

**ERM-Northeast**

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**INSTALLATION AND SAMPLING  
OF MONITORING WELLS  
AT THE FUEL FARM  
NAVAL SUBMARINE BASE  
GROTON, CONNECTICUT**

**PROJECT NO. 10  
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## 1.0 INTRODUCTION

ERM-Inc. and ERM-Northeast (ERM) are pleased to present this report titled INSTALLATION AND SAMPLING OF MONITORING WELLS AT THE FUEL FARM, NAVAL SUBMARINE BASE, GROTON CONNECTICUT. This document fulfills the reporting requirement of the Navy contract N62472-89-D-1448, project no 10.

The investigation area lies at the Southern end of the Naval Submarine Base (SUBASE) around three underground 750,000 gallon tanks (OT-1, OT-2, and OT-3) used to store #6 fuel oil. The tanks were installed in the early 1940's in an area that once was the site of a shallow lake known as Crystal Lake (figure 1). Recently, fuel oil had been discovered in storm drains in the tank farm area.

The objective of this project was to determine which, if any, of the tanks are or had been leaking by installing and sampling twelve monitoring wells, four around each of the three tanks. ERM conducted the project in four tasks.

- Task 1 - Work Plan Development
- Task 2 - Drilling/Installation of Wells
- Task 3 - Well Sampling and Analysis
- Task 4 - Reporting

This report includes five sections.

- 1. Introduction
- 2. Field Investigation
- 3. • Geologic and Hydrogeologic Setting
- 4. Analytical Results
- 5. Summary of Conclusions and Recommendations

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## 2.0 FIELD INVESTIGATION

### 2.1 Summary

The field investigation was conducted as follows:

1. On-site file review
2. Soil Boring / Monitoring Well Installation
3. Monitoring Well Development
4. Ground Water Sampling
5. Vertical Survey of Monitoring Wells
6. Complete Round of Ground Water Level Measurements

### 2.2 File Review

ERM conducted an initial file review on September 18, 1990 at the Public Works office at the SUBASE. This review provided ERM with local lithology, hydrogeology, and subsurface utility configurations which aided in the well network design.

A second review of the subsurface utility blueprints immediately before drilling helped finalize the well locations. On May 2, 1991, ERM obtained and briefly reviewed an O'Brien and Gere study on the Navy Exchange Gasoline Station across Tang Avenue to the north of the tanks. This preliminary review indicates the presence of a gasoline soil and ground water problem in the area.

### 2.3 Soil Borings and Monitoring Well Installation

Four soil borings were installed around each of the three tanks for a total of twelve borings. A two inch diameter well was installed in each boring.

#### 2.3.1 Soil Borings

The borings were labeled with two digits. The first digit refers to the adjacent oil tank, OT-1, OT-2, or OT-3 and the second digit refers to the sequence of drilling. For instance, boring B-2-3 was the third boring installed around OT-2.

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Connecticut Test Boring of Seymour, Connecticut performed the drilling activities under the full time supervision of an ERM geologist. The drillers used a model CME model 55 truck mounted drill rig equipped with four and a quarter inch inner diameter hollow stem augers. The borings had a six and a half inch outer diameter and ranged from sixteen to seventeen feet deep. Detailed boring logs are found in Appendix A.

The file review indicated that the three # 6 fuel oil tanks are concrete cylindrical structures, 110 feet in diameter and eleven feet high. The top of the tanks are about four feet below grade and their bottoms are at fifteen feet below grade. Based on those dimensions, the borings were drilled down from one to two feet below the tank bottoms. Where utilities and structures permitted, the borings were on four sides of each tank within about ten feet of the tank side. Softball field bleachers required repositioning of the borings around OT-2. The boring/well locations are shown on Figure 2.

All components of the drill rig that came in contact with the soil were steam cleaned. These included auger sections, drill rods and connectors, the drive cap, cutter heads, split spoon sampler assemblies, and the back of the rig. Steam cleaning occurred before drilling, after all clean auger sections had been used, and at the end of soil boring activities. Sufficient auger sections were on hand to allow three soil borings to be dug before needing to steam clean. Steam cleaning took place on a paved staging area near OT-5 (OT-10) and the oil water separator.

Split spoon samplers were decontaminated between steam cleaning as follows:

- A tap water rinse,
- An Alconox solution scrub,
- A tap water rinse,
- A methanol rinse,
- Three distilled water rinses, and
- Air dry.

### 2.3.1.1 Soil Boring Sampling

Split spoon samples were collected at two foot intervals from grade to the first occurrence of ground water. In most cases continuous split spoon samples were also collected to the bottom of the borings. Each sample was described in detail and presence of oil, soil discoloration, and the first occurrence of ground water was noted. Samples were screened for volatile organic vapors using a Photovac Microtip, photoionization detector (PID).

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One soil sample was selected from each boring for laboratory analysis from above the water table. PID readings also helped select soil samples for analysis. Samples were collected in laboratory supplied jars, labeled, and stored in a chilled cooler.

A rinsate blank, trip blank, and a blind duplicate were included in the soil analysis for quality assurance and quality control (QA/QC). The rinsate blank was collected by pouring laboratory supplied water down a steam cleaned open split spoon sampler and collecting the rinsate in a laboratory supplied jar. The blind duplicate (labeled B-1-35) was collected from boring B-1-3.

Excess soil from the borings were stockpiled near OT-5. Soils were segregated into visually clean and stained piles and were underlain and covered with 6 mil plastic sheeting. Soil samples not sent to the laboratory for analysis were stockpiled with the clean soils.

### **2.3.2 Well Installation**

The wells were installed (in each soil boring) to collect ground water and to determine ground water flow near the oil tanks. Each well was inspected for the presence of free product using a Plexiglass bailer or an oil/water interface probe.

The wells were constructed of two inch diameter, PVC screen with 0.010 inch slot. The screened interval was positioned to straddle the water table. A sand pack of #1 morie sand surrounds the screen. A minimum of one foot bentonite seal tops the sand pack above the screen. The wells were finished with neat cement with flush mounted curb boxes. Appendix A contains detailed well construction diagrams.

### **2.4 Well Development**

ERM conducted well development on March 14, 15, and 18, 1991. Development consisted of two methods; pumping and surge block. The pumping served to remove sands and fines that entered the well and sand pack during and subsequent to well installation. The surge block technique helped improve the well's recharge capacity. The downward and upward motion of the surge block inside the well forces water back and forth through the sand pack dislodging and mobilizing silt and fines that may have formed flow blockages between the formation and the sand pack.

#### **2.4.1 Pumping**

Pumping of each well was conducted using a 2" centrifugal pump retrofitted with a one inch coupler. First, the initial depth to ground water was recorded to determine drawdown during pumping. A dedicated length of one inch diameter polyethylene hose was placed in the well three to five feet below ground water. Ground water was slowly pumped from the well while the depth to water was monitored. The hose was advanced down the well as the

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ground water level dropped until the water level reached equilibrium or the well was completely evacuated. Ground water turbidity and presence of a sheen, if any, was noted. Pumping was halted periodically, allowing the well to recharge. A surge block was used between pumping intervals. The process was repeated until the ground water cleared or the turbidity was reduced. Evacuated ground water was containerized in drums and periodically discharged to an oil/water separator on site.

The volume of purged water from each well varied depending on well recharge rate and amount of suspended sediment. Purged volumes ranged from 5 gallons from ERM-12 to 50 gallons from ERM-10. Typical purged volumes were around 30 gallons.

Hydraulic conductivity testing was beyond the scope of the project. However, the wells around OT-1 had faster recharge than the wells around OT-2 and OT-3. ERM-12, west of OT-3, had the slowest recharge rate.

### **2.4.2 Surge Block**

Between episodes of pumping the hose was removed from the well and a rubber surge block was attached to the end. The ground water was allowed to recharge. The surge block fit snugly into the two inch well. The hose was reinserted into the well and quickly pushed to the bottom of the well. The hose was then pulled back until the surge block could be heard coming out of the water. The up and down surging action was repeated six to eight times between each pumping episode.

### **2.5 Ground Water Sampling**

ERM conducted ground water sampling on March 25 and 26, 1991, one week after well development. Detailed purging and sampling information is found in Appendix B. Sampling protocol was as follows:

The wells were unlocked and inspected for damage. Depth to water and total well depth were measured to determine the volume of water in the wells. Wells were prepared for sampling by removing three to five volumes of water. Water was purged using dedicated polyethylene bailers and bailing twine. Purged water was containerized and periodically discharged to an oil/water separator on site.

The ground water was allowed to recharge overnight. Each sample was collected using a dedicated polyethylene bailer and bailing twine. The bailer was slowly lowered into the ground water with minimum disturbance. The bailer was fully submerged before being retrieved. The water was then drawn off the bottom of the bailer into laboratory supplied 40 ml vials using a VOC sampler specially designed to minimize agitation. Two vials were collected for VOC analysis. A second bailer was retrieved from each well to fill a one liter amber glass bottle preserved with sulfuric acid for TPH analysis.

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Samples were stored in a chilled cooler from the time of sampling to the arrival at the lab.

A blind duplicate (labeled ERM-17) was collected from well ERM-7. A field blank was prepared by pouring laboratory supplied distilled water through a clean sampling bailer and collecting the rinse in laboratory supplied bottles. The field blank and a trip blank accompanied the water samples at all times.

### 2.6 Elevation Survey

The monitoring well elevation survey was completed on April 15, 1991 by John Kopko Inc., New London, CT. The purpose of the survey was to establish elevations based on the Subbase Vertical Datum (SVD) for the twelve wells installed by ERM. In order to construct a more complete ground water flow map, four of twelve Fuss and O'Neill (Fuss) wells installed around tank #8, one of the three diesel tanks to the south, were also surveyed to verify their elevations (previously determined by Fuss).

The SVD is 1.321 feet below mean sea level (National Geodetic Vertical Datum, 1967 adjustment). Appendix C contains the summary of the elevation survey.

A preliminary review of an O'Brien and Gere report indicated that the nine monitoring wells installed at the Naval Exchange gas station (NEX), north of tanks OT-2 and OT-3 had been surveyed in relation to catch basin #1 (see figure 3). Catch basin #1 was assigned, by O'Brien and Gere, a relative elevation of 100 feet. Based on the site topographic map, this catch basin has an estimated elevation of 25.90 feet SVD. This correlation allowed ERM to estimate the elevation of the NEX wells in relation to the SVD. Due to damages, ground water levels were measured in only seven of the nine NEX wells. The estimated ground water elevations from these seven wells were also used to establish a broader ground water contour map.

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### **3.0 GEOLOGIC AND HYDROGEOLOGIC SETTING**

#### **3.1 Regional Site Description**

The SUBASE is located in southeastern Connecticut along the east side of the lower Thames River. The area has a mixture of land use consisting of retail outlets, car dealerships, and residential. Two chemical plants, (DOW chemical and Pfizer chemical) and a submarine building facility (General Dynamics) are located along the Thames river.

##### **3.1.1 Regional Geology/Hydrogeology**

The bedrock of the surrounding area is represented by two rock groups; the Waterford group, and the Sterling Group. The Waterford Group is composed of a stratified Proterozoic age gneiss and quartzite suite. The Sterling Plutonic Group consists of an intrusive Proterozoic age gneiss suite. The Mamacoke Formation gneiss (from the Waterford Group) lies beneath the study area.

The Mamacoke Formation is covered with a fine grained stratified drift deposit that ranges from ten to eighty feet thick. The stratified drift consists of chiefly fine sand, silt or clay with less than ten feet of coarse-grained material in the lower part of the saturated zone. Local ground water occurs in the overburden and discharges into the Thames River.

#### **3.2 Site Geology and Topography**

The area around the three fuel oil tanks is fairly flat with elevations ranging from 21 to 23 feet SVD. The tank farm is hemmed in by several rock outcrops and highlands. A small rock outcrop rises forty feet to the southwest. Bailey Hill rises 195 feet to the south. A north northwest striking rock outcrop rises forty to sixty feet to the west northwest. About 2000 feet to the east and 1500 feet to the north highlands rise 200 feet above the tank farm field. The highland to the north divides the Naval reserve into northern and southern ground water systems.

A shallow lake called " Crystal Lake" formerly occupied the area of the oil tanks. In the early to middle 1940's the lake was drained, and dredged to prepare for the construction of the fuel tank farm. After the completion to the tank farm, the area was filled with upland soils.

The twelve wells drilled in the former Crystal Lake area did not reach bedrock. The soils encountered throughout the twelve wells was fairly uniform (see soil boring logs in Appendix A). No distinct bedding or layering structures were observed. The soil consists of fine to medium fine sand with trace of gravel and pebble. Occasional thin (0.1 to 0.5 feet) layers of black or brown peat, grey silt or gravel were unevenly distributed in the borings. The soil

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color varied irregularly from brown to dark brown to gray to green gray. Due to the proximity to the tanks, the soil column observed in the borings is likely composed of imported fill materials and/or reworked native soil. None of the borings had native undisturbed soils clearly identified.

### 3.3 Site Ground Water Occurrence and Flow

#### 3.3.1 Ground Water Occurrence

The local ground water at the SUBASE is classified as GB/GA by the Connecticut Department of Environmental Protection (CTDEP). Ground water with a GB/GA rating may not be suitable for direct human consumption without treatment due to waste discharges, spills or leaks of chemical or land use impact. The state's goal is to restore the ground water to drinking water quality.

Ground water occurs under water table condition from 2.5 to 6 feet below grade in the area of the fuel oil tanks. Fluctuation in the water table ranged from 0.07 feet in ERM-8 to 1.26 feet in ERM-10 (Table 1). ERM-10 is the most upgradient well. The water table straddles the screened section of each well. No floating product was found in any of the twelve wells installed around the three #6 fuel oil tanks.

#### 3.3.2 Ground Water Flow

In order to establish a broader, more complete ground water contour map, water levels were also obtained from monitoring wells to the south end to the north of the three #6 fuel oil tanks. A total of thirty wells were measured on May 2, 1991:

- 12 ERM wells around the oil tanks
- 11 Fuss and O'Neill wells around the diesel tanks to the south.
- 7 O'Brien and Gere wells in the Naval Exchange station to the north.

During the May 2, 1991 water level measurement, floating product was found in two wells. In well MW-7, located to the south of diesel tank #8, 2.10 feet of product, assumed to be diesel fuel, was measured. In well OBG-9, located to the west of building 428, 0.10 feet of product, assumed to be gasoline was detected. In well OBG-8, near OBG-9, a sheen was observed on top of the ground water. The complete ground water levels and elevations are compiled on Table 1.

The ground water contour map established with the May 2, 1991 ground water elevations, shows several flow directions (Figure 3). Ground water flows in a general southerly direction in the vicinity of tanks OT-1 and OT-2. At the tank OT-3 area, the flow direction is to the west. To the south of the tanks, ground water moves in a general northwesterly direction in the area of diesel tanks OT-8 and OT-9. Between the three oil tanks and the

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two westerly diesel tanks, ground water converges and flows to the west towards the river in an elongated trough. To the north of tanks OT-2 and OT-3, in the area of the service station, ground water flow appears more complex, possibly influenced by subsurface interferences (UST's, high permeable backfill material, underground piping, sewer and other utility lines, etc...).

Ground water flow directions are consistent with the general topographic slope near the three oil tanks and near the two westerly diesel tanks. Near the easterly diesel tank OT-7, the four wells indicate a northeasterly flow in the opposite direction to the general topographic slope of the area rising towards the east. Although, to the northeast of the tank, there are two gentle depressions where a loading rack and an oil/water separator are located. The northeasterly ground water flow in the vicinity of diesel tank #7 could be induced by these gentle depressions to the northeast of the tank and/or by local subsurface structures (e.g., sewer lines, utility trenches, etc...).

