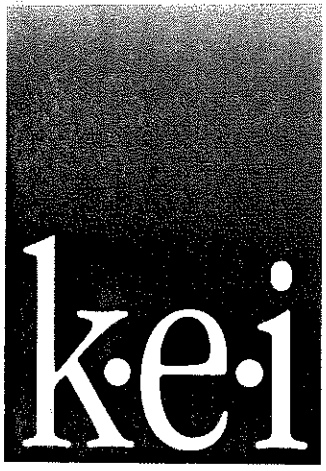

ENVIRONMENTAL INVESTIGATION

EXXON PIPELINE CORPORATION
HARBOR ISLAND STATION
PORT ARANSAS, TEXAS

VOLUME I

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EPC HARBOR ISLAND STATION ENVIRONMENTAL INVESTIGATION

EXXON PIPELINE COMPANY ARANSAS PASS, TEXAS

Prepared for

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Job No. 430003

April 15, 1994

CONFIDENTIAL AND PRIVILEGED ATTORNEY WORK PRODUCT

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(continued)

EXECUTIVE SUMMARY

In February and March, 1994, KEI Consultants, Inc. (KEI) conducted an environmental investigation of the Exxon Pipeline Company (EPC) Harbor Island Station, located in Aransas Pass, Texas. The Harbor Island Station is a crude oil storage and handling facility, which was in continual operation from the late 1920's until 1993. At that time, tanker unloading operations ceased and EPC began the process of decommissioning the facility, which is ongoing as of this writing.

Field work was performed at the facility during February and March, 1994. Major investigative activities included a surface geophysical survey of the site, collection and sampling of approximately 450 soil cores and 65 ground water samples, collection of selected surficial soil and marine sediment samples, and preparation of a detailed geologic and hydrogeologic evaluation of the site. Selected samples were preserved and submitted for laboratory analysis, as described in this report, and all soil cores were logged and visually classified in the field.

Based on the results of our investigation, the following summary highlights findings of potential environmental significance:

1) The geology and hydrogeology of the Harbor Island facility were found to be relatively uniform across the site. The soil was generally found to be sandy with variable percentages of silt and clay, probably reflecting the heterogeneity of dredged materials placed on the site prior to development. The relatively high sand content has created an aerobic soil profile aboveground water, which is conducive to natural biodegradation of hydrocarbons and organic materials (evidenced by the findings of our geochemical investigation). Ground water was generally encountered at depths of less than five feet, with a general flow direction toward the ship channel. Due to the shallow and unconfined nature of this aquifer, ground water is considered unsuitable as a water supply or other water resource in this area.

2) Prior operational and maintenance practices at Harbor Island resulted in the placement of basic sediments, either in shallow trenches or landfarms, across much of the developed portion of the site (excluding those areas occupied by tanks or, in most cases, within tank firewalls). Irrespective of the method of placement or treatment, TPH concentrations in areas of reworked basic sediments were generally below 0.5 percent, and BTEX and other VOC and SVOC constituents were generally below method detection limits. Relatively low hydrocarbon concentrations in these deposits reflect a combination of effective treatment at the time of placement and an aerobic soil structure. Impacts to ground water from basic sediment placements were also limited to areas where basic sediments were placed in trenches at depths below the static water table. As in the case of soil, however, hydrocarbons attenuated rapidly away from the trench locations to below method detection limits for most hydrocarbon constituents.

3) Areas of highest soil TPH concentration (up to 20 percent in one location) appear attributable to relatively recent (10 to 15 years ago or less) cleanup efforts, based on input from EPC personnel familiar with the facility. Natural biodegradation will continue until hydrocarbon concentrations are reduced to acceptable levels; however, on-site remediation of soil in some areas of the property would dramatically increase the rate of degradation. As of this writing, no evidence of off-site impact from any crude oil releases at Harbor Island were documented. The site supports a healthy native flora and fauna, with localized evidence of vegetative distress adjacent to recently active facilities and higher (greater than 5 percent) TPH soil concentrations.

   Areas of ground water impact appear to be similarly attributable to more recent releases. Although phase-separated hydrocarbons (PSH) were identified, at three locations on the site, overall impact to ground water was limited, and was contained within the property boundaries.

4) Of the non-petroleum constituents evaluated during the investigation, only lead, barium, chromium, and selenium appeared in multiple locations. Barium, chromium, and selenium are naturally-occurring in crude oil, and are not present in concentrations sufficient to represent an environmental issue. Lead occurrences were generally restricted to within the tank firewalls, and may represent relic coating material from the tanks. EPA threshold TCLP concentrations levels for lead is 5.0 mg/l, barium is 100 mg/l, for chromium is 5 mg/l, and for selenium is 1.0 mg/l. The metals concentrations at the site fall below regulatory action levels. No ground water impacts were noted. 1,1,2-trichloroethane (TCE) was identified in one soil sample near a former tank location and had a concentration of 14 ppm. This compound is a common solvent and degreaser, which may have been used during demolition operations. As an isolated occurrence, TCE does not pose a threat to the environment.

5) Evaluation of marine sediment geochemistry at stormwater outfalls indicate no consequential impacts. One bay sediment sample collected near the Port Aransas ferry dock contained small quantities of TPH (less than 100 ppm). The source of these hydrocarbons is unknown, but could be a result of prior stormwater discharges from Harbor Island Station, historical oil spills in Corpus Christi Bay or the Gulf of Mexico (these types of spills have periodically covered bay waters and shorelines with oil in the Harbor Island/Port Aransas area), ongoing ferry operations, or transient commercial or military shipping.

6) Based on the collective findings of the investigation, approximately 50,596 cubic yards of soil at the Harbor Island Station are estimated to have TPH concentrations from 1 percent to 5 percent. In addition, approximately 26,000 cubic yards of soil are estimated to have concentrations greater than 5% TPH. Much of this soil will biodegrade over time, and does not pose an apparent risk to human health or the environment. Areas of higher TPH concentration in soil (greater than 5 percent) may be readily remediated within a one year time frame if desired.

The overall impact to ground water was limited. TPH concentrations are low and may not need to be treated. PSH in ground water, although limited in extent, should be considered to be removed. A limited risk based analysis of the site should be conducted to further evaluate if PSH removal is necessary. A more detailed discussion of remediation alternatives and probable costs will be presented under separate cover.

In summary, environmental impacts to the Harbor Island Station are limited to TPH constituents in soil and ground water, and may be readily addressed by soil bioremediation and limited ground water treatment. Cleanup levels will be negotiated with the Texas Railroad Commission, based on precedent and the low probability of impact to known environmental receptors. In some instances implementation of remediation activities may create a greater health based risk than leaving the substance in-place, and should be evaluated prior to selecting a remedial alternative. The site supports a healthy native flora and fauna, with localized evidence of vegetative distress adjacent to recently active facilities and higher (greater than 5 percent) TPH soil concentrations. Remedial activities, if required, should be completed within a 12 to 18 month period under anticipated circumstances.

1.0 INTRODUCTION

An environmental investigation was conducted from February 14 to March 3, 1994 at the Exxon Pipeline Company Harbor Island Station located in Aransas Pass, Texas. The purpose of the investigation was to identify and evaluate the impact to the facility resulting from historical crude oil storage and handling operations. The investigation consisted of a historical review of the facility and a subsurface investigation of the soil and ground water. This report describes the investigative methods, results of the site investigation, and conclusions based on our findings.

2.0 SITE HISTORY

The Harbor Island Station is located along Highway 361 in Port Aransas, Texas and consists of 300 acres of land. The facility was constructed in the late 1920's and was in operation until 1993 as a crude oil tank farm. The decommissioning operations were in progress during the investigation. Periodic tank cleaning was performed as part of site maintenance operations. Basic sediments (tank bottoms) were generated as a result of these operations. A review of the Exxon Harbor Island Survey Map (revised 1992) indicates open areas around the tanks were used to land farm basic sediments. Employees of the facility noted that crude oil spills had occurred occasionally during the history of the facility, and were contained and remediated on-site. A copy of the Site Plan is presented in Figure 1.

Five aerial photographs were obtained from Tobin Surveys, Inc. located in San Antonio, Texas for review of site activities. These aerial photographs are dated and described as follows:

<u>1937 Photograph (approximate scale 1" = 1,500'):</u> This photo depicts early construction and development of the site. The ballast pit area associated with Tank 945 is clearly visible, although not clearly defined on the southeast portion of the facility. Approximately eleven storage tanks were present in this photograph. The photo also indicates the presence of four (4) residential homes on the northeast corner of the property. Adjacent property is undeveloped to the north and west of the site. A existing tank farm is located east of the site, and the ship channel is located south of the site.

1958 Photograph (approximate scale 1" = 3,030'): This photo indicates approximately 25 tanks on-site. The residential homes do not appear on this or any of the other photographs. The ballast pit associated with Tank 945 is better defined than in the 1937 photograph. The pump station and electric substation located between Tanks 952 and 954 are clearly visible. Apparent land farming activities can be observed north and south of Tank 1358. Highway 361 appears as a dirt road and has not been completed toward Aransas Pass, Texas. This photo also indicates the Port Aransas Ferry in operation to the south. The adjacent property to the west indicates light development. The adjacent tank farm to the east indicates additional tanks have been constructed.

