	.0	.0
59	4.5	9120.3	.0	.0	.0	.0	.0	.0	.0
60	4.4	8844.2	.0	.0	.0	.0	.0	.0	.0
61	4.3	8552.5	.0	.0	.0	.0	.0	.0	.0
62	4.3	8246.3	.0	.0	.0	.0	.0	.0	.0
63	4.2	7926.5	.0	.0	.0	.0	.0	.0	.0
64	4.2	7594.3	.0	.0	.0	.0	.0	.0	.0
65	4.1	7250.9	.0	.0	.0	.0	.0	.0	.0
66	4.0	6897.4	.0	.0	.0	.0	.0	.0	.0
67	3.9	6439.0	.0	.0	.0	.0	.0	.0	.0
68	.1	96.1	.0	.0	.0	.0	.0	.0	.0
69	3.9	6113.5	.0	.0	.0	.0	.0	.0	.0
70	3.8	5640.8	.0	.0	.0	.0	.0	.0	.0
71	3.7	5169.0	.0	.0	.0	.0	.0	.0	.0
72	3.7	4699.6	.0	.0	.0	.0	.0	.0	.0
73	3.6	4234.0	.0	.0	.0	.0	.0	.0	.0
74	3.5	3773.7	.0	.0	.0	.0	.0	.0	.0
75	3.4	3320.2	.0	.0	.0	.0	.0	.0	.0

76	3.3	2874.9	.0	.0	.0	.0	.0	.0	.0
77	3.2	2439.2	.0	.0	.0	.0	.0	.0	.0
78	3.1	2014.7	.0	.0	.0	.0	.0	.0	.0
79	3.1	1602.6	.0	.0	.0	.0	.0	.0	.0
80	3.0	1204.5	.0	.0	.0	.0	.0	.0	.0
81	2.9	821.6	.0	.0	.0	.0	.0	.0	.0
82	2.8	455.4	.0	.0	.0	.0	.0	.0	.0
83	2.2	112.6	.0	.0	.0	.0	.0	.0	.0

Failure Surface Specified By 77 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.84
2	107.49	87.89
3	111.60	85.04
4	115.76	82.28
5	119.99	79.61
6	124.28	77.03
7	128.62	74.54
8	133.01	72.16
9	137.45	69.87
10	141.95	67.68
11	146.49	65.58
12	151.07	63.59
13	155.70	61.70
14	160.37	59.91
15	165.08	58.22
16	169.82	56.64
17	174.60	55.16
18	179.40	53.78
19	184.24	52.51
20	189.10	51.35
21	193.99	50.30
22	198.90	49.35
23	203.83	48.51
24	208.77	47.78
25	213.74	47.15
26	218.71	46.64
27	223.69	46.23
28	228.68	45.94
29	233.68	45.75
30	238.68	45.68
31	243.68	45.71
32	248.68	45.85
33	253.67	46.11
34	258.66	46.47
35	263.64	46.94
36	268.60	47.52
37	273.55	48.21
38	278.49	49.01
39	283.41	49.91
40	288.30	50.92
41	293.18	52.04
42	298.02	53.27

43	302.84	54.60
44	307.63	56.04
45	312.39	57.58
46	317.11	59.23
47	321.79	60.98
48	326.44	62.83
49	331.04	64.79
50	335.60	66.84
51	340.11	68.99
52	344.57	71.25
53	348.99	73.59
54	353.35	76.04
55	357.66	78.58
56	361.91	81.22
57	366.10	83.94
58	370.23	86.76
59	374.29	89.67
60	378.30	92.66
61	382.23	95.75
62	386.10	98.92
63	389.90	102.17
64	393.62	105.51
65	397.27	108.92
66	400.85	112.42
67	404.35	115.99
68	407.76	119.64
69	411.10	123.36
70	414.36	127.16
71	417.53	131.03
72	420.61	134.96
73	423.61	138.96
74	426.52	143.03
75	429.34	147.16
76	432.07	151.35
77	434.01	154.48

*** 5.110 ***

Failure Surface Specified By 81 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	103.45	90.84
2	107.65	88.12
3	111.89	85.48
4	116.19	82.92
5	120.53	80.45
6	124.93	78.06
7	129.36	75.75
8	133.84	73.53
9	138.36	71.39
10	142.92	69.35
11	147.52	67.38

H-118

12	152.16	65.51
13	156.83	63.73
14	161.53	62.03
15	166.27	60.42
16	171.03	58.91
17	175.83	57.49
18	180.65	56.16
19	185.49	54.92
20	190.36	53.77
21	195.24	52.71
22	200.15	51.75
23	205.08	50.89
24	210.02	50.12
25	214.97	49.44
26	219.93	48.85
27	224.91	48.37
28	229.90	47.97
29	234.89	47.67
30	239.88	47.47
31	244.88	47.36
32	249.88	47.35
33	254.88	47.43
34	259.88	47.61
35	264.87	47.88
36	269.86	48.25
37	274.83	48.72
38	279.80	49.28
39	284.76	49.93
40	289.70	50.68
41	294.63	51.52
42	299.54	52.46
43	304.44	53.49
44	309.31	54.61
45	314.16	55.82
46	318.99	57.13
47	323.79	58.53
48	328.56	60.02
49	333.30	61.60
50	338.01	63.27
51	342.69	65.04
52	347.34	66.89
53	351.95	68.83
54	356.52	70.85
55	361.05	72.96
56	365.54	75.16
57	369.99	77.45
58	374.39	79.82
59	378.75	82.27
60	383.06	84.81
61	387.32	87.42
62	391.53	90.12
63	395.69	92.90
64	399.79	95.75
65	403.84	98.69
66	407.83	101.70
67	411.76	104.78
68	415.64	107.95

69	419.45	111.18
70	423.20	114.49
71	426.89	117.86
72	430.51	121.31
73	434.07	124.83
74	437.55	128.41
75	440.97	132.06
76	444.32	135.77
77	447.60	139.55
78	450.80	143.39
79	453.93	147.28
80	456.99	151.24
81	459.77	155.00

*** 5.141 ***

Failure Surface Specified By 77 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	113.79	93.34
2	117.51	90.00
3	121.31	86.75
4	125.19	83.60
5	129.15	80.54
6	133.19	77.59
7	137.29	74.73
8	141.46	71.98
9	145.71	69.33
10	150.01	66.79
11	154.38	64.36
12	158.81	62.04
13	163.29	59.82
14	167.83	57.72
15	172.42	55.73
16	177.05	53.86
17	181.73	52.10
18	186.46	50.46
19	191.22	48.94
20	196.02	47.54
21	200.85	46.25
22	205.71	45.09
23	210.60	44.05
24	215.52	43.13
25	220.45	42.33
26	225.41	41.65
27	230.38	41.10
28	235.36	40.68
29	240.35	40.37
30	245.35	40.19
31	250.35	40.14

32	255.35	40.20
33	260.34	40.40
34	265.33	40.71
35	270.31	41.16
36	275.28	41.72
37	280.23	42.41
38	285.17	43.22
39	290.08	44.15
40	294.97	45.21
41	299.83	46.38
42	304.66	47.68
43	309.45	49.10
44	314.21	50.63
45	318.93	52.28
46	323.60	54.05
47	328.24	55.94
48	332.82	57.94
49	337.35	60.05
50	341.83	62.27
51	346.25	64.61
52	350.61	67.05
53	354.91	69.61
54	359.14	72.27
55	363.31	75.03
56	367.41	77.89
57	371.43	80.86
58	375.38	83.93
59	379.26	87.09
60	383.05	90.35
61	386.76	93.70
62	390.39	97.14
63	393.93	100.67
64	397.38	104.29
65	400.74	107.99
66	404.00	111.78
67	407.17	115.64
68	410.25	119.59
69	413.22	123.61
70	416.10	127.70
71	418.87	131.86
72	421.54	136.09
73	424.10	140.38
74	426.56	144.74
75	428.90	149.15
76	431.14	153.63
77	431.51	154.43

*** 5.174 ***

Failure Surface Specified By 82 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

H-121

1	108.62	92.09
2	112.63	89.09
3	116.69	86.18
4	120.82	83.36
5	125.00	80.62
6	129.24	77.97
7	133.53	75.40
8	137.87	72.93
9	142.27	70.54
10	146.71	68.25
11	151.20	66.05
12	155.74	63.94
13	160.31	61.93
14	164.93	60.01
15	169.59	58.19
16	174.28	56.47
17	179.01	54.84
18	183.77	53.32
19	188.56	51.89
20	193.38	50.56
21	198.23	49.33
22	203.10	48.20
23	207.99	47.17
24	212.91	46.25
25	217.84	45.42
26	222.79	44.70
27	227.75	44.08
28	232.72	43.57
29	237.70	43.16
30	242.70	42.85
31	247.69	42.64
32	252.69	42.54
33	257.69	42.54
34	262.69	42.65
35	267.68	42.86
36	272.67	43.17
37	277.66	43.58
38	282.63	44.10
39	287.59	44.72
40	292.54	45.45
41	297.47	46.28
42	302.38	47.20
43	307.28	48.23
44	312.15	49.37
45	316.99	50.60
46	321.81	51.93
47	326.60	53.36
48	331.36	54.89
49	336.09	56.52
50	340.78	58.25
51	345.44	60.07
52	350.05	61.99
53	354.63	64.01
54	359.16	66.12
55	363.65	68.32
56	368.09	70.62
57	372.49	73.00

58	376.83	75.48
59	381.12	78.05
60	385.36	80.70
61	389.54	83.45
62	393.66	86.27
63	397.72	89.19
64	401.73	92.19
65	405.67	95.26
66	409.54	98.42
67	413.35	101.66
68	417.09	104.98
69	420.76	108.38
70	424.36	111.85
71	427.89	115.39
72	431.34	119.01
73	434.72	122.70
74	438.02	126.45
75	441.24	130.28
76	444.38	134.17
77	447.44	138.12
78	450.42	142.14
79	453.31	146.21
80	456.12	150.35
81	458.84	154.55
82	459.11	154.98

*** 5.188 ***

Failure Surface Specified By 68 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.97	94.60
2	122.55	91.11
3	126.23	87.72
4	130.01	84.46
5	133.90	81.30
6	137.87	78.27
7	141.94	75.36
8	146.09	72.57
9	150.32	69.91
10	154.63	67.38
11	159.02	64.98
12	163.47	62.71
13	168.00	60.58
14	172.58	58.59
15	177.23	56.74
16	181.93	55.02
17	186.67	53.45
18	191.46	52.03
19	196.30	50.75
20	201.17	49.62
21	206.07	48.63
22	211.00	47.79
23	215.95	47.11
24	220.92	46.57
25	225.91	46.18

26	230.90	45.95
27	235.90	45.86
28	240.90	45.93
29	245.90	46.14
30	250.88	46.51
31	255.86	47.03
32	260.81	47.70
33	265.74	48.52
34	270.65	49.48
35	275.52	50.60
36	280.36	51.86
37	285.16	53.27
38	289.91	54.82
39	294.62	56.51
40	299.27	58.35
41	303.86	60.32
42	308.39	62.43
43	312.86	64.68
44	317.25	67.07
45	321.58	69.58
46	325.82	72.23
47	329.98	75.00
48	334.06	77.89
49	338.04	80.91
50	341.94	84.05
51	345.73	87.30
52	349.43	90.67
53	353.02	94.14
54	356.51	97.73
55	359.89	101.42
56	363.15	105.20
57	366.30	109.09
58	369.33	113.07
59	372.24	117.13
60	375.02	121.29
61	377.68	125.52
62	380.20	129.84
63	382.60	134.23
64	384.86	138.69
65	386.99	143.21
66	388.97	147.80
67	390.82	152.44
68	391.25	153.63

*** 5.195 ***

Failure Surface Specified By 77 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	124.14	95.85
2	127.99	92.66
3	131.91	89.56
4	135.90	86.55
5	139.97	83.63

6	144.10	80.82
7	148.29	78.10
8	152.55	75.47
9	156.87	72.95
10	161.24	70.54
11	165.68	68.22
12	170.16	66.01
13	174.70	63.91
14	179.28	61.91
15	183.91	60.02
16	188.58	58.24
17	193.29	56.57
18	198.04	55.01
19	202.83	53.56
20	207.65	52.22
21	212.50	51.00
22	217.37	49.89
23	222.27	48.90
24	227.19	48.02
25	232.14	47.26
26	237.09	46.61
27	242.07	46.08
28	247.05	45.67
29	252.04	45.37
30	257.04	45.19
31	262.04	45.13
32	267.04	45.18
33	272.03	45.35
34	277.02	45.64
35	282.01	46.05
36	286.98	46.57
37	291.94	47.21
38	296.88	47.97
39	301.81	48.84
40	306.71	49.83
41	311.58	50.93
42	316.43	52.14
43	321.25	53.47
44	326.04	54.91
45	330.80	56.46
46	335.51	58.13
47	340.18	59.90
48	344.82	61.78
49	349.40	63.78
50	353.94	65.87
51	358.43	68.08
52	362.86	70.39
53	367.24	72.80
54	371.57	75.31
55	375.83	77.93
56	380.03	80.64
57	384.16	83.45
58	388.23	86.36
59	392.23	89.36
60	396.15	92.46
61	400.01	95.65
62	403.78	98.92

