1997 RELEASE INVESTIGATION REPORT

HOT OIL PIPELINE

TESORO ALASKA REFINERY

PREPARED FOR

TESORO ALASKA COMPANY

PREPARED BY

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ENVIRONMENTAL CONSULTANTS

Project No. 01-25

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1.0 INTRODUCTION

This report documents the results of an investigation performed in the hot oil pipeline release area in August and September 1997 and provides a 2001 update to report additional data collected from the release area since 1997. The 1997 investigation was performed for Tesoro Alaska Petroleum Company (Tesoro) by Kent & Sullivan, Inc. (KSI) in general accordance with Tesoro's Cook Inlet bluff area hydrocarbon release action plan (Dames & Moore, 1992a). The work was carried out on the Cook Inlet beach west of the Phillips Petroleum Corporation (Phillips) Kenai LNG Plant. The investigation was performed in response to the appearance of hydrocarbon sheens on the beach during short periods of certain tide cycles. The objectives of the investigation were to assess the hydrocarbon sheen source and to characterize the extent and concentrations of hydrocarbon present in the beach area. Section 2.0 of this report describes the activities and findings from the 1997 investigation and Section 3.0 provides the 2001 update with recommendations for additional monitoring.

1.1 BACKGROUND

A leak was discovered in an underground pipeline in September 1987 after the line failed a pressure test. The pipeline carries hot oil (heated #2 diesel fuel) that traces a ballast water line between Phillips wharf and the Tesoro refinery. The release occurred in the northwest portion of the Phillips property approximately 60 feet from the edge of the Cook Inlet bluff (Figure 1). Tesoro excavated impacted soil to a depth of 12 to 15 feet below the release point, and they did not excavate deeper because of concern for the integrity of the pipeline and the stability of the bluff. At the time of the cleanup action, Tesoro estimated that approximately 20 to 50 barrels (800 to 2,100 gallons) of product had been released.

Hydrocarbon-stained soil on the bluff and hydrocarbon sheening on the beach were discovered directly west of the hot oil release in mid-1992. At this time the bluff face was a steep slope vegetated from the crest to the high tide line with grasses and low-growing brush. Tesoro investigated the hydrocarbon occurrence and determined that the hot oil release was the source. Investigation work was subsequently performed over a two-year period to assess the extent and levels of contamination. The work included the following tasks:

- September 1992: 110 soil samples were collected on a 10-foot grid to characterize the extent of impacts on the bluff and beach. Nine beach sediment and bluff soil samples were analyzed (Dames & Moore, 1992b).
- July 1993: Four well points were installed on the beach and sampled to characterize potential impacts to groundwater (Dames & Moore, 1993).
- January 1994: Six soil and/or beach sediment samples were collected from a 2-foot deep trench excavated on the beach and one of the well points was sampled (Dames & Moore, 1995a).
- July 1994: Two monitoring wells (wells B-1 and B-2) were installed on the bluff (near the hot oil pipeline) to evaluate the extent of groundwater contamination (Dames & Moore, 1995a).
- February 1995: Seven soil borings (boreholes B-3 through B-9) were drilled and sampled on the bluff to evaluate the source of light non-aqueous phase liquid (LNAPL) that appeared in well B-1 for the first time in February 1995 (Dames & Moore, 1995b).

The results of the investigations show that diesel fuel had impacted soil and groundwater in a 35- to 40-foot wide zone directly beneath the release point. Well B-1 is located near the middle of the impacted area. Soil and groundwater were not impacted in well B-2 located 50 feet due west of well B-1, and groundwater at well E-128, located 45 feet south of B-1, did not contain detectable hydrocarbons. Hydrocarbon seeped onto the bluff face approximately 175 feet north-northwest of the release point. Hydrocarbon also occurred in beach sediments near the toe of the bluff below the seepage zone, and contaminated soil and groundwater were present below a hard clay layer 14 feet below the beach surface in the same area.

Tesoro also excavated approximately 250 cubic yards of hydrocarbon-impacted soil from the toe of the bluff. The work was performed in July 1994 after storm erosion had exposed the contaminated soil.

Tesoro evaluated methods to remediate the impacted soil, beach sediment, and groundwater based on the results of the investigations. This work included a geotechnical investigation to evaluate the potential effects of certain in-situ remediation methods on bluff stability. A risk assessment was performed to evaluate the potential impact of the hydrocarbon occurrence on human and ecological receptors and to establish risk-based soil and groundwater cleanup criteria. The results of the geotechnical investigation and risk assessment were reported to ADEC in September 1995 (Dames & Moore, 1995a). The principal findings of Tesoro's work are as follows:

- In-situ cleanup methods such as bioremediation, surfactant washing, or chemical oxidation that involve infiltration of water east of the bluff would tend to increase the potential for failure of the bluff face.
- The hot oil release did not pose significant risks to human health or environmental receptors under the bluff and beach conditions that existed in 1995.
- Marine surface water cleanup levels were proposed based on the risk assessment.
- Natural degradation combined with a groundwater and surface water monitoring program were appropriate response actions based on 1995 conditions.

2.0 1997 INVESTIGATION ACTIVITIES AND RESULTS

Hydrocarbon sheens were identified on the beach west of the hot oil release area in 1997. This section describes the work that was performed in 1997 to investigate the source and migration pathway of these sheens. Appendix A contains the laboratory analytical reports, and Appendix B contains the log of borehole 97B-33.

2.1 1997 CONDITIONS

The morphology of the beach and bluff face west of the hot oil release area was significantly altered by a major storm in October 1996. The toe of the bluff was eroded back approximately 25 to 35 feet based on a comparison of points surveyed in the area during 1992 and 1997. Storm wave action stripped sediments off a large section of the middle and upper portion of the beach. The erosion exposed Pleistocene clay and gravelly sand deposits on the beach and bluff face as well as northwest-striking, near-vertical faults that offset the Pleistocene deposits. The bluff face was altered from a vegetated slope to an embankment partially covered with scree with near-vertical exposures of hard clay and gravelly sand. Figure 2 is a photograph showing the condition of the beach and bluff after the storm. Beach sediments had been re-deposited by 1997 over much of the beach that had been stripped during the October 1996 storm. The bluff face was mapped in July 1997 based on exposures present at that time and the photographs taken after the October 1996 storm. Figure 3 is the portion of the bluff geologic map showing the stratigraphy and structure in the hot oil release area.