Ground water flow directions around the three oil tanks were indirectly confirmed by ground water temperatures measured during sampling. In order to flow, #6 fuel oil, a thick viscous semi-fluid material, is heated between 200 to 260°F inside the tanks which can be considered a fairly constant heat source to the surrounding soil. The wells are located approximately within the same distance from the tanks. Ground water flowing by the tanks is exposed to subsurface temperature higher than the normal temperature of the aquifer typically 50 to 55°F (10 to 13°C). The longer ground water flowing around the tanks is exposed to higher subsurface temperature from the tanks, the warmer it will become. As a consequence, the ground water temperature is likely to increase from the upgradient side to the downgradient side of the tank. This is the case for the three tanks. The downgradient wells had the highest temperatures, 70 to 79°F (21°C to 26°C), the upgradient wells had the lowest temperatures, 53 to 57°F (12°C to 14°C), and the mid gradient wells had temperatures between the two extremes.

The hydraulic gradients across the study area, ranged from 0.015 to 0.02 (or 1.5% to 2.0%) representing moderately high gradients. Between the oil and diesel tanks, where ground water flow directions converge to the west, the hydraulic gradient is much lower at about 0.5% (a slope of 0.5 feet per 100 feet).

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### 4.0 ANALYTICAL RESULTS

Soil and ground water samples were analyzed by York Services Corporation, Stamford, Connecticut, a CTDHS approved analytical laboratory.

Soil and water samples, including field blanks, were analyzed for volatile aromatic compounds (Method 8020) and for total petroleum hydrocarbons (TPH) (Method 418.1) the trip blanks were tested only for volatile aromatic compounds.

The analytical results are summarized on Table 2 for the soil samples and on Table 3 for the ground water samples. Complete laboratory reports are found in Appendix D.

#### 4.1 Soil Analytical Results

These results are discussed below for each of the three tanks investigated from tank #1 to the west to tank #3 to the east. The tanks and soil borings locations are shown on Figure 2. At each borehole one soil sample was selected for analysis within one to two feet above the water table determined during drilling. Visual observations and organic vapor readings conducted in the field with a PID also helped select soil samples for analysis.

##### 4.1.1 Tank 1

From the four soil samples collected around this tank, no volatile aromatic compounds and TPH were detected, with the exception of 49 ppm of TPH in sample B-1-3 collected in well ERM-3 located on the downgradient side to the south of the tank. A duplicate analysis did not show the presence of TPH. Due to low recovery from the split spoons, the field duplicate (B-1-35) was not collected from the same interval than sample B-1-3. This latter was taken from the 2 to 4 feet split spoon while the duplicate sample B-1-35, was collected deeper from the 6 to 8 foot split spoon.

This TPH level of 49 ppm is fairly low (below the CTDEP guideline of 50 ppm for TPH in soil) and no field observations such as odor, staining and PID readings suggested a possible oil contamination.

This low TPH concentration could be inherent to the fill material used to backfill the former Crystal Lake area or could have been caused by small debris of the asphalt pavement carried down at shallow depth by the drilling operations. The deeper soil sample B-1-35 had no TPH detected, further suggesting no oil contamination.

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### 4.1.2 Tank 2

No benzene, toluene, ethylbenzene, xylenes (BTEX) and TPH were detected in the soil of the two borings ERM-6 and ERM-8 respectively located on the east and west side of tank 2. The field observations did not reveal any oil staining, or any PID readings indicative of organic vapors in the soil. These analytical results and field observations suggest there is no soil impact on both east and west side of that tank.

To the north side (upgradient) and south side (downgradient) of the tank, however, TPH were respectively detected at moderately high level (545 ppm) in well ERM-5 and at elevated concentration (6,930 ppm) in well ERM-7. In well ERM-5, the 545 ppm TPH concentration was not reflected in the field by staining, oil odor, or PID readings above background. But in well ERM-7, the high TPH concentration detected is clearly due to the black oil stained soil observed in the 4 to 6 foot split spoon. It also should be noted that low levels of organic vapors were detected in the field from the two stained soil intervals (4 to 6 and 6 to 8 feet below ground) but no BTEX were found through the laboratory analysis, probably because No. 6 fuel oil, a highly viscous oil composed of a complex mixture of heavy molecular weight hydrocarbons with typically more than 20 carbon atoms per molecule, likely does not contain light aromatic compounds such as BTEX.

### 4.1.3 Tank 3

No BTEX and TPH were detected in the four soil samples collected around this tank. These samples were collected from the four wells respectively located on the upgradient (ERM-10) and downgradient (ERM-12) sides and on the north (ERM-9) and south (ERM-11) sides. In the field, no staining, no oil odor and no organic vapor readings were observed in any of the soil samples of those four wells. These observations, complemented by the analytical results, suggest that the soils on four sides of that tank #3 have not been impacted.

### 4.4.1 Summary

The field observations and soil sampling and analysis suggest that soils are impacted by oil in the vicinity of tank #2, particularly on its downgradient side (south). On its upgradient side (north) there may also be oil contaminated soil but the field observations did not clearly reveal the presence of oil-stained soil.

The soils around the two remaining tanks (#1 and #2) are not contaminated with oil and suggest no subsurface impact from these two tanks. The low level of TPH (49 ppm) detected in one soil sample on the downgradient side of tank #1, probably does not reflect an impact from that tank.

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### 4.2 Ground Water Analytical Results

Ground water samples from the twelve wells were analyzed for BTEX and TPH. The analytical results are summarized on Table 3 and Figure 3 and the laboratory report is in Appendix C.

#### 4.2.1 Tank #1 Ground Water Quality

No BTEX and no TPH were detected in the four wells around this tank. The ground water contour map shows that the four wells monitor ground water flowing around the tank on its upgradient side, downgradient side and on its east and west side. Based on this distribution of sampling points and the non-detection of BTEX and TPH, it is likely that tank #1 has not impacted the local ground water quality. However, due to the diameter of tank (110 feet), there are large gaps (110 to 140 feet) between the wells where soil and/or ground impact from localized oil leaks could be presently undetected.

#### 4.2.2 Tank #2 Ground Water Quality

On the east side of this tank, the ground water is not impacted. No BTEX and no TPH were found in well ERM-6. On the west side of the tank, ground water contamination was identified in the three remaining wells.

In the downgradient well ERM-7, fairly low concentrations of benzene, toluene and xylenes were detected (total BTX at 70 ppb), no TPH was found. In this well oily stained soil was found which was reflected by an elevated TPH concentration in soil, but no BTEX were detected. The soil contamination is characterized by high TPH and no BTEX while the ground water contamination has no TPH and low levels of BTX. There does not appear to be a direct relation between the soil contamination and the ground water contamination in this well on the southwest side of the tank. The fairly low BTX contamination in the ground water might have another (or additional) source than the oily-stained soil present on the southwest side of the tank.

In the upgradient well ERM-5 and side gradient well ERM-8, significantly higher concentrations of aromatic compounds than the downgradient well ERM-7, were found. In these two wells the ground water contamination has similar characteristics in terms of contaminant distribution and concentration (Table 3). It is characterized by high concentration of benzene (1.5 to 1.7 mg/l) well above the CTDEP action level of 0.001 mg/l for benzene, none to low level of toluene, fairly high level of xylenes (0.8 to 1.2 mg/l) and variable levels of ethylbenzene (0.1 to 1 mg/l) above the CTDEP action level of 0.700 mg/l for ethylbenzene. The total BTEX concentrations are greater in well ERM-8 on the west side (3.7 mg/l) than in the upgradient well ERM-5 on the north side (2.6 mg/l). These high BTEX levels in ground water are commonly related to light petroleum products like gasoline and diesel fuel. Volatile aromatic compounds such as BTEX are major constituents

of gasoline. Heavier petroleum product such as #6 fuel oil contains much lower percentage of volatile compounds. The elevated BTEX concentrations observed in these two wells are not likely the result of #6 fuel oil leaks from tank #2. Therefore, it is probable that BTEX migrates with the ground water and originates from different potential sources than tank #2 in an upgradient location.

A preliminary review of a 1990 O'Brien & Gere report indicates that there is a plume of contaminated ground water due to a former pump island and associated gasoline USTs west of building #428. In this area, a well OBG-9 exhibited high levels of dissolved BTEX in ground water (10.1 mg/l total BTEX). This well OBG-9 is at about 125 feet to the north in an upgradient location of well ERM-5 (Figure 3). The report states that the downgradient extent of that plume of ground water contaminated by gasoline, is not known. Furthermore, during the May 2, 1991 complete round of water level measurements, ERM measured a 0.1 foot thick layer of floating product (likely gasoline) in well OBG-9 and observed a sheen in nearby well OBG-8, showing a residual product source is still present in this area and contributes to the plume of dissolved gasoline constituents in ground water.

These facts suggest that the ground water contamination observed in well ERM-5 and ERM-8 is not a result of an impact from tank #2 but is more likely due to a gasoline upgradient source identified at a former pump island and gasoline USTs located across Tang Avenue on building #428 west side.

#### 4.2.3 Tank #3 Ground Water Quality

In this area, ground water flows around the tank in a general westerly direction. The wells monitor ground water quality around the tank in an upgradient and downgradient locations and on the north and south sides of the tank. Ground water from wells ERM-9, ERM-10 and ERM-12 is not impacted. No BTEX and TPH were found. In the fourth well, ERM-11, on the south side of the tank, low level of benzene (3 ppb), toluene (9 ppb) and xylenes (13 ppb) were detected. The soil from that well is not contaminated, no evidence of oil was found. In this case, it is also probable that this low level BTX ground water contamination has an upgradient source and does not represent an impact from tank #3.

#### 4.2.4 Ground Water Quality Summary

- Ground water contamination, characterized by elevated concentrations of dissolved BTEX (Total 2.6 to 3.8 ppm) was found on the upgradient northwestern side of tank #2, in wells ERM-5 and ERM-8.
- Much lower levels of BTEX (Total 0.07 ppm) were detected in the downgradient well ERM-7, to the south of tank #2.

- Ground water contamination observed on the west side of tank #2 is likely due to an upgradient source, identified as the former pump island and gasoline USTs to the west of building #428.
- No TPH and BTEX were detected in the ground water around tank #1, the westernmost tank.
- Around the eastern tank #3, low levels of BTX (total 25 ppb) were found in well ERM-11, located on the south side. The remaining upgradient, downgradient and northern wells did not exhibit BTEX or TPH.

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### 5.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Summary of Conclusions

##### Soils

- The soil samples from four sides of oil tank #1 had no BTEX and TPH detected (except 49 ppm of TPH on the north side of the tank), suggesting no impact from the tank in the surrounding soils. However, the four boreholes around the 110 foot diameter tank, are 120 to 140 feet apart from each other. Potential oil leaks between borings could be presently undetected. This is also the case for the two other tanks.
- Tank #2 and/or associated piping have impacted soil on its south side where oily-stained soil was observed and 6,930 ppm of TPH were detected (Well above the CTDEP 50 ppm guideline for TPH in soils). There may also be an impact on the north side of the tank where 545 ppm of TPH were found, but no oil was observed in the field.
- No BTEX and TPH were found in the four borings around tank #3, suggesting no soil impact from the tank.

##### Ground Water

- Ground water flowing to the south around tank #1 is not contaminated, no BTEX and TPH were detected in the four wells surrounding the tank, suggesting no impact from the tank or from other potential upgradient sources
- Elevated dissolved BTEX concentrations (total 2.6 to 3.8 ppm) were found on the upgradient and side gradient wells west of the tank. Much lower BTEX levels were detected in the downgradient well (total 0.07 ppm). This high BTEX contamination, characteristics of light petroleum product like gasoline, is probably not caused by leaks from the tank, but is more likely due to the gasoline ground water contamination existing 120 to 150 feet upgradient of well ERM-5, in an area west of building #428, where a pump island and gasoline USTs were formerly located. During the complete ground water level measurements of May 2, 1991, ERM measured 0.10 feet of product (likely gasoline) in well OBG-9 and observed a sheen in nearby well OBG-8 confirming the gasoline ground water impact of the area. These two wells were part of the investigation conducted at the Naval Exchange Service Station by O'Brien & Gere.

## ERM-Northeast

- No significant BTEX and TPH were detected in the ground water flowing westward around tank #3 (only trace levels of BTX in southern well ERM-11), suggesting no impact from the tank and probably minimal impact from other potential upgradient source(s) to the east and southeast of tank #3, possibly from the tank #4 area.

### 5.2 Recommendations

This investigation has identified four soil and ground water contamination problems, two in the vicinity of one of the three oil tanks investigated and two farther away from the three tanks investigated and related to other sources:

1. Oil contaminated soil at well ERM-7 on the south side of tank #2.
2. Elevated dissolved BTEX ground water contamination on the west side of tank #2.
3. Floating product (gasoline) in previously installed well OBG-9 to the north of tank #2.
4. Floating product (diesel oil) in previously installed well MW-7 on the southwestern side of diesel tank #8.

These four problems need to be further addressed with the following recommendations proposed below:

1. The vertical and areal extent of oil contaminated soil on the southwestern side of tank #2 need to be delineated to estimate the area and volume of soil to be remediated and possibly help better locate the source of the oil. ERM proposes to conduct a soil boring program initially centered on well ERM-7. Four borings will be drilled and continuously sampled down to a few feet below the water around ERM-7 in a radial pattern.

The borings will be located at about 10 to 15 feet from ERM-7, with one borehole placed, if possible, between the tank and ERM-7. If during the field work oily-stained soils are encountered, additional borings would be drilled 10 to 15 feet farther away from the boring(s) where oily soil would be found until visually clean soil would be encountered (i.e., no oil observed, no odor, no PID readings). From each boring, a selected visually clean soil sample would be analyzed for TPH to confirm that the soil is free of oil.

## ERM-Northeast

2. The plume of dissolved BTEX in ground water on the west side of tank #2 needs to be delineated. ERM proposes to drill and install five additional 2-inch monitoring wells. The location of these proposed five wells is shown on Figure 4. The three proposed wells north of ERM-5 are designed to determine the ground water contamination in upgradient locations of well ERM-5, as it is strongly suspected that the BTEX contamination originates from north of Tang Avenue at the area of a former pump island and gasoline UST west of building #428.

The two other proposed wells to the southwest of ERM-8 and ERM-7 are designed to help determine the lateral and downgradient extent of the BTEX plume. The wells would be typically located 50 to 70 feet from the existing wells. They would be installed, surveyed and sampled with the same protocols followed for the existing wells. Ground water samples from the 9 wells (4 existing, 5 proposed) around tank #2 would be analyzed for BTEX, TPH and also for MTBE and lead, other common constituents of gasoline. As part of this ground water sampling event, ERM recommends that the wells around tanks #1 and #3 be also sampled to establish a complete confirmatory second round of ground water quality data and ground water flow around the three #6 fuel oil tanks.

ERM also proposes to conduct slug tests on selected wells around tank #2. The slug tests or *in-situ* permeability tests, will help determine the hydraulic conductivity of the aquifer in the vicinity of the tank. This parameter is necessary to estimate ground water and contaminant migration rates and to design a ground water recovery and treatment system, if necessary.

As an alternative to installing five new wells around tank #2 in an attempt to delineate the BTEX ground water plume, an *in-situ* ground water sampling tool, called the Hydropunch, could be used. This tool is designed to collect representative ground water samples in a faster and more cost effective fashion without installing wells. Based on ERM's experience with this ground water sampling device and the site subsurface conditions, ERM believes that the use of the Hydropunch would be efficient in this situation because it would allow the collection of more ground water samples in less time required to install and sample five new wells. By increasing the ground water sampling points, one would have a greater chance to delineate the BTEX plume in one event as opposed to several events which would require monitoring wells to be installed, sampled, data evaluated and recommendations made for additional wells until the plume is fully delineated. The plume delineation with the Hydropunch can then help place fewer additional wells and in more appropriate locations for long term monitoring purposes, if needed.

## ERM-Northeast

3. The floating product in the area of previously installed wells OBG-9 and OBG-8 is being addressed separately under Amendment No. 14 of the A/E contract N62472-89-D-1448.

It should be noted that the three proposed wells to be installed north of tank #2 will also address the downgradient extent of the gasoline ground water contamination problem originating to the west of building #428.

4. The floating product problem and associated ground water contamination in the vicinity of diesel tank #8 need to be delineated to determine the most effective method for recovering the floating product and determine the extent of the plume of diesel oil dissolved constituents.