63	407.48	102.28
64	411.10	105.73
65	414.64	109.27
66	418.10	112.88
67	421.46	116.58
68	424.74	120.35
69	427.94	124.20
70	431.04	128.12
71	434.04	132.12
72	436.96	136.18
73	439.77	140.31
74	442.49	144.51
75	445.11	148.77
76	447.63	153.09
77	448.56	154.77

*** 5.201 ***

Failure Surface Specified By 80 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	118.97	94.60
2	122.87	91.47
3	126.83	88.42
4	130.87	85.47
5	134.96	82.60
6	139.12	79.83
7	143.35	77.15
8	147.62	74.56
9	151.96	72.07
10	156.35	69.67
11	160.79	67.37
12	165.28	65.17
13	169.81	63.07
14	174.39	61.07
15	179.02	59.17
16	183.69	57.37
17	188.39	55.68
18	193.13	54.09
19	197.90	52.60
20	202.71	51.23
21	207.55	49.95
22	212.41	48.79
23	217.30	47.73
24	222.20	46.78
25	227.13	45.94
26	232.08	45.20
27	237.04	44.58
28	242.01	44.06
29	247.00	43.66
30	251.99	43.37
31	256.98	43.18

32	261.98	43.11
33	266.98	43.14
34	271.98	43.29
35	276.98	43.54
36	281.96	43.91
37	286.94	44.39
38	291.90	44.97
39	296.86	45.67
40	301.79	46.47
41	306.71	47.38
42	311.60	48.40
43	316.47	49.53
44	321.32	50.77
45	326.13	52.11
46	330.92	53.56
47	335.67	55.11
48	340.39	56.77
49	345.07	58.53
50	349.71	60.39
51	354.31	62.36
52	358.86	64.42
53	363.37	66.59
54	367.82	68.85
55	372.23	71.22
56	376.58	73.68
57	380.88	76.23
58	385.12	78.88
59	389.30	81.62
60	393.42	84.45
61	397.48	87.38
62	401.47	90.39
63	405.40	93.49
64	409.25	96.67
65	413.03	99.94
66	416.74	103.29
67	420.38	106.73
68	423.94	110.24
69	427.42	113.83
70	430.82	117.49
71	434.14	121.23
72	437.37	125.05
73	440.52	128.93
74	443.59	132.88
75	446.57	136.90
76	449.45	140.98
77	452.25	145.12
78	454.96	149.33
79	457.57	153.59
80	458.37	154.97

*** 5.202 ***

Failure Surface Specified By 77 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	124.14	95.85
2	127.93	92.59
3	131.79	89.41
4	135.73	86.34
5	139.75	83.35
6	143.83	80.47
7	147.98	77.68
8	152.19	74.99
9	156.47	72.40
10	160.81	69.92
11	165.21	67.54
12	169.66	65.27
13	174.17	63.10
14	178.73	61.05
15	183.33	59.10
16	187.98	57.26
17	192.68	55.54
18	197.41	53.92
19	202.18	52.42
20	206.98	51.04
21	211.82	49.77
22	216.68	48.62
23	221.58	47.58
24	226.49	46.66
25	231.43	45.86
26	236.38	45.17
27	241.35	44.61
28	246.33	44.16
29	251.32	43.84
30	256.31	43.63
31	261.31	43.54
32	266.31	43.57
33	271.31	43.72
34	276.30	43.99
35	281.29	44.38
36	286.26	44.89
37	291.22	45.52
38	296.17	46.27
39	301.09	47.13
40	305.99	48.11
41	310.87	49.21
42	315.72	50.42
43	320.54	51.75
44	325.33	53.20
45	330.08	54.76
46	334.79	56.43
47	339.46	58.22
48	344.09	60.11
49	348.67	62.12
50	353.20	64.23
51	357.68	66.46

52	362.10	68.78
53	366.47	71.22
54	370.78	73.76
55	375.02	76.40
56	379.20	79.14
57	383.32	81.98
58	387.37	84.91
59	391.34	87.95
60	395.24	91.08
61	399.07	94.30
62	402.81	97.61
63	406.48	101.01
64	410.07	104.49
65	413.57	108.06
66	416.98	111.71
67	420.30	115.45
68	423.54	119.26
69	426.68	123.15
70	429.73	127.11
71	432.69	131.15
72	435.54	135.25
73	438.30	139.42
74	440.96	143.66
75	443.51	147.95
76	445.96	152.31
77	447.26	154.75

*** 5.208 ***

Failure Surface Specified By 67 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	129.31	97.10
2	132.90	93.62
3	136.60	90.25
4	140.39	87.00
5	144.29	83.86
6	148.27	80.85
7	152.35	77.95
8	156.51	75.18
9	160.76	72.54
10	165.08	70.03
11	169.48	67.65
12	173.95	65.41
13	178.49	63.31
14	183.08	61.34
15	187.74	59.52
16	192.45	57.84
17	197.21	56.30
18	202.01	54.91
19	206.85	53.66
20	211.73	52.56

21	216.64	51.61
22	221.57	50.82
23	226.53	50.17
24	231.51	49.67
25	236.50	49.33
26	241.49	49.14
27	246.49	49.10
28	251.49	49.21
29	256.48	49.48
30	261.47	49.89
31	266.43	50.46
32	271.38	51.18
33	276.30	52.05
34	281.20	53.07
35	286.06	54.24
36	290.89	55.55
37	295.67	57.02
38	300.40	58.62
39	305.08	60.37
40	309.71	62.27
41	314.28	64.30
42	318.78	66.47
43	323.22	68.78
44	327.58	71.22
45	331.87	73.79
46	336.08	76.49
47	340.20	79.32
48	344.24	82.28
49	348.18	85.35
50	352.02	88.55
51	355.77	91.86
52	359.42	95.28
53	362.96	98.81
54	366.39	102.45
55	369.71	106.19
56	372.91	110.03
57	375.99	113.96
58	378.95	117.99
59	381.79	122.11
60	384.50	126.31
61	387.09	130.59
62	389.54	134.95
63	391.85	139.38
64	394.03	143.88
65	396.08	148.44
66	397.98	153.07
67	398.24	153.76

*** 5.217 ***

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                      Y            A     X     I     S           F     T

                     .00      57.50    115.00    172.50    230.00    287.50

X           .00 +---------+-W--**---+---------+---------+---------+
                -             ...
                -           .....
                -          ......
                -         .......
                -        ........
          57.50 +       .........
                -      ..........
                -     ...........
                -     ...........
                -    ............*
                -   ...........11
A        115.00 +   ..........114
                -  ..........11*67
                -  .........11667.
                - .........21477...
                - .........1470....
                - ........2170.....
X        172.50 + .......4160*.....
                -........217*.......
                -.......421..*......
                -.......217..........
                -.......21............
                -......421............
I        230.00 +......421............
                - .....421.............
                - .....421.............
                - .....4211.............
                - .....4261.............
                -  ....4221.............
S        287.50 +  .....4261.............
                -   ....4261.............
                -   ....42261.............
                -    ...842611............
                -    ....43261............
                -     ...8422011...........
         345.00 +      ...5322011..........
                -       ...5322011..........
                -        ...5322.116.......*
                -         ..83322.01666.....
                -          ..83342..110666..
                -           ..853422..110066
F        402.50 +            ...53942...1110
                -              ..533.22....1
                -               ..5337.22...
                -                 ..33379222
                -                   ..33377.
                -                      .3337
T        460.00 +           W*           .3*
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H-131

RECEIVED SEP 29 1997

Environmental
Geotechnical
Construction
Consulting • Engineering • Testing

September 25, 1997

Finch Energy & Environmental Services
P.O. Box 73
Kingsville, Texas 78364

Re: Subsurface Exploration and
Laboratory Analysis
Proposed Landfill Expansion
Kingsville, Texas
PSI File Number: 326-72026
Addendum

Gentlemen:

It was requested that PSI provide ϕ′ and c′ values for the samples on which we performed unconsolidated undrained triaxial tests. These values are provided in the following table.

Soil Identification	Effective Cohesion, c′ (psf)	Effective Angle of internal Friction, ϕ′
SB-12, 7' - 8'	200	26
SB-12, 47' - 48'	200	26
SB-14, 10' - 11'	200	26
SB-14, 34' - 35'	200	24
SB-15, 12' - 13'	200	21
SB-15, 24' - 25'	200	24
SB-16, 3' - 5'	200	26
SB-17, 32' - 33'	200	24
SB-18, 9' - 10'	200	21
SB-18, 17' - 18'	200	24
SB-18. 40' - 42'	200	24

PS... South Padre Island Drive • Corpus Christi, TX 78416 • Phone 512/854-4801 • Fax 512/854-6049

GEOTECHNICAL DATA
P.S.I. Laboratory, ASTM D-3080
Light Olive Green Clay (Aquiclude)

Lt. Olive Green Clay Geotechnical Properties					
Soil Boring	Depth,	C',Cohesion Coefficient	Psi, Angle of Int. Friction	W_m	Rho,
Number	ft (bgs)	Lbf/ft^2	degrees	wt %	Lbm/ft^3
21	64' - 66'	1100	26.3	20	108
23	82' - 84'	700	19.4	28	90
24	52' - 54'	560	35.0	28	89.6
25	58' - 60'	940	26.6	30	85.3
Avg.	65'	825	26.8	26.5	93.2
Max.	84'	1100	35.0	30	108
Min.	52'	560	19.4	20	85.3

November 1997
Revision 1- June 1998

H.2 Settlement Analysis

psi Environmental Geotechnical Construction
Consulting • Engineering • Testing

APPENDIX H.2

SETTLEMENT ANALYSIS

STATE OF TEXAS
RALPH F. REUSS
9691
REGISTERED
PROFESSIONAL ENGINEER

11/24/97

THIS CERTIFICATION IS INTENDED FOR PERMITTING PURPOSES ONLY AND INCLUDES PAGES 1 THROUGH 2.

Information To Build On

PSI • 810 South Padre Island Drive • Corpus Christi, TX 78416 • Phone 512/854-4801 • Fax 512/854-6049

SETTLEMENT ANALYSIS
Kingsville Landfill

1. **Design Section and Loading**
   a. Surface Grade - EL 50
   b. Bottom of Landfill - EL 30
   c. Groundwater - EL 25
   d. Maximum Waste Height - EL 125
   e. Waste Density as defined by H.E.L.P. 3.1 model for EPA
   $\delta = 33.3$ pcf
   f. Excavation Stress = 20 x 120 = 2400 psf
   g. Fill Stress = 95 x 33.3 = 3163.5
   h. Net Stress increase = 763.5 psf
   I. Depth of Stress - $\Delta P \leq 0.1\ P_o$ = 80 ft, EL -30
   (2.5 x 120 + x 57.6) .10 = 763.5
   x = 80 ft.

2. **Settlement Estimate**
   a. Average Natural Moisture Content of Soils 22.3 %, $e_o = 0.602$
   b. Coefficient of Consolidation
   Cc = 0.30 (eo - .27) = 0.100
   Cr = 0.15 x Cc = 0.015
   c. Depth to Center of Compressible Zone = EL -0
   d. Overburden Pressure = 25 x 120 + 30 x 57.6
   $P_o = 4828$ psf
   e. Stress Increase = 763.5 psf
   f. Strength and Plasticity Data Indicate Soils are Preconsolidated
   Therefore use Cr = 0.015
   g. Assume Clay is Continuous from EL 30 to EL -44
   H = 74 ft
   h. Settlement - Preconsolidated Clay
   p = (H Cr / 1 + eo) Log (Po+ΔP / Po)

   p = (60 x 12 x 0.015 / 1 + 0.602) Log (4728 + 763.5 / 4728)

   p = 0.44 inch

   I. Settlement - Normally Consolidated
   p = 0.44 x 0.10 / 0.015 = 2.9 inches

Use maximum potential settlement = 3.0 inches at center of landfill and 1.50 inches along edge of landfill.

psi

H.3 Pipe Stability Analysis

1/19

APPENDIX H.3

LEACHATE PIPE DESIGN AND STABILITY ANALYSIS

STATE OF TEXAS
JOSEPH O. SAI
70926
11/7/97
REGISTERED PROFESSIONAL ENGINEER

THIS CERTIFICATION IS INTENDED FOR PERMITTING PURPOSES ONLY AND INCLUDES PAGES 1 THROUGH 19.