Well B-1 continued to contain LNAPL through 1997. The LNAPL thickness ranged between 0.1 and ~0.3 feet during 1997 gauging events. Hydrocarbon-impacted gravelly sand cropped out on the bluff face in a 25- to 35-foot wide and 2- to 5-foot thick zone approximately 15 feet above the beach (Figure 3). Ongoing erosion brought hydrocarbon impacted detritus to the beach level where it formed scree deposits. During parts of August and September 1997, groundwater with sheens was observed discharging from below a clay outcrop on the beach. The sheens occurred during a 10- to 20-minute period when the incoming tide was just below the level of the clay. The investigation described in this section was conducted, in part, to evaluate the source and migration pathways of the hydrocarbons in this area.

2.2 SURFACE WATER SAMPLING

One surface water sample was collected in the area of hydrocarbon sheening on August 15, 1997. The sample was collected on a flood tide at the location shown on Figure 4 where hydrocarbon sheens were present. The sheens occurred in a 15- to 20-foot wide area where a poorly-graded medium sand cropped out between exposures of hard gray clay. The sand immediately below the clay was very dark gray and had a noticeable hydrocarbon and decaying-organic odor. The water sample was analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) by EPA method 8020, gasoline-range organics (GRO) by method AK-101, diesel-range organics (DRO) by method AK-102, and residual-range organics (RRO) by method AK-103. The analytical results are provided on Table 1. The sample contained 2,300 µg/L DRO but no detectable GRO, RRO, or BTEX with the exception of 2 µg/L xylenes. The DRO chromatogram for the sample shows a weathered diesel pattern (Figure 5).

2.3 TRENCH EXCAVATION AND SAMPLING

Two trenches were excavated on the beach on September 2, 1997. Trench 1 was excavated near the toe of the bluff and Trench 2 was excavated just inland from the seep area (Figure 4). The work was performed on a flood tide to allow maximum drainage from the beach sediments; however, saturated conditions in most of Trench 2 resulted in rapid sloughing that hampered observations and collection of analytical samples. Odors were closely monitored during the excavation, and a photo-ionization detector (PID) was used to screen soil samples. A total of eight beach sediment and soil samples were collected from the trenches.

Trench 1 was 320 feet long and located 10 to 20 feet from the toe of the bluff. The northern 260 to 270 feet of the trench were excavated through 1.5 to 2.5 feet of recent beach sediments and into four to eight inches of the underlying hard gray clay. The hard gray clay unit was absent in the southern 50 feet of the trench. The beach sediments consisted predominantly of sand and gravelly sand. A thin (+/- 0.5-foot) interbed containing hard gray clay clasts in a sandy matrix was present in most of the middle section of the trench. The interbed was typically 0.5 to 1 foot below the surface. Saturated conditions were locally present immediately above the hard gray clay, but in general, little groundwater was present in most of the trench. Saturated conditions were encountered immediately below the surface in the southern-most part of the trench, and that portion of the trench rapidly sloughed and flooded.

Weak to moderate hydrocarbon odors and low PID readings of 10 to 15 ppm were locally present in the central part of trench 1. Hydrocarbon odors were observed in beach sediments immediately above the hard gray clay unit and in individual clay clasts within the layer of clastic clay fragments. PID readings that exceeded background levels occurred only in the layer of clastic clay fragments. Six samples of the beach sediments (HOT-1 through HOT-6) were collected from this part of trench 1 at the locations shown on Figure 4. Four of the samples (HOT-1, HOT-3, HOT-4, and HOT-6) consisted of gravelly sand and gray clay collected from the contact between the beach sediments and underlying clay unit. The other two samples (HOT-2 and HOT-5) were from the clastic clay interbed. The samples were analyzed for BTEX, GRO, and DRO by the methods listed above in Section 2.2. Table 2 provides the analytical results from the soil samples. DRO was present in all of the samples at concentrations between 17 and 230 mg/Kg. The highest DRO concentration (HOT-5) is associated with low concentrations of GRO, benzene, and xylenes. The DRO chromatograms for all of the samples display a distinct weathered #2 diesel pattern (Figure 5).

Trench 2 was approximately 280 feet long and located 60 to 75 feet from the toe of the bluff. The recent beach sediments in this area consisted of gravelly sand that ranged from 0.5 to over four feet thick. Saturated conditions in most of the beach sediment caused rapid flooding and sloughing that made it difficult to evaluate conditions in the deeper part of the trench. The northern part of the trench appeared to bottom in hard gray clay at a depth of three to four feet. Sand was present below the hard gray clay in the central and southern portions of the trench.

Moderate hydrocarbon odor and PID readings up to 90 ppm were detected in a 30- to 40-foot long area where the sand underlying the hard gray clay was exposed. Elsewhere in the trench the sand underlying the clay generated PID readings at background levels and did not contain odors or only a weak hydrogen sulfide odor. Two samples (HOT2-1 and HOT2-2) were collected from the sand in which field observations indicated the presence of hydrocarbon and analyzed for BTEX, GRO, and DRO by the methods listed above in Section 2.2.

The samples contained 2,600 and 5,000 mg/Kg DRO, respectively and also contained low concentrations of GRO and xylenes. The chromatograms from these analyses closely match those of the trench 1 samples and show a weathered #2 diesel pattern (Figure 5).

2.4 TEMPORARY WELL INSTALLATION

Temporary well 97B-33 was drilled and installed on August 28, 1997 at the location shown on Figure 4. The boring log and well construction diagram are included in Appendix B. The borehole was drilled using a hollow-stem auger drilling rig, and the well was completed in the aquifer underlying the hard gray clay unit using standard well construction techniques. The well was built with 2-inch diameter PVC materials and had a 5-foot screened interval set in filter pack sand.