ERM proposes to conduct a soil boring program centered around well MW-7 to determine the level of residual diesel oil in soils and install three additional monitoring wells to help delineate the plume of dissolved diesel oil constituents in ground water on the southwest side of tank #8. The proposed boring and well locations are shown on Figure 5.

As proposed for tank #2, four soil borings will be initially drilled within 10 to 15 feet around well MW-7, with possibly one borehole between the tank and the well. If oil-stained soils are found in the field, additional borings would be drilled and sampled 10 to 15 feet farther away from the borings that would exhibit evidence of oil until visually clean soil would be encountered (i.e., no oil observed, no odor, no PID readings above background). One soil sample per borehole, (visually clean in the field) would be analyzed for TPH and BTEX, which are, like for gasoline, important constituents of diesel oil. As diesel oil also contains naphthalene and other numerous semi-volatile hydrocarbons, the sample should also be analyzed for semi-volatile organic compounds (base neutrals).

As an alternative to soil borings and if surface disturbance is not an issue, test pits excavated with a backhoe represent a fast cost-effective method to estimate the extent of oil residual contamination in soils.

Three wells, one upgradient, two downgradient of MW-7 would be drilled, surveyed and sampled for BTEX, base neutrals and TPH. To obtain two more complete sets of ground water quality data, ERM recommends that all the wells free of floating product around tank #8 be sampled at the same time and ground water samples analyzed for BTEX, base neutrals and TPH. In this case, also, a faster more effective plume delineation could be performed by using the Hydropunch instead of three additional wells.

ERM also recommends that slug tests be conducted at a few selected wells around tank #8.

In summary, the recommended additional field investigative efforts are as follows:

- Soil boring program around ERM-7, southwest of tank #2
- Five additional wells around tank #2, (or Hydropunch plume delineation).
- Slug tests at selected wells around tank #2.
- Sampling and analysis of all wells around the three #6 fuel oil tanks.
- Soil boring program around MW-7, southwest of tank #8.
- Three additional wells around tank #8, (or Hydropunch plume delineation).
- Slug tests at selected wells around tank #8
- Sampling and analysis of all wells (without floating product) around tank #8.

# TABLES

**TABLE 1**  
**GROUND WATER LEVEL/ELEVATION DATA**  
 UNITED STATES SUBMARINE BASE, GROTON, CT

WELL No. { [Top of PVC elevation] [Ground elevation]}	DATE OF MEASUREMENT	WATER LEVELS		GROUND WATER ELEVATIONS (1)	FLOATING PRODUCT THICKNESS (in ft)
		(ft below PVC casing)	(ft below ground)		
ERM-1 { 22.62 23.00 }	21-Feb-91	7.50	7.88	15.12	0
	21-Feb-91	5.73	6.11	16.89	0
	22-Feb-91	5.65	6.03	16.97	0
	25-Feb-91	5.73	6.11	16.89	0
	14-Mar-91	5.65	6.03	16.97	0
	25-Mar-91	5.62	6.00	17.00	0
	26-Mar-91	5.64	6.02	16.98	0
	02-May-91	5.53	5.91	17.09	0
ERM-2 { 21.54 22.07 }	22-Feb-91	7.50	8.03	14.04	0
	22-Feb-91	5.30	5.83	16.24	0
	25-Feb-91	5.38	5.91	16.16	0
	14-Mar-91	5.22	5.75	16.32	0
	25-Mar-91	5.27	5.80	16.27	0
	26-Mar-91	5.26	5.79	16.28	0
	02-May-91	5.23	5.76	16.31	0
ERM-3 { 20.40 21.03 }	22-Feb-91	8.00	8.63	12.40	0
	22-Feb-91	7.12	7.75	13.28	0
	25-Feb-91	5.74	6.37	14.66	0
	14-Mar-91	5.67	6.30	14.73	0
	25-Mar-91	5.88	6.51	14.52	0
	26-Mar-91	5.78	6.41	14.62	0
	02-May-91	5.64	6.27	14.76	0
ERM-4 { 21.90 22.25 }	21-Feb-91	7.00	7.35	14.90	0
	21-Feb-91	6.84	7.19	15.06	0
	21-Feb-91	5.52	5.87	16.38	0
	22-Feb-91	5.36	5.71	16.54	0
	25-Feb-91	5.51	5.86	16.39	0
	14-Mar-91	5.44	5.79	16.46	0
	25-Mar-91	5.30	5.65	16.60	0
	26-Mar-91	5.25	5.60	16.65	0
02-May-91	5.30	5.65	16.60	0	
ERM-5 { 21.67 21.94 }	25-Feb-91	6.00	6.27	15.67	0
	25-Feb-91	4.50	4.77	17.17	0
	25-Feb-91	4.34	4.61	17.33	0
	18-Mar-91	4.10	4.37	17.57	0
	25-Mar-91	3.97	4.24	17.70	0
	26-Mar-91	4.02	4.29	17.65	0
	02-May-91	3.93	4.20	17.74	0
ERM-6 { 21.34 21.77 }	22-Feb-91	5.50	5.93	15.84	0
	22-Feb-91	5.24	5.67	16.10	0
	25-Feb-91	4.99	5.42	16.35	0
	18-Mar-91	4.79	5.22	16.55	0
	25-Mar-91	4.52	4.95	16.82	0
	26-Mar-91	4.61	5.04	16.73	0
	02-May-91	4.81	5.24	16.53	0
	ERM-7 { 21.38 21.85 }	25-Feb-91	7.00	7.47	14.38
25-Feb-91		5.88	6.35	15.50	0
25-Feb-91		5.85	6.32	15.53	0
18-Mar-91		5.74	6.21	15.64	0
25-Mar-91		5.94	6.41	15.44	0
26-Mar-91		5.91	6.38	15.47	0
02-May-91		5.67	6.14	15.71	0
ERM-8 { 21.55 22.04 }	25-Feb-91	7.50	7.99	14.05	0
	25-Feb-91	4.89	5.38	16.66	0
	25-Feb-91	4.77	5.26	16.78	0
	18-Mar-91	4.55	5.04	17.00	0
	25-Mar-91	4.50	4.99	17.05	0
	26-Mar-91	4.52	5.01	17.03	0
	02-May-91	4.48	4.97	17.07	0
ERM-9 { 21.55 22.00 }	20-Feb-91	6.12	6.57	15.43	0
	20-Feb-91	4.84	5.29	16.71	0
	21-Feb-91	4.76	5.21	16.79	0
	25-Feb-91	4.88	5.33	16.67	0
	15-Mar-91	4.97	5.42	16.58	0
	25-Mar-91	4.82	5.27	16.73	0
	26-Mar-91	4.55	5.00	17.00	0
	02-May-91	4.85	5.30	16.70	0

**TABLE 1**  
**GROUND WATER LEVEL/ELEVATION DATA**  
 UNITED STATES SUBMARINE BASE, GROTON, CT

WELL No. {Top of PVC elevation} [Ground elevation]	DATE OF MEASUREMENT	WATER LEVELS		GROUND WATER ELEVATIONS (1)	FLOATING PRODUCT THICKNESS (in ft)
		(ft below PVC casing)	(ft below ground)		
ERM-10 { 21.63 } [ 22.00 ]	20-Feb-91	2.91	3.28	18.72	0
	20-Feb-91	3.04	3.41	18.59	0
	21-Feb-91	3.29	3.66	18.34	0
	25-Feb-91	3.92	4.29	17.71	0
	15-Mar-91	4.06	4.43	17.57	0
	25-Mar-91	2.80	3.17	18.83	0
	26-Mar-91	2.95	3.32	18.68	0
	02-May-91	3.55	3.92	18.08	0
ERM-11 { 22.94 } [ 23.29 ]	20-Feb-91	9.65	10.00	13.29	0
	20-Feb-91	6.94	7.29	16.00	0
	21-Feb-91	5.63	5.98	17.31	0
	25-Feb-91	5.84	6.19	17.10	0
	18-Mar-91	5.55	5.90	17.39	0
	25-Mar-91	5.24	5.59	17.70	0
	26-Mar-91	5.10	5.45	17.84	0
	02-May-91	5.91	6.26	17.03	0
ERM-12 { 22.56 } [ 22.92 ]	20-Feb-91	8.38	8.74	14.18	0
	20-Feb-91	6.14	6.50	16.42	0
	21-Feb-91	6.02	6.38	16.54	0
	25-Feb-91	6.18	6.54	16.38	0
	15-Mar-91	6.27	6.63	16.29	0
	25-Mar-91	5.81	6.17	16.75	0
	26-Mar-91	5.87	6.23	16.69	0
	02-May-91	6.22	6.58	16.34	0
MW-1 { 21.92 } [ 22.33 ]	19-Feb-91	4.30	4.71	17.62	Not checked
	26-Mar-91	4.20	4.61	17.72	Not checked
	02-May-91	4.09	4.50	17.83	0
MW-2 { 21.84 } [ 22.33 ]	19-Feb-91	5.06	5.55	16.78	Not checked
	26-Mar-91	5.12	5.61	16.72	Not checked
	02-May-91	5.05	5.54	16.79	0
MW-3 { 21.56 } [ 21.83 ]	19-Feb-91	3.50	3.77	18.06	Not checked
	26-Mar-91	3.34	3.61	18.22	Not checked
	02-May-91	3.21	3.48	18.35	0
MW-4 { 22.33 } [ 22.83 ]	19-Feb-91	3.82	4.32	18.51	Not checked
	26-Mar-91	2.97	3.47	19.36	Not checked
	02-May-91	3.32	3.82	19.01	0
MW-5 { 21.35 } [ 22.00 ]	19-Feb-91	4.49	5.14	16.86	Not checked
	26-Mar-91	3.43	4.08	17.92	Not checked
	02-May-91	4.08	4.73	17.27	0
MW-6 { 21.89 } [ 22.30 ]	19-Feb-91	3.62	4.03	18.27	Not checked
	26-Mar-91	2.54	2.95	19.35	Not checked
	02-May-91	3.23	3.64	18.66	0
MW-7 { 21.49 } [ 21.90 ] (2)	19-Feb-91	5.64	6.05	15.85	Not checked
	26-Mar-91	5.37	5.78	16.12	Not checked
	02-May-91	5.20	5.61	16.29	2.10
	02-May-91	3.40	3.81	18.09	0
MW-8 { 21.56 } [ 21.90 ]	19-Feb-91	4.73	5.07	16.83	Not checked
	26-Mar-91	3.67	4.01	17.89	Not checked
	02-May-91	4.94	5.28	16.62	0
MW-9 { 21.57 } [ 21.88 ]	19-Feb-91	6.29	6.60	15.28	Not checked
	26-Mar-91	4.32	4.63	17.25	Not checked
	02-May-91	5.96	6.27	15.61	0

**TABLE 1**  
**GROUND WATER LEVEL/ELEVATION DATA**  
 UNITED STATES SUBMARINE BASE, GROTON, CT

WELL No. {Top of PVC elevation} [Ground elevation]	DATE OF MEASUREMENT	WATER LEVELS		GROUND WATER ELEVATIONS (1)	FLOATING PRODUCT THICKNESS (in ft)
		(ft below PVC casing)	(ft below ground)		
MW-10 { 22.50 } [ 22.88 ]	19-Feb-91 26-Mar-91 02-May-91	5.69 4.60 6.10	6.07 4.98 6.48	16.81 17.90 16.40	Not checked Not checked 0
MW-11 { 21.12 } [ 21.48 ]	19-Feb-91 26-Mar-91 02-May-91	4.80 2.58 5.64	5.16 2.94 6.00	16.32 18.54 15.48	Not checked Not checked 0
MW-12 { 27.62 } [ 27.88 ]	19-Feb-91 26-Mar-91 02-May-91	DRY DRY DRY	DRY DRY DRY	DRY DRY DRY	
(5) OBG-1 { 25.74 } [ 25.93 ]	02-May-91	8.79	8.98	16.95	0
(5) OBG-2 { 25.56 } [ 26.03 ]	02-May-91	8.65	9.12	16.91	0
(5) OBG-3 { 25.80 } [ 25.99 ]	02-May-91	NM (3)			
(5) OBG-4 { 25.65 } [ 25.87 ]	02-May-91	NM (4)			
(5) OBG-5 { 25.61 } [ 25.86 ]	02-May-91	8.56	8.81	17.05	0
(5) OBG-6 { 24.99 } [ 25.50 ]	02-May-91	8.36	8.87	16.63	0
(5) OBG-7 { 25.15 } [ 25.37 ]	02-May-91	6.70	6.92	18.45	0
(5) OBG-8 { 24.63 } [ 24.82 ]	02-May-91	6.33	6.52	18.30	0 sheen
(5) OBG-9 { 25.39 } (6) [ 25.51 ]	02-May-91	7.59	7.71	17.80	0.10

**NOTES**

NM: Not Measured

(1): Measured in feet above Subbase Vertical Datum.

(2): 2.10' of free product present. Corrected Depth to water (DTW) was calculated using the formula:

$$DTW - product\ thickness \times product\ density = corrected\ DTW$$

The free product was assumed to be diesel with a density of 0.875 .

(3): Curb box was completely filled with sand and had no steel cover.

(4): Curb box flooded with water with a strong sheen.

(5): O'Brian and Gere benchmark of 100' at catch basin one is assumed to be at 25.9' subbase veterical datum.

(6): 0.10' of free product present. Corrected DTW was calculated using the formula in note (2) and assuming the product to be gasoline with a density of 0.80.

By: NL  
 Checked By: PD  
 Job no. 101.107

**TABLE 2  
SOIL ANALYSIS RESULTS  
U. S. SUBMARINE BASE, GROTON, CT**

WELL NUMBER	BORING NUMBER	DEPTH INTERVAL	BENZENE (1)	TOLUENE (1)	ETHYL-BENZENE (1)	TOTAL XYLENES (1)	TOTAL BTEX (1)	TPH (2)
<b>TANK OT-1</b>								
ERM-1	B-1-1	2'-4'						
ERM-2	B-1-4	6'-8'						
ERM-3	B-1-3	2'-4' & 6'-8'						49
	B-1-35 (3)	2'-4' & 6'-8'						
ERM-4	B-1-2	4'-6'						
<b>TANK OT-2</b>								
ERM-5	B-2-4	2'-4'						545
ERM-6	B-2-1	2'-4'						
ERM-7	B-2-2	4'-6'						6,930
ERM-8	B-2-3	4'-6'						
<b>TANK OT-3</b>								
ERM-9	B-3-2	2'-4'						
ERM-10	B-3-3	4'-6'						
ERM-11	B-3-4	6'-8'						
ERM-12	B-3-1	4'-6'						

NOTES
Field work was completed on February 25, 1991
(1) Concentrations in $\mu\text{g}/\text{kg}$ (equivalent to ppb) Method 8020, Detection limit: 10 ppb
(2) Concentrations in $\text{mg}/\text{kg}$ (equivalent to ppm) Method 418.1, Detection limit: 25 ppm
(3) B-1-35 is a blind duplicate of B-1-3
TPH: Total Petroleum Hydrocarbons
Blank = Compound analyzed for but not detected above the detection limit.
Field blank and trip blank had no compounds detected.