2/19

Pipe Stability Analysis

Objective

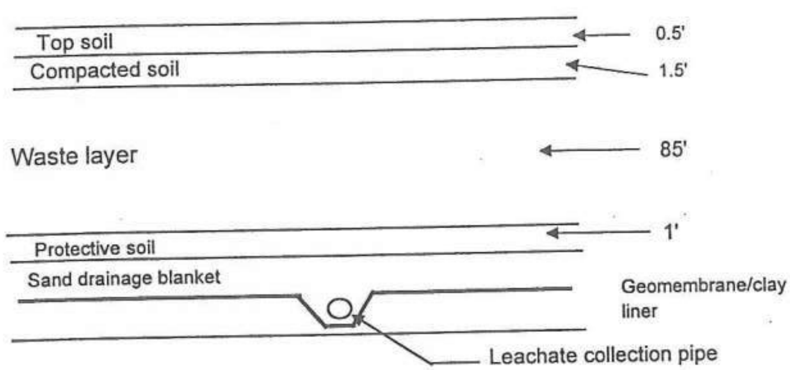
Perform structural stability analysis for the leachate collection pipes under maximum cover loads at the City of Kingsville, Texas (COK) Municipal Solid Waste Landfill.

Approach

Spangler's Equation was used to determine the deflection of the rigid PVC Pipes

Assumptions:

1. Weight of geonet and geomembrane are negligible
2. Granular bedding with little or no fines, with relative density (D_r) of 40-70% (Class D)
3. All loads are applied perpendicular to pipes.
4. Six-inch PVC perforated pipe with total open area of 0.55 in^2/ft of pipe
5. Maximum allowable deflection of PVC pipe = 0.33 inches (Ref 2)
6. Water table at elevation of 30 ft above mean sea level
7. Total unit weight of top soil (γ_{ts}) = 110 pcf
8. Total unit weight of protective soil (γ_{PS}) = 110 pcf
9. Total unit weight of compacted soil (γ_{cs}) = 115 pcf
10. Total unit weight of waste (γ_w) = 27.5 pcf



Top Soil		Protective Soil		Compacted Soil		Waste Layer	
γ_{ts} (pcf)	Depth (ft)	γ_{PS} (pcf)	Depth (ft)	γ_{cs} (pcf)	Depth (ft)	γ_w (pcf)	Depth (ft)
110	0.50	110	1	115	1.5	27.5	85

Calculation of Total Pressure above Pipes

$$P_T = P_s + P_L + P_i$$

3/19

P_s (psf)	P_s (psi)	P_L (psi)	P_I (psi)
2675.0	18.58	6.25	0

(No vacuum in perforated pipe)

$P_s > P_L > P_I$

Hence $P_T = P_s$

$P_T =$ 2,675.0 psf = 18.6 psi

Wall Crushing Factor of Safety (F.S)

$$S_A = \frac{(SDR-1)}{2} P_T$$

where:

S_A = actual compressive stress (psi)

SDR = standard dimension ratio (SDR=15.3) From Table 3.4

P_T = external total pressure above pipe (psi)

$S_A =$ 132.8 psi

$S_y =$ 1,500.0 psi (From Discopipe manual - Ref .1)

$$F.S = \frac{S_y}{S_A}$$

F.S = 11.3

Deflection of PVC pipe using Spanglers Method

$$Y_V = \frac{D_L K W_c}{\frac{2E}{3(DR-1)^3} + 0.061 E'}$$

where:

Y_v = vertical deflection (in)

D_L = deflection lag factor = 1.0 for Prism Load Method

K = bedding constant = 0.110 for Class D (Table A.3)

DR = dimension Ratio = O.D./wall thickness

E = modulus of elasticity (psi)

$E_{PVC} = 4 \times 10^5$ psi for Class 12454-A or Class 12454-B materials

E' = modulus of soil reaction (3,000 psi) for coarse grained soilwith no fines (from Table A.4)

O.D	Thickness	D_L	K	W_c (lb/in)	E (psi)	DR	E'	Y_v	Strain (%)
6.625	0.432	1.0	0.11	123.1	400,000	15.34	2,000	0.064	0.96

4/19

Allowable deflection = 5% (Reference 2, allowable strain due to external loads)

Allowable deflection= $O.D \times \frac{5}{100}$

Allowable deflection 0.33

$$F.S. = \frac{allowable\ \ deflection}{vertical\ \ deflection} = \frac{0.33}{0.064} = \quad 5.2 \quad \text{O.K.}$$

<u>Conclusion:</u>

The calculated deflection is less than the allowable deflection stated in AAWA C900-89. A six-inch, Schedule 80 PVC will be adequate.

<u>Attachments</u>

1. Driscopipe Charts
2. PVC Table
3. Soil.Modulus of Elasticity Table

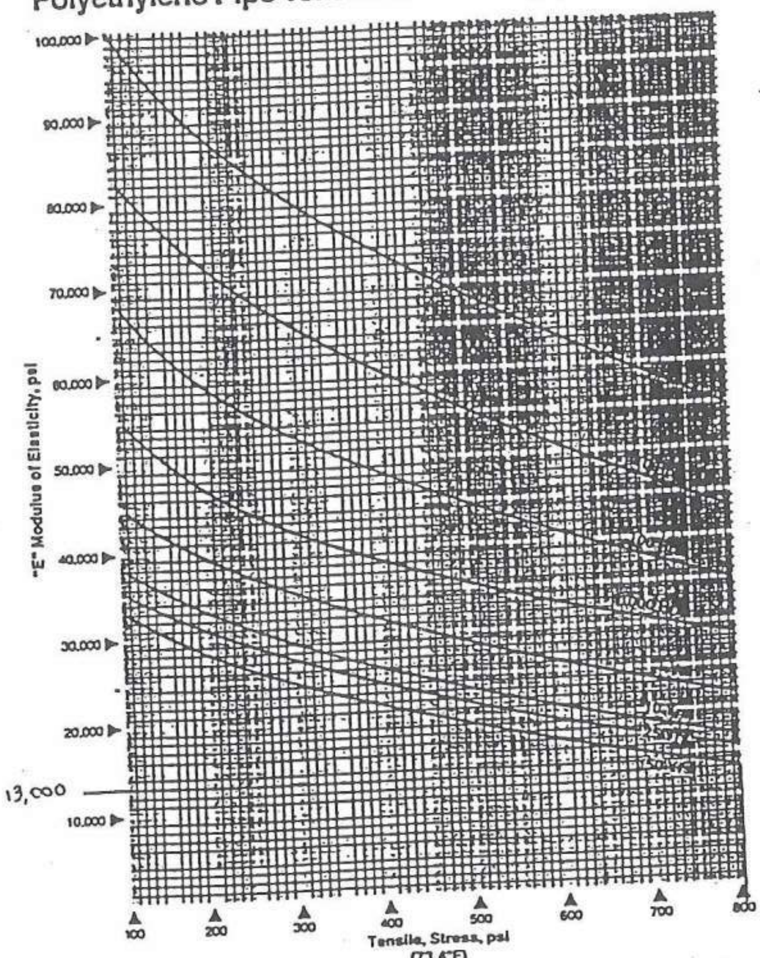
References

1. Driscopipe Manual, 1993
2. American Water Works Assoc. (AWWA), C900-89

5/19

ATTACHMENT 1

Chart 25
Time Dependent Modulus of Elasticity for Polyethylene Pipe vs. Stress Intensity (73.4°F)



NOTE: The short term modulus of elasticity of Driscopipe per ASTM D 638 is approximately 100,000 psi. Due to the cold flow (creep) characteristic of the pipe material, this modulus is dependent upon the stress intensity and the time duration of the applied stress.

H-141

6/19

TYPICAL PHYSICAL PROPERTIES* — DRISCOPIPE 8600 PIPE MATERIAL

PROPERTY	TEST METHOD	UNIT	VALUE
Density	ASTM D 1505	gms/cc	0.957
Melt Flow	ASTM D 1238 (cond. F)	gms/10 min.	1.5
Environmental Stress Cracking Resistance	ASTM D 1693 (cond. C)	hrs.	>1500**
Tensile Strength, Yield	ASTM D 638 (2"/min.)	psi	3500
Elongation at Break	ASTM D 638 (2"/min.)	%	>600
Impact Strength, .25" thickness .125" thickness	ASTM D 256	ft.lbs/in.notch	7 12
Vicat Softening Temperature	ASTM D 1525	°F	257
Brittleness Temperature	ASTM D 746	°F	<-180
Flexural Modulus	ASTM D 3350	psi	125,000
Modulus of Elasticity	ASTM D 638	psi	110,000
Hardness	ASTM D 2240	Shore D	65
Coefficient of Linear Thermal Expansion: Molded Specimen Extruded Pipe	ASTM D 696	in./in./°F in./in./°F	$.778 \times 10^{-4}$ 1.2×10^{-4}
Thermal Conductivity	Dynatech-Colora Thermoconductor	BTU, in/ft²/hrs/°F	2.7
Long Term Strength 73°F 120°F 140°F	ASTM D 2837	psi psi psi	1600 1000 800
Material Cell Classification	ASTM D 3350		355434C
Material Designation	PPI Recommendation		PE3408

Driscopipe 8600 is listed by the National Sanitation Foundation.

*This list of typical physical properties is intended for basic characterization of the material and does not represent specific determinations or specifications. The physical properties values reported herein were determined on compression molded specimens prepared in accordance with Procedure C of ASTM D 1928 and may differ from specimens taken from pipe.

**Tests discontinued because of no failures and no indication of stress crack initiation.

7/19

Chart 26
Plot of Vertical Stress-Strain Data for Typical Trench Backfill (Except Clay) from Actual Tests*

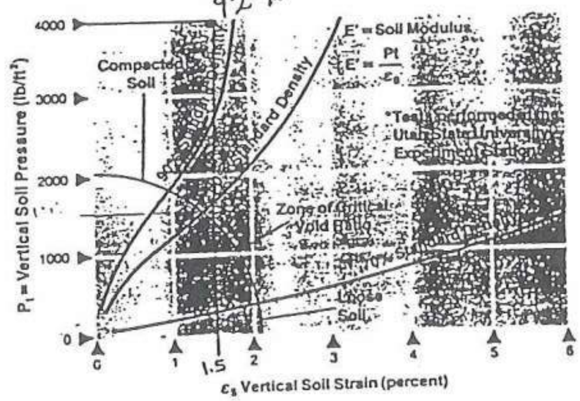
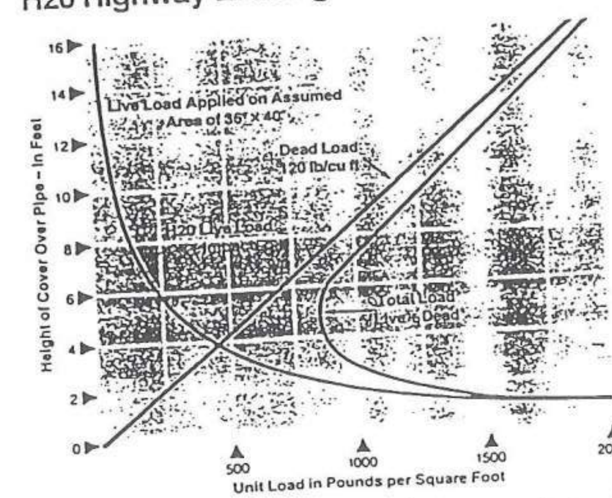


Chart 27

SDR	Allowable Ring Deflection
32.5	8.1%
26.0	6.5%
21.0	5.2%
19.0	4.7%
17.0	4.2%
15.5	3.9%
13.5	3.4%
11.0	2.7%

Chart 30
H20 Highway Loading



Note: The H20 live load assumes two 16,000 lb. concentrated loads applied to two 18" × 20" areas, one located over the point in question, and the other located at a distance of 72" away. In this manner, a truckload of 20 simulated.

Source: American Iron and Steel Institute, Washington, D.C.

H-143

8/19

ATTACHMENT I

TABLE 3.4

GEOMETRIC CHARACTERISTICS OF ABS AND PVC CASING "SPECIALS" IN SCHEDULE DIMENSIONS

Reference Standards	Outside Diameter (Inches)		Minimum Wall Thickness (Inches)		Diameter Ratio (DR)		Minimum Internal Diameter (Inches)		Minimum Annular Wall Area (sq. in.)		Internal Transverse Area (sq. ft.) & Volume (cu. ft./ft.)	
	Nominal	Average	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80	Sch 40	Sch 80
ASTM D1527 for ABS + ASTM D1785 for PVC	2	2.375	0.154	0.218	15.4	10.9	1.99	1.86	1.07	1.48	0.023	0.020
"	2½	2.875	0.203	0.276	14.2	10.4	2.37	2.26	1.70	2.25	0.033	0.029
"	3	3.500	0.216	0.300	16.2	11.7	2.95	2.78	2.23	3.02	0.050	0.045
"	3½	4.000	0.226	0.318	17.7	12.6	3.41	3.23	2.68	3.68	0.068	0.060
"	4	4.500	0.237	0.337	19.0	13.3	3.88	3.68	3.17	4.41	0.087	0.078
"	5	5.563	0.258	0.375	21.6	14.8	4.86	4.62	4.30	6.11	0.137	0.124
"	6	6.625	0.280	0.432	23.7	15.3	5.85	5.53	5.58	8.40	0.198	0.178
"	8	8.625	0.322	0.500	26.8	17.2	7.70	7.34	8.40	12.76	0.344	0.312
"	10	10.750	0.365	0.593	29.4	18.1	9.68	9.20	11.91	18.92	0.543	0.492
"	12	12.750	0.406	0.687	31.4	18.6	11.53	10.96	15.74	26.04	0.771	0.696
None	14	14.000	0.437	0.750	32.0	18.7	12.68	12.04	18.62	31.22	0.932	0.840
"	16	16.000	0.500	0.843	32.0	19.0	14.49	13.78	24.35	40.14	1.217	1.102

The ratio of average outside pipe diameter to minimum wall thickness in a given SDR series is a set and constant value regardless of actual pipe diameter.