Approximately one foot of beach sediment was present above the hard gray clay unit at the borehole location. The clay is approximately 11 feet thick and overlies poorly-graded, fine to medium sand which grades downward into fine to coarse sand with gravel. A slight hydrocarbon odor was observed in the sand unit, but PID readings from this interval were only slightly above background levels (3.4 to 5.7 ppm). One soil sample was collected from 4.5 feet below the bottom of the clay unit and analyzed for BTEX, GRO, and DRO by the methods listed above in Section 2.2. The analytical results are summarized in Table 2. Hydrocarbons were not detected in the sample.

A groundwater sample was collected from the temporary well on September 5, 1997 and analyzed for the same parameters. The sample contained 610 µg/L DRO but no detectable BTEX or GRO concentrations (Table 1). The chromatogram from the groundwater sample shows a weathered #2 diesel pattern (Figure 5) that closely matches that of the soil samples.

2.5 DISCUSSION

This section discusses the hydrogeology of the hot oil release area, the source of hydrocarbons in shallow beach sediments and beneath the hard gray clay unit, and migration of the hot oil plume based on the results of this investigation.

2.5.1 Hydrogeology

The hydrogeology of the hot oil release area is based on observations of exposures created during the October 1996 storm and the results of other nearby projects (KSI, 1997). The bluff geologic map (Figure 3), the faults shown on the site map (Figure 4), and a diagrammatic east-west cross-section (Figure 6) illustrate the hydrogeologic interpretations of the hot oil release area.

The hot oil pipeline release area is located in an uplifted structural block, or horst, bound to the north and south by steeply dipping faults (Figure 3 and 4). Approximately 18 feet of stratigraphic separation occurs across the fault on the south side of the horst. The north side of the horst is defined by a series of smaller faults that cut stratigraphic units that are dipping 20° to 30° to the north. The southern fault forms a no-flow or low-flow barrier to groundwater migration between the aquifer at wells B-1 and B-2 and the aquifers south of the fault as indicated by large differences in water levels. Groundwater conditions more than 35 feet north of well B-1

are not known. The following hydrostratigraphic units, in order of increasing depth, are present in the hot oil release area.

- *A-unconfined aquifer*. This unit consists predominantly of well-graded sand and gravel deposited in a series of 1- to 3-foot thick fining-upward sequences. Saturated conditions do not occur in this unit at the bluff face or at wells B-1 and B-2.
- *60-foot clay*. This is a fine-grained stratigraphic unit that occurs across most of the Phillips property that was originally identified at an elevation of approximately 60 feet. The 60-foot clay in the hot oil release area is an interbedded sequence of varved clay, silty sand, sand, and gravelly sand that is generally ~10 feet thick. Well B-2 intercepted approximately 22 feet of this unit, but the sequence is probably repeated by faulting at this location. Groundwater at well B-2 occurs within the 60-foot clay at an elevation of approximately 35 to 37 feet, but the unit is not saturated at well B-1 or at the bluff face (Figure 6).
- *B-unconfined aquifer*. This name refers to the sequence of sand and gravelly sand occurring beneath the 60-foot clay. The unit is five to 12 feet thick in the hot oil release area and consists of poorly-graded sand, well-graded gravelly sand, and silty sand. Groundwater and LNAPL at well B-1 occur within this unit at a potentiometric surface elevation of approximately 39 to 40 feet (Figure 6). Hydrocarbon and a small volume of groundwater seep from the base of this unit on the bluff face.
- *Main aquitard*. The main aquitard is a regionally extensive hard gray clay unit separating the unconfined aquifers from the upper confined aquifer. It is approximately 20 to 25 feet thick in the hot oil release area (Figure 3) and outcrops prominently on the lower part of the bluff face and occasionally on the beach.
- *Upper confined aquifer (UCA)*. This unit is of unknown thickness in the hot oil release area. The upper-most portion consists of poorly-graded sand and well-graded gravelly sand that occasionally outcrops in the middle and lower portions of the beach. Groundwater in this unit generally exists under confined conditions but is tidally-influenced and may become locally unconfined during low tides. The water level elevation at temporary well 97B-33 at the time of drilling was approximately 10.5 feet.

2.5.2 Hydrocarbon in Beach Sediments

The low hydrocarbon concentrations in soil samples from trench 1 (17 to 230 mg/Kg DRO) are derived from the bluff face hydrocarbon. Hydrocarbon-impacted detrital sand, gravel, and clay clasts washed down the bluff face and accumulated at the toe of the bluff below the seepage zone. The nearly continuous layer of clay clasts encountered in trench 1 was formed by the redistribution of this detrital material by wave action. The highest hydrocarbon concentration detected in trench 1 was in a sample that contained contaminated detrital clay. The contamination along the erosional surface of the main aquitard in trench 1 is thought to be from leaching of the hydrocarbon-impacted detritus that accumulated at the toe of the bluff.

The concentrations of BTEX, GRO, and DRO in the recent beach sediments do not exceed the most stringent cleanup criteria contained on Table B2 in 18 AAC 75 except for one sample which contained 0.026 mg/kg benzene which is slightly greater than the migration to groundwater criteria for benzene (0.02 mg/kg).

2.5.3 Hydrocarbon in the Upper Confined Aquifer

The beach groundwater sample, trench 2 soil samples, and the soil and groundwater samples from temporary well 97B-33 characterize contamination in the UCA in the hot oil release area. With the exception of the soil sample from 97B-33 which did not contain detectable hydrocarbon, all of these samples have DRO chromatographic patterns that match #2 diesel and are similar to chromatograms for LNAPL in well B-1 and the hydrocarbon in the bluff seep (Dames & Moore, 1995b). The similarity of the patterns and the location of the impacted zone in the UCA directly below the contamination in the B-unconfined aquifer and beach sediments indicate that the source of the deeper contamination is the hot oil release.