By: NL

Chkd by: PD  
Job no. 101.107

**TABLE 3**  
**GROUND WATER ANALYSIS RESULTS**  
**U. S. SUBMARINE BASE, GROTON, CT**

WELL NUMBER	SAMPLE NUMBER	BENZENE (1)	TOLUENE (1)	ETHYL-BENZENE (1)	TOTAL XYLENES (1)	TOTAL BTEX (1)	TPH (2)
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**TANK OT-1**

ERM-1	ERM-1					0	
ERM-2	ERM-2					0	
ERM-3	ERM-3					0	
ERM-4	ERM-4					0	

**TANK OT-2**

ERM-5	ERM-5	1,700		106	780	2,586	
ERM-6	ERM-6					0	
ERM-7	ERM-7	25	29		16	70	
	ERM-17 (3)	23	24		15	62	
ERM-8	ERM-8	1,470	115	990	1,180	3,755	

**TANK OT-3**

ERM-9	ERM-9					0	
ERM-10	ERM-10					0	
ERM-11	ERM-11	3	9		13	25	
ERM-12	ERM-12					0	

**NOTES**

The wells were sampled on March 26, 1991

- (1) Concentrations in  $\mu\text{g/l}$  (ppb)  
 Method 8020, Detection limit: 1 ppb
- (2) Concentrations in  $\text{mg/l}$  (ppm)  
 Method 418.1, Detection limit: 5 ppm
- (3) ERM-17 is a blind duplicate of ERM-7

TPH Total Petroleum Hydrocarbons

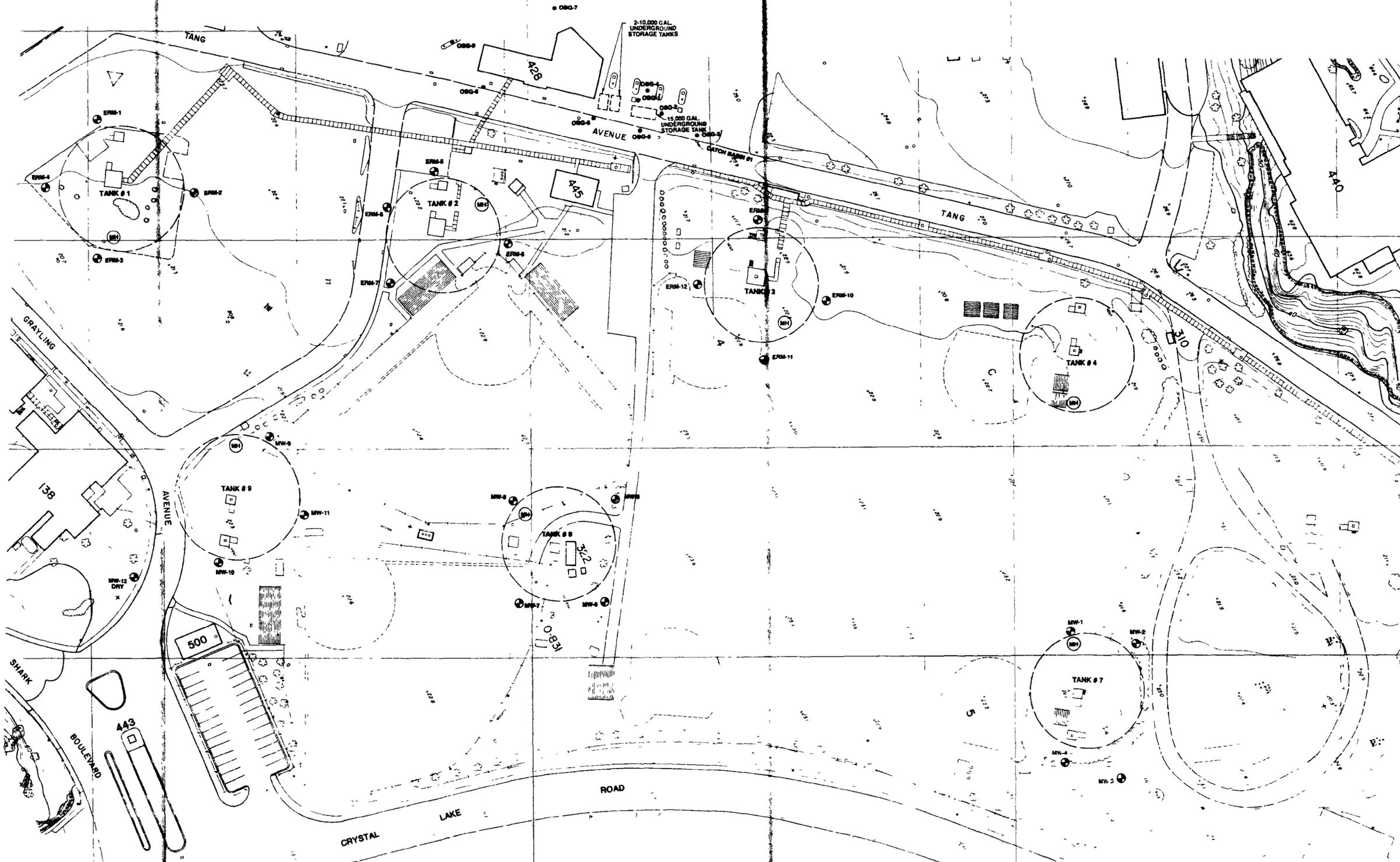
Blank = Compound analyzed for but not detected above the detection limit.

Field blank and trip blank had no compounds detected.

By: NL

Chkd by: PD

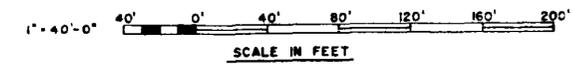
Job no. 101.107



**LEGEND**

- ERM - ERM-NORTHEAST MONITORING WELL (FEB 81)
- MW - FUSO & O'NEILL MONITORING WELL (1989)
- OGG - O'BRIEN & GIERE MONITORING WELL (1989)

NOTES  
 1. BASE MAP SOURCE: NAVFAC DRAWING NO. 2015043 AND 2015044, 12/31/74 BY JAMES S. BRIGGS & ASSOC. CARLSON & SWEATT FARMINGTON, CT & NEW YORK, NY  
 2. TANKS 1 TO 3 ARE 15 FUEL OIL CONCRETE UNDERGROUND TANKS, TANKS 7 TO 9 ARE DIESEL FUEL CONCRETE UNDERGROUND TANKS.

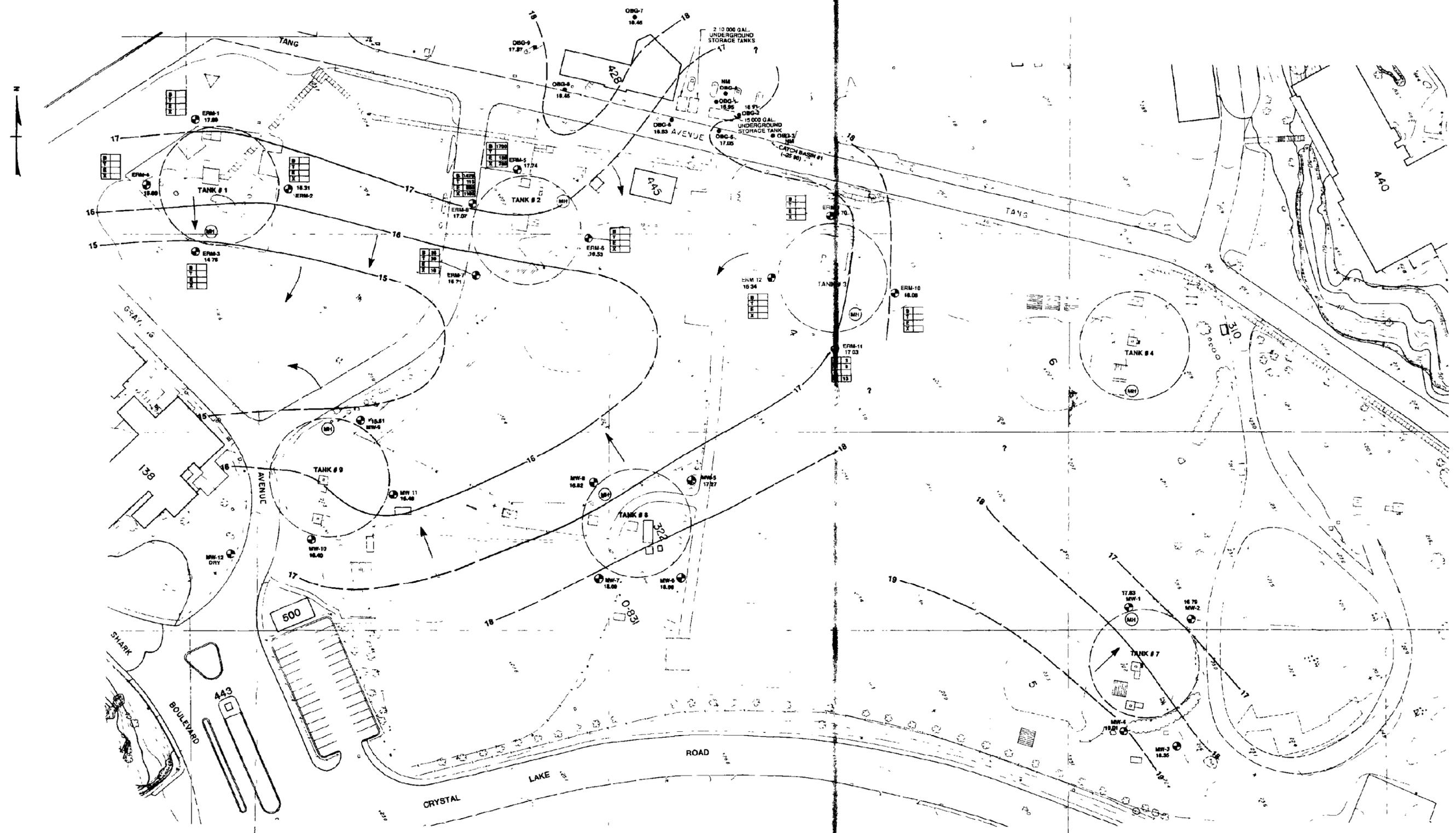


0012101X

No.	Date	Appr.	Revision	No.	Date	Appr.	Revision



CHECKED: _____ DESIGN ENGINEER PROJECT ENGINEER PROJECT MANAGER APPROVED: _____ APPROVED: _____		DRAWN: _____ DATE: MAY 14, 1991 W.C. NO. 101107 ISSUED FOR: _____ DATE: _____ SHEET: _____ OF _____		DRAWING NO. <b>2</b> REV. NO. _____
<b>MONITORING WELL LOCATION MAP</b> <b>NAVAL SUBMARINE BASE NEW LONDON,</b> <b>GROTON, CT</b>				

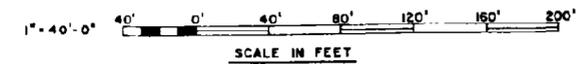


**LEGEND**

- ERM-3 ERM-NORTHEAST MONITORING WELL WITH WATER TABLE ELEVATION IN FT ABOVE SUBMARINE BASE VERTICAL DATUM 14.75
  - MW-8 PUGS & O'NEILL MONITORING WELL WITH WATER TABLE ELEVATION IN FT ABOVE SUBMARINE BASE VERTICAL DATUM 15.81
  - OBG-6 O'BRIEN & GERE MONITORING WELL WITH WATER TABLE ELEVATION IN FT ABOVE SUBMARINE BASE VERTICAL DATUM 15.83
  - GROUND WATER CONTOUR, DASHED WHERE INFERRED
  - GROUND WATER FLOW DIRECTION
- |   |    |  |
|---|----|--|
| B | 25 | = BENZENE (IN UGL)                                 |
| T | 25 | = TOLUENE (IN UGL)                                 |
| E | 18 | = ETHYLBENZENE (IN UGL) (BLANK MEANS NOT DETECTED) |
| X | 18 | = XYLENES (IN UGL)                                 |

**NOTES**

1. BASE MAP SOURCE NAVFAC DRAWING NO. 2015843 AND 2015844, 12/31/74 BY JAMES S. MINOES & ASSOC. CARLSON & SWEATT FARMINGTON, CT & NEW YORK, NY
2. TANKS 1 TO 3 ARE 80 FUEL OIL CONCRETE UNDERGROUND TANKS, TANKS 7 TO 8 ARE DIESEL FUEL CONCRETE UNDERGROUND TANKS
3. OBG WELLS WERE ORIGINALLY SURVEYED IN RELATION TO CATCH BASIN 1, ASSUMING AN ARBITRARY ELEVATION OF 130.00 FT. ELEVATIONS OF THE OBG WELLS WERE CONVERTED TO THE SUB-BASE DATUM, BASED ON ESTIMATED ELEVATION OF 2580 FT FOR CATCH BASIN #1.



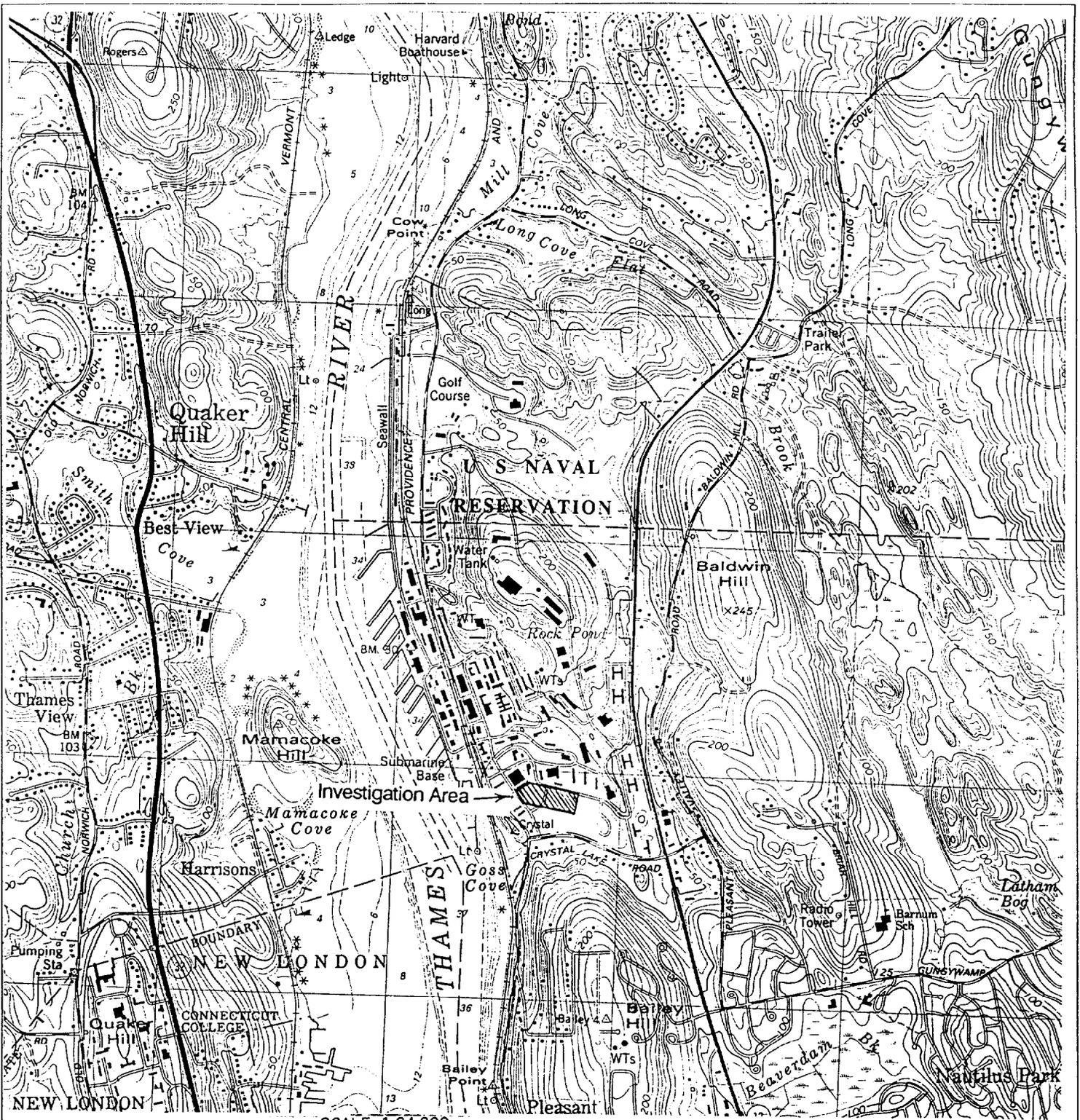
No.	Date	Author	Revision



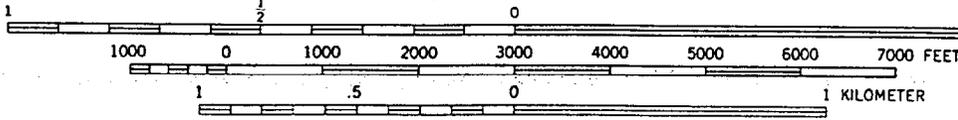
Checked	Date	<p align="center"><b>GROUND WATER CONTOUR MAP OF MAY 2, 1991 AND GROUND WATER ANALYTICAL RESULTS NAVAL SUBMARINE BASE NEW LONDON, GROTON, CT</b></p>	<p align="center"><b>3</b></p>
Design Engineer			
Project Engineer			
Project Manager			
Approved	Date	Date	Client Approval
		MAY 14 1991	