1965 Photograph (approximate scale 1" = 800'): This photo indicates the removal of three tanks and the addition of Tank 1953. Approximately 23 tanks were on-site at the time this photograph was taken. The photograph depicts State Highway 361 as paved and completed toward Aransas Pass, Texas. The adjacent property to the west and the land farm to the east appears much as they did in the 1958 photo.

1975 Photograph (approximate scale 1' = 800'): This photo indicates three tanks have been decommissioned and an additional ballast pit is located on the west end of the property. Approximately 20 tanks are noted on-site. Apparent land farming activities are present in the area located north of Tank 1359. The adjacent property located to the west across State Highway 361 is being developed for industrial purposes. The photo also indicates the Port Aransas Ferry has expanded its capacity.

1987 Photograph (no scale): This photo is not a true aerial photograph, but accurately reflects the site much in the way that it appeared during the subject investigation. Three tanks have been decommissioned since the 1975 photo. The area located between Tanks 952 and 946 appear to have been land farmed. The ballast pits have been closed. The property across Highway 361 is used for industrial construction. The aerial photographs are presented in Figures 2-6.

Tank 945, shown as a black-coated water tank in the photograph foreground, was decommissioned in 1992.

3.0 ENVIRONMENTAL SETTING

3.1 Regional Geology

The regional geology of Harbor Island consists of fill and spoil and some alluvium. Fill is material dredged for raising land surface above alluvium and barrier island deposits for creating land. Spoil is dredged material that forms islands along water ways. Soil characteristics are highly variable, with mixed mud, silt, sand, and shell.

Alluvium areas consist of clay, silt, sand and gravel, and organic material is abundant locally. This includes point bar, natural levee, stream channel, backswamp, coastal marsh, mud flat, clay dune, sand dune, and oyster reef deposits. Also, some terrace deposits are included along streams other than the Nueces. A map showing the Regional Geology is presented in Figure 7.

The Harbor Island flood delta consists of shell and sand deposited near the mouth of Aransas-Lydia Ann tidal channel; the flood delta is comprised of sediment moving into the bay through tidal channels with flood tides, and a part of the sediment load accumulates as fan-shaped bodies near the bay terminus of a tidal channel. Sediment generally becomes finer grained on the bayward side of the delta. Flood delta sediments have been deposited near the bay terminus of Lydia Ann Channel. These features are presented in Figure 8. A further description of the local geology is characterized in the soil investigation (section 4.1).

3.2 Regional Hydrology

Two natural tidal inlets existed in the Corpus Christi area until the early 1900's; these were Aransas Pass and Corpus Christi Pass (i.e. Packery Channel). The old Corpus Christi Pass was closed in 1929 as a consequence of development activities in northern Laguna Madre and Corpus Christi Bay. Aransas Pass has been stabilized in its present position by jetties since the late 1800's. Aransas Pass, the only major tidal pass in the Corpus Christi map area, lies between St. Joseph and Mustang Island.

Aransas Pass has been open continuously since historic records have been maintained. Tidal currents move freely through this pass, but sediment movement has been restricted since jetty construction. Maximum diurnal current velocities for

Aransas Pass are 2.0 knots during flood and 1.9 knots during ebb (U.S. Department of Commerce, 1973).

Mean tidal range at Aransas Pass is 1.7 feet (U.S. Department of Commerce, 1972). Aransas Pass is maintained by dredging at a width of 700 feet and a depth of 42 feet.

Harbor Island became emergent when storms raised the water level in the bay, allowing vertical accretion of sediment. With subsidence of the storm and associated high tides, parts of the flood delta may become emergent and may be subsequently stabilized by marsh vegetation. Subaqueous parts of the tidal delta are covered by shallow marine grass flats and sparsely vegetated sand flats. Wind-tidal flats are transitional between the bay and the sub-aerial part of the tidal delta; shell berms and beach ridges occur along the margin of the exposed tidal delta. Channel dredging with concomitant disposal of spoil has occurred in Corpus Christi, Aransas and Redfish Bays. Redfish Bay has experienced the most intensive dredging within the bay-estuary-lagoon system. Spoil deposited in shallow water has been extensively reworked by waves and currents, modifying nearby shorelines and bay bottoms.

3.3 Regional Water Quality

The salinity of the bay complex is variable and depends on the amount of fresh-water discharge into the bay. Following intensive rains, such as those that occur during hurricane aftermath storms, saline bay waters are greatly diluted by fresh water, and only slightly brackish salinities occur near river mouths. Conversely, during hot, comparatively dry summers, the salinity of the bays and lagoons is increased significantly by inflowing Gulf water, evaporation within the bays and lagoons, and the low discharge of streams. The bay complex is not used as a water supply resource in the vicinity of Harbor Island.

4.0 SITE INVESTIGATION

The site investigation was performed in two phases. Phase I consisted of a pilot study which would be used to evaluate investigative methods for the remainder of the site. The pilot study area is located on the southeast end of the property and consists of approximately nine acres. The activities performed in this phase consisted of a subsurface soil investigation, geophysical survey, and ground water investigation. The area was designated as the pilot study because it contains a representative cross section of maintenance and operational activities at the site. These activities include crude oil storage, land farming of basic sediments, remediation of historical crude oil spills, sandblasting of steel tanks and dock areas for corrosion control, storage of ballast water, and discharge of ballast water.

Phase II of the investigation consisted of evaluating the remainder of the facility based on the data acquired daily from the pilot study. The work consisted of the same activities as the pilot study. Photographs documenting investigation activities are presented in Appendix A.

4.1 Soil Investigation

The Pilot study area was divided into four sectors for soil sample collection. Soil samples were obtained in the pilot area utilizing an all terrain vehicle, hand augers, a backhoe, or marine sediment sampler. Soil borings were advanced through the soil strata utilizing an all terrain vehicle with a mounted geoprobe sampler (henceforth Geoprobe). The subsurface profile was classified in accordance with the Unified Soil Classification System (USCS) by visually observing soil samples obtained using the Geoprobe. In general, one soil type was encountered, consisting of a light brown to black sand. The sand was predominantly clean, fine to medium grained, and moist to wet.

Soil samples were obtained on 100 or 200 centers across the pilot area. Soil samples were obtained by hydraulically pushing a 2-inch diameter stainless steel core barrel until ground water was encountered. The locations of the soil borings are presented on FIG. 9.

Selected soil samples, based on a visual representation of probable maximum concentrations, were hand delivered to Core Laboratories in Corpus Christi, Texas for determination of Total Petroleum Hydrocarbons (TPH) concentrations by EPA Modified Method 418.1 and benzene, toluene, ethyl-benzene, and xylenes (BTEX) concentrations by EPA Method SW846-8020.

In addition, three samples from within the pilot study area where tank bottoms were present were analyzed for Volatile Organic Compounds (VOC) by EPA Method 8260, Base/Neutral Acids (BNA) by EPA Method 8270, and Total Metals By EPA Method Series 6000.

Soil cores were also obtained from within the fire walls of the existing tanks. Prior to entry into the firewalls, the area was cleared for entry by EPC personnel. Soil samples within the pilot area were advanced utilizing a hand auger until ground water was encountered. The soil was visually logged in accordance with the USCS and a composite soil sample was collected at each location. All soil core samples were analyzed for TPH and BTEX. In addition, based on visual observations, selected representative soil samples were analyzed for VOC's, BNA's, and total RCRA metals.

Composite soil samples were obtained from trench excavations within the pilot area. The soil strata was visually logged in accordance with the USCS. The excavations were approximately five feet in depth, and varied in length up to 100 feet. The excavations were utilized to transect lateral trenches from suspected land farming activities. Trenching was also conducted in the area of former Tanks 1799 and 945 to determine if PSH was present. Composite soil samples were analyzed for TPH and BTEX.

Marine sediment samples were obtained near the dock areas. The marine samples were obtained by manually advancing a 2-inch sampling tool through the benthic marine sediments. Sediment samples were also collected from two stormwater outfall areas located near the docking area. The sediment samples were analyzed for total lead and TPH. Marine sediment samples obtained near the dock were obtained to determine if sandblasting the dock had created an environmental concern.

As the pilot study progressed and sample results identified areas of potential concern from each sector, additional soil borings were collected on 100 foot centers. Designated samples were obtained based on discoloration and the presence of hydrocarbon staining. The identified areas of concern were analyzed for TPH and BTEX.

Upon completion of the pilot study, Phase II of the site investigation was performed. The Phase II area was divided into four sectors as used in the pilot study. Soil samples were collected on 100 foot centers outside the tank fire walls. Soil samples were obtained based on visually identifying tank bottoms, hydrocarbon staining or discoloration. Designated samples were analyzed for TPH and BTEX. Soil coring from around the tank areas were collected and analyzed for TPH and BTEX. Representative samples of probable maximum concentration from designated soil coring from the tank areas were also analyzed for Total Metals, VOCs and BNA's. All samples were collected using either the Geoprobe or hand auger.

In addition, test pits were excavated in the Trash Pit area located on the west end of the property. Five (5) test pit areas were excavated and samples were collected and analyzed for TPH and BTEX. Soil borings were also collected in the Trash Pit area on 100 foot centers. The test pits were logged and designated samples were analyzed for TPH and BTEX. A map indicating soil sample locations with the TPH soil concentrations is presented on Figure 10.