H-144

9/19

American Water Works Association
ANSI/AWWA C900-89
(Revision of ANSI/AWWA C900-81)

AWWA STANDARD
FOR

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE, 4 IN. THROUGH 12 IN., FOR WATER DISTRIBUTION

AMERICAN NATIONAL STANDARD

Effective date: July 1, 1989.
First edition approved by AWWA Board of Directors June 8, 1975.
This edition approved Jan. 29, 1989.
Approved by American National Standards Institute, Inc., May 4, 1989.

AMERICAN WATER WORKS ASSOCIATION
6666 West Quincy Avenue, Denver, Colorado 80235

Where:

P_s = pressure rise, in pounds per square inch
a = wave velocity, in feet per second
V = velocity change, in feet per second, occurring within the critical time $2L/a$, where L is the length of the pipeline, in feet
g = gravitational acceleration = 32.2 ft/s^2.

A.3.3.3 *Cyclic surge pressure*. The cyclic application of surge pressure in water mains can result in product failure if it is not accommodated in product or system design. The design stress given in C900-89 is derived using a safety factor of 2.5 plus a surge-pressure allowance and accommodates the cyclic surge conditions customarily anticipated for municipal water distribution systems.

Sec. A.3.4 Hydrostatic Design Basis (HDB)

The HDB of PVC pipe (class 12454-A and class 12454-B materials) for water service at 73.4°F (23°C) is 4000 psi. The HDB will be less than 4000 psi for pipe used at temperatures greater than 73.4°F (23°C) (Sec. A.3.5). The HDB will be greater than 4000 psi for pipe used at temperatures less than 73.4°F (23°C); however, the 4000 psi should be used as a maximum in normal design. HDB is defined in accordance with ASTM D2837.

Sec. A.3.5 Design Stress

The allowable design stress HDB/F (where F is a safety factor) for use of PVC pressure pipe at 73.4°F (23°C) and lower temperatures is 1600 psi (11.03 MPa). For pipe used at higher operating temperatures, the allowable design stress shall be determined by use of an HDB rating recommended by the Plastics Pipe Institute Hydrostatic Design Stress Committee for the operating temperature or by applying the appropriate temperature coefficient from Table A.1 to the design stress allowed for pipe service at 73.4°F (23°C) (Sec. A.7.4). The temperature coefficients are derating factors that may be applied also to pressure-class ratings for pipe used at temperatures greater than 73.4°F (23°C).

Sec. A.3.6 Factor of Safety

The safety factor F of 2.5 specified for use in the pressure-class and total-pres-

Table A.1 Temperature Coefficients

Maximum Service Temperature °F	(°C)	Allowable Design Stress or Pressure-Class Rating at 73.4°F (23°C) %
80	(27)	88
90	(32)	75
100	(38)	62
110	(43)	50
120	(49)	40
130	(54)	30
140	(60)	22

11/19

sure equations (Eq A.1, Eq A.2, Eq A.3, and Eq A.4) is only a portion of that provided for working pressure and for total system pressure.

There are two pressure conditions, and a different factor of safety applies to each. The conditions are (1) sustained working pressure, which is a long-term pressure condition and relates to the long-term hydrostatic strength HDB of the pipe, and (2) total system pressure, which is a short-term, peak-pressure condition and relates to the short-term hydrostatic strength of the pipe. The long- and short-term hydrostatic strengths of PVC pressure pipe at 73.4°F (23°C) are 4000 and 6400 psi (27.58 and 44.13 MPa), respectively. The latter is the minimum hoop-stress specified in Table 3 of AWWA C900-89 for the quick-burst strength of the pipe.

The factor of safety provided for sustained working pressure in the pressure-class ratings (Table 1, AWWA C900-89) is 3.0 or greater, depending on the dimension ratio of the pipe. The factor of safety for working pressure is a function of the surge-pressure allowance as well as the allowable design stress HDB/2.5.

A safety factor of 4.0 is provided for total system pressure. It is the ratio of 6400 psi (44.13 MPa) (minimum short-term strength) to 1600 psi (11.03 MPa) (allowable design stress, HDB/2.5).

Sec. A.3.7 Pressure-Class Selection—Example

A municipal system with buried water main temperatures below 70°F operates with a maximum sustained working pressure of 85 psi. System designers determine the maximum surge pressure input to be the the result of an instantaneous velocity change (ΔV) of 2 ft/s. What pressure class or corresponding dimension ratio is required?

First, solve the pressure surge term using Eq A.5.

$$a = \frac{4700}{(1 + KD_i / Et)^{1/2}}$$

Assume nominal 8-in. pipe and anticipate a DR 18 wall thickness.

$$a = \frac{4700}{[1 + (300{,}000)\ (8.044) / (400{,}000)\ (.503)\ ]^{1/2}}$$

$$= 1304$$

Calculate pressure rise using Eq A.6

$$P_s = \frac{aV}{2.31g}$$

$$= \frac{(1304)\ (2)}{(2.31)\ (32.2)}$$

$$= 35 \text{ psi}$$

Total pressure is sustained pressure plus surge pressure

$$P_t = 85 + 35$$

$$= 120 \text{ psi}$$

12/19

and

$$P_t = \frac{2}{\text{DR} - 1} \times \frac{\text{HDB}}{F}$$

Solving for DR

$$\text{DR} = \left(\frac{2}{P_t} \times \frac{\text{HDB}}{F}\right) + 1$$

$$= \left(\frac{2}{120} \times \frac{4000}{2.5}\right) + 1$$

$$= 27.7$$

Select available dimension ratio that is equal to or lower than

$$\text{DR} = 25, \text{PC } 100.$$

Recalculating P_s with actual t gives

$$a = 1100$$

$$P_s = 30 \text{ psi}$$

then

$$P_t = 115$$

$$\text{DR} = 28.8$$

Proper design requires selection of DR 25, PC 100 C900-89 pipe.

SECTION A.4: EXTERNAL LOADS

Sec. A.4.1 Dead Loads

The earth load shall be determined using the modified Marston formula[1] for loads imparted to a flexible pipe, as follows:

$$W_c = C_d w B_d B_c \qquad \text{(Eq A.7)}$$

Where:

W_c = earth load, in pounds per linear foot
C_d = a coefficient based on type of backfill soil and on the ratio of H (depth of fill to top of pipe, in feet) to B_d (Figure A.1)
w = unit weight of soil, in pounds per cubic feet
B_d = ditch width at top of pipe, in feet
B_c = outside diameter of pipe, in feet

15/19

16 AWWA C900-89

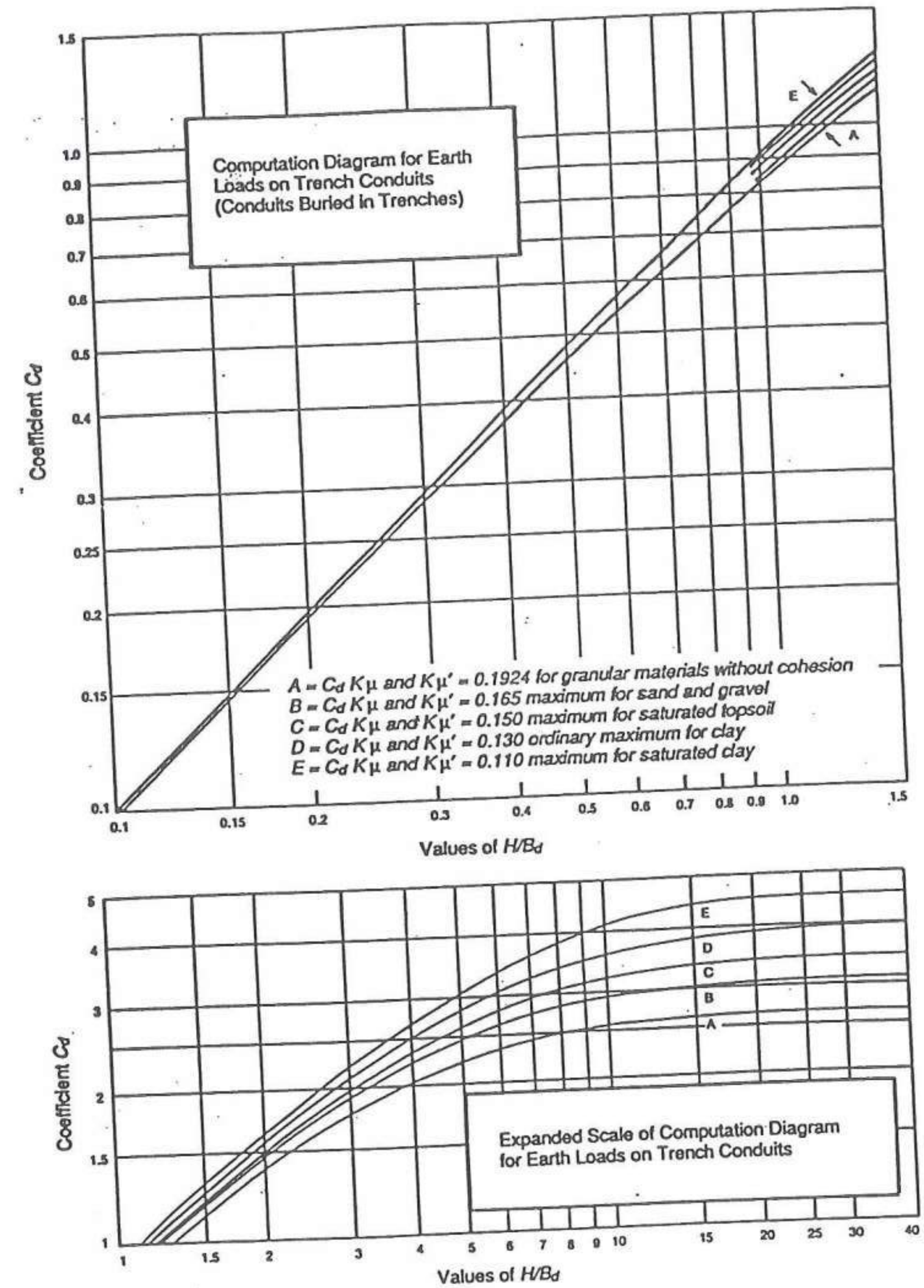


Figure A.1 Computation diagram for earth loads on trench conduits.

14/19

Table A.2 Highway Live Loads*

Pipe Size in.	Depth of Cover—ft 2.5	3.5	5	8	12	16	20	24
	W_l—lb/lin ft							
4	297	162	81	54	40	27	18	14
6	567	324	189	94	68	40	26	20
8	783	486	297	148	94	54	36	28
10	972	621	378	189	108	68	45	35
12	1161	756	459	243	122	81	53	41

*Extracted from Table 1-8, ANSI/AWWA C101/A21.1-67 (R77), American National Standard for Thickness Design of Cast-Iron Pipe.

Sec. A.4.2 Live Loads

The live load W_l shall be determined using the modified AASHO H-20 loading as described in ANSI/AWWA C101/A21.1,[2] and listed in Table A.2. Table A.2 is based on two passing trucks with adjacent wheels 3 ft (0.9 m) apart, having a 9000-lb wheel load on unpaved road or flexible pavement, and having a 50 percent impact factor.

Sec. A.4.3 Total Load

The total load W on buried flexible pipe is as follows:

$$W = W_e + W_l \text{ (pounds per linear foot)} \qquad \text{(Eq A.8)}$$

Where:

W_e = earth load and superimposed dead load
W_l = superimposed live load

SECTION A.5: DEFLECTION

Sec. A.5.1 General

The stresses that result from internal pressure and external load are not additive in the design of a flexible conduit such as PVC pipe. Although a maximum deflection of 5 percent is specified in Sec. A.1.1.3 for a design limit, PVC pressure pipe can be deflected up to 7 1/2 percent without reducing its ability to resist internal pressure. Failure modes are discussed in Sec. A.7.