0012102X

# FIGURES



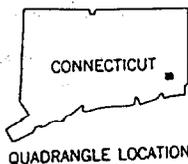
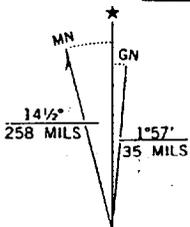
SCALE 1:24 000



UNCASVILLE, CONN.  
 41072-D1-TF-024

1984

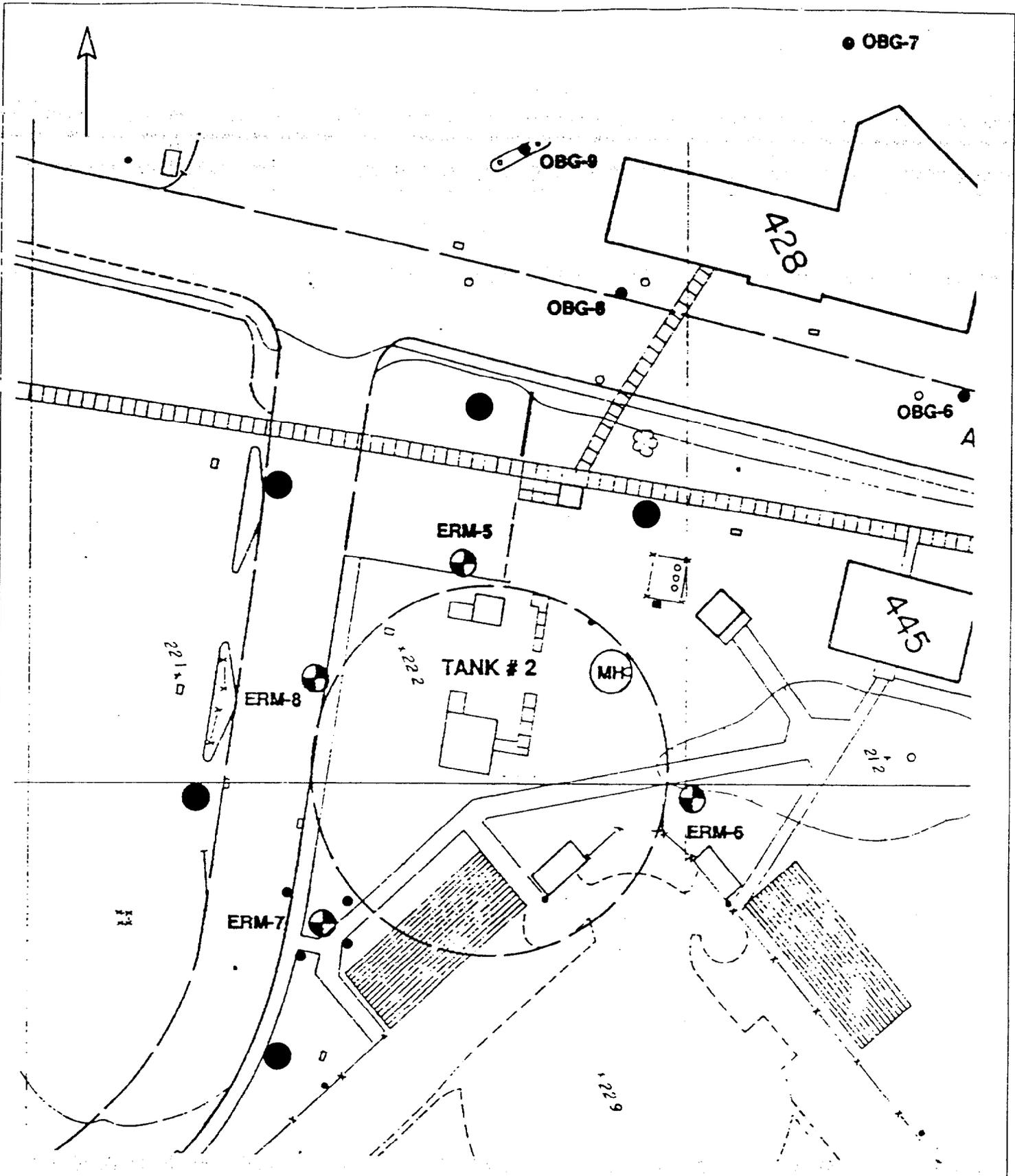
CONTOUR INTERVAL 10 FEET  
 NATIONAL GEODETIC VERTICAL DATUM OF 1929



UTM GRID AND 1984 MAGNETIC NORTH  
 DECLINATION AT CENTER OF SHEET

Source: USGS Quadrangle Topo Map, Uncasville, CT, 1984.

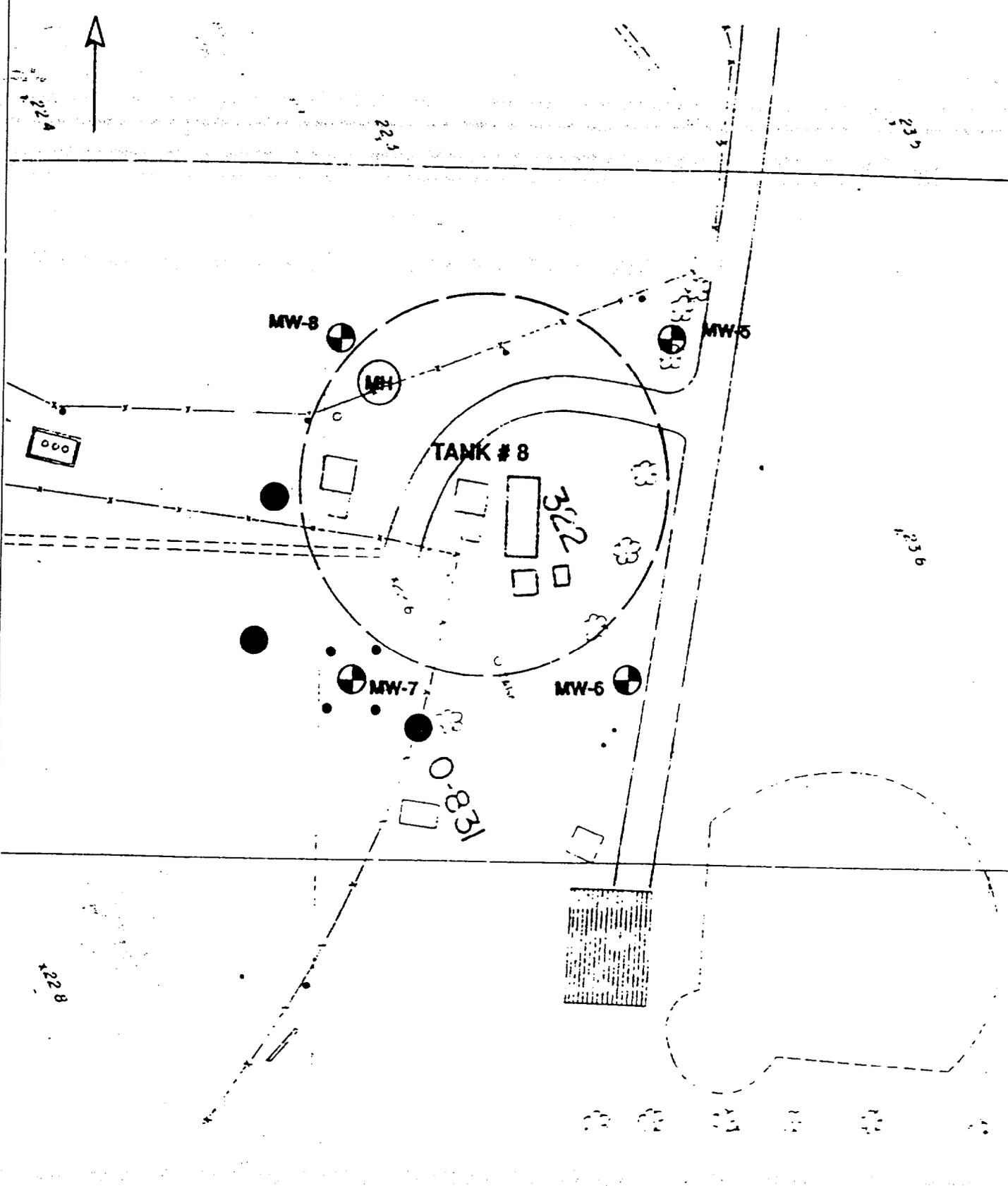
Title		<b>SITE LOCATION</b>	
		U.S. Submarine Base	
		Groton, Connecticut	
Prepared for			
Northern Division 24 State Area			
Prepared by		Scale	Project No.
<b>ERM-Northeast</b>		As noted	101.107
Environmental Resources Management		Date	Figure
375 Bridgeport Ave. Shelton, CT 06484		05/10/91	1



**LEGEND**

- PROPOSED SOIL BORING
- PROPOSED MONITORING WELL
- ◐ EXISTING MONITORING WELL

Title <b>PROPOSED ADDITIONAL BORINGS AND WELLS, TANK # 2 VICINITY</b> Submarine Naval Base, Groton, CT		
Prepared for U.S. Navy, NAVFAC Northern Division		
Prepared by <b>ERM-Northeast</b> Environmental Resources Management 375 Bridgeport Ave. Shelton, CT 06484	Scale 1 in=40 ft	Project No. 101.107
	Date 05/21/91	Figure <b>4</b>



**LEGEND**

- PROPOSED SOIL BORING
- PROPOSED MONITORING WELL
- ⊕ EXISTING MONITORING WELL

Title <b>PROPOSED ADDITIONAL BORINGS AND WELLS, TANK # 8 VICINITY</b> Submarine Naval Base, Groton, CT		
Prepared for U.S. Navy, NAVFAC Northern Division		
Prepared by <b>ERM-Northeast</b> Environmental Resources Management 375 Bridgeport Ave. Shelton, CT 06484	Scale 1 in=40 ft	Project No. 101.107
Date 05/21/91	Figure <b>5</b>	

**ERM-Northeast**

**APPENDIX A**

**BORING AND WELL CONSTRUCTION LOGS**

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

# LOG OF BORING: B-1-1 (ERM-1)

Project name & location U.S. Submarine Base, Groton, CT		Project number 101.107		Date & time started 2/21/91 10:15		Date & time completed 2/21/91 11:55	
Drilling company Connecticut Test Boring, Seymour, CT.		Driller Chris DeAngelis		Ground elevation & datum 23.0' Subbase Datum		Completion depth 16'	
Drilling equipment CME model 55 truck mounted rig		Method 4 1/4" HSA		Number of soil and/or rock samples:		disturbed 8 undisturbed 0 rock core N/A	
Bit(s) 4 1/4" ID HSA shoe		Casing hammer N/A		Drop N/A		Ground Water level(s) information: in ft below ground	
Casing N/A		Sampler hammer 140 lb.		Drop 30"		Time 10:30 13:14 9:06	
S Split Spoon Sampler N 1 1/2" ID X 24"				Drilling angle & direction Vertical		Depth to Water 7.0 5.65 5.73	
						Notes initial measure 2/22/91 2/25/91	
						Geologist Noah Levine	

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Reco- very (ft)	Blow per 6 in.	Time taken	Sam- ple	Amb- lent air	Time of meas.	
0.3' Macadam	0								~ 68' North of the center of OT-1
0.3' Brown-light brown fine-v. coarse SAND, little fine gravel, stiff, moist.	1	S-1	0.9	5	10:18	0.0	0.0	15:45	Microtip readings were taken from head space on 2/22/91
0.6' Dark brown v.f.-fine SAND, little brown fine sand, little fine gravel, loose, moist	2			8					
0.4' Brown fine-v. coarse SAND, some fine gravel, loose, wet water is probably perched	3	S-2	1.0	10	10:22	0.0	0.0	15:46	Sample sent to lab for analysis of TPH 418.1 and BTEX 8020
0.6' Dark brown v.f.- fine SAND, tr. fine gravel, stiff, dry	4			10					
0.45' V. dark brown v.f.-fine SAND, tr. 20mm gravel, stiff, dry	5	S-3	0.8	4	10:26	0.0	0.0	15:48	
0.15' Gray brown fine-med. SAND, loose, dry	6			2					
0.2' Brown fine SAND, loose, dry	7			3					
0.1' Brown v.f.-fine SAND, stiff, dry	8	S-4	1.1	3	10:30	0.0	0.0	15:49	
0.15' Black/white pulverized gneiss GRAVEL, dry	9			1					
0.25' Brown v.f.-fine SAND, stiff, dry	10			1					first water in augers
0.1' Yellow brown fine-med. SAND, stiff, moist	11			2					
0.02' Black PEAT, wet	12			1					
0.5' Brown med.-coarse SAND, mod. stiff, wet	13	S-5	0.4	0	10:38	0.0	0.0	15:50	
0.3' Brown-dark brown fine- coarse SAND, loose, wet	14			0					
0.1' Black med.-coarse SAND, loose, wet	15			0					
0.3' Brown fine-coarse SAND, tr. fine black sand, loose, wet	16	S-6	0.3	1	10:46	0.0	0.0	15:51	
	17			0					
0.4' Brown/yellow brown/black fine-coarse SAND, loose, wet	18	S-7	0.4	1	10:55	0.0	0.0	15:52	
	19			0					
	20			0					
0.5' Brown/black med.-coarse SAND, little fine sand one 40mm pebble, loose, wet	21	S-8	0.5	1	11:00	0.0	0.0	15:53	
	22			2					
	23			1					
	24			0					
	25			0					
	26								16' bottom of boring Bottom of fuel oil vault is at 15'
	27								
	28								
	29								
	30								
	31								
	32								
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tr - trace, < 10%  
 little <25%, >10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-1 installed in this boring

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

**LOG OF BORING: B-1-2 (ERM-4)**

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project number</b> 101.107	<b>Date &amp; time started</b> 2/21/91 12:20	<b>Date &amp; time completed</b> 2/21/91 13:50
<b>Drilling company</b> Connecticut Test Boring, Seymour, CT		<b>Driller</b> Chris DeAngelis	<b>Ground elevation &amp; datum</b> 22.25' Subase Datum	<b>Completion depth</b> 16'
<b>Drilling equipment</b> CME model 55 truck mounted rig		<b>Method</b> 4 1/4" HSA	<b>Number of soil and/or rock samples:</b>	<b>Rock depth</b> N/A
<b>Bit(s)</b> 4 1/4" ID HSA shoe			<b>disturbed</b> 8	<b>undisturbed</b> 0
<b>Casing</b> N/A		<b>Casing hammer</b> N/A	<b>Drop</b> N/A	<b>Notes</b> initial measure
<b>Split Spoon Sampler</b> 1 1/2" ID X 24"		<b>Sampler hammer</b> 140 lb.	<b>Drop</b> 30"	<b>Geologist</b> Noah Levine