4.2 Geophysical Survey

The objective of the geophysical survey was to assist in evaluating basic sediment and trench geometry at the site. To accomplish this task, the survey was conducted by establishing a survey grid; conducting an electromagnetic conductivity survey; and data reduction and interpretation.

A survey grid was established on a 20 foot spacing aligned in a general north-south orientation and was placed on a base map of the facility. In order to establish survey control in the field, north-south, and east-west lines were located along the perimeter of the site. Stations between the surveyed control lines were located by measuring the distance from the nearest control line. The point was then aligned and

marked to establish the 20 foot spacing. Some site features, such as buildings, tanks, firewalls, and microwave towers restricted the establishment of the grid.

An Electromagnetic (EM) conductivity survey was performed along the survey grid using a Geonics EM31-Q Conductivity Meter. The conductivity meter measures the apparent terrain conductivity in millimohs per meter.

The survey was conducted utilizing a 12 foot coil separation between the transmitting and receiving sensors. The configuration of coil positions yields approximately 6 meters of ground penetration. The survey was conducted in accordance with the manufacturers application and survey manual.

Variations in EM readings indicate the presence of a subsurface anomaly or other change in electrical conductivity. Since the EM is an electromagnetic tool, it is subject to interference from radiant energy sources or when near large power lines. For example, a microwave station and tower was located within the pilot area, as well as a number of overhead power lines. The overhead lines should not have contributed significantly to the EM readings, however the area around the microwave tower suggest that some interference may have occurred. The readings were assigned x-y coordinates based on survey grid locations. A contour map was then generated using the survey data to aid in data interpretation. Finally, the anomalies were then mapped to evaluate the geometry of the feature (i.e. - trenches, pits, windrows, etc.) Each anomaly representing a reasonable geometric pattern was then furthered evaluated for soil and/or ground water characteristics and geochemistry using the Geoprobe. A Net Basic Sediment Thickness Map (In Soil) was generated and is presented as FIG. 12.

4.3 Ground Water Investigation

The ground water investigation was conducted in two phases; the same as the soil investigation. Ground water samples were obtained in the pilot area by hydraulically pushing a hollow stainless steel probe rod with a disposable tip to the required sampling depth. The probe was then retracted approximately three inches. A screened filter was attached to one end of disposable tubing and inserted through the probe rod. The tubing was then attached to a peristaltic pump and ground water was purged until turbidity was reduced. Ground water samples were obtained in preserved

containers supplied by Core Laboratories. The ground water was analyzed for TPH, BTEX, and total metals. Based on visual observation, select ground water samples were obtained from the perimeter of the site and were analyzed for VOC's. Approximately 31 ground water samples were obtained in the pilot area.

After reviewing analytical results obtained from the soil sampling in the area out side of the pilot study, 34 ground water samples were obtained across the remainder of the site. The ground water samples were analyzed for TPH, BTEX, and total metals concentrations. In addition, a free oil sample from piezometer PCC-2 was collected and fingerprinted at the laboratory to verify that the sample represents crude oil. A map indicating the ground water sample locations and TPH concentrations is presented on Figure 11.

The ground water investigation also included the installation of 12 temporary piezometers in the pilot area and 14 piezometers across the remainder of the site. The piezometers were installed utilizing a 4-inch diameter continuous flight power auger. The piezometers were installed approximately three feet below the water table. The piezometers were constructed of 2-inch solid and 0.010 slotted PVC pipe. The PVC was flush threaded with flush threaded end caps. The screened portion of each piezometer was wrapped with a geofabric to prevent plugging, and backfilled with sand to the surface. The piezometers were allowed to stabilize and ground water levels were recorded twice per day for a period of one week. The ground water level measurements were observed during high and low tide to determine if the ground water direction of flow was significantly affected by tidal influence. Ground water levels during the investigation indicated that no tidal influence was encountered. Ground water level measurements are presented in Appendix B.

4.4 Sampling and Analysis Procedures

All samples were collected and placed in the sampling containers for transport to the laboratory on accordance with USEPA, chapter 11 of SW846 (Revision 0, September 1986) and the Technical Enforcement Guidance Document. Each sample was properly labeled and preserved according to the analysis to be performed. Information on each label consisted of the date and time of sample collection, type of analysis to be performed, sample number, preservative used, and signature of collector.

The sample containers were placed in an ice chest for transport to the laboratory. A chain of custody accompanied each ice chest to verify its contents. Copies of the chain of custody can be found in Appendix C. All analytical results for the pilot study area and the Phase II area are tabulated in Appendices D and E respectively.

The sampling event was also documented in daily field reports and boring logs forms presented in Appendix F. Information documented on the forms included time and date, names of collectors, how samples were obtained, discoloration (if applicable), and the presence of phase-separated hydrocarbons, and free liquids (if applicable).

5.0 ANALYTICAL RESULTS

5.1 Soil

Laboratory analyses of the soil samples resulted in the identification of approximately 18 areas on-site that contain maximum TPH concentrations between 1 and 20 percent (i.e. 10,000-200,000 ppm). These areas are identified on a TPH isopleth map presented in Figure 10. The analytical results for TPH from the samples collected in each areas are presented in Table I.

The following analytes were also detected as described:

- BTEX: up to 488 ppm
- 1,1,2-Trichloroethane: 14 ppm in one sample (PBC-6)
- Total Barium: up to 261 ppm
- Total Lead: up to 42 ppm
- Total Chromium: up to 7 ppm
- Total Selenium: up to 4 ppm

Base/Neutral/Acid's (BNA's) were not detected in the samples analyzed. Further investigation of the area did not show any other VOCs (with the exception of detectable BTEX) to be present on-site. Detailed analytical results for all soil testing are presented in Volume II of this report.

5.2 Geophysical Survey

Data from the electromagnetic surveys were plotted to locate areas of suspected basic sediment and trenches. The anomaly areas are generally concentrated around the existing tanks.

The area south of existing Tank 1953 indicates two anomalies in a east/west direction and one anomaly with a north/south trend. The area between Tanks 952, 951 and 946 indicate the presence of a former tank location. In addition, two anomalies exist south of Tank 952 with an east/west trend.

One anomaly exists north and east of Tank 946. Two anomalies exist between Tank 1351 and former Tank 945. The anomalies have east/west trends. Several anomalies exist south of Tank 1356. However, the trends of these anomalies are inconsistent. Some anomalies appear to run east/west and other anomalies appears to be north/south.

Several small anomalies are located north of Tanks 1358 and 1359, however most of the anomalies are most likely associated with a former trash pit area. Two anomalies do not appear to be associated with the trash pit and trend east to west. These trends are located north of Tank 1358.

The EM data was used in conjunction with information from the boring logs to determine the thickness of basic sediments throughout the site. This data is presented in Figure 12.

5.3 Ground Water

Results from the analysis of the ground water resulted in the identification of approximately four (4) areas on-site with TPH concentrations up to 40 ppm. These areas are identified on a ground water contour map presented in Figure 11. The analytical results for TPH from the samples collected in each area are presented in Table II.

The following parameters were also detected:

- Total BTEX: up to 0.103 ppm
- Total Barium: up to 33.8 ppm
- Total Chromium: up to 0.18 ppm
- Total Lead: up to 0.16 ppm
- Total Selenium: up to 0.14 ppm

Ground water flow direction was determined to be towards the ship channel, as shown in Figure 11. Daily water level measurement readings determined that tidal influence was not a significant factor affecting flow direction.

A sample of PSH from sample point PCC-2 submitted for finger printing to the laboratory to determine the boiling range and components of the compound were inconclusive. However, the sample was determined to chemically resemble weathered crude oil, and smelled distinctly like crude oil. Documentation of this information is presented in Appendix G.