The migration pathway of hydrocarbons from the B-unconfined aquifer to the UCA is not known. The main aquitard in the hot oil release area is 25 to 30 feet thick and consists predominantly of massive, hard clay. As such, it is unlikely that hydrocarbon has migrated directly through undisturbed portions of the aquitard. However, the head difference of ~25 feet that exists between the two aquifers above and below the clay would drive downward migration if a discontinuity, such as a high-angle fault or fracture, occurs in the aquitard. The faulting observed in the outcrops north of the bluff seepage zone indicates that these structures are present in the hot oil release area.

The BTEX and GRO concentrations in the UCA soil samples do not exceed the most stringent Table B2 criteria contained in 18 AAC 75. The DRO concentrations do not exceed the inhalation or ingestion criteria although they do exceed the migration to groundwater criterion.

3.0 2001 UPDATE

Tesoro has continued to monitor the hot oil release area since the 1997 investigation was performed. Water levels have been gauged (Table 3) and the beach area has been monitored for sheens on a regular basis. Groundwater samples were collected from monitoring well B-2 in February 2001 and analyzed for BTEX, GRO, DRO, and RRO (Table 4 and Appendix A).

The principal results from these activities are summarized below.

1. The UCA may no longer discharge intertidally because a thick mantle of sand and gravel has built up on the beach since 1997. Consequently, the UCA is most likely discharging subtidally at this time. The intertidal discharges in 1997 may have been the result of the October 1996 storm which drastically cut into the beach, and such discharges may not be seen again until the next major storm event. The dynamic environment of the beach, however, necessitates continued monitoring for UCA seeps in this area at least until groundwater hydrocarbon levels do not pose unacceptable exposure risk to human or environmental receptors. The seeps in this area should be sampled and analyzed for total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) by EPA methods 602 and 610 to assess compliance with the Alaska surface water criteria (18 AAC 70). We recommend collecting samples from wells B-1 and B-2 for these analyses at this time since the beach seeps are not currently present. If the analytical results from wells B-1 or B-2 exceed the surface water criteria contained in 18 AAC 70, then any future seeps that are observed in the beach seep area should also be sampled for TAqH and TAH.

2. Groundwater contamination may have decreased. This possibility is supported by the absence of LNAPL in well B-1 (Table 3) and the absence of BTEX and only a low concentration of DRO in the groundwater sample from well B-2 collected in February 2001 (Table 4). Sufficient data are not available, however, to confirm this hypothesis. The absence of LNAPL could alternatively be the result of rising groundwater levels and the analytical data are difficult to interpret since data from the time of the release are not available. Additional data are needed to confirm the potential decrease in groundwater contamination. Gauging will need to continue at least through another cycle of low groundwater levels to confirm the absence of LNAPL, and groundwater samples should be collected and analyzed for the parameters described in the previous paragraph.

3. The seep area on the bluff is currently covered with scree and cannot be seen and hydrocarbon-impacted scree is not present at the toe of the bluff. This area should continue to be monitored on a routine basis even though the results from the 1997 investigation indicate that this soil does not pose unacceptable risk to human or environmental receptors. The routine monitoring should consist of visually observing the area to confirm that hydrocarbon levels do not increase to unacceptable levels.

4.0 REFERENCES

Dames & Moore, 1992a, *Hydrocarbon Release Action Plan for Cook Inlet Bluff Area,* prepared for Tesoro Alaska Petroleum Company, September 16, 1992.

Dames & Moore, 1992b, *Letter Report Soil Sampling Along Cook Inlet Bluff Phillips Petroleum Company,* prepared for Tesoro Alaska Petroleum Company, December 2, 1992.

Dames & Moore, 1993, *Letter Report Well Point Installation at Base of Cook Inlet Bluff,* prepared for Tesoro Alaska Petroleum Company, July 20, 1993.

Dames & Moore, 1995a, *Report, Slope Stability Investigation and Contaminant Risk Assessment, Cook Inlet Bluff Site, Kenai, Alaska,* prepared for Tesoro Alaska Petroleum Company, September 13, 1995.

Dames & Moore, 1995b, *Report Product Assessment at Monitoring Well B-1, Tesoro Kenai Refinery, Alaska,* prepared for Tesoro Alaska Petroleum Company, March 14, 1995.

Kent & Sullivan, 1997, *Characterization Report, PIRM Extension Area*, Tesoro Alaska Petroleum Company, prepared for Tesoro Alaska Petroleum Company, November 21, 1997.

Table 1

Summary of 1997 Groundwater Analyses

Hot Oil Release Beach Investigation

Tesoro Alaska Company

Area	Sample No.	Benzene	Toluene	Ethylbenzene	Total Xylenes	GRO	DRO	RRO
Beach Seep Water								
	HOW-1	1 U	1 U	1 U	**2**	100 U	**2,300**	500 U
Temporary Well 97B-33 (UCA groundwater)								
	97B-33	1 U	1 U	1 U	1 U	100 U	**610**	--

Data are reported in ug/L.

-- Not analyzed

BOLD Analyte was detected.

DRO Diesel-range organics.

GRO Gasoline-range organics.

RRO Residual-range organics.

U The analyte was not detected above the concentration shown.

UCA Upper confined aquifer.