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Recovery (ft)	Blow per 6 in.	Time taken	Sample	Ambient air	Time of meas.	
Sod	0								~ 70' West of the center of OT-1
0.35' Dark brown v.f. SAND, stiff, some grass/roots, damp	1	S-1	1.0	3	12:25	0.0	0.0	15:54	Microtip readings were taken from head space on 2/22/91.
0.65' Brown v.f.-fine SAND, stiff, tr. 5mm gravel, damp	2			5					
1.2' Brown fine-coarse SAND, stiff, tr. 5mm gravel, damp	3	S-2	1.2	4	12:28	0.0	0.0	15:55	
	4			3					
1.1' Brown fine-coarse SAND, stiff, tr. 7-10mm gravel, moist	5	S-3	1.1	1	12:30	0.0	0.0	15:57	Sample sent to lab for analysis of TPH 418.1 and BTEX 8020
	6			2					
0.3' Brown fine-coarse SAND, mod. stiff, moist first water	7	S-4	0.65	1	12:34	0.0	0.0	15:57	
0.2' Gray brown fine-coarse SAND, mod. stiff, moist	8			2					
0.15' Brown fine-coarse SAND, tr. orange brown fine-coarse sand surrounding an orange brown 25mm pebble	9	S-5	0.4	1	12:42	0.0	0.0	15:58	
0.4' Brown fine-coarse SAND, loose, little orange brown fine-coarse sand, tr. 10-15mm gravel, wet	10			1					
0.4' Brown fine-med. SAND, tr. gray fine-med. sand, mod. stiff, wet	11	S-6	0.5	0	12:47	0.0	0.0	15:59	
0.1' Dark brown fine-coarse SAND, loose, wet	12			1					
0.1' Strong brown fine-coarse SAND, loose, wet	13	S-7	0.5	1	12:56	0.0	0.0	16:00	
0.4' Olive gray fine-coarse SAND, loose, wet	14			1					
0.5' Olive brown med.-coarse SAND, little white med.-coarse SAND, little v.f.-fine sand, loose, wet	15	S-8	0.5	9	13:00	0.0	0.0	16:01	
	16			6					
	17			5					
	18								16' bottom of boring
	19								Bottom of fuel oil vault is at 15'
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little <25%, >10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-4 installed in this boring

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

# LOG OF BORING: B-1-3 (ERM-3)

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project number</b> 101.107	<b>Date &amp; time started</b> 2/22/91 12:00	<b>Date &amp; time completed</b> 2/22/91 13:35
<b>Drilling company</b> Connecticut Test Boring, Seymour, CT		<b>Driller</b> Chris DeAngelis	<b>Ground elevation &amp; datum</b> 21.03' Subbase Datum	<b>Completion depth</b> 16'
<b>Drilling equipment</b> CME model 55 truck mounted rig		<b>Method</b> 4 1/4" HSA	<b>Number of soil and/or rock samples:</b>	<b>disturbed</b> 8 <b>undisturbed</b> 0 <b>rock core</b> N/A
<b>Bit(s)</b> 4 1/4" ID HSA shoe			<b>Ground Water level(s) information, in ft below ground</b>	<b>Time</b> 12:40 13:35 8:54 <b>Depth to Water</b> 8.0 7.12 5.74 <b>Notes</b> initial measure 2/22/91 2/25/91
<b>Casing</b> N/A	<b>Casing hammer</b> N/A	<b>Drop</b> N/A	<b>Drilling angle &amp; direction</b> Vertical	
<b>Split Spoon Sampler</b> 1 1/2" ID X 24"	<b>Sampler hammer</b> 140 lb.	<b>Drop</b> 30"	<b>Geologist</b> Noah Levine	

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Recovery (ft)	Blow per 6 in.	Time taken	Sam-ple	Amb-ient air	Time of meas	
0.3' Macadam	0								~ 65' South of the center of OT-1
0.1' Black fine-coarse SAND, some med. gravel, loose, dry	1	S-1	1.0	3	12:05	0.0	0.0	16:02	Microtip readings were taken from head space.
0.4' Brown fine-med. SAND, tr. med. gravel, stiff, dry				6					
0.5' Gray v.f.-med. SAND, stiff, dry	2			5					
0.7' Olive gray fine-med. SAND, tr. peat, mod. stiff, dry	3	S-2	0.7	4	12:08	0.0	0.0	16:03	Sample sent to lab analyzed for TPH 418.1
1 - 25 mm sub-rounded pebble				4					
0.9' Olive gray v.f.-med. SAND, little coarse sand, tr. 10-15mm gravel, moist	4			6					
0.1' White/clear pulverized pebble, dry	5	S-3	1.0	2	12:12	0.0	0.0	16:04	Fuel oil odor coming from tank vent
0.2' Olive gray fine SAND, stiff, moist				2					
1.0' Olive gray v.f.-med SAND, tr. dark brown v.f.-med. sand, tr. gray v.f.-med. sand, tr. fine gravel, moist	6			5					
1.3' Olive gray fine-med. SAND, tr. gray fine sand, tr. brown fine sand, loose, wet	7	S-4	1.2	2	12:15	0.0	0.0	16:05	Sample sent to lab for analysis of TPH 418.1 and BTEX 8020 The blind duplicate was taken from sample S-4 and labeled B-1-35.
first water in augers				1					
1.5' Olive gray fine-med. SAND loose, tr. gray v.f. sand tr. fine gravel, wet	8			1					
0.2' Olive gray fine-med. SAND, loose, wet, tr. fine gravel, tr. fine black sand	9	S-5	1.3	2	12:25	0.0	0.0	16:06	
				1					
0.2' Olive gray v.f.-med SAND, loose, wet 1 - 30mm pebble, tr. fine gravel.	10	S-6	1.5	2	12:32	0.0	0.0	16:07	
				1					
	11			1					
	12			1					
	13	S-7	0.2	1	12:37	0.0	0.0	16:08	
				0					
	14			1					
	15	S-8	0.2	1	12:40	0.0	0.0	16:09	
				0					
	16			0					
	17								
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little <25%, >10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-3 installed in this boring

16' bottom of boring  
 Bottom of fuel oil vault is at 15'

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

# LOG OF BORING: B-1-4 (ERM-2)

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project number</b> 101.107	<b>Date &amp; time started</b> 2/22/91 9:37	<b>Date &amp; time completed</b> 2/22/91 11:30
<b>Drilling company</b> Connecticut Test Boring, Seymour, CT		<b>Driller</b> Chris DeAngelis	<b>Ground elevation &amp; datum</b> 22.07' Subbase Datum 16.1'	
<b>Drilling equipment</b> CME model 55 truck mounted rig		<b>Method</b> 4 1/4" HSA	<b>Number of soil and/or rock samples:</b>	<b>Completion depth</b> 16.1'
			disturbed 8	undisturbed 0
				rock core N/A
<b>Bit(s)</b> 4 1/4" ID HSA shoe			<b>Ground Water level(s) information, in ft below ground</b>	<b>Time</b> 10:35 11:45 8:45
<b>Casing</b> N/A		<b>Casing hammer</b> N/A	<b>Drop</b> N/A	<b>Depth to Water</b> 7.50 5.30 5.38
<b>Split Spoon Sampler</b> 1 1/2" ID X 24"		<b>Sampler hammer</b> 140 lb.	<b>Drop</b> 30"	<b>Notes</b> initial measure 2/22/91 2/25/91
			<b>Drilling angle &amp; direction</b> Vertical	<b>Geologist</b> Noah Levine

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Recovery (ft)	Blow per 6 in.	Time taken	Sam-ple	Amb-ient air	Time of meas.	
0.25' Macadam, 0.25' Concrete	0				9:48				~ 64' East of the center of OT-1
0.15' Gray brown v.f.-med. SAND, loose, dry, little light gray sand	1	S-1	0.65	8	9:50	0.0	0.0	16:10	Microtip readings were taken from head space.
0.35' White pulverized PEBBLE, dry	2			6					Split spoon driven only 18"
0.1' Brown pulpy PEAT, damp	2			8					
0.1' White pulverized PEBBLE, dry	3			6		0.0	0.0	16:12	
0.4' Dark brown fine-med. SAND, some brown v.f. sand	3	S-2	1.1	6	9:52				
0.6' Olive gray fine-med. SAND, mod. sorting, dry	4			7					
	4			6					
0.7' Dark brown fine-med. SAND, mod. stiff, damp	5			3		0.0	0.0	16:13	
0.4' Olive gray fine-coarse SAND mod. sorting, little black fine-med. SAND, mod. stiff, damp	5	S-3	1.5	3	9:56				
0.4' Gray v.f. SAND, some silt, stiff	6			4					
0.5' Olive gray fine-med. SAND, damp	6			3		0.0	0.0	16:14	Sample sent to lab for analysis of TPH 418.1 and BTEX 8020
0.3' Gray SILT, little black peat, tr. brown fine-med. sand lamina, damp	7	S-4	0.9	2	10:00				
0.1' Gray fine-med. SAND, mod. stiff, wet first water	8			2					
0.5' Dark brown fine-med. SAND, little gray fine sand, tr. dark brown peat, stiff, wet	9	S-5	1.8	1	10:05	0.0	0.0	16:15	
0.1' Brown v.f.-med. SAND, wet	9			1					
1.2' Olive gray fine-coarse SAND, tr. black fine sand, tr. fine gravel, loose, wet	10			0					
0.6' Olive gray fine-coarse SAND, tr. fine gravel, tr. gray v.f. sand occurring in pockets, loose, wet	11	S-6	0.6	0	10:18	0.0	0.0	16:16	
	12			1					
0.7' Olive gray fine-coarse SAND, tr. fine gravel, tr. gray v.f. sand occurring in pockets, loose, wet	13	S-7	0.7	0	10:25	0.0	0.0	16:18	
	14			0					
	14			0					
0.2' Olive gray fine-coarse SAND, loose, wet	15	S-8	0.3	1	10:31	0.0	0.0	16:19	
0.1' Yellow brown fine-coarse SAND, loose, wet	15			1					
	16			0					
	17								16' bottom of boring Bottom of fuel oil vault is at 15'
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little <25%, >10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-2 installed in this boring

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

## LOG OF BORING: B-2-1 (ERM-6)

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project number</b> 101.107		<b>Date &amp; time started</b> 2/22/91 14:28		<b>Date &amp; time completed</b> 2/22/91 15:40	
<b>Drilling company</b> Connecticut Test Boring, Seymour, CT		<b>Driller</b> Chris DeAngelis		<b>Ground elevation &amp; datum</b> 21.77' Subbase Datum		<b>Completion depth</b> 16'	
<b>Drilling equipment</b> CME model 55 truck mounted rig		<b>Method</b> 4 1/2" HSA		<b>Number of soil and/or rock samples:</b>		<b>Rock depth</b> N/A	
<b>Bit(s)</b> 4 1/2" ID HSA shoe				<b>Number of soil</b> 8		<b>Number of undisturbed rock core</b> 0	
<b>Casing</b> N/A		<b>Casing hammer</b> N/A		<b>Drop</b> N/A		<b>Notes</b>	
<b>Split Spoon Sampler</b> 1 1/2" ID X 24"		<b>Sampler hammer</b> 140 lb.		<b>Drop</b> 30"		<b>Geologist</b> Noah Levine	
				<b>Drilling angle &amp; direction</b> Vertical			
				<b>Ground Water level(s) information, in ft below ground</b>			
				15:10		5.50	
				15:43		5.24	
				12:42		4.99	

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Reco- very (ft)	Blow per 6 in.	Time taken	Sam- ple	Amb- ient air	Time of meas.	
Sod	0								~ 62' East of the center of OT-2
0.8' Dark brown v.f. SAND, stiff, dry, little silt, little grass/roots	1	S-1	1.4	3	14:30	0.0	0.0	14:32	Microtip readings were taken from open split spoon.
0.6' Brown fine-med. SAND, mod. stiff, dry	2			8					
	2			8					
0.6' Yellow brown fine-med. SAND, loose, dry, tr. v.f. gray sand, tr. fine gravel	3	S-2	0.6	4	14:33	0.0	0.0	14:35	Sample sent to lab for analysis of TPH 418.1 and BTEX 8020
	4			4					
	4			3					
0.2' Yellow brown fine-med. SAND, loose, damp	5	S-3	0.4	1	14:38	0.0	0.0	14:40	
0.2' Strong brown v.f.-coarse SAND, poor sorting, wet first water	5			1					
	6			1					
0.25' Light olive brown v.f.-med. SAND, wet	7	S-4	0.35	1	14:42	0.0	0.0	14:44	
0.1' 30mm subrounded pebble	7			2					
	8			2					
	8			4					
0.3' Light olive brown v.f.-med. SAND, wet	9	S-5	1.05	1	14:50	0.0	0.0	14:52	
0.45' Gray SILT, mod. stiff, wet	9			1					
0.3' Gray brown fine-med. SAND, loose, tr. coarse sand, wet	10			1					
	10			1					
0.4' Brown v.f.-med. SAND, wet	11	S-6	0.6	1	14:53	0.0	0.0	14:55	
0.2' Dark gray v.f. SAND some gray silt, wet	11			1					
	12			0					
0.2' Gray v.f.-med. SAND/SILT, wet	13	S-7	1.0	0	14:55	0.0	0.0	14:57	
0.8' Olive gray fine-med. SAND, loose, wet	13			0					
	14			0					
	14			0					
0.35' Olive gray fine-med. SAND, loose, wet	15	S-8	0.35	1	15:02	0.0	0.0	15:04	
	15			0					
	16			1					
	16			0					
	17								
	18								16' bottom of boring Bottom of fuel oil vault is at 15'
	19								
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little <25%, >10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-6 installed in this boring

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

# LOG OF BORING: B-2-2 (ERM-7)

Project name & location U.S. Submarine Base, Groton, CT		Project number 101.107		Date & time started 2/25/91 15:10		Date & time completed 2/25/91 16:40	
Drilling company Connecticut Test Boring, Seymour, CT.		Driller Chris DeAngelis		Ground elevation & datum 21.85' Subbase Datum		Completion depth 16'	
Drilling equipment CME model 55 truck mounted rig		Method 4 1/4" HSA		Number of soil and/or rock samples:		disturbed 8	
Bit(s) 4 1/4" ID HSA shoe		Casing hammer N/A		Drop N/A		undisturbed 0	
Casing N/A		Sampler hammer 140 lb.		Drop 30"		rock core N/A	
Split Spoon Sampler 1 1/2" ID X 24"		Drilling angle & direction Vertical		Geologist Noah Levine			

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Reco- very (ft)	Blow per 6 in.	Time taken	Sam- ple	Amb- ient air	Time of meas	
Sod	0								~ 59' Southwest of the center of OT-2
0.25' Dark brown v.f.-med. SAND, little grass/roots, stiff, dry				5		0.0	0.0	15:15	Microtip readings were taken from open split spoon.
0.4' Yellow brown fine-med. SAND and fine-coarse gravel, dry	1	S-1	1.35	8	15:13				
0.1' Light yellow brown v.f. SAND, stiff, dry				7					
0.3' Dark brown v.f. SAND/SILT, stiff, dry	2			6					
0.3' Light yellow brown v.f.-fine SAND, little silt, dry				6		0.0	0.0	15:18	
1.1' Light yellow brown v.f.-fine SAND, dry	3	S-2	1.2	6	15:16				
0.1' Dark brown v.f.-fine SAND, dry				5					
0.5' Dark brown v.f.-fine SAND, stiff, dry	4			4					
0.4' Olive brown v.f.-med. SAND, little gray silt, 25mm pebble	5	S-3	1.3	3	15:20	6.0	0.0	15:22	Sample sent to lab for analysis of TPH 418.1 and BTEX 8020 Oil present in soil. Brown paper bag test confirmed presence of oil.
0.4' Olive brown v.f.-med. SAND, black OIL present	6			2					
0.5' Olive brown v.f.-med. SAND, mod stiff, wet soils shows a sheen.				3		29.2	0.0	15:25	Brown paper bag test confirms presence of oil.
first water	7	S-4	0.5	3	15:22				
	8			3					
	8			2					
0.6' Olive gray v.f.-med. SAND, tr. gray silt, mod. stiff, wet				1		6.7	0.0	15:40	
	9	S-5	0.6	1	15:37				
	10			2					
	10			1					
1.2' Olive gray v.f.-med. SAND, little coarse sand, little silt, loose, wet				0		0.0	0.0	15:47	
	11	S-6	1.2	1	15:45				
	12			1					
	12			0					
0.4' Dark olive gray v.f.-med. SAND, tr. black v.f. sand/silt, wet				1		2.4	0.0	15:54	
	13	S-7	0.4	0	15:52				
	14			0					
	14			0					
0.9' Dark gray v.f.-med. SAND, tr. dark brown peat, mod. stiff				1		0.4	0.0	15:57	
0.1' Gray SILT, cohesive, wet	15	S-8	1.0	0	15:55				
	16			1					
	16			0					
	17								16' bottom of boring Bottom of fuel oil vault is at 15'
	18								
	19								No floating product on water Strong chromatic sheen on the soils on the augers. Soils are stockpiled apart from the other well cuttings.
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little <25%, >10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-7 installed in this boring