FIGURE 1

SITE PLAN

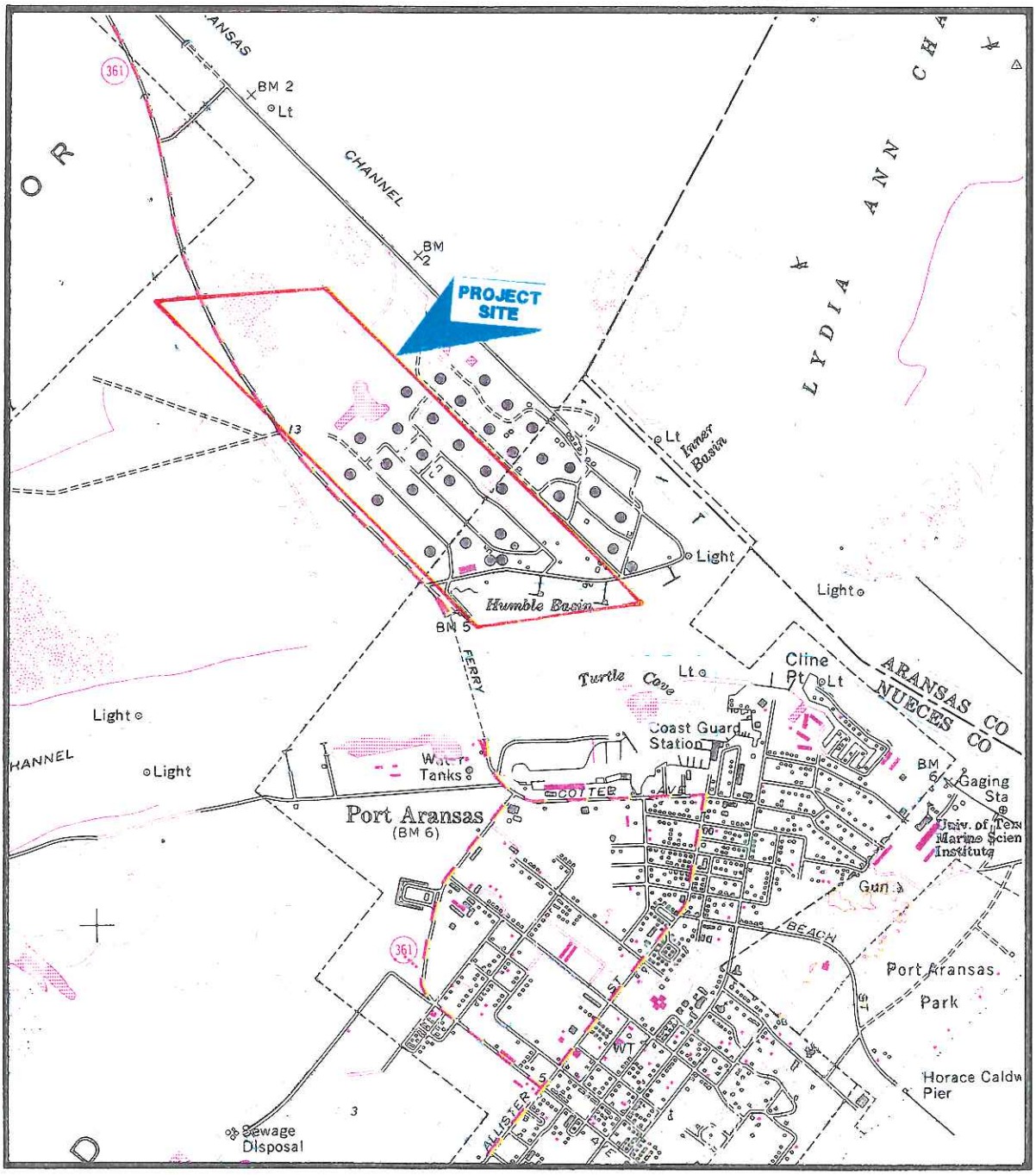
PORT ARANSAS QUADRANGLE

TEXAS NUECES CO.

LAT-27° 50'51"

LONG-97° 3'44"

PHOTOREVISED 1975



SCALE 1:24000

1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

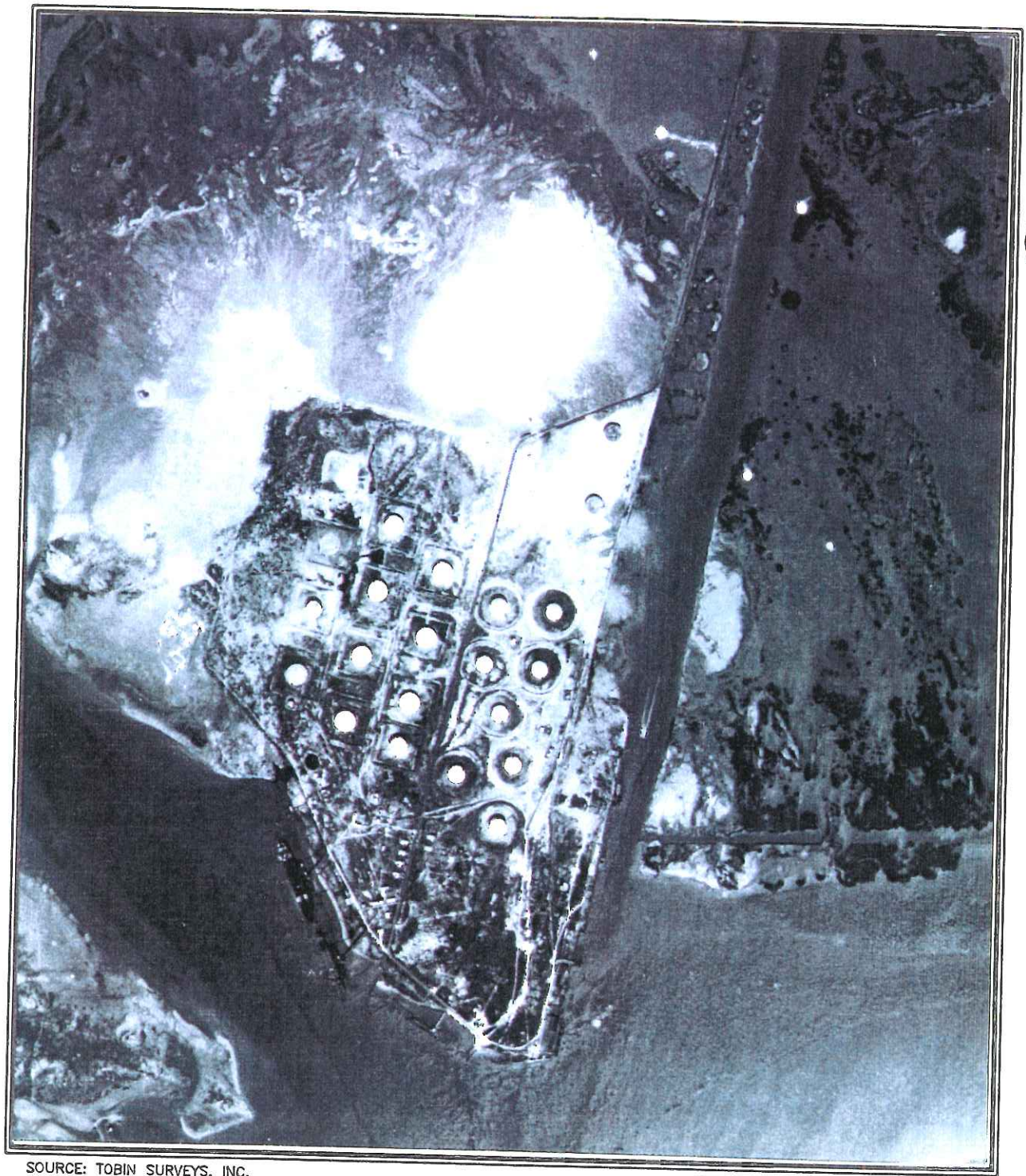
CONTOUR INTERVAL 5 FEET

BF

SITE LOCATION MAP	110220
EXXON PIPELINE COMPANY USA **HARBOR ISLAND FACILITY**	FIG 1

FIGURE 2

AERIAL PHOTOGRAPH - APRIL 17, 1937



SOURCE: TOBIN SURVEYS, INC.

APPROXIMATE SCALE: 1"=1500'

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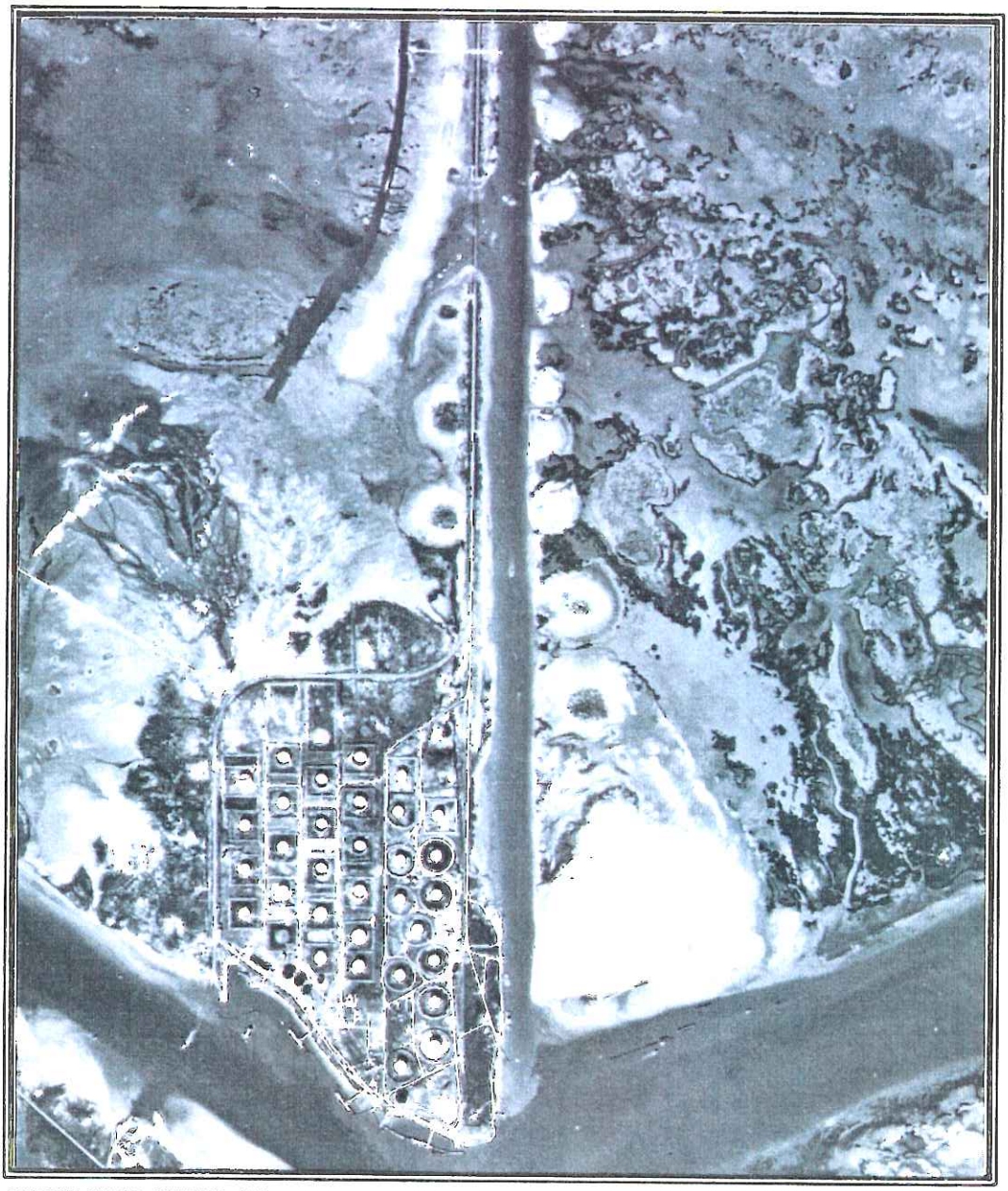
PROJECT SITE AERIAL PHOTOGRAPH - 1937