Table 2

Summary of 1997 Soil Analyses

Hot Oil Release Beach Investigation

Tesoro Alaska Company

Area	Sample	Sample Depth *(feet)*	Benzene	Toluene	Ethylbenzene	Total Xylenes	GRO	DRO
		*Ingestion**	*290*	*20,300*	*10,000*	*203,000*	*1,400*	*10,250*
		*Inhalation**	*9*	*180*	*89*	*81*	*1,400*	*12,500*
		*Groundwater**	*0.02*	*5.4*	*5.5*	*78*	*300*	*250*
Upper Beach Sediments (recent beach deposits)								
	Hot-1	2.0	0.0083 U	0.0083 U	0.0083 U	**0.0094**	**0.53**	**160**
	Hot-2	1.0	0.017 U	0.017 U	0.017 U	0.017 U	**0.85**	**110**
	Hot-3	2.0	0.0073 U	0.0073 U	0.0073 U	0.0073 U	0.29 U	**17**
	Hot-4	2.5	0.022 U	0.022 U	0.022 U	0.022 U	**1.5**	**65**
	Hot-5	0.5	**0.026**	0.024 U	0.024 U	**0.032**	**1.7**	**230**
	Hot-6	2.0	0.0069 U	0.0069 U	0.0069 U	0.0069 U	0.28 U	**31**
Intertidal Seeps (UCA soil)								
	Hot2-1	1.0	0.013 U	0.013 U	0.013 U	**0.013**	**10**	**2,600**
	Hot2-2	1.5	0.010 U	0.010 U	0.010 U	**0.068**	**5.2**	**5,000**
Temporary Well 97B-33 (UCA soil)								
	97B-33-15	15	0.011 U	0.011 U	0.011 U	0.011 U	0.43 U	13 U

Data are reported in mg/kg.

* Method 2 Soil Clean Levels per 18 AAC 75 Table B1.

-- Not analyzed

BOLD Analyte was detected.

Analyte exceeds one or more applicable criteria.

DRO Diesel-range organics.

GRO Gasoline-range organics.

U The analyte was not detected above the concentration shown.

UCA Upper confined aquifer.

Table 4

Summary of 2001 Groundwater Data

Hot Oil Release Area

Tesoro Alaska Company

Sample ID	Sample Date	Benzene	Ethylbenzene	Toluene	Xylenes	GRO	DRO	RRO
B-2	1/25/2001	0.5 U	2 U	2 U	2 U	90 U	**2,670**	500 U

Data are reported in ug/L.

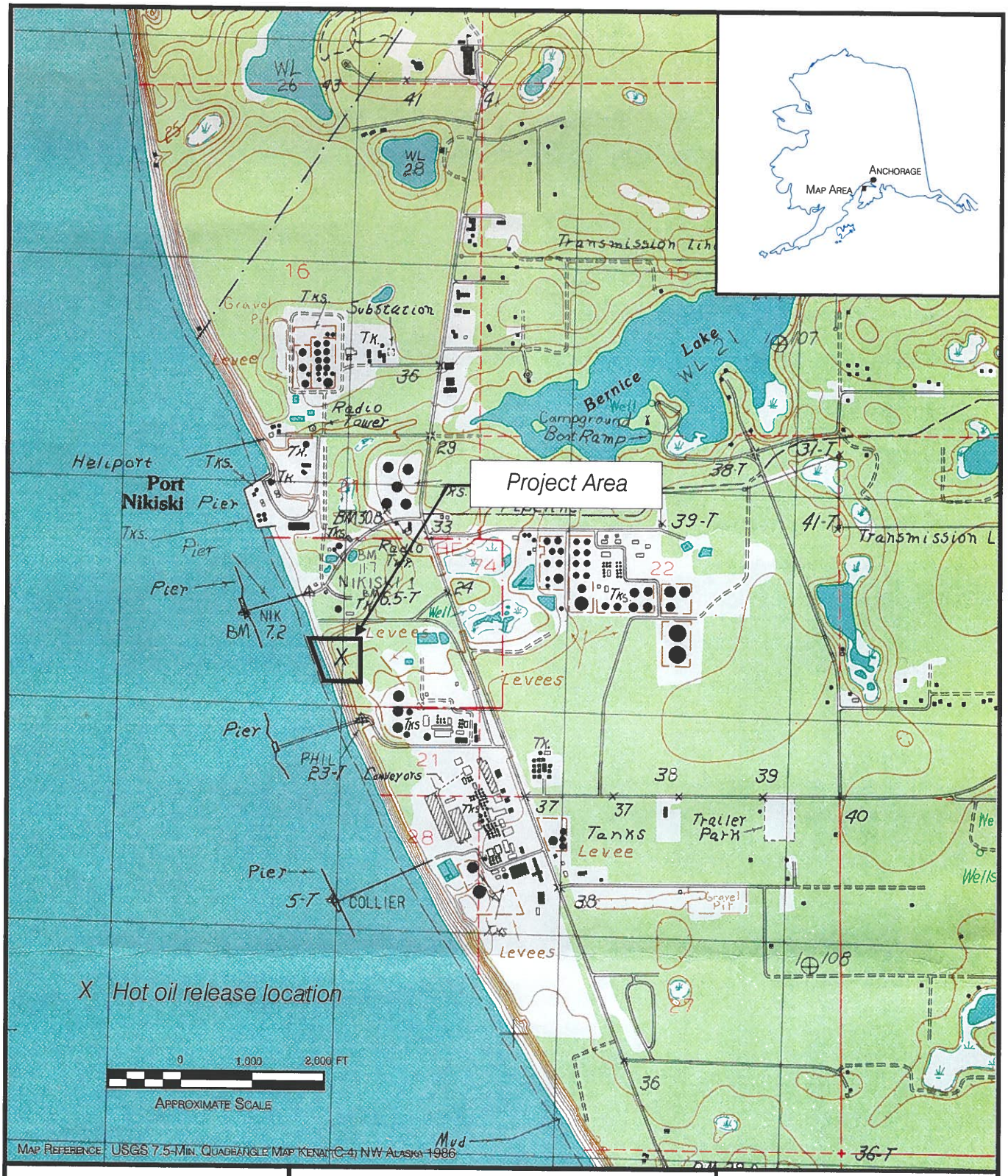
BOLD Analyte was detected.

DRO Diesel-range organics.