Sec. A.5.2 Design Theory—Earth Loads

Currently, the best-documented and best-known design theory for the deflection of a cylindrical horizontal tube under earth load is Spangler's modified formula[3,4] for the deflection of a buried unpressurized tube. The formula for PVC pipe is as follows:

$$y_v = \frac{D_L K W_c}{2E / [3 (DR - 1)^3] + 0.061 E'} \qquad \text{(Eq A.9)}$$

Where:

y_v = vertical deflection of pipe, in inches
D_L = deflection lag factor (approximately 1.5)
K = bedding constant (see Table A.3, Sec. A.5.4)
W_c = earth load on pipe = $W_c / 12$, in pounds per linear inch
DR = dimension ratio
E = modulus of elasticity of pipe material (for PVC class 12454-A or class 12454-B materials, E = 400,000 psi)
E' = modulus of soil reaction (Table A.4).

Sec. A.5.3 Earth Load Plus Live Load

For inclusion of live loads, Spangler's formula must be further modified because the deflection lag factor is not applicable to live loads. The formula is as follows:

$$y_v = \frac{D_L K W_c + K W_d}{2E / [3(\mathrm{DR} - 1)^3] + 0.061 E'} \qquad \text{(Eq A.10)}$$

Where:

W_d = live load on pipe = $W_l / 12$, in pounds per linear inch

Other factors are the same as in Eq A.9.

Sec. A.5.4 Deflection Formula Factors D_L, K, and E'

The values for D_L, K, and E' corresponding to different pipe embedment conditions for use in Eq A.9 and Eq A.10 are listed in Tables A.3 and A.4.

SECTION A.6: INSTALLATION

Sec. A.6.1 Pipe Embedment

The embedment of pipe shall conform with the recommended practices given in ASTM D2774, Recommended Practice for Underground Installation of Thermoplastic Pressure Piping and *PVC Pipe*.[6] Flexible pipe, unlike a rigid pipe, tends to bed itself. For flexible pipe, the most important parameters are stability of the bedding and density of the sidefills. Installation precautions are also given in ASTM 2774

Table A.3 Values for Deflection-Formula Factors

	Comparable Bedding			
Class*	Laying Condition*	Field Condition	Bedding Angle	K
D	Types 1 & 2	A & B	0°	0.110
—	Type 3	—	60°±	0.102±
—	—	E & F	90°	0.096
—	—	—	96°	0.095
C	—	S	180°	0.083
B	Types 4 & 5			

*As described in *Design and Construction of Sanitary and Storm Sewers*, ASCE Manual No. 37 (WPCF Manual of Practice No. 9), WPCF, ASCE, Washington, D.C. (1967).[5]

Attachment 3

Table A.4 Typical Values of Modulus of Soil Reaction E′ for Average Initial Flexible Pipe Deflection*

Soil type—pipe zone material (Unified Classification System†) (1)	E′ for Degree of Compaction of Pipe Zone Backfill psi Loose (2)	Slight, <85% Proctor, <40% relative density (3)	Moderate, 85–95% Proctor, 40–70% relative density (4)	High, >95% Proctor, >70% relative density (5)
Fine-grained soils (LL>50)‡ Soils with medium to high plasticity; CH, MH, CH–MH	No data available: consult a competent soils engineer; otherwise use E′ = 0			
Fine-grained soils (LL<50) Soils with medium to no plasticity; CL, ML, ML–CL, with less than 25% coarse-grained particles	50	200	400	1000
Fine-grained soils (LL<50) Soils with medium to no plasticity; CL, ML, ML–CL, with more than 25% coarse-grained particles	100	400	1000	2000
Coarse-grained soils with fines; GM, GC, SM, SC;§ contains more than 12% fines	100	400	1000	2000
Coarse-grained soils with little or no fines; GW, GP, SW, SP;§ contains less than 12% fines	200	1000	2000	3000
Crushed rock	1000	3000	3000	3000
Accuracy in terms of percentage deflection**	±2	±2	±1	±0.5

NOTE: Values applicable only for fills less than 50 ft (15 m). Table does not include any safety factor. For use in predicting initial deflections only, appropriate Deflection Lag Factor must be applied for long-term deflections. If bedding falls on the borderline between two compaction categories, select lower E′ value or average the two values. Percentage Proctor based on laboratory maximum dry density from test standards using about 12,500 ft-lb/ft³ (598,000 J/m³) (ASTM D698, AASHTO T-99, USBR Designation E-11). 1 psi = 6.9 kN/m².

*The pipe-zone embedment conditions included in this table are not intended as installation recommendations and are provided for information only. For installation recommendations, see Sec. A.6.

†ASTM Designation D2487. USBR Designation E-3.

‡LL=Liquid Limit.

§Or any borderline soil beginning with one of these symbols (for example, GM–GC, GC–SC).

**For ±1% accuracy and predicted deflection of 3%, actual deflection would be between 2% and 4%.

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H-152

11/19

and *PVC Pipe*. Embedment and backfill procedures should be in accordance with the applicable manufacturer's instructions.

SECTION A.7: FAILURE MODES

Sec. A.7.1 General

Flexible conduits can fail by buckling or can collapse because of an excessive external load, a negative or vacuum pressure, excessive bending stresses in the walls, excessive deflection, or a combination of these forces. Plastic conduits can also fail by reduction of ring stiffness (strength) caused by excessive temperature of the fluid that is being transported or of the environment in which they are installed.

Sec. A.7.2 Buckling

Experiments performed at Utah State University[7] indicate that plastic pipe does not fail by buckling in the same manner as steel pipe. Steel pipe dimples inward, the dimple reverses curvature, and then it folds in on the lower portion. Steel conforms to Timoshenko's formula[8] in a free environment, but the formula must be modified if the pipe is confined in an earth envelope. However, plastic pipe tends to deform (flatten) during vertical deflection and then folds inward on the lower portion. Therefore, if deflection is controlled, buckling will not occur under normal embedment conditions.

Sec. A.7.3 Negative or Vacuum Pressure

According to the experiments conducted at Utah State University, negative (vacuum) pressure cannot collapse an underground plastic pipe that is properly encased in a soil envelope and exposed to normal service temperatures. However, if the temperature of a plastic pipe becomes excessive because of the temperature of the fluid it is conveying, then the application of a negative pressure can cause the pipe to collapse.

Sec. A.7.4 Excessive Temperature

If PVC pipe is used to convey fluids of excessive temperature or if it is installed in an environment where excessive temperatures can influence the conduit, then the allowable design stress or the AWWA pressure-class ratings should be appropriately reduced in accordance with Table A.1.

Sec. A.7.5 Bending Stresses in Walls

Plastic pipe embedded in soil reacts similarly to steel pipe in that it tends to bed itself and thereby readjusts wall stresses. The pipe will not fail from excessive wall stresses (caused by deformation under external load) if deflection is controlled by proper installation.

$$\Delta x = D_l \left(\frac{K W r^3}{EI + 0.061 E' r^3} \right) \qquad (6\text{-}5)$$

Where:

Δx = horizontal deflection of pipe (in.)
D_l = deflection lag factor (1.0–1.5)
K = bedding constant (0.1)
W = load per unit of pipe length (lb/lin in. of pipe)
r = radius (in.)
EI = pipe wall stiffness (in.-lb)
where E = modulus of elasticity (30 000 000 psi for steel and 4 000 000 psi for cement mortar)
I = transverse moment of inertia per unit length of pipe wall*
E' = modulus of soil reaction (lb/in.^{2}) (Tables 6-1 and 6-2).

*Under load, the individual elements—i.e., mortar lining, steel shell, and mortar coating—work together as laminated rings ($E_s I_s + E_l I_l + E_c I_c$ – shell, lining, and coating). Structurally, the combined action of these elements increases the moment of inertia of the pipe section, above that of the shell alone, thus increasing its ability to resist loads. The pipe wall stiffness EI of these individual elements is additive.

Table 6-1 Average Values* of Modulus of Soil Reaction (E′) (For initial flexible pipe deflection)

Soil Type/Primary Pipe Zone Backfill Material (Unified Classification System)†	E′ for Degree of Compaction of Bedding, *psi (MPa)*		
	Slight <85% Proctor <40% rel. den.	Moderate 85–95% Proctor 40–70% rel. den.	High >95% Proctor >70% rel. den.
Fine-grained soils (LL>50)‡/Soils with medium to high plasticity CH, MH, CH–MH	Soils in this category require special engineering analysis to determine required density, moisture content, compactive effort.		
Fine-grained soils (LL<50)/Soils with medium to no plasticity CL, ML, ML–CL, CL–CH, ML–MH, with less than 25% coarse-grained particles	200 (1.4)	400 (2.8)	1000 (6.9)
Fine-grained soils (LL<50)/Soils with medium to no plasticity CL, ML, ML–CL, CL–CH, ML–MH, with more than 25% coarse-grained particles; Coarse-grained soils with fines/GM, GC, SM, SC§ containing more than 12% fines	400 (2.8)	1000 (6.9)	2000 (13.8)
Coarse-grained soils with little or no fines/GW, GP, SW, SP§ containing less than 12% fines	1000 (6.9)	2000 (13.8)	3000 (20.7)
Crushed rock		3000 (20.7)	
Accuracy in terms of difference between predicted and actual average percent deflection	±2%	±1%	±0.5%

*As determined by the US Bureau of Reclamation.
†Refer to Table 6-2.
‡LL = Liquid limit.
§Or any borderline soil beginning with one of these symbols (i.e., GM–GC, GC–SC).

NOTES:
1. Values applicable only for fill less than 50 ft (15 m).
2. For use in predicting initial deflections only, appropriate Deflection Lag Factor must be applied for long-term deflections.
3. Percent Proctor based on laboratory maximum dry density from test standards using about 12 500 ft·lbf/ft^3 (598 000 J/m^3) (Method D698, AASHTO T-99).

Allowable deflection for various lining and coating systems that are often accepted are:

Mortar-lined and coated = 2 percent of pipe diameter
Mortar-lined and flexible coated = 3 percent of pipe diameter
Flexible lining and coated ≐ 5 percent of pipe diameter

Live-load effect, added to dead load when applicable, is generally based on AASHTO HS-20 truck loads or Cooper E-80 railroad loads as indicated in Table 6-3. These values are given in pounds per square foot and include 50-percent impact factor. It is noted that there is no live-load effect for HS-20 loads when the earth cover exceeds 8 ft or for E-80 loads when the earth cover exceeds 30 ft.

Modulus of soil reaction E' is a measure of stiffness of the embedment material, which surrounds the pipe. This modulus is required for the calculation of deflection and critical buckling stress. E' is actually a hybrid modulus that has been introduced to eliminate the spring constant used in the original Iowa formula. It is the product of the modulus of passive resistance of the soil used in Spangler's early derivation and the radius of the pipe. It is not a pure material property.

Table 6-2 Unified Soil Classification

Symbol	Description
GW	Well-graded gravels, gravel–sand mixtures, little or no fines
GP	Poorly graded gravels, gravel–sand mixtures, little or no fines
GM	Silty gravels, poorly graded gravel–sand–silt mixtures
GC	Clayey gravels, poorly graded gravel–sand–clay mixtures
SW	Well-graded sands, gravelly sands, little or no fines
SP	Poorly graded sands, gravelly sands, little or no fines
SM	Silty sands, poorly graded sand–silt mixtures
SC	Clayey sands, poorly graded sand–clay mixtures
ML	Inorganic silts and very fine sand, silty or clayey fine sands
CL	Inorganic clays of low to medium plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH	Inorganic clays of high plasticity, fat clays
OL	Organic silts and organic silt–clays of low plasticity
OH	Organic clays of medium to high plasticity
Pt	Peat and other highly organic soils

Source: Classification of Soils for Engineering Purposes. ASTM Standard D2487-69, ASTM, Philadelphia, Pa. (1969).

Table 6-3 Live-Load Effect

Highway HS-20 Loading*		Railroad E-80 Loading*	
Height of Cover *ft*	Load *psf*	Height of Cover *ft*	Load *psf*
1	1800	2	3800
2	800	5	2400
3	600	8	1600
4	400	10	1100
5	250	12	800
6	200	15	600
7	176	20	300
8	100	30	100

*Neglect live load when less than 100 psf; use dead load only.