EXXON PIPELINE COMPANY USA HARBOR ISLAND FACILITY

430003

FIGURE 3

AERIAL PHOTOGRAPH - DECEMBER 3, 1958



SOURCE: TOBIN SURVEYS, INC.

APPROXIMATE SCALE: 1"=3030'

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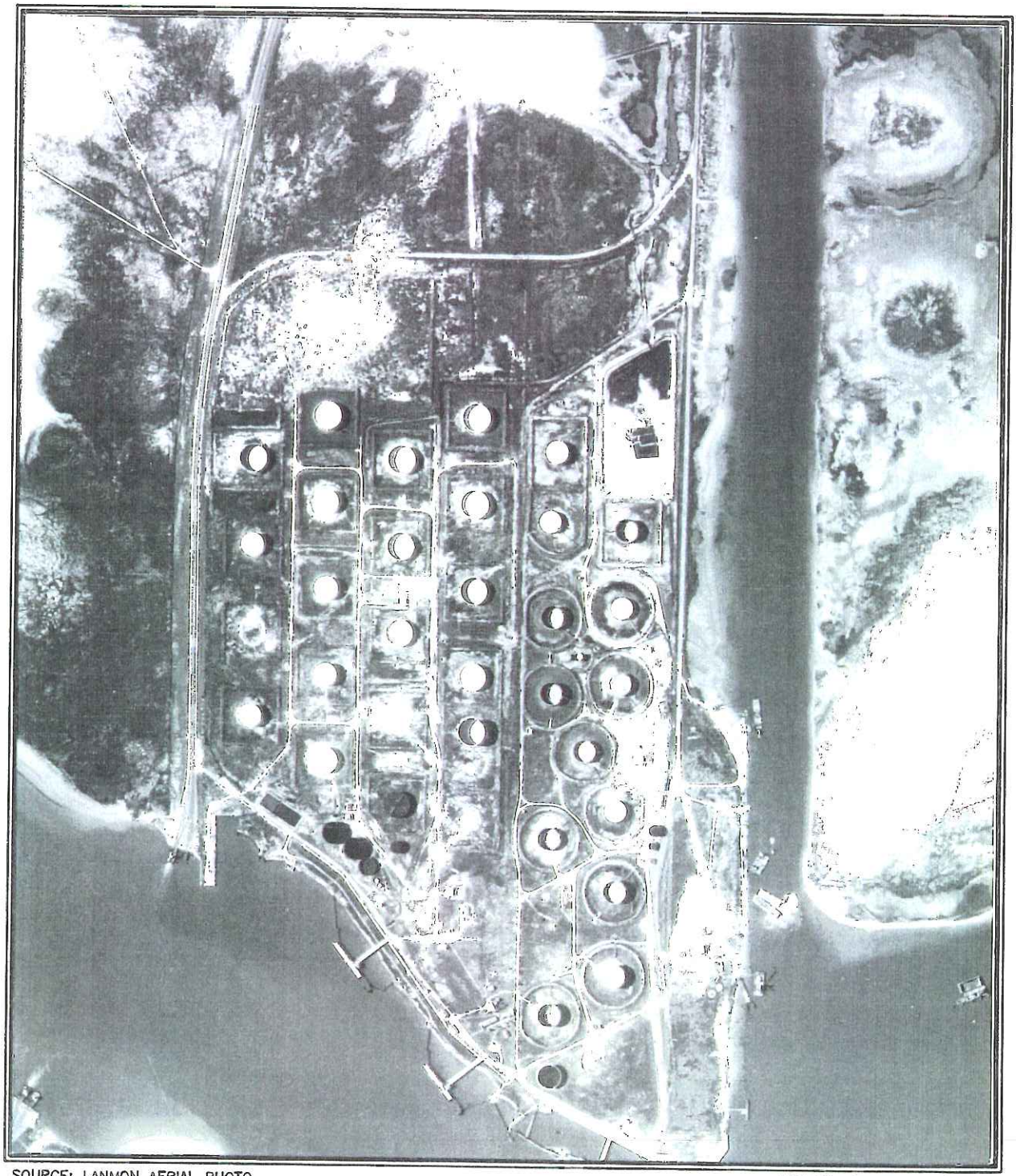
PROJECT SITE AERIAL PHOTOGRAPH - 1958	430003
EXXON PIPELINE COMPANY USA HARBOR ISLAND FACILITY	

FIGURE 4

AERIAL PHOTOGRAPH - OCTOBER 27, 1965



SOURCE: LANMON AERIAL PHOTO

APPROXIMATE SCALE: 1"=800'

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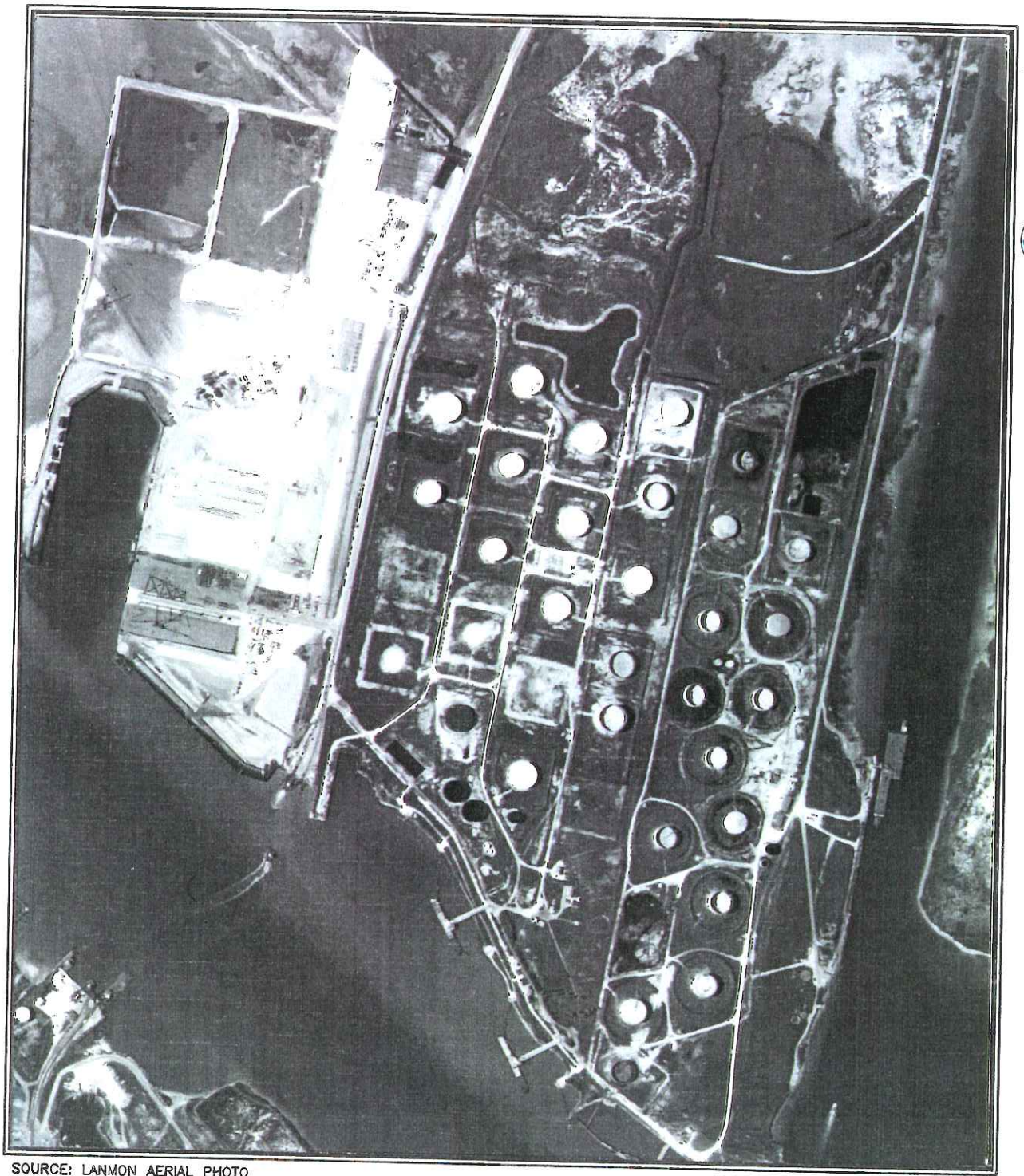
PROJECT SITE AERIAL PHOTOGRAPH - 1965	
EXXON PIPELINE COMPANY USA	HARBOR ISLAND FACILITY