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

## LOG OF BORING: B-2-3 (ERM-8)

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project number</b> 101.107		<b>Date &amp; time started</b> 2/25/91 12:20		<b>Date &amp; time completed</b> 2/25/91 13:55	
<b>Drilling company</b> Connecticut Test Boring, Seymour, CT		<b>Driller</b> Chris DeAngelis		<b>Ground elevation &amp; datum</b> 22.04' Subase Datum		<b>Completion depth</b> 16'	
<b>Drilling equipment</b> CME model 55 truck mounted rig		<b>Method</b> 4 1/4" HSA		<b>Number of soil and/or rock samples:</b>		<b>Rock depth</b> N/A	
<b>Bit(s)</b> 4 1/4" ID HSA shoe				<b>disturbed</b> 8		<b>undisturbed rock core</b> 0 N/A	
<b>Casing</b> N/A		<b>Casing hammer</b> N/A		<b>Drop</b> N/A		<b>Notes</b>	
<b>Split Spoon Sampler</b> 1 1/2" ID X 24"		<b>Sampler hammer</b> 140 lb.		<b>Drop</b> 30"		<b>Geologist</b> Noah Levine	

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Reco- very (ft)	Blow per 6 in.	Time taken	Sam- ple	Amb- ient air	Time of meas.	
0.2' Macadam	0								~ 60' West of the center of OT-2
0.5' Yellow brown fine-med. SAND, some white/red fine-med. angular gravel, loose, dry	1	S-1	1.25	7	12:22	0.0	0.0	12:24	Microtip readings were taken from open split spoon.
0.75' Olive gray v.f.-med. SAND, tr. fine gravel, mod. stiff, dry	2			9					
				7					
1.0' Olive gray v.f.-med. SAND, tr. fine gravel, tr. black peat, mod stiff, damp	3	S-2	1.0	5	12:24	0.0	0.0	12:26	
	4			3					
				3					
0.7' Olive gray v.f.-med. SAND, tr. black silt/peat, mod. stiff	5	S-3	1.2	2	12:26	0.0	0.0	12:28	Sample sent to lab for analysis of TPH 418.1 and BTEX 8020
0.02' Yellow brown v.f.-med SAND, dry	6			1					
0.5' Dark gray fine-med. SAND, little gray fine-med. sand, loose, wet	7			2					
0.2' Olive gray fine -med. SAND, wet	8			2					
0.3' Dark gray fine-med. SAND, some med. gravel	9	S-4	0.6	3	12:30	0.0	0.0	12:32	
0.1' Dark gray v.f.-med SAND and fine-med. first water gravel, rounded, wet	10			4					
				3					
				3					
1.4' Olive brown- gray brown v.f.-med. SAND, little coarse sand, loose, wet, flecks of mica minerals present.	11	S-5	1.4	2	12:37	0.0	0.0	12:39	
	12			1					
				2					
				2					
0.3' Dark gray brown v.f.-med. SAND, loose, wet	13	S-6	1.0	2	12:40	0.0	0.0	12:42	
0.2' Gray brown v.f.-med. SAND, loose, wet	14			1					
0.5' Olive brown fine-med. SAND, tr. gray silt, loose, wet	15			1					
				1					
0.45' Olive brown v.f.-med. SAND, tr. black peat, tr. fine gravel, loose, wet	16	S-7	0.5	0	12:47	0.0	0.0	12:49	
0.05' Dark gray SILT, stiff, slightly plastic	17			0					
	18			0					
				0					
0.4' Olive brown v.f.-med SAND, mod. stiff, little pockets of dark brown/black pulpy peat, tr. light olive brown v.f.-fine sand, wet	19	S-8	0.4	1	12:51	0.0	0.0	12:53	
	20			0					
				2					
				2					
	21								
	22								
	23								
	24								
	25								

16' bottom of boring  
 Bottom of fuel oil vault is at 15'

tr - trace, < 10%  
 little <25%, >10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-8 installed in this boring

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

# LOG OF BORING: B-2-4 (ERM-5)

Project name & location U.S. Submarine Base, Groton, CT		Project number 101.107	Date & time started 2/25/91 10:45	Date & time completed 2/25/91 12:15
Drilling company Connecticut Test Boring, Seymour, CT		Driller Chris DeAngelis	Ground elevation & datum 21.94' Subbase Datum	Completion depth 16.0'
Drilling equipment CME model 55 truck mounted rig		Method 4 1/4" HSA	Number of soil and/or rock samples:	disturbed 8
Bit(s) 4 1/4" ID HSA shoe			undisturbed 0	rock core N/A
Casing N/A	Casing hammer N/A	Drop N/A	Ground Water level(s) information, in ft below ground	Time 11:20 12:08 17:48
Split Spoon Sampler 1 1/2" ID X 24"	Sampler hammer 140 lb.	Drop 30"	Depth to Water 6.00 4.50 4.34	Notes initial measure 2/25/91 2/25/91
			Drilling angle & direction Vertical	Geologist Noah Levine

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Reco- very (ft)	Blow per 6 in.	Time taken	Sam- ple	Amb- ient air	Time of meas.	
0.2' Macadam	0								~ 66' North of the center of OT-2
0.5' Dark brown v.f.-med. SAND, little dark brown silt, tr. fine gravel, stiff, damp	1	S-1	1.05	3	10:52	0.0	0.0	10:54	Microtip readings were taken from open split spoon.
0.55' Brown v.f.-med. SAND, little fine gravel. mod. stiff, damp	2			6					
0.1' Brown v.f.-med. SAND, loose, dry				7					
0.15' Gray/black/brown med.-coarse SAND, some fine gravel	3	S-2	1.2	5	10:54	0.0	0.0	10:56	Sample sent to lab for analysis of TPH 418.1 and BTEX 8020
0.4' Strong brown fine-med. SAND, little fine gravel, dry				6					
0.3' Yellow red (stained) v.f.-med. SAND & gray silt, stiff	4			5					
0.1' Yellow brown med-coarse SAND, clean, loose, dry				3		0.0	0.0	11:00	
0.15' Olive gray v.f.-fine SAND and fine-med. gravel, stiff, dry	5	S-3	0.1	3	10:58				
0.1' Gray brown v.f.-med. SAND	6			3					first water
0.3' Very dark gray dark gray v.f.-med SAND and gray brown v.f.-mod. sand, white 35mm piece of gravel, wet	7	S-4	0.3	4	11:02	0.0	0.0	11:04	
0.3' Dark olive gray-very dark gray/black fine-coarse. SAND,	8			4					
0.15' Olive gray v.f. SAND/SILT, stiff, wet				1		0.0	0.0	11:10	
0.7' Olive gray med.-coarse SAND, little pockets of gray silt	9	S-5	1.15	1	11:06				
little olive brown v.f.-med sand, loose, wet	10			1					
0.5' Very dark gray/black fine-med. SAND, little olive brown v.f.-med sand, wet	11	S-6	1.7	0	11:10	0.0	0.0	11:12	Petroleum odor in the air coming from the OT-2 pump block
1.2' Dark gray med.-coarse SAND, little pockets of gray silt	12			0					
0.15' Dark gray med.-coarse SAND, loose, wet				1					
	13	S-7	0.15	0	11:15	0.0	0.0	11:17	
	14			0					
0.7' Dark gray-gray med.-v. coarse SAND, little fine gravel, little white fine sand, loose, wet	15	S-8	1.5	1	11:20	0.0	0.0	11:22	
	16			1					
	17			2					
	18								16' bottom of boring Bottom of fuel oil vault is at 15'
	19								
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little <25%, > 10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-5 installed in this boring

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

# LOG OF BORING: B-3-1 (ERM-12)

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project number</b> 101.107	<b>Date &amp; time started</b> 2/19/91 11:50	<b>Date &amp; time completed</b> 2/19/91 13:45
<b>Drilling company</b> Connecticut Test Boring, Seymour, CT		<b>Driller</b> Chris DeAngelis	<b>Ground elevation &amp; datum</b> 22.92' Subbase Datum	<b>Completion depth</b> 16.'
<b>Drilling equipment</b> CME model 55 truck mounted rig		<b>Method</b> 4 1/4" HSA	<b>Number of soil</b> 8	<b>Number of rock samples:</b> 0
<b>Bit(s)</b> 4 1/4" ID HSA shoe			<b>Ground Water level(s) information, in ft below ground</b> 15:00 15:50 14:56	<b>Depth to Water</b> 8.38 6.14 6.02
<b>Casing</b> N/A	<b>Casing hammer</b> N/A	<b>Drop</b> N/A	<b>Notes</b> initial measure 2/20/91 2/21/91	
<b>S. Split Spoon Sampler</b> N 1 1/2" ID X 24"	<b>Sampler hammer</b> 140 lb.	<b>Drop</b> 30"	<b>Drilling angle &amp; direction</b> Vertical <b>Geologist</b> Noah Levine	

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Recovery (ft)	Blow per 6 in.	Time taken	Sample	Ambient air	Time of meas.	
Sod	0								~ 63.5' West of the center of OT-3
0.2' Dark brown v.f. SAND, stiff, some grass/roots damp	1	S-1	0.75	3	11:50	70	20	11:52	rain caused unreliable readings
0.3' Brown v.f. SAND, stiff, damp				10					
0.25' Dark brown v.f. SAND, stiff, damp	2			12					
0.2' Dark brown v.f. SAND, stiff, little med. sand, damp				21					
0.1' Lt. brown/orange brown pulverized gneissic fragment	3	S-2	0.45	12	11:55				
0.15' Brown fine-med. SAND, mod. stiff, little coarse sand, damp	4			9					
0.7' Gray brown fine-med. SAND, stiff, damp				5					
0.2' Lt. brown med. SAND, mod. stiff, some yellow/red brown coarse-v. coarse sand, little fine gravel, damp	5	S-3	0.9	4	12:02				Sample sent to lab for analysis of TPH 418.1 and BTEX 8020
	6			3					
				2					
0.3' Brown med. SAND, mod. stiff, little gneiss first water gravel, 20mm gneissic pebble, wet	7	S-4	0.3	3	12:05				
	8			4					
				2					
0.2' Brown med. SAND, loose, wet				1					
0.2' Gray med. SAND, loose, 40mm rounded pebble, wet	9	S-5	0.4	1	12:15				
	10			1					
				1					
1.1' Gray med. SAND, loose, little white & black fine gravel, wet	11	S-6	1.1	2	12:35				
	12			1					
				1					
0.5' Gray-gray brown fine-med. SAND, loose, some gneissic gravel, little v.f. sand, slightly cohesive, wet	13	S-7	0.5	2	12:43				
	14			4					
				3					
0.4' Gray v.f. SAND, stiff, little silt, little fine gravel, wet	15	S-8	0.4	2	12:47				
	16			1					
				2					
	17								16' bottom of boring Bottom of fuel oil vault is at 15'
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little <25%, > 10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

**Well ERM-12 installed in this boring**

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

## LOG OF BORING: B-3-2 (ERM-9)

<i>Project name &amp; location</i> U.S. Submarine Base, Groton, CT		<i>Project number</i> 101.107		<i>Date &amp; time started</i> 2/19/91 14:00		<i>Date &amp; time completed</i> 2/19/91 15:40	
<i>Drilling company</i> Connecticut Test Boring, Seymour, CT		<i>Driller</i> Chris DeAngelis		<i>Ground elevation &amp; datum</i> 22.00' Subbase Datum		<i>Completion depth</i> 17.'	
<i>Drilling equipment</i> CME model 55 truck mounted rig		<i>Method</i> 4 1/4" HSA		<i>Number of soil and/or rock samples:</i>		<i>disturbed</i> 6 <i>undisturbed</i> 0 <i>rock core</i> N/A	
<i>Bit(s)</i> 4 1/4" ID HSA shoe				<i>Ground Water level(s) information, in ft below ground</i>		<i>Time</i> 15:50 <i>Depth to Water</i> 6.12 <i>Notes</i> initial measure	
<i>Casing</i> N/A		<i>Casing hammer</i> N/A		<i>Drop</i> N/A			
<i>S. Split Spoon Sampler</i> N 1 1/2" ID X 24"		<i>Sampler hammer</i> 140 lb.		<i>Drop</i> 30"		<i>Drilling angle &amp; direction</i> Vertical <i>Geologist</i> Noah Levine	

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Reco- very (ft)	Blow per 6 in.	Time taken	Sam- ple	Amb- ient air	Time of meas	
Sod	0								~ 65.5' North of the center of OT-3
0.3' Dark brown v.f. SAND, organics; grass roots, damp	1	S-1	0.3	5	14:05	35.2	10	14:50	rain caused unreliable readings Microtip reading from jarred sample
0.05' Orange/white/clear pulverized gneiss				6					
				9					
0.15' Brown fine-med. SAND, some lt. yellow/brown coarse sand, dry	3	S-2	0.3	9	14:09				Sample sent to lab analyzed for TPH 418.1
0.15' Gray v.f. SAND, little silt, trace black/white gneiss gravel.				7					
	4			5					
0.1' Brown fine-coarse SAND, little black/white gneiss, damp	5	S-3	0.1	6	14:15	98	22	14:51	Fuel oil odor coming from tank vent
				3					
				3					
0.15' Brown med. SAND, damp	7	S-4	0.3	3	14:22				Sample sent to lab analyzed for BTEX 8020
0.15' Gray-gray brown v.f. SAND-SILT, first water some fine sand, wet.				2					
				2					
	9								
	10								
0.4' Brown v.f. SAND-SILT, slightly cohesive, little organics	11	S-5	1.1	2	14:30	126	20	14:52	
0.01' Black/white med. SAND loose, 1mm bed				1					
0.35' Gray v.f. SAND-SILT, alternating lt. gray/gray bedding trace black peat; reed fragments, trace fine gravel				2					
0.35' Gray-lt. gray v.f. SAND-SILT, 3 beds white gray fine sand ~ 3mm thick, wet	4								
	13								
	14								
	15								
0.5' Dark brown-brown v.f. SAND, little silt trace med. black/white sand	16	S-6	1.8	2	14:50				
0.5' Reddish brown v.f. SAND-SILT				1					
0.1' Lt. gray to white v.f. SAND-SILT, little white med. sand, little med. gravel	1								
0.7' Gray SILT, little clay, stiff, slightly plastic, little v.f. sand	17								
	18								17' bottom of boring Bottom of fuel oil vault is at 15'
	19								Lab samples were collected from two intervals because there was not enough volume from either interval.
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little < 25%, > 10%  
 some < 40%, > 25%  
 and < 50%, > 40%  
 v.f. - very fine  
 med. - medium

**Well ERM-9 installed in this boring**

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

# LOG OF BORING: B-3-3 (ERM-10)

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project number</b> 101.107	<b>Date &amp; time started</b> 2/20/91 10:20	<b>Date &amp; time completed</b> 2/20/91 12:00
<b>Drilling company</b> Connecticut Test Boring, Seymour, CT		<b>Driller</b> Chris DeAngelis	<b>Ground elevation &amp; datum</b> 22.00' Subbase Datum	
<b>Drilling equipment</b> CME model 55 truck mounted rig		<b>Method</b> 4 1/4" HSA	<b>Completion depth</b> 16'	<b>Rock depth</b> N/A
<b>Bit(s)</b> 4 1/4" ID HSA shoe		<b>Number of soil</b> and/or rock samples:	<b>disturbed</b> 8	<b>undisturbed</b> 0
<b>Casing</b> N/A		<b>Casing hammer</b> N/A	<b>Drop</b> N/A	<b>rock core</b> N/A
<b>Split Spoon Sampler</b> 1 1/2" ID X 24"		<b>Sampler hammer</b> 140 lb.	<b>Drop</b> 30"	<b>Notes</b> initial measure 2/20/91 2/21/91
<b>Ground Water level(s) information, in ft below ground</b>			<b>Time</b> 12:00 15:58 15:03	<b>Depth to Water</b> 2.91 3.04 3.29
<b>Drilling angle &amp; direction</b> Vertical			<b>Geologist</b> Noah Levine	