1/3

APPENDIX H.3 (cont'd)

UPSLOPE RISER PIPE DESIGN AND STABILITY ANALYSIS

STATE OF TEXAS
JOSEPH O. SAI
70926
1/7/97
REGISTERED
PROFESSIONAL ENGINEER

Joe Sai

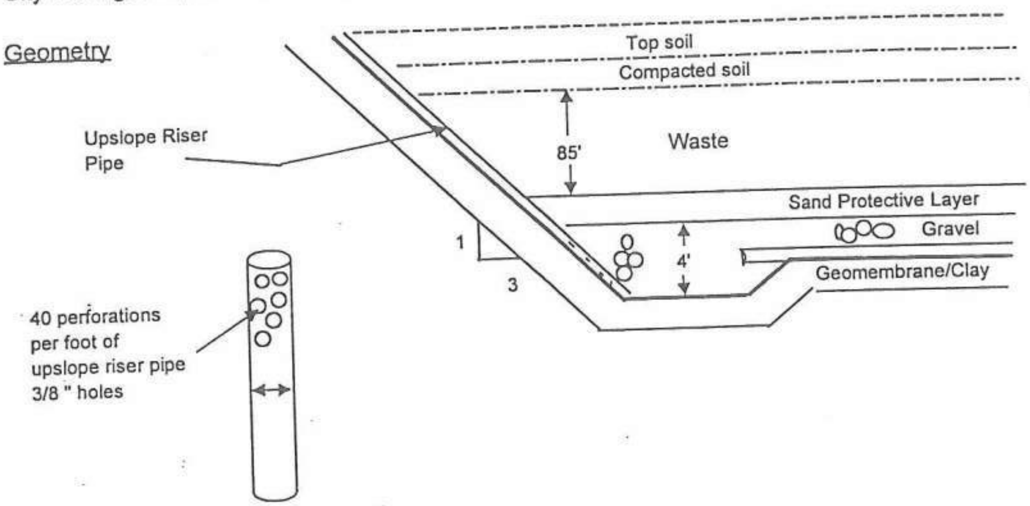
THIS CERTIFICATION IS INTENDED FOR PERMITTING PURPOSES ONLY AND INCLUDES PAGES 1 THROUGH 3.

Upslope Pipe Design & Stability Analysis

Objective

Peform a structural stability analysis for the upslope riser pipe under maximum loads at the City of Kingsville, Texas, Municipal Solid Waste Landfill.

Geometry



Upslope Riser Pipe

Assumptions:

1. Weight of geonet and geomembrane are negligible
2. SDR-17, 18-inch HDPE pipe will be used
3. Total unit weight of top soil (γ_{ts}) = 110 pcf
4. Total unit weight of protective soil (γ_{PS}) = 110 pcf
5. Total unit weight of compacted soil (γ_{cs}) = 115 pcf
6. Total unit weight of waste (γ_w) = 27.5 pcf
7. Total unit weight of gravel (γ_w) = 100 pcf

Top Soil		Protective Soil		Compacted Soil		Waste Layer		Gravel Layer	
γ_{ts}	Depth (ft)	γ_{PS}	Depth (ft)	γ_{cs}	Depth (ft)	γ_w	Depth (ft)	γ_G	Depth (ft)
110	0.50	110	1	115	1.5	27.5	85	100	4

P_T (psf)	Pipe diam. (in)	Hole diam (in)	# of Perf	$A_{18" pipe}$ (in^2)	A_{perf} (in^2)	P_{TC} (psf)
3075	18	0.375	40	254.57	4.42	3129

3/3

Deflection Calculation

$$\Delta_X = \frac{D_L K W_c}{\frac{2E}{3(DR-1)^3} + 0.061E'}$$

Where:

Δ_X = allowable deflection (2/100 x (diam. A_{18}+ diam. hole)

D_L = deflection lag factor, 1.0 for Prism load method (Ref. 1)

K = bedding constant, 0.110 (Ref. 1, Class D, table A.3)

W = design vertical load, P_{Tc} (ft)/12

DR = dimension rate, O.D./thickness of wall, 18"/1.059" = 17

E_{HDPE} = 30 x 10^6

E' = modulus of soil resistance = 0

O.D	Thickness	D_L	K	$W_{c\ (lb/in)}$	E (psi)	DR	E'	Δ_X
18	1.059	1.0	0.11	260.8	3.E+07	17.0	0	0.01

Allowable deflection = 2% x (diam of pipe + diam. Of hole)

Allowable deflection= 0.37 in

Hence actual deflection (0.01 in) < allowable deflection (0.37 in) O.K.

Conclusion

The upslope riser pipe of the leachate collection system shall be SDR-17, 18-inch HDPE with a wall thickness (t) = 1.059 inches to support a 2 % deflection.

References

1. Steel Pipe Design and Installation. AAWA M11

H.4 HDPE Liner Stress Analysis

1/8

APPENDIX H.4

HDPE LINER STRESS ANALYSIS

STATE OF TEXAS
JOSEPH O. SAI
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REGISTERED
PROFESSIONAL ENGINEER

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2/8

HDPE Liner Stress Analysis

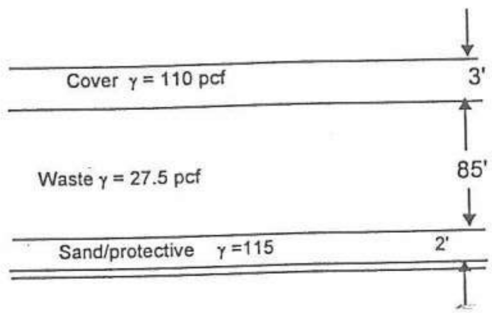
Objective

Determine the suitability of a 60-mil HDPE with respect to puncture resistance

Approach

The factor of Safety for the 60-mil HDPE liner against puncture was determined

Configuration



Failure Mode

Puncture of liner due to penetration of soil particles. Analyze factor of safety for various particle sizes.

Analyses

$R_p = Pd^2$ (Ref. 1)

where,

R_p = required puncture resistance (lbs)
P = overburden pressure (psf)
d = particle size (ft)

Rp = 108 lb for 60 mil double sided textured HDPE liner (Ref. 2)

$$P_T = (\gamma_s t_s) + (\gamma_w t_w) + (\gamma_{pc} t_{pc})$$

Soil Cover		Waste Layer		Protective Cover		P_T (psf)
γs (pcf)	depth (ft)	γw (pcf)	depth (ft)	γpc (pcf)	depth (ft)	
110	3	27.5	85	115	2	2898

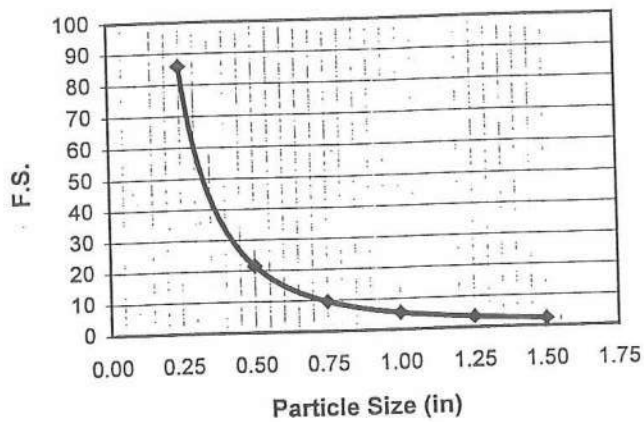
$$R_p = 2897 \quad d^2$$

Calculate R_p for different particle sizes

$$F.S. = \frac{allowable \quad puncture \quad resist.}{required \quad puncture \quad resist.}$$

3/8

Particle Size (in)	Particle Size (ft)	R_p (lb)	F.S
0.25	0.0208	1.26	85.88
0.50	0.0417	5.03	21.47
0.75	0.0625	11.32	9.54
1.00	0.0833	20.12	5.37
1.25	0.1042	31.44	3.44
1.50	0.1250	45.27	2.39



Conclusion

For 8 oz/yd^2 geotextile fabric, the maximum average roll puncture strength is 130-155 lbs (Ref. 3) This value is greater than the 108 lbs for textured HDPE liner. The factor of safety against failure would therefore be slightly higher for the corresponding particle size. The above analysis is the limiting case.

References

1. Koerner, Robert, M. "Designing with Geosynthetics" 1990
2. NSC Specification Guide
3. Synthetic Industries, Nonwoven Polypropylene Geotextiles, Specifications, and Samples.

ONWOVEN GEOTEXTILES – ENGLISH VALUES

PROPERTY	TEST METHOD	UNITS	VALUE	311	351	401	451	501	601	701	801	1001	1201	1601
MECHANICAL														
Grab Tensile Strength	ASTM D-4632	lbs	TYPICAL	100	105	115	135	155	170	205	230	275	340	425
			MARV	80	90	100	120	135	150	180	200	250	300	380
Grab Elongation	ASTM D-4632	%	TYPICAL	55	56	56	56	56	56	60	60	60	60	65
			MARV	45	50	50	50	50	50	50	50	50	50	50
Puncture Strength	ASTM D-4833	lbs	TYPICAL	65	70	80	90	105	120	135	155	185	220	290
			MARV	50	55	65	70	85	95	110	130	160	180	240
Mullen Burst	ASTM D-3786	psi	TYPICAL	220	240	265	290	325	385	425	475	590	680	950
			MARV	165	185	225	240	275	325	350	400	510	600	800
Trapezoidal Tear	ASTM D-4533	lbs	TYPICAL	40	45	55	60	68	70	88	98	115	130	165
			MARV	30	35	45	50	57	60	75	85	100	115	145
HYDRAULIC														
Apparent Opening Size (AOS)	ASTM D-4751	US Sieve	TYPICAL	100	100	100	100	100	100	100	100	140	140	140
			MARV	70	70	70	70	70	70	70	80	100	100	100
Permittivity	ASTM D-4491	sec^{-1}	TYPICAL	2.50	2.50	2.50	1.90	1.80	1.70	1.80	1.90	1.60	1.50	1.00
			MARV	2.00	2.00	2.00	1.50	1.40	1.30	1.50	1.50	1.20	1.00	0.70
Permeability	ASTM D-4491	cm/sec	TYPICAL	0.28	0.31	0.34	0.29	0.29	0.32	0.40	0.48	0.40	0.43	0.39
			MARV	0.22	0.25	0.22	0.22	0.23	0.24	0.34	0.38	0.30	0.29	0.27
Water Flow Rate	ASTM D-4491	gpm/ft^2	TYPICAL	130	130	160	140	130	130	130	130	100	90	65
			MARV	110	110	140	120	115	110	110	110	85	75	50
ENDURANCE														
UV Resistance	ASTM D-4355	% Retained @ 500 hrs	MARV	70	70	70	70	70	70	70	70	70	70	70
STANDARD PACKAGING														
Roll Width	Measured	feet	TYPICAL	12.5/15.0	12.5/15.0	12.5/15.0	12.5/15.0	12.5/15.0	12.5/15.0	12.5/15.0	15.0	15.0	15.0	15.0
Roll Length	Measured	feet	TYPICAL	360	360	360	360	360	300	300	300	300	300	300
Roll Area	Calculated	yd^2	TYPICAL	500/600	500/600	500/600	500/600	500/600	416.67/500	416.67/500	500	500	500	500

NOTES

▲ Values reported in weaker principle direction.

▲ "MARV" indicates minimum average roll value calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the value reported.

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H-63

ONWOVEN GEOTEXTILES – METRIC VALUES

PROPERTY	TEST METHOD	UNITS	VALUE	311	351	401	451	501	601	701	801	1001	1201	1601
MECHANICAL														
Grab Tensile Strength	ASTM D-4632	N	TYPICAL	445	465	510	600	685	755	910	1020	1220	1510	1890
			MARV	355	400	445	530	600	665	800	890	1110	1335	1690
Grab Elongation	ASTM D-4632	%	TYPICAL	55	56	56	56	56	56	60	60	60	60	65
			MARV	45	50	50	50	50	50	50	50	50	50	50
Puncture Strength	ASTM D-4833	N	TYPICAL	285	310	355	400	465	530	600	685	820	975	1290
			MARV	220	240	285	310	375	420	485	575	710	800	1065
Mullen Burst	ASTM D-3786	kPa	TYPICAL	1510	1650	1820	1990	2240	2650	2920	3270	4060	4680	6540
			MARV	1130	1270	1550	1650	1890	2240	2410	2750	3510	4130	5510
Trapezoidal Tear	ASTM D-4533	N	TYPICAL	175	200	240	265	300	310	390	435	510	575	730
			MARV	130	155	200	220	250	265	330	375	445	510	645
HYDRAULIC														
Apparent Opening Size (AOS)	ASTM D-4751	mm	TYPICAL	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.106	0.106	0.106
			MARV	0.212	0.212	0.212	0.212	0.212	0.212	0.212	0.180	0.150	0.150	0.150
Permittivity	ASTM D-4491	sec^{-1}	TYPICAL	2.50	2.50	2.50	1.90	1.80	1.70	1.80	1.90	1.60	1.50	1.00
			MARV	2.00	2.00	2.00	1.50	1.40	1.30	1.50	1.50	1.20	1.00	0.70
Permeability	ASTM D-4491	cm/sec	TYPICAL	0.28	0.31	0.34	0.29	0.29	0.32	0.40	0.48	0.40	0.43	0.39
			MARV	0.22	0.25	0.22	0.22	0.23	0.24	0.34	0.38	0.30	0.29	0.27
Water Flow Rate	ASTM D-4491	$l/min/m^2$	TYPICAL	5295	5295	6515	5700	5295	5295	5295	5295	4070	3665	2645
			MARV	4480	4480	5700	4885	4685	4480	4480	4480	3460	3055	2035
ENDURANCE														
UV Resistance	ASTM D-4355	% Retained @ 500 hrs	MARV	70	70	70	70	70	70	70	70	70	70	70
STANDARD PACKAGING														
Roll Width	Measured	meter	TYPICAL	3.81/4.57	3.81/4.57	3.81/4.57	3.81/4.57	3.81/4.57	3.81/4.57	3.81/4.57	4.57	4.57	4.57	4.57
Roll Length	Measured	meter	TYPICAL	109.8	109.8	109.8	109.8	109.8	91.5	91.5	91.5	91.5	91.5	91.5
Roll Area	Calculated	m^2	TYPICAL	418.05/ 501.66	418.05/ 501.66	418.05/ 501.66	418.05/ 501.66	418.05/ 501.66	348.37/ 418.05	348.37/ 418.05	418.05	418.05	418.05	418.05

NOTES

▲ Values reported in weaker principle direction.