430003

FIGURE 5

AERIAL PHOTOGRAPH - NOVEMBER 5, 1975



SOURCE: LANMON AERIAL PHOTO

APPROXIMATE SCALE: 1"=800'

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PROJECT SITE AERIAL PHOTOGRAPH - 1975

EXXON PIPELINE COMPANY USA HARBOR ISLAND FACILITY

430003

FIGURE 6

AERIAL PHOTOGRAPH - JUNE 22, 1987

SOURCE: LANMON AERIAL PHOTO

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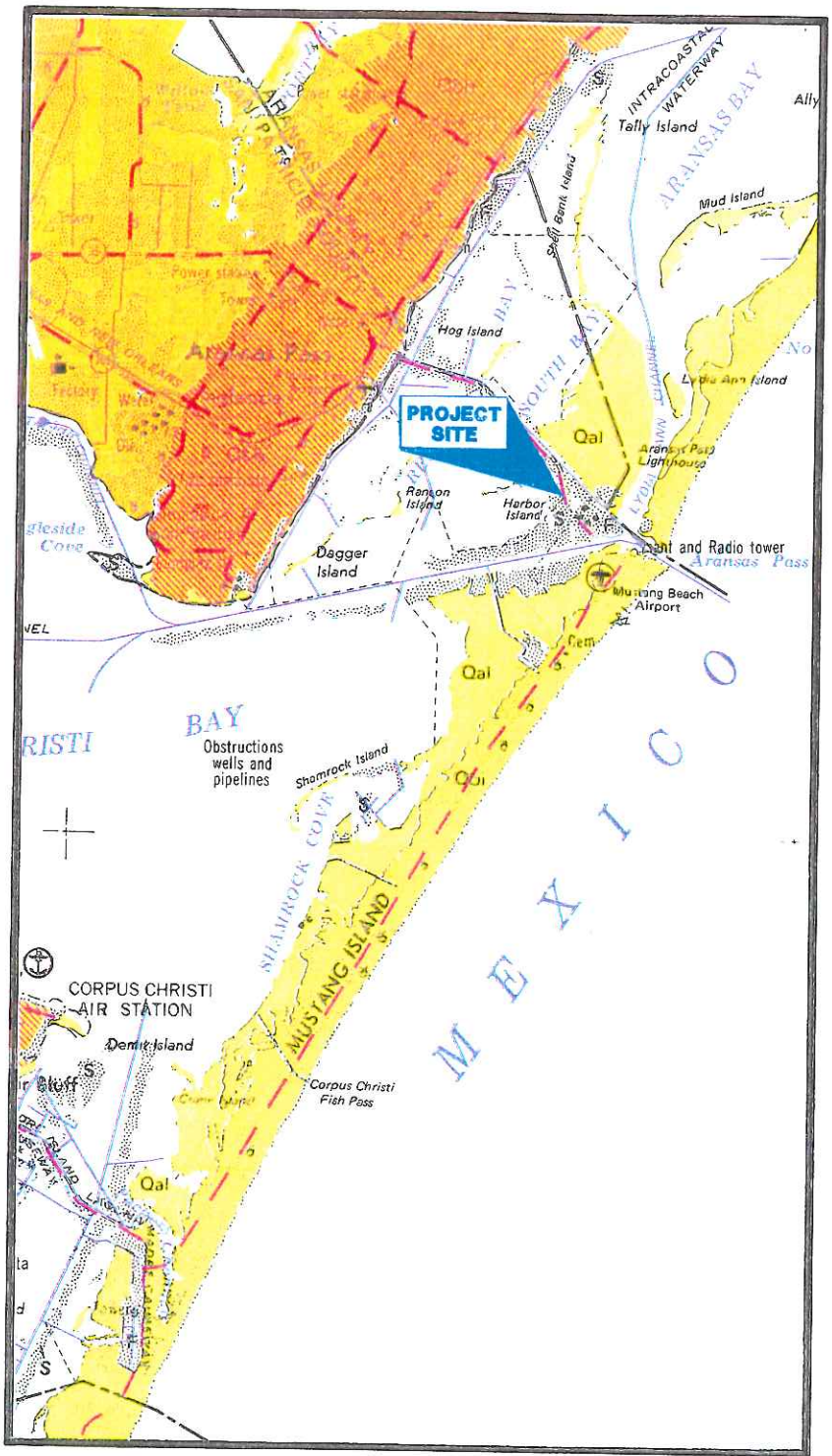
PROJECT SITE AERIAL PHOTOGRAPH - 1987

EXXON PIPELINE COMPANY USA HARBOR ISLAND FACILITY

430003

FIGURE 7

REGIONAL GEOLOGY MAP - CORPUS CHRISTI AREA



Adapted from the Geologic Atlas of Texas, Corpus Christi Sheet

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

Qbl

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"

Qbm Qbb

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

Fault

U / D

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

SCALE 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

CONTOUR INTERVAL 50 FEET

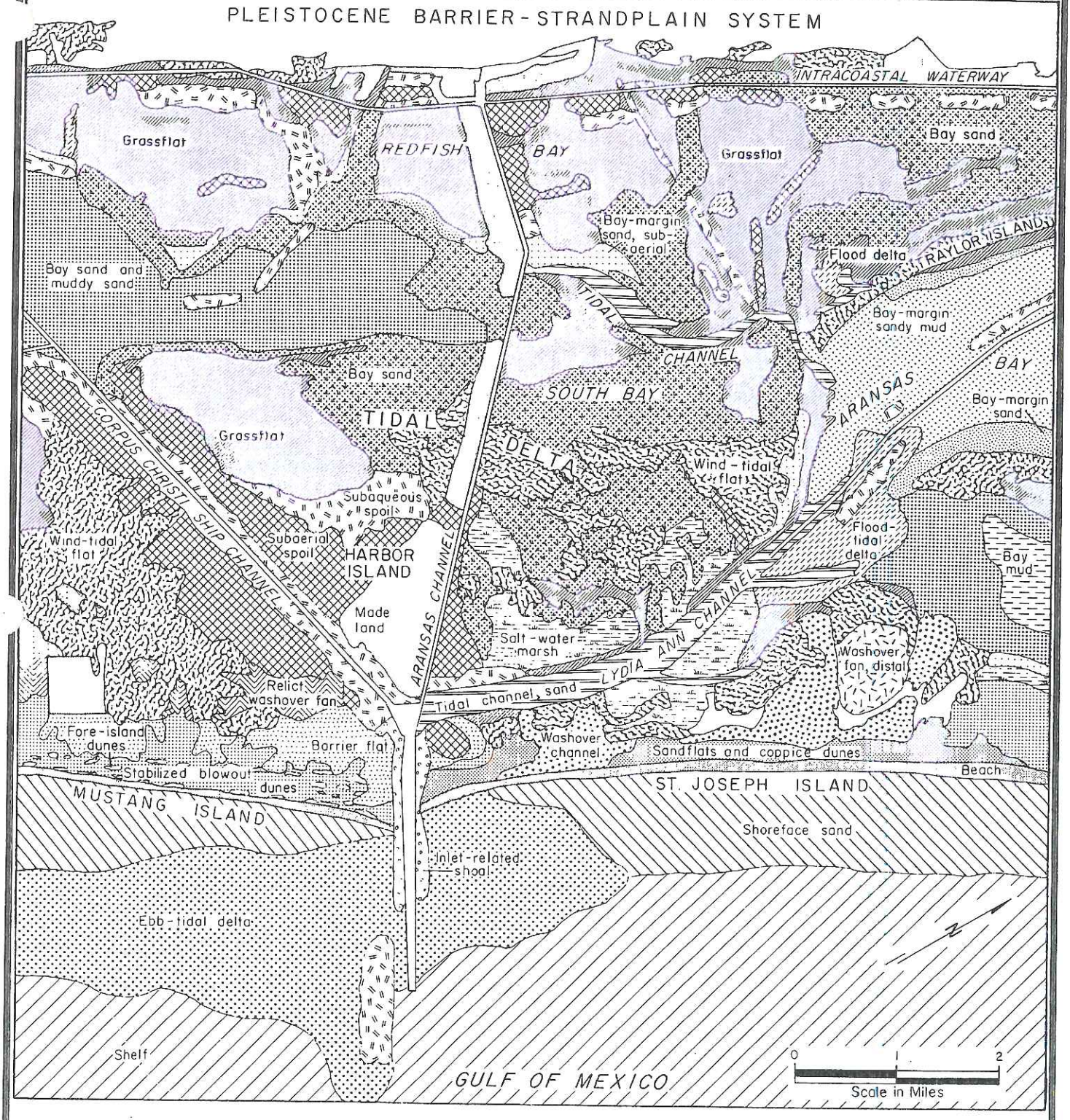
BF

k·e·i

SITE GEOLOGIC MAP	430003
EXXON PIPELINE COMPANY USA HARBOR ISLAND FACILITY	FIG 7

FIGURE 8

HARBOR ISLAND FLOOD DELTA MAP



SOURCE: ENVIRONMENTAL GEOLOGIC ATLAS of TEXAS COSTAL ZONE – CORPUS CHRISTI AREA 1976.