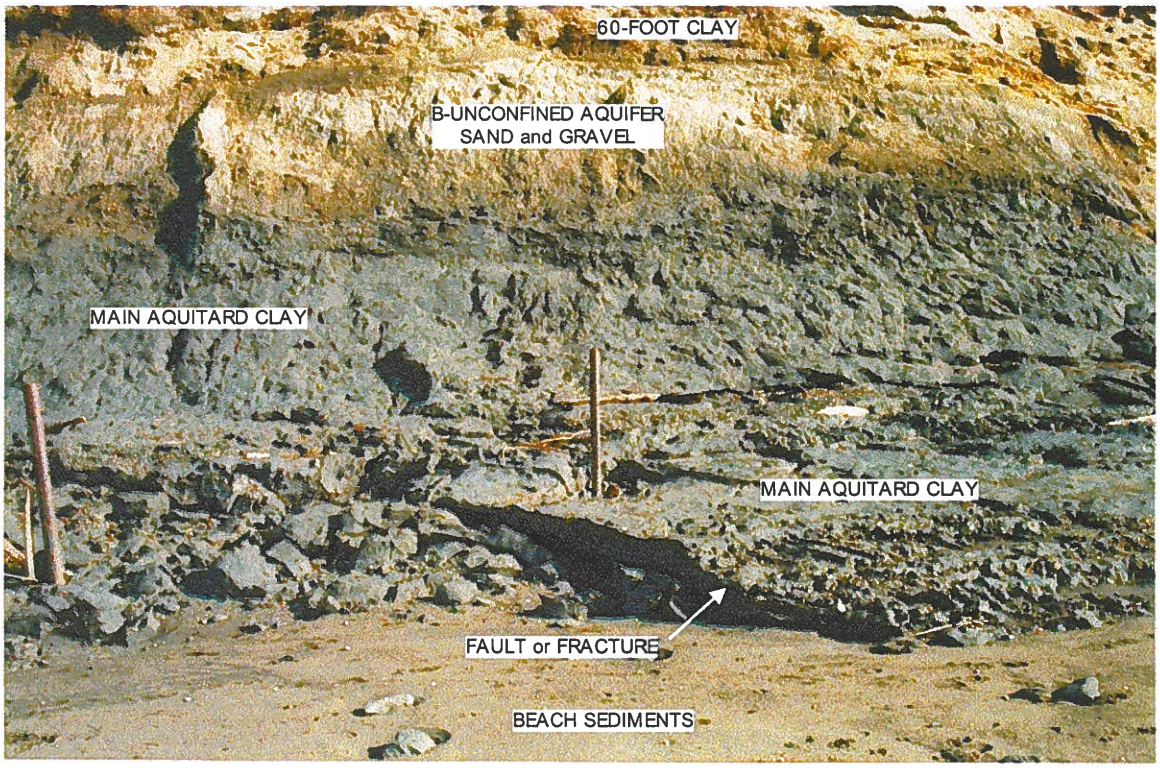
GRO Gasoline-range organics.

RRO Residual-range organics.

U The analyte was not detected above the concentration shown.



Kent & Sullivan, Inc.	Tesoro Refinery Project	Figure 1
Project No. 01-25 S:\01-28\HotOilInv\Apr01Edits\Fig1	**Tesoro Alaska Petroleum Company**	**Site Location Map**



Photograph of Beach and Bluff after October 1996 Storm

Tesoro Alaska Petroleum Company

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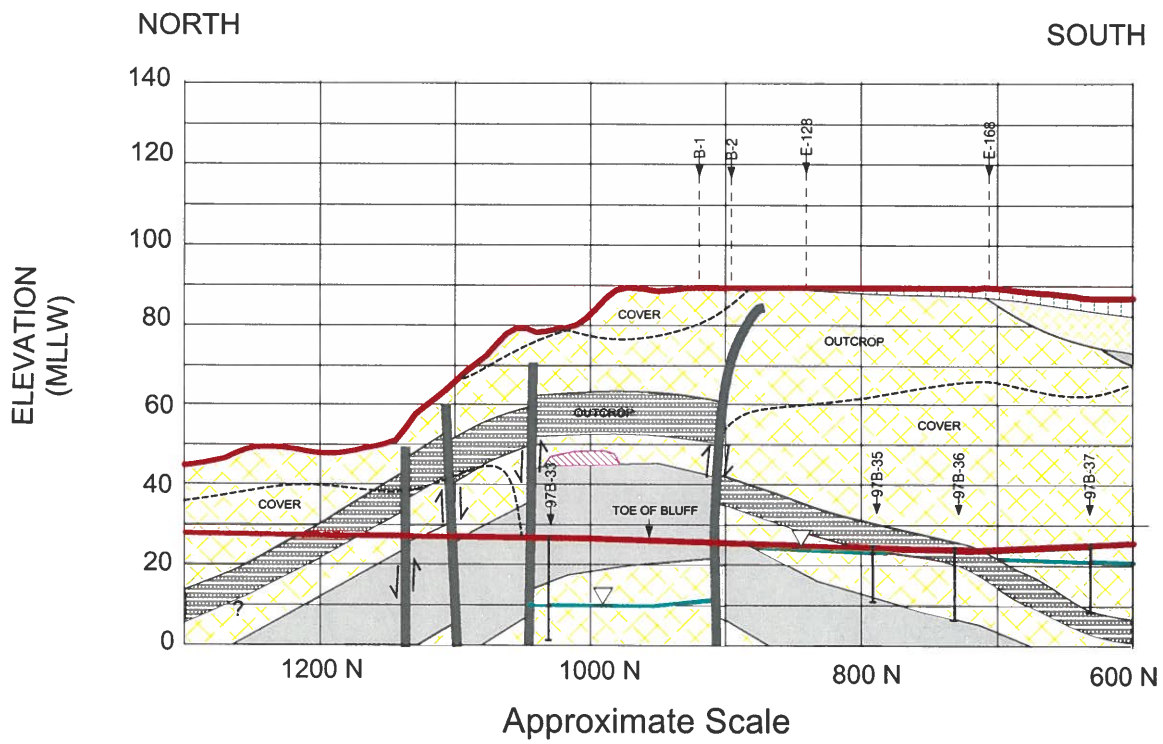
KENT & SULLIVAN, INC.