▲ "MARV" indicates minimum average roll value calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the value reported.

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H-64

[illegible]OVEN GE[illegible]EXTILES – ENGLISH VALUES

PROPERTY	TEST METHOD	UNITS	VALUE	135ST	200ST	300ST	370ST
MECHANICAL							
Grab Tensile Strength	ASTM D-4632	lbs	TYPICAL	155	240	350	340
			MARV	135	200	300	300
Grab Elongation	ASTM D-4632	%	TYPICAL	20	25	20	18
			MARV	15	15	15	15
Puncture Strength	ASTM D-4833	lbs	TYPICAL	80	120	140	160
			MARV	70	100	120	110
Mullen Burst	ASTM D-3786	psi	TYPICAL	300	500	650	775
			MARV	265	450	600	650
Trapezoidal Tear	ASTM D-4533	lbs	TYPICAL	65	95	145	150
			MARV	45	75	120	100
HYDRAULIC							
Apparent Opening Size (AOS)	ASTM D-4751	US Sieve	TYPICAL	40-50	50-70	50-70	70-100
			MARV	40	40	40	70
Permittivity	ASTM D-4491	sec^{-1}	TYPICAL	0.08	0.13	0.08	0.06
			MARV	0.06	0.07	0.06	0.05
W[illegible]r Flow Rate	ASTM D-4491	gpm/ft^2	TYPICAL	6	17	6	2
			MARV	4	6	5	1
ENDURANCE							
UV Resistance	ASTM D-4355	% Retained @ 500 hrs	MARV	90 @ 150 hrs.	90	90	90
STANDARD PACKAGING							
Roll Width	Measured	feet	TYPICAL	12.5	12.5/15/17.5	12.5/15/17.5	12.5/15/17.5
Roll Length	Measured	feet	TYPICAL	432	432/360/309	360/300/258	360/300/258
Roll Area	Calculated	yd^2	TYPICAL	600	600/600/600.83	500/500/501.67	500/500/501.67

NOTES

- Values reported in weak principle direct[illegible]
- "MARV" indicates minimum average roll value calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the value reported.

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WOVEN GEOTEXTILES – METRIC VALUES

PROPERTY	TEST METHOD	UNITS	VALUE	135ST	200ST	300ST	370ST
MECHANICAL							
Grab Tensile Strength	ASTM D-4632	N	TYPICAL	685	1065	1555	1510
			MARV	600	890	1335	1335
Grab Elongation	ASTM D-4632	%	TYPICAL	20	25	20	18
			MARV	15	15	15	15
Puncture Strength	ASTM D-4833	N	TYPICAL	355	530	620	710
			MARV	310	445	530	485
Mullen Burst	ASTM D-3786	kPa	TYPICAL	2060	3440	4480	5340
			MARV	1820	3100	4130	4480
Trapezoidal Tear	ASTM D-4533	N	TYPICAL	285	420	645	665
			MARV	200	330	530	445
HYDRAULIC							
Apparent Opening Size (AOS)	ASTM D-4751	mm	TYPICAL	0.425-0.300	0.300-0.212	0.300-0.212	0.212-0.150
			MARV	0.425	0.425	0.425	0.212
Permittivity	ASTM D-4491	sec^{-1}	TYPICAL	0.08	0.06	0.08	0.06
			MARV	0.06	0.06	0.06	0.05
Water Flow Rate	ASTM D-4491	$l/min/m^2$	TYPICAL	240	240	240	80
			MARV	160	160	200	40
ENDURANCE							
UV Resistance	ASTM D-4355	% Retained @ 500 hrs	MARV	90 @ 150 hrs	90	90	90
STANDARD PACKAGING							
Roll Width	Measured	meter	TYPICAL	3.81	3.81/4.57/5.33	3.81/4.57/5.33	3.81/4.57/5.33
Roll Length	Measured	meter	TYPICAL	131.70	131.70/109.75/94.20	109.75/91.46/78.66	109.75/91.46/78.66
Roll Area	Calculated	m^2	TYPICAL	501.66	501.66/501.66/502.36	418.05/418.05/419.44	418.05/418.05/419.44

II-156

Notes

Values reported in weak principle direction

"MARV" indicates minimum average roll value calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed the value reported.

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REFERENCE TABLE FOR MASS PER UNIT AREA AND THICKNESS OF STANDARD NONWOVEN GEOTEXTILES

Nonwoven Style	MASS PER UNIT AREA (WEIGHT) ASTM D5261				THICKNESS ASTM D5199			
	ENGLISH (oz/yd²)		METRIC (g/m²)		ENGLISH (mils)		METRIC (mm)	
	TYP	MARV	TYP	MARV	TYP	MARV	TYP	MARV
311	3.1	2.7	105	90	40	30	1.0	0.7
351	3.5	3.0	115	100	45	35	1.1	0.8
381*	3.9	3.5	130	115	40	30	1.0	0.7
401	4.1	3.6	135	120	55	45	1.3	1.1
451*	4.6	4.0	155	135	55	45	1.3	1.1
501	5.3	4.7	175	155	65	55	1.6	1.3
601	6.0	5.6	200	185	70	60	1.7	1.5
701	7.2	6.5	245	220	85	75	2.1	1.9
801	8.1	7.3	270	245	90	80	2.2	2.0
1001	10.0	9.25	335	310	110	100	2.7	2.5
1201	12	11.2	405	375	130	110	3.3	2.7
1601	16.5	15.1	555	510	160	140	4.0	3.5

Notes: * Indicates product data sheets also contain mass per unit area and thickness values.
"Min" indicates typical value minus three (3) standard deviations.
"MARV" indicates typical value minus two (2) standard deviations
"Typ" indicates average value

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%

H.5 Anchor Trench Pullout Analysis

APPENDIX H.5

ANCHOR TRENCH PULLOUT ANALYSIS

THIS CERTIFICATION IS INTENDED FOR PERMITTING PURPOSES ONLY AND INCLUDES PAGES 1 THROUGH 7.

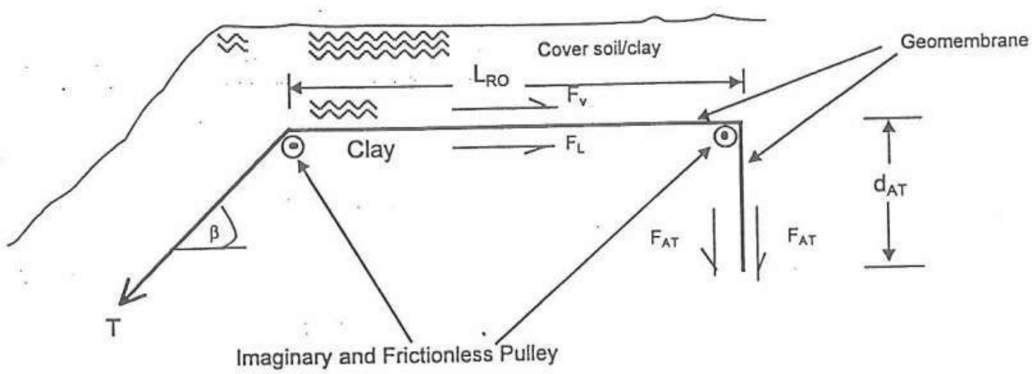
Anchor Trench Pattern Analysis

Objective

Determine run-out lengths and their corresponding anchor trench depths.

Approach

The method suggested by Koerner (1990) was used to determine run-out lengths and anchor trench design depth. Static equilibrium was established by using an assumed system of imaginary pulleys as shown below. This system allowed the geomembrane to be considered in its continuous form.



Assumptions:

1. 60 mil HDPE double textured liner with geomembrane/clay interface angle of 24°
2. Clay soil angle of internal friction (ϕ) = 0
3. Factor of safety F.S. = 2

Calculation

$$T_{all} = \tau_{all}\, t$$

where:

$$\tau_{all} = \frac{\tau_{ult}}{F.S}$$

t = 0.06 inches for a 60 mill HDPE
Strain = 15 % (Ref 1, Table 5.5, pg. 438)
τ_{ult} = 2,300 psi (Fig. 5.3, pg. 439, using strain = 15 %)

H-170

$T_{all} = F_u + F_L + 2F_{AT}$ (ref 1, pg. 500)

$F_u = 0$ (friction above geomembrane = 0, i.e., cover moves along with geomembrane)

$F_L = q\,\delta\,(L_{RO})$

$q = d_{cs}\,\gamma_{cs}$

τ_{ult} (psi)	Thickness	T_{all} (lb/in)	T_{all} (lb/ft)	$depth_{cs}$	γ_{cs}	δ	q (psf)	$q\,\delta$
1150	0.06	69	828	2	110	24	220	98.0

F_L	ϕ	H_{avg}	$\tau_{h(avg)}'$	$2F_{AT}'$
98.0 L_{RO}	0	$\frac{1}{2} d_{AT}$	55	49.0

$$F_L = 98\ L_{RO}$$

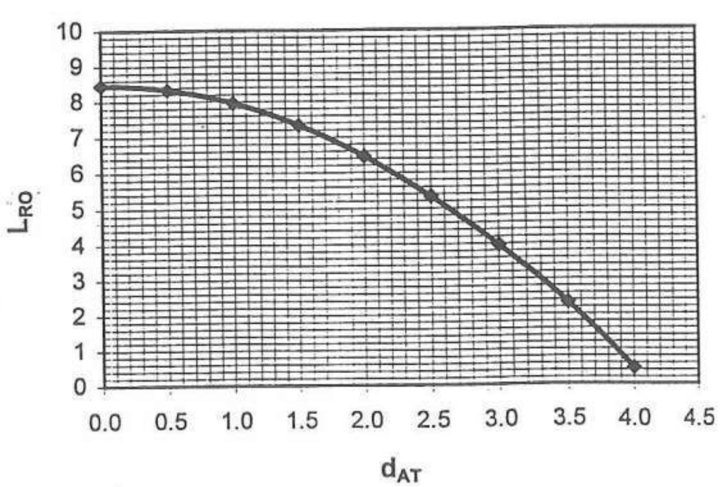
$$2F_{AT} = 49\ d_{AT}^{\ 2}$$

$$T_{all} = 98L_{RO} + 49d_{AT}2$$

$828 = 98L_{RO} + 49d_{AT}^2$

d_{AT}	L_{RO}
0.0	8.45
0.5	8.33
1.0	7.95
1.5	7.33
2.0	6.45
2.5	5.33
3.0	3.95
3.5	2.33
4.0	0.45

Figure 1. Runout length (L_{RO}) vrs Trench depth (d_{AT})



H-171

Conclusion

The design of the anchor trench and the corresponding run-out length shall follow the guidelines described in the table and /or graph (Figure 1) shown above. The geomembrane should not fail when the above guidelines are followed.

References

1. Koerner, Robert, M. " Designing with Geosynthetics: 3rd Edition (Chapter 5, pg. 500-501) Prentice Hall, 1994
2. Rust, E. "A database of geosynthetics/soils(and other interfaces) angles of friction (Attachment A)

Table 5.5 Tensile behavior properties of 60-mil HDPE, 40-mil VLDPE, 30-mil PVC, and 36-mil CSPE-R

		Index Tension Tests (Figure 5.2)				Wide-Width Tension Tests (Figure 5.3)				Axi-Symmetric Tension Tests (Figure 5.5)			
Test Property	Units	HDPE	VLDPE	PVC	CSPE-R	HDPE	VLDPE	PVC	CSPE-R	HDPE	VLDPE	PVC	CSPE-R
Maximum stress	(lb./in.²)	2700	~1200	3000	7900	2300	~1100	2000	4500	3400	1500	2100	4500
	(MPa)	19	8	21	55	16	8	14	31	23	10	15	31
Corresponding strain	(%)	17	500+	480	19	15	400+	210	23	12	75	100	13
Modulus	(lb./in.²)	48,000	11,000	4500	48,000	61,000	10,000	2900	43,000	105,000–	24,000–	15,000–	50,000–
	(MPa)	330	76	31	330	450	69	20	300	720–	170–	100–	350–
Ultimate stress	(lb./in.²)	~2000	~1200	3000	830	~1600	~1100	2000	410	3400	1500	2100	4500
	(MPa)	14	8	21	6	11	8	14	3	23	10	15	31
Corresponding strain	(%)	500+	500+	480	110	400+	400+	210	79	25	75	100	13

Note: + = did not fail;
– = values felt to be high.