BF

k·e·i

HABOR ISLAND FLOOD DELTA	430003
EXXON PIPELINE COMPANY USA HARBOR ISLAND FACILITY	FIG 8

FIGURE 9

SOIL BORING LOCATIONS

Scale: 1" = 250'
0 125 250

LEGEND

- Geoprobe Soil Bores
- Soil Coring
- Grab Sediment Sample
- Out Fall Sample
- Approx. Limits of Pilot Study Area
- Backhoe Transects

FINA

End Of Ditch

End Of Paved County Road (N.C.R.)

Bulkhead

DOCK NO. 1

PUMP HOUSE AREA

DOCK NO. 2

Short Line

Bridgeway

High Ground

Ballast Water Pool

Pump Station

Ballast Pit

Dirt Road

Bulkhead

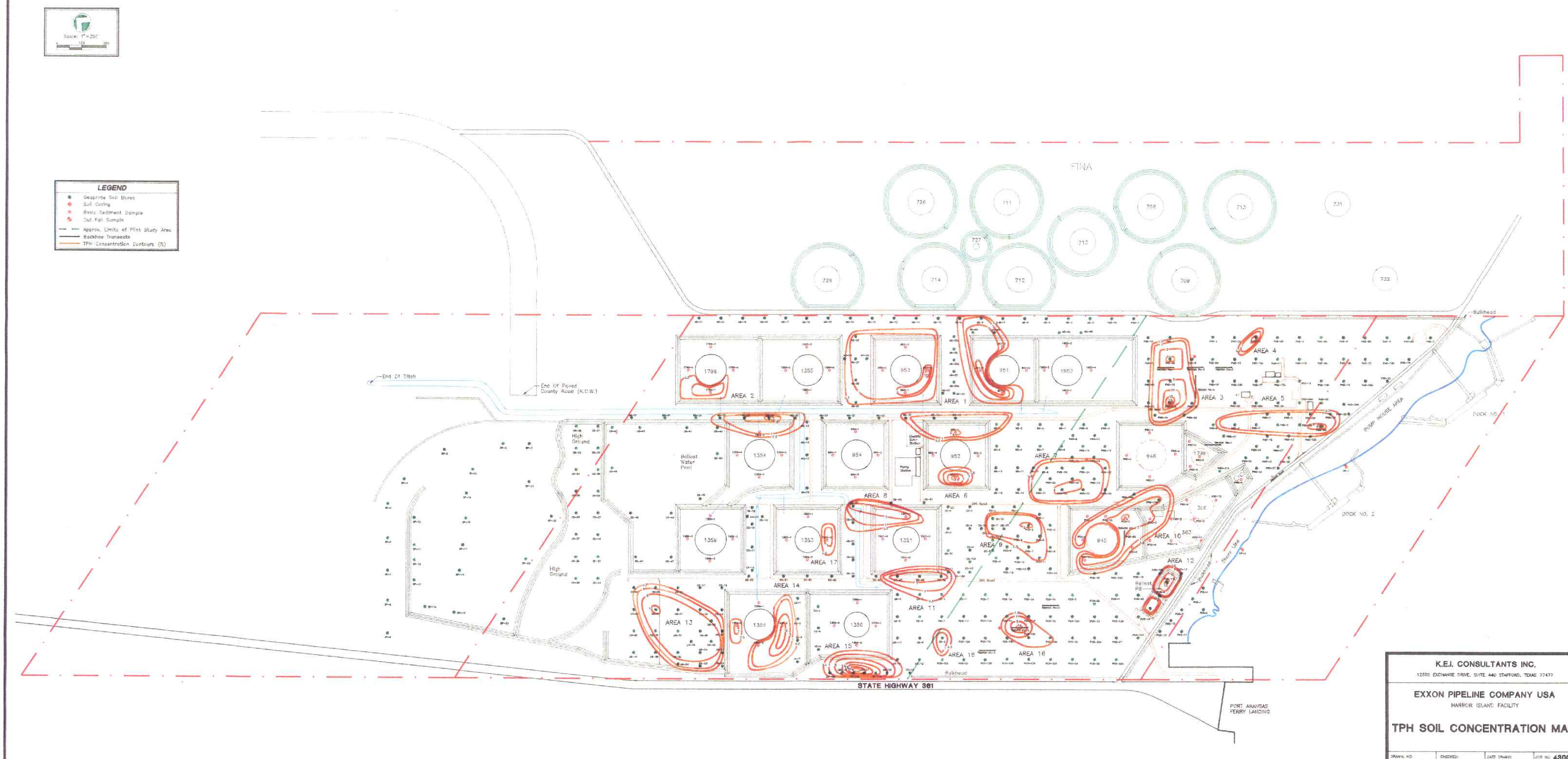
STATE HIGHWAY 361

PORT ARANSAS FERRY LANDING

K.E.I. CONSULTANTS INC.	
12502 EXCHANGE DRIVE, SUITE 440 STAFFORD, TEXAS 77477	
EXXON PIPELINE COMPANY USA	
HARBOR ISLAND FACILITY	
SOIL BORING LOCATIONS	
DRAWN BY:	CHECKED:
DATE DRAWN:	JOB NO: 430003
REVISED BY:	REVIEWED BY:
DATE REVISED:	FIGURE: 9

FIGURE 10

TPH SOIL CONCENTRATION MAPS



K.E.I. CONSULTANTS INC.
12502 EXCHANGE DRIVE, SUITE 440 STAFFORD, TEXAS 77477

EXXON PIPELINE COMPANY USA
HARBOR ISLAND FACILITY

TPH SOIL CONCENTRATION MAP

DRAWN: HSI	CHECKED:	DATE DRAWN:	JOB NO: 430003
REVISED BY:	REVIEWED BY:	DATE REVISED:	FIGURE: 10

FIGURE 11

GROUND WATER GRADIENT AND TPH CONCENTRATIONS

Scale: 1"=250'

0 60 150 300

LEGEND

- Water Sample/Piezometer.
- Out Fall Sample.
- 0.003 / 1 — BTEX Concentration in ppm. / TPH Concentration in ppm.
- ND — Not Detected.
- TPH — Total Petroleum Hydrocarbon.
- PSH — Phase Seperated Hydrocarbon.
- 4.54 H — High Tide Ground Water Elevation.
- 4.54 L — Low Tide Ground Water Elevation.
- Approx. Limit of Plot Study Area
- TPH Concentration.
- Ground Water.
- Ground Water Direction of Flow
- Backhoe Transects.

FINA

726 711 708 713 731 727 710 728 714 712 709 732

AREA 1 AREA 5 AREA 4 AREA 3 AREA 2

1798 1355 953 951 1353 946 1799 1354 954 950 1359 1363 1351 1358 363

End Of Ditch

End Of Paved County Road (R.O.W.)

High Ground

Ballast Water Pool

Bulkhead

PUMP HOUSE AREA

DOCK NO. 1

DOCK NO. 2

Ballast Pit

STATE HIGHWAY 361

PORT ARANSAS FERRY LANDING

K.E.I. CONSULTANTS INC.
11200 EXCHANGE DRIVE, SUITE 440 STAFFORD, TEXAS 77477

EXXON PIPELINE COMPANY USA
HARBOR ISLAND FACILITY

GROUND WATER GRADIENT AND TPH CONCENTRATIONS

DRAWN BY:	CHECKED:	DATE DRAWN: 12/05/94	JOB NO. 430008
REVISED BY: BY	REVISED BY:	DATE REVISED: 03/14/95	FIGURE: 11

FIGURE 12

NET BASIC SEDIMENT THICKNESS MAP (IN SOIL)

Scale: 1" = 250'

0 125 250

LEGEND

- Geoprobe Soil Bores
- Soil Coring
- Basic Sediment Sample
- Out Fall Sample
- Approx. Limits of Pilot Study Area
- Haskhoe Transects
- Basic Sediment Thickness Contours (ft)

FINA

End Of Ditch

End Of Paved County Road (R.O.W.)