FIGURE 2



Explanation

- Diatomaceous earth
- Fine sand unit
- Silty peat
- Sand and gravel of unconfined aquifer
- 60-foot clay
- Main aquitard clay
- Sand and gravel of upper confined aquifer
- Limit of outcrop in July 1997
- Fault with relative sense of movement indicated
- Approximate location of water table
- Approximate location of bluff seep

NOTES:
1. Mapping based on Summer 1997 field work including 10 beach boreholes.
2. Mapping also based on October 1996 oblique photographs. The photographs were taken after a major storm when outcrop was present along most of the bluff face.
3. Map constructed by projecting structures on the bluff face onto a vertical surface oriented along the toe of the bluff.
4. Baseline tied to beach survey point SM-1: Tesoro coordinate grid point 6877.85 east, 8493.97 north, 20.73 MLLW.

Bluff Face Geologic Map in Hot Oil Release Area

Tesoro Alaska Petroleum Company

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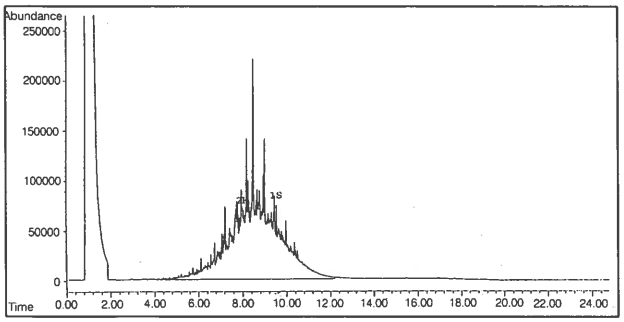
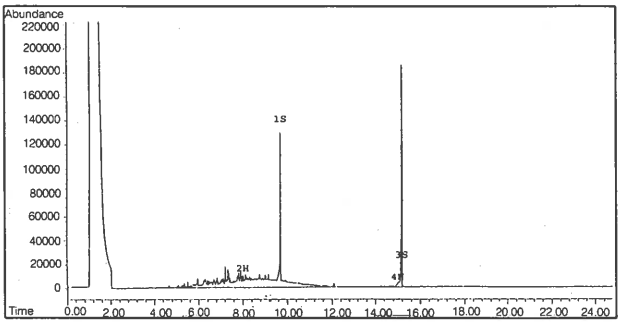
KENT & SULLIVAN, INC.

FIGURE 3

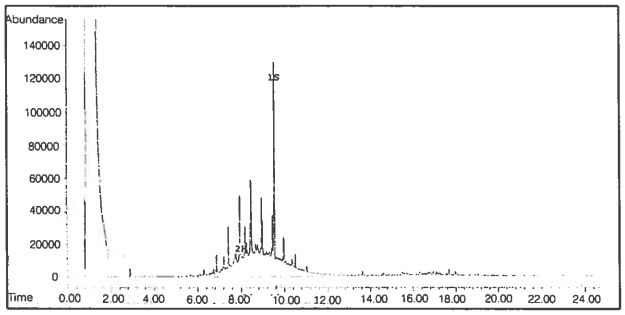
HOT2-2
UCA Soil Sample



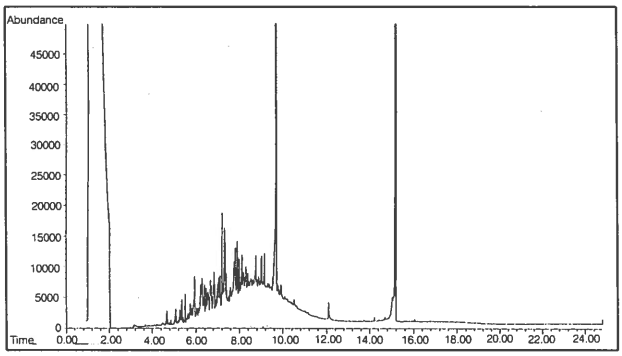
Temporary Well 97B-33
UCA Groundwater Sample



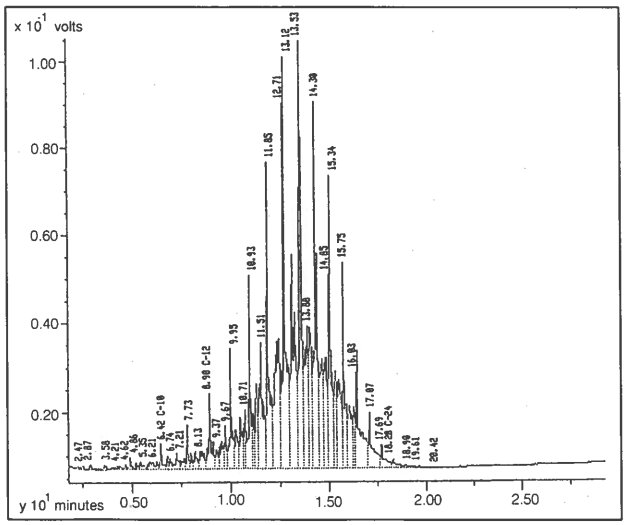
HOT-5
Beach Sediment Sample



HOW-1
UCA Seep Surface Water Sample



Well B-1
LNAPL and Water Sample



Representative Hot Oil Release Chromatograms

Tesoro Alaska Petroleum Company

DATE:1/16/98 DRAWN BY: CRS
PROJECT NO.: 01-25 CHECKED BY: ____
S:\01-28\HotOilInv\Apr01Edits\chromatogram.dwg