H-171
H-173

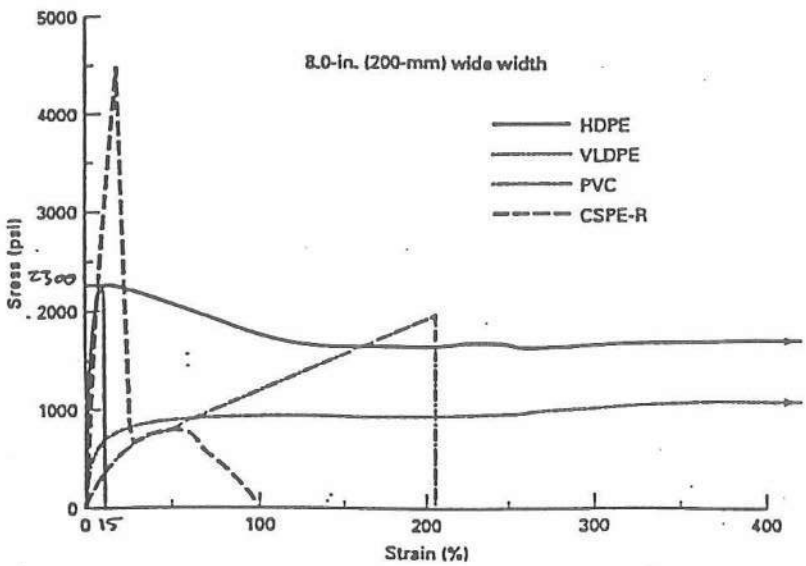


Figure 5.3 Tensile test results on 8.0-in. (200-mm) wide-width specimens of commonly used geomembranes using ASTM D4885 test method.

(200 mm) width. While the general shape of each material is the same, the results of the various points of interest are quite different. These results are tabulated in column 2 of Table 5.5. It is felt that the 8.0-in. (200-mm) wide-width type of test specimen results in much more design-oriented value than do test results from dumbbell or narrow-width specimens. This is particularly the case when plane-strain conditions are assumed in the design process (e.g., in side slope stability calculations).

5.1.3.3 Tensile Behavior (Axi-Symmetric) There are situations that call for a geomembrane's tensile behavior when mobilized by out-of-plane stresses. Localized deformation beneath a geomembrane is such a case. This type of behavior could well be anticipated for a geomembrane used in a landfill cover placed over subsiding solid waste material. The situation can be modeled by placing the geomembrane in an empty container, as shown in Figure 5.4. An appropriate seal is made with the cover section, and water is introduced above the geomembrane. Pressure is mobilized until failure of the test specimen occurs. Beginning with Steffen [5], a number of variations of this test can be made.

The following development for stress and strain calculations follows GRI Test Method GM4. In it, pressure versus centerpoint deformation readings are taken from which stress and strain can be calculated [6]. The following equations are based on a spheroidal shape being generated up to a deflection equal to the radius of the test specimen (i.e., for use with HDPE and CSPE-R geomembranes which fail within this region).

use short-term peak value w/ a FS=2.0

RUST E & I FRICTION TESTING DATABASE
=> Ø = 24°
GEOMEMBRANE-SOIL INTERFACE

DATE REVISED: 04-MAR-94
FILE NAME: NEWGM_SL.WK1

INTERFACE TESTED		PEAK FRICTION ANGLE (DEGREES)	PEAK APPARENT ADHESION (PSF)	RESIDUAL FRICTION ANGLE (DEGREES)	RESIDUAL APPARENT ADHESION (PSF)	TESTING COND. WET/DRY	SAMPLE ORIENT.	TESTING LABORATORY	NORMAL LOAD RANGE (PSF)	SHEARING RATE (IN/MIN)	TESTING DEVICE	SAMPLE SIZE (IN x IN)	TESTING DATE (M/YR)	DATA BASE REF.#
HDPE 60M TX GND	clay 10(-7) cm/sec	44	0	34	NA	NA	NA	Golder Assoc	100-500	0.0394	shear box	12 x 12	June-90	301
HDPE 60M TX NSC	clay 10(-7) cm/sec	35	40	32	15	NA	NA	Golder Assoc	100-500	0.0394	shear box	12 x 12	June-90	301
HDPE 60M TX GND	loam clay	21.4	90	NA	NA	dry	NA	GeoServices	432-1296	0.04	shear box	12 x 12	Aug-90	209
HDPE 60M TX GND	loam clay	22	68	NA	NA	dry	NA	GeoServices	432-1296	0.04	shear box	12 x 12	Aug-90	209
HDPE 60M TX GND	loam clay	23	64	NA	NA	dry	NA	GeoServices	432-1296	0.04	shear box	12 x 12	Aug-90	209
HDPE 60M TX GND	clay 10(-7) cm/sec	32	15	NA	NA	NA	NA	Golder Assoc	100-500	0.0394	shear box	12 x 12	June-90	301
HDPE 60M TX GND	clay CNTP-240	8	545	NA	NA	wet	machine	GeoSyntec	2880-11520	0.04	shear box	12 x 12	Apr-91	210
HDPE 60M TX GND	clay CNTP-240	6	890	NA	NA	wet	machine	GeoSyntec	2880-11520	0.04	shear box	12 x 12	Apr-91	210
HDPE 60M TX GND	clay CNTP-240	14	710	NA	NA	wet	machine	GeoSyntec	2880-11520	0.04	shear box	12 x 12	Apr-91	210
HDPE 60M TX GND	clay CNTP-240	13	455	NA	NA	wet	machine	GeoSyntec	2880-11520	0.04	shear box	12 x 12	Apr-91	210
HDPE 60M TX GND	clay CNTP-234	20	150	NA	NA	wet	machine	GeoSyntec	2880-11520	0.04	shear box	12 x 12	Apr-91	210
HDPE 60M TX GND	clay CNTP-234	16	130	NA	NA	wet	machine	GeoSyntec	2880-11520	0.04	shear box	12 x 12	Apr-91	210
HDPE 60M TX GND	Clay	11	584	NA	NA	moist	NA	Bing-Yen Assoc.	2880-11520	NA	Triaxial	8 x 12	Jun-91	909
HDPE 60M TX GND	Clay	14	122	NA	NA	moist	NA	Bing-Yen Assoc.	2880-11520	NA	Triaxial	8 x 12	Jun-91	909
HDPE NSC	Silt Clay	38	240	29	150	wet	NA	GeoSyntec	432-1296	0.04	shear box	12 x 12	Jun-91	219

PVC GEOMEMBRANE – COHESIVE SOIL

INTERFACE TESTED		PEAK FRICTION ANGLE (DEGREES)	PEAK APPARENT ADHESION (PSF)	RESIDUAL FRICTION ANGLE (DEGREES)	RESIDUAL APPARENT ADHESION (PSF)	TESTING COND. WET/DRY	SAMPLE ORIENT.	TESTING LABORATORY	NORMAL LOAD RANGE (PSF)	SHEARING RATE (IN/MIN)	TESTING DEVICE	SAMPLE SIZE (IN x IN)	TESTING DATE (M/YR)	DATA BASE REF.#
[illegible]	Glacial Till	25	21	NA	NA	NA	NA	Georgia Tech	100-500	0.01	shear box	12 x 12	Conf'87	1005
[illegible]	Gulf Coast Clay	23	34	NA	NA	NA	NA	Georgia Tech	100-500	0.01	shear box	12 x 12	Conf'87	1005
[illegible]	Sand-10% Clay	19	14	NA	NA	NA	NA	Georgia Tech	100-500	0.01	shear box	12 x 12	'87 Conf	1005
PVC	Sand-5% Clay	19	16	NA	NA	NA	NA	Georgia Tech	100-500	0.01	shear box	12 x 12	'87 Conf	1005

CSPE GEOMEMBRANE – COHESIVE SOIL

INTERFACE TESTED		PEAK FRICTION ANGLE (DEGREES)	PEAK APPARENT ADHESION (PSF)	RESIDUAL FRICTION ANGLE (DEGREES)	RESIDUAL APPARENT ADHESION (PSF)	TESTING COND. WET/DRY	SAMPLE ORIENT.	TESTING LABORATORY	NORMAL LOAD RANGE (PSF)	SHEARING RATE (IN/MIN)	TESTING DEVICE	SAMPLE SIZE (IN x IN)	TESTING DATE (M/YR)	DATA BASE REF.#
HDPE 80M mod SLT	typ cover soil	29.5	75	NA	NA	NA	NA	GeoServices	576-1008	0.04	shear box	12 x 12	Sept-89	206
HDPE 80M TX SLT	typ cover soil	33	153	NA	NA	NA	NA	GeoServices	576-1008	0.04	shear box	12 x 12	Sept-89	206
HDPE 80M TX SLT	typ cover soil	34.6	124	NA	NA	NA	NA	GeoServices	576-1008	0.04	shear box	12 x 12	Sept-89	206

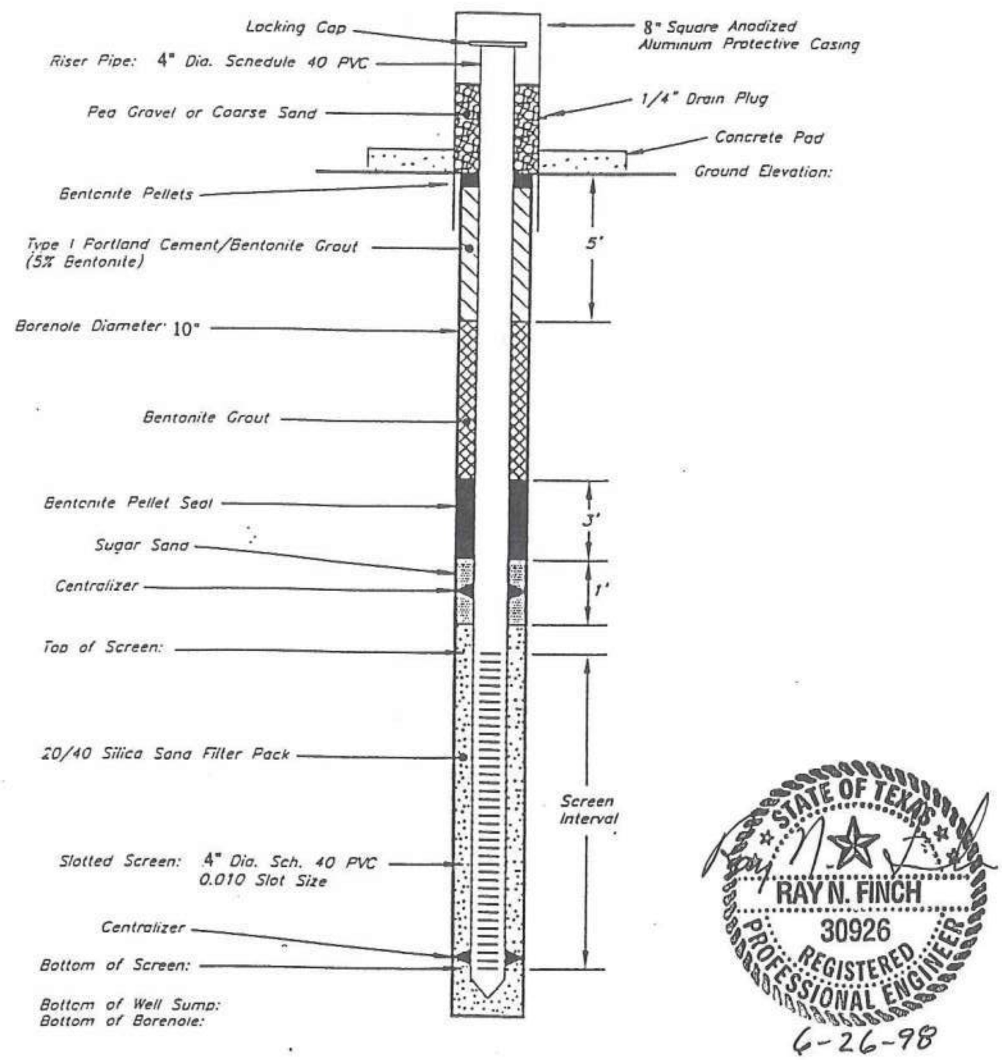
ATTACHMENT I

APPENDIX I

MONITOR WELL SCHEMATIC

Proposed Monitor Well SchematicI-1

November 1997



Notes:

1) Elevations referenced to National Geographic Vertical Datum (NGVD).

2) Depths are referenced to feet below ground surface.

THIS DOCUMENT IS ISSUED FOR PERMITTING PURPOSES ONLY.

Proposed Monitor Well Schematic

FINCH ENERGY & ENVIRONMENTAL SERVICES, Inc.

I-1