Bulkhead

DOCK NO. 1

PUMP HOUSE AREA

DOCK NO. 2

High Ground

Ballast Water Pool

Pump Station

Ballast Pit

Bulkhead

STATE HIGHWAY 361

PORT ARANSAS FERRY LANDING

K.E.I. CONSULTANTS INC.			
12502 EXCHANGE DRIVE, SUITE 440 STAFFORD, TEXAS 77477			
EXXON PIPELINE COMPANY USA			
HARBOR ISLAND FACILITY			
NET BASIC SEDIMENT THICKNESS MAP (IN SOIL)			
DRAWN: HDS	CHECKED:	DATE DRAWN:	JOB NO. 430003
REVISED BY:	REVIEWED BY:	DATE REVISED:	FIGURE: 12

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 1
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
AS-8	02/21/94	1.160	53,800
AS-9	NS	NS	NS
AS-10	NS	NS	NS
AS-11	NS	NS	NS
AS-12	NS	NS	NS
AS-8B	02/21/94	ND	24
AS-26	NS	NS	NS
AS-22A	03/01/94	ND	284
AS-8A	NS	NS	NS
AS-28	NS	NS	NS
AS-22	NS	NS	NS
Tank 953-#3	02/21/94	0.730	138
Tank 951-#3	02/21/94	ND	36
Tank 953-#2	02/21/94	13.710	28,700
Tank 953-#4	02/21/94	4.450	41,200
AS-23A	03/01/94	ND	230
AS-23	NS	NS	NS
Tank 951-#2	02/21/94	29.110	101,000
Tank 953-#1	02/21/94	ND	79
AS-24A	03/01/94	ND	209
AS-25	NS	NS	NS
AS-24	NS	NS	NS
BS-21	NS	NS	NS
BS-20	NS	NS	NS
BS-19	02/28/94	214.950	97,000
Tank 952-#1	NS	NS	NS

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 2
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
Tank 1798-#1	02/21/94	44.290	32,000
BS-29	NS	NS	NS
BS-28	NS	NS	NS
BS-27	NS	NS	NS
BS-26	02/28/94	26.050	84,000
BS-25	NS	NS	NS
CS-40	NS	NS	NS
Tank 1354-#1	02/21/94	11.100	47,700

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 3
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
PAS-1	NS	NS	NS
PAS-8	02/15/94	ND	1,160
PAS-9A	02/21/94	158.970	125,000
PAS-9	NS	NS	NS
PAS-8A	02/21/94	ND	1,300
PAS-15	02/15/94	52.860	54,300
PAS-21	NS	NS	NS
PAS-21A	02/21/94	0.779	191,000
PAS-22	02/15/94	82.200	35,700
PBS-2A	02/25/94	ND	11,000

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 4
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
PAS-3	02/15/94	ND	46,200
PAS-2A	NS	NS	NS

TABLE I
SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 5
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
PBS-1	NS	NS	NS
PBS-2	NS	NS	NS
PAS-2A	NS	NS	NS
PBS-2B	02/21/94	ND	505
PBS-6	02/16/94	1.320	26,900
PBS-7	NS	NS	NS
PBS-8	02/16/94	4.100	44,100
PBS-8A	NS	NS	NS
PAS-8B	NS	NS	NS

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 6
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
952-3	02/15/94	ND	29

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 7
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
PBS-18	NS	NS	NS
PBS-19	NS	NS	NS
BS-10	NS	NS	NS
BS-9	NS	NS	NS
PBS-23	NS	NS	NS
PBS-24	NS	NS	NS
PBS-25	02/16/94	ND	9,400
PBS-28	NS	NS	NS
PBS-29	NS	NS	NS
PBS-30	NS	NS	NS
PBS-31	NS	NS	NS
PBS-32	02/16/94	95.000	40,700
PBS-33	NS	NS	NS
PBS-34	NS	NS	NS

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 8
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
Tank 1351-#1	02/21/94	5.500	55,800

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 9
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
CS-7A	NS	NS	NS
PCS-1	02/18/94	ND	1,330
CS-7	02/21/94	30.310	36,100
CS-7C	02/21/94	2.000	20,200
PCS-2	02/18/94	ND	57,100
PCS-4	02/18/94	3.400	8,430
PCS-5	02/18/94	ND	67

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 10
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
PBS-34A	02/21/94	ND	3,660
PBS-34B	02/21/94	4.540	60,900
PCC-1A	02/21/94	7.770	6,260
PCC-2	02/17/94	11.340	23,400
PCC-7	02/25/94	17.510	70,000
PCC-4	02/21/94	ND	24,500
PCC-5A	02/21/94	38.800	47,700
PCC-6	02/17/94	ND	74,400
PCC-5	02/17/94	2.740	2,660

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 11
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
CS-10	02/21/94	NS	NS
DS-47	NS	NS	NS
DS-46	02/28/94	ND	40
CS-11	NS	NS	NS
DS-45	NS	NS	NS
CS-12B	NS	NS	NS
DS-4	02/21/94	119.070	73,800
DS-3	NS	NS	NS
DS-2	02/21/94	338.200	78,200

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 12
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
PCS-16A	NS	NS	NS
PCS-17	02/18/94	ND	ND
PCS-17A	02/25/94	ND	600
PDS-5	02/18/94	ND	2,240

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 13
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
DS-41	NS	NS	NS
DS-36	NS	NS	NS
DS-27	NS	NS	NS
DS-18	NS	NS	NS
DS-30	NS	NS	NS
DS-42	NS	NS	NS
DS-37	02/22/94	412.990	102,000
DS-31	NS	NS	NS
DS-26	NS	NS	NS
DS-19	NS	NS	NS
DS-43	NS	NS	NS
DS-38	NS	NS	NS
DS-32	NS	NS	NS
DS-28	02/22/94	8.200	3,520
DS-25	NS	NS	NS
DS-20	02/22/94	218.140	43,700
DS-35	02/22/94	42.000	13,000
DS-29	02/22/94	203.000	58,700
DS-24	02/22/94	209.500	68,400
DS-21	02/22/94	197.820	49,000
DS-44	NS	NS	NS
DS-39	NS	NS	NS
DS-33	02/22/94	99.500	56,900
DS-34	NS	NS	NS
DS-23	NS	NS	NS
DS-22	02/22/94	66.100	16,000

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 14
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
Tank 1358-#1	02/21/94	ND	ND
Tank 1358-#2	02/21/94	ND	ND
Tank 1358-#3	02/21/94	43.430	21,000
Tank 1358-#4	02/21/94	ND	16

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 15
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
Tank 1356-#3	02/21/94	ND	14
DS-16A	03/01/94	488.600	134,000
DS-16	NS	NS	NS
DS-15A	03/01/94	346.100	104,000
DS-15	02/21/94	178.000	202,000
DS-14A	03/01/94	380.000	90,100
DS-14	NS	NS	NS
DS-11	NS	NS	NS
DS-13	NS	NS	NS

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 16
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
Trench D-2	02/22/94	89.600	110,000
PDS-11	NS	NS	NS
PDS-11A	02/28/94	ND	40
PDS-19A	02/28/94	0.530	5,200

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 17
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
Tank 1353-#2	02/21/94	75.000	19,600

TABLE I

SUMMARY OF LABORATORY RESULTS - SOIL
HARBOR ISLAND STATION - AREA 18
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
DS-8	02/21/94	139.810	47,900

GENERAL NOTES

ND	-	Indicates constituent was not detected above the method detection limit.
NS	-	Indicates sample location was not sampled for constituent indicated.
*	-	Indicates sample consisted of free floating product and was tested by fingerprint analysis. Results of analysis appear in Appendix G.

Method detection limits - Soil:	BTEX	- 0.250 ppm
	TPH	- 10.0 ppm
Laboratory test methods - Soil:	BTEX	- EPA Method SW-846 8020
	TPH	- EPA Modified Method 418.1
Method detection limits - Water:	BTEX	- 0.001 ppm
	TPH	- 1.0 ppm
Laboratory test methods - Water:	BTEX	- EPA Method SW-846 8020
	TPH	- EPA Method 418.1

TABLE II

SUMMARY OF LABORATORY RESULTS - WATER
HARBOR ISLAND STATION - AREA 1
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
AW-2P	02/21/94	0.003	1

TABLE II

SUMMARY OF LABORATORY RESULTS - WATER
HARBOR ISLAND STATION - AREA 2
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
DW-4	02/24/94	0.011	3

TABLE II

SUMMARY OF LABORATORY RESULTS - WATER
HARBOR ISLAND STATION - AREA 3
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
BW-4	02/24/94	ND	ND
PBW-5A	02/1/894	0.103	45
PCC-2	03/01/94	*	*
PCW-5	02/24/94	ND	ND
PBW-8	02/24/94	ND	4
PBW-3	02/16/94	0.021	20
PBW-1	02/16/94	ND	ND
PAW-17	02/16/94	0.040	23
PAW-9A	02/18/94	0.021	4

TABLE II

SUMMARY OF LABORATORY RESULTS - WATER
HARBOR ISLAND STATION - AREA 4
PORT ARANSAS, TEXAS

SAMPLE LOCATION	SAMPLE DATE	BTEX (ppm)	TPH (ppm)
PBW-6	02/24/94	0.022	6
PBW-2A	NS	NS	NS
PBW-2	02/16/94	0.035	7
PAW-18	02/16/94	ND	ND

GENERAL NOTES

ND	-	Indicates constituent was not detected above the method detection limit.
NS	-	Indicates sample location was not sampled for constituent indicated.
*	-	Indicates sample consisted of free floating product and was tested by fingerprint analysis. Results of analysis appear in Appendix G.

Method detection limits - Soil:	BTEX	- 0.250 ppm
	TPH	- 10.0 ppm
Laboratory test methods - Soil:	BTEX	- EPA Method SW-846 8020
	TPH	- EPA Modified Method 418.1
Method detection limits - Water:	BTEX	- 0.001 ppm
	TPH	- 1.0 ppm
Laboratory test methods - Water:	BTEX	- EPA Method SW-846 8020
	TPH	- EPA Method 418.1