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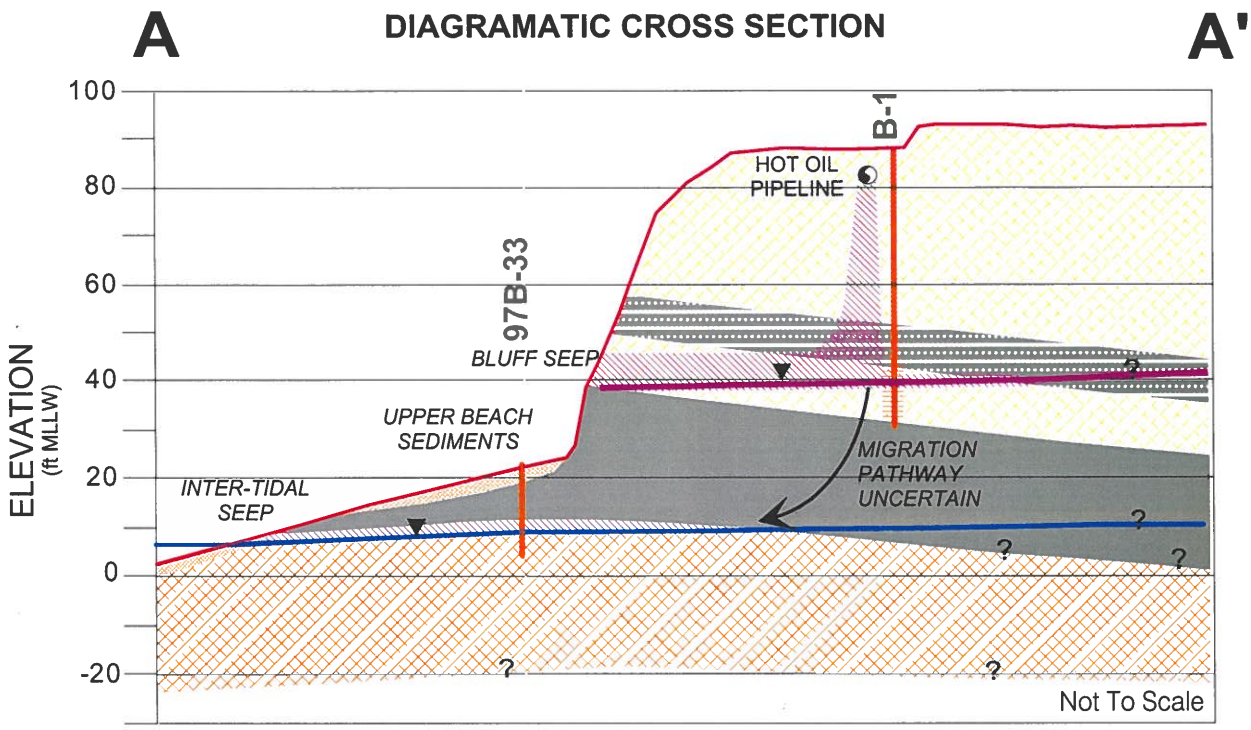
FIGURE
5



Explanation

- Beach sand
- Sand and gravel of unconfined aquifer
- 60-foot clay
- Main aquitard
- Sand and gravel of upper confined aquifer
- Well or borehole, well screen interval indicated
- Potentiometric surface in B-unconfined aquifer
- Potentiometric surface in upper confined aquifer
- Zone of soil or beach sediment contamination

Diagramatic Cross Section of Hot Oil Release Area

Tesoro Alaska Petroleum Company

DATE:1/16/98 DRAWN BY: CRS
PROJECT NO.: 01-25 CHECKED BY: ___
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FIGURE 6

BORING LOG

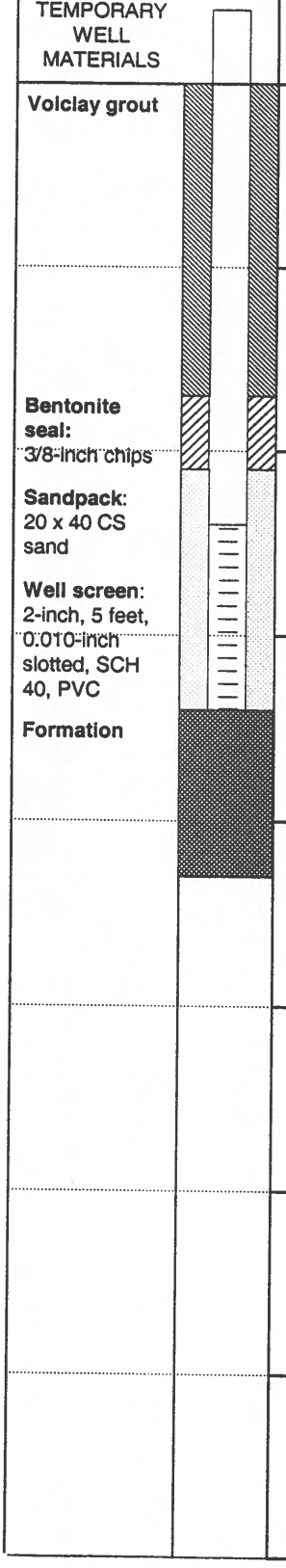
TEMPORARY WELL 97B-33

Ground Elevation: 23.9 ft.

Borehole TD: 21.5 ft.

Client: Tesoro Alaska
Area: PIRM
Geologist: M. Plitnik
Project No.: 01-19

Driller: Hughes
Start Date: 8/28/97
End Date: 8/28/97
Method: HSA/SSS



DEPTH IN FEET	SAMPLE ID	BLOW COUNT (per 6")	SAMPLE INTERVAL	PID READINGS (ppm)	USCS	DESCRIPTION
0					sw	Grey-brown, fine to coarse SAND.
				1.1		Grey, silty, sandy CLAY.
5		1 3 3 5		1.1	ml/cl	Stiff, grey, silty CLAY.
10		1 4 5 6		5.7		
						Medium dense, grey, fine SAND, moist, slight hydrocarbon odor.
15	97B33-15	2 4 10 12		3.4	sp	Medium dense, grey, fine to medium SAND, saturated, slight odor. @ 16 feet: 6 inches of dense, gray CLAY.
20		6 12 12		3.4	sw	Medium dense, grey, fine to coarse SAND with 30% fine gravel, saturated, slight odor.
25						Total depth = 21.5 feet.
30						
35						
40						

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