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Recovery (ft)	Blow per 6 in.	Time taken	Sample	Ambient air	Time of meas	
Sod	0								~ 67' East of the center of OT-3
0.45' Dark brown v.f. SAND, little silt, little grass and roots, damp	1	S-1	0.95	2	10:25	1.7	0	10:27	
0.4' Brown v.f. SAND, 1-30mm pebble	2			5					
0.1' Gray brown v.f. SAND, some silt, damp	2			8					
0.4' Yellow brown f. to c. SAND, poorly sorted, damp	3	S-2	0.65	5	10:27	9.7	5.7	10:29	Raining lightly. Humidity still affecting the Microtip's performance
0.15' 40mm partly pulverized gneiss pebble	3			5					
0.1' Dark gray brown v.f. SAND/SILT, damp	4			4					
0.4' Gray brown v.f. SAND, little 4mm gravel, moist	5	S-3	0.9	1	10:30	57+	27	10:33	Sample sent to lab. Analyzed for TPH 418.1 and BTEX 8020
0.5' Dark gray brown v.f. SAND, little silt, moist	5			1					
first water	6			1					
0.7' Olive gray v.f. SAND, some fine sand, fine-med. gravel, wet	7	S-4	0.7	1	10:33	370	45	10:35	Discontinued microtip monitoring
	7			1					
	8			1					
0.3' Black v.f. PEAT and med.-coarse sub-angular GRAVEL trace white fine angular gravel, wet	9	S-5	0.5	2	10:47				
0.2' Dark gray SILT, cohesive, wet	10			1					
	10			2					
0.1' Black PEAT	11	S-6	1.1	1	10:53				
1.0' Dark gray v.f. SAND, some v.f.-fine gray sand, wet	11			2					
	12			4					
0.4' Black v.f.-fine SAND, little peat, wet	13	S-7	1.2	2	11:05				
0.8' Olive gray-dark gray v.f.-fine SAND, little silt, wet	13			1					
	14			2					
0.6' Gray black v.f. SAND, wet	15	S-8	0.6	1	11:15				
	15			1					
	16			1					
	17								16' bottom of boring Bottom of fuel oil vault is at 15'
	18								
	19								
	20								
	21								
	22								
	23								
	24								
	25								

tr - trace, < 10%  
 little <25%, >10%  
 some <40%, >25%  
 and <50%, >40%  
 v.f. - very fine  
 med. - medium

Well ERM-10 installed in this boring.

ERM - Northeast  
 375 Bridgeport Avenue, Shelton CT 06484 (203) 929-8687

# LOG OF BORING: B-3-4 (ERM-11)

Project name & location U.S. Submarine Base, Groton, CT		Project number 101.107	Date & time started 2/20/91 12:25	Date & time completed 2/20/91 13:50
Drilling company Connecticut Test Boring, Seymour, CT		Driller Chris DeAngelis	Ground elevation & datum 23.29' Subbase Datum	Completion depth 16.1'
Drilling equipment CME model 55 truck mounted rig		Method 4 1/4" HSA	Number of soil and/or rock samples: disturbed 8    undisturbed 0    rock core N/A	
Bit(s) 4 1/4" ID HSA shoe		Casing hammer N/A	Drop N/A	Ground Water level(s) information, in ft below ground
Split Spoon Sampler 1 1/2" X 24"		Sampler hammer 140 lb.	Drop 30"	Time 13:50 16:02 15:07
		Drilling angle & direction Vertical		Depth to Water 9.65 6.94 5.63
				Notes initial measure 2/20/91 2/21/91
				Geologist Noah Levine

SOIL DESCRIPTION	DEPTH (ft below grade)	SOIL SAMPLES				MICROTIP READINGS (ppm)			REMARKS
		No.	Recovery (ft)	Blow per 6 in.	Time taken	Sample	Ambient air	Time of meas.	
Sod	0								~ 68' South of the center of OT-3
0.8' Dark brown v.f. to fine SAND, little grass and roots, trace white fine sand, dry	1	S-1	1.3	2	12:30	0	0	12:32	recalibrated the Microtip
0.5' Yellow brown v.f. to fine SAND, trace lt. gray v.f. sand, trace coarse gravel, dry	2			3					
0.3' Yellow brown v.f. to fine SAND, trace white/black pulverized gneiss, dry	3	S-2	1.1	5	12:35	0	0	12:36	
0.3' Dark brown v.f. SAND, little silt, dry	4			9					
0.5' Olive brown v.f. to med. SAND, little med. gravel, dry	5	S-3	1.3	13	12:38	45	0	10:40	Microtip readings taken from the nose of a closed spoon. The Microtip readings are likely affected by the rain.
1.3' Olive brown v.f. to med. SAND, trace orange brown v.f. sand, dry	6			5					
0.4' Brown v.f. to coarse SAND, little med. grave	7	S-4	1.0	6	12:40	26.7	0	12:41	Sent sample to the lab
0.3' Lt. brown gray v.f. SAND, compact, dry	8			5					Analyzed for TPH 418.1 & BTEX 8020
0.3' Gray v.f. SAND, dry	9	S-5	0.8	1	12:58	1794	0	12:59	
0.8' Gray v.f. SAND, little silt, trace organics; sm. roots, wet	10			1					first water
1.2' Gray v.f. SAND, trace lt. gray silt	11	S-6	1.2	1	13:08	189	13.5	13:11	Rain becomes heavier. Discontinued microtip readings.
0.6' Gray v.f. SAND wet trace organic; sm. roots	12			0					
1.0' Gray v.f. SAND, wet	13	S-7	0.6	1	13:15				
	14			0					
	15	S-8	1.0	1	13:19				
	16			2					
	17			1					16' bottom of boring
	18			4					Bottom of fuel oil vault is at 15'
	19								
	20								
	21								
	22								
	23								
	24								
	25								

Well ERM-11 installed in this boring.

# CONSTRUCTION OF MONITORING WELL: ERM-1

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>			<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.			<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>	<b>Subase Vertical Datum</b>
<b>Surveyor</b> John Kopko Jr.			2/21/91	10:30	7.0'	<b>Ground elevation</b> 23.00 ft
<b>Date and time of completion</b> Feb. 21, 1991, 11:55		<b>Geologist</b> Noah Levine	2/22/91	13:14	5.65'	<b>Top of protective steel casing elevation</b> 23.00 ft
			2/25/91	9:06	5.73'	<b>Top of riser PVC pipe elevation</b> 22.62 ft
			3/14/91	9:15	5.65'	
			3/25/91	9:15	5.62'	
			3/26/91	9:10	5.64'	

<b>GENERALIZED SOIL DESCRIPTION</b>	<b>ELEVATIONS</b> (ft above Subase Datum)	<b>DEPTHS</b> (ft below ground, <b>not to scale</b> )	<b>CONSTRUCTION DETAILS</b>
	23.00	0.00	
Macadam	22.62	0.38	
Dark brown v.f.-coarse SAND			
Brown fine-med. SAND	22.00	1.00	
	21.00	2.00	
	19.46	3.54	
Brown v.f.-fine SAND			
Brown/dark brown fine-coarse SAND	10.46	12.54	
Brown/yellow brown/black fine-coarse SAND	9.96	13.04	
	7.00	16.00	

**REMARKS (Installation, development) :**  
 2' x 2' Concrete pad surrounding a 9" diameter, 12" deep curb box  
 Secured with two 3/4" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 14, 1991.  
 About 30 gallons of water removed and delivered to an onsite oil/water separator.

installed in boring B-1-1

## CONSTRUCTION OF MONITORING WELL: ERM-2

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT	<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>			<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.		<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>	<b>Subase Vertical Datum</b>
<b>Surveyor</b> John Kopko Jr.		2/22/91	10:35	7.5'	<b>Ground elevation</b> 22.07 ft
<b>Date and time of completion</b> Feb. 22, 1991, 11:30	<b>Geologist</b> Noah Levine	2/22/91	11:45	5.30'	<b>Top of protective steel casing elevation</b> 22.07 ft
		2/25/91	8:45	5.38'	<b>Top of riser PVC pipe elevation</b> 22.07 ft
		3/14/91	14:25	5.22'	
		3/25/91	10:10	5.27'	
		3/26/91	9:47	5.26'	21.54 ft

<u>GENERALIZED SOIL DESCRIPTION</u>	<u>ELEVATIONS</u> (ft above Subase Datum)	<u>DEPTHS</u> (ft below ground, <b>not to scale</b> )	<u>CONSTRUCTION DETAILS</u>
	22.07	0.00	GROUND SURFACE
.25' Macadam .25' Concrete Gray brown v.f.-med. SAND and gravel	21.54	0.53	
Dark brown and olive gray fine-med. SAND	21.07	1.00	<ul style="list-style-type: none"> <li>← PROTECTIVE STEEL CASING CEMENTED IN PLACE</li> <li>← RISER PIPE: 2 in I.D., schedule 40, threaded PVC</li> <li>← ANNULUS GROUTED WITH: Portland cement</li> <li>← SEAL: Bentonite pellets</li> </ul>
Gray-olive gray fine-med. SAND	20.07	2.00	<ul style="list-style-type: none"> <li>← SCREEN: 9 ft of 2 in I.D., schedule 40, threaded PVC, 0.010 in slot</li> </ul>
Brown-dark brown v.f.-med SAND	18.36	3.71	<ul style="list-style-type: none"> <li>← SAND/GRAVEL PACK: Morie #1 sand</li> </ul>
Olive Gray fine-coarse SAND	9.36	12.71	<ul style="list-style-type: none"> <li>← BOTTOM OF SCREEN:</li> </ul>
Yellow Brown fine-coarse SAND	8.86	13.21	<ul style="list-style-type: none"> <li>← BOTTOM CAP</li> <li>← SAND BACKFILL</li> </ul>
	6.07	16.00	DIAMETER OF BOREHOLE: 6 1/2 in.

**REMARKS (Installation, development):**  
 2' x 2' Concrete pad surrounding a 8" diameter, 10" deep curb box  
 Secured with three 9/16" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 14, 1991.  
 About 35 gallons of water removed and delivered to an onsite oil/water separator.

installed in boring B-1-4

# CONSTRUCTION OF MONITORING WELL: ERM-3

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>			<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.			<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>	<b>Subase Vertical Datum</b>
<b>Surveyor</b> John Kopko Jr.			2/22/91	12:40	8.0'	<b>Ground elevation</b> 21.03 ft
<b>Date and time of completion</b> Feb. 22, 1991, 13:35		<b>Geologist</b> Noah Levine	2/22/91	13:35	7.12'	<b>Top of protective steel casing elevation</b> 21.03 ft
			2/25/91	8:54	5.74'	<b>Top of riser PVC pipe elevation</b> 20.40 ft
			3/14/91	12:07	5.67'	
			3/25/91	10:17	5.88'	
			3/26/91	10:05	5.78'	

<u>GENERALIZED SOIL DESCRIPTION</u>	<u>ELEVATIONS</u> (ft above Subase Datum)	<u>DEPTHS</u> (ft below ground, <u>not to scale</u> )	<u>CONSTRUCTION DETAILS</u>
	21.03	0.00	
0.3' Macadam	20.40	0.63	
Brown fine-med. SAND. tr. Gravel			
	20.03	1.00	
Grey v.f.-med. SAND	19.03	2.00	
	17.81	3.22	
Olive gray v.f.-med. SAND			
	8.81	12.22	
	8.31	12.72	
	5.03	16.00	

**REMARKS (Installation, development):**  
 2' x 2' Concrete pad surrounding a 9" diameter, 12" deep curb box  
 Secured with two 3/4" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 14, 1991.  
 About 30 gallons of water removed and delivered to an onsite oil/water separator.

Installed in boring B-1-3

**ERM-Northeast**  
 375 Bridgeport Avenue, Shelton, CT 06484 (203) 929-8687

## CONSTRUCTION OF MONITORING WELL: ERM-4

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project No.</b> 101.107		<b>Ground water (ft below top PVC)</b>		<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.		<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>	<b>Subbase Vertical Datum</b>	
<b>Surveyor</b> John Kopko Jr.		2/21/91	12:34	7.0'	<b>Ground elevation</b>	
<b>Date and time of completion</b> Feb. 21, 1991, 13:50		2/21/91	13:49	6.84'	22.25 ft	
<b>Geologist</b> Noah Levine		2/21/91	15:18	5.52'	<b>Top of protective steel casing elevation</b>	
		2/22/91	13:18	5.36'	22.25 ft	
		2/25/91	9:00	5.51'	<b>Top of riser PVC pipe elevation</b>	
		3/14/91	10:54	5.44'	21.90 ft	

<u>GENERALIZED SOIL DESCRIPTION</u>	<u>ELEVATIONS</u> (ft above Subbase Datum)	<u>DEPTHS</u> (ft below ground, <b>not to scale</b> )	<u>CONSTRUCTION DETAILS</u>
	22.25	0.00	<p align="center">9" DIAMETER BOLTED PROTECTIVE STEEL CAP, FLUSH WITH GROUND</p> <p align="center">GROUND SURFACE</p>
Sod	21.90	0.35	
Dark brown v.f. SAND			
	21.25	1.00	
Brown fine-coarse SAND			
	20.25	2.00	
	18.72	3.53	
Dark brown-Olive gray fine-coarse SAND	9.72	12.53	
	9.22	13.03	
	6.25	16.00	

**REMARKS (Installation, development):**

2' x 2' Concrete pad surrounding a 9' diameter, 12' deep curb box  
 Secured with two 3/4" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 14, 1991.  
 About 35 gallons of water removed and delivered to an onsite oil/water separator.

installed in boring B-1-2

**ERM-Northeast**  
 375 Bridgeport Avenue, Shelton, CT 06484 (203) 929-8687

## CONSTRUCTION OF MONITORING WELL: ERM-5

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT	<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>			<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.		<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>	<b>Subase Vertical Datum</b>
<b>Surveyor</b> John Kopko Jr.		2/25/91	11:20	6.00	<b>Ground elevation</b> 21.94 ft
		2/25/91	12:08	4.50	<b>Top of protective steel casing elevation</b> 21.94 ft
		2/25/91	17:48	4.34	<b>Top of riser PVC pipe elevation</b> 21.94 ft
		3/18/91	9:24	4.10	
<b>Date and time of completion</b> Feb. 25, 1991, 12:15	<b>Geologist</b> Noah Levine	3/25/91	14:58	3.97	<b>Top of riser PVC pipe elevation</b> 21.67 ft
		3/26/91	12:18	4.02	

<b>GENERALIZED SOIL DESCRIPTION</b>	<b>ELEVATIONS</b> (ft above Subase Datum)	<b>DEPTHS</b> (ft below ground, <b>not to scale</b> )	<b>CONSTRUCTION DETAILS</b>
	21.94	0.00	<p align="center">8" DIAMETER BOLTED PROTECTIVE STEEL CAP, FLUSH WITH GROUND</p> <p align="center">GROUND SURFACE</p>
Macadam	21.67	0.27	
Dark brown v.f.-med. SAND			
	20.94	1.00	
Brown/gray/black v.f.-coarse SAND, some gravel	19.94	2.00	
	18.42	3.52	
Yellow brown fine-coarse SAND			
Olive gray and gray brown v.f.-med. SAND			
	9.42	12.52	
Dark gray med-coarse SAND	8.92	13.02	
	5.94	16.00	

**REMARKS (Installation, development) :**  
 2' x 2' Concrete pad surrounding a 8" diameter, 12" deep curb box  
 Secured with three 9/16" hex bolts and a padlocked expansion cap.

Well developed by pumping and surge block on March 18, 1991.  
 About 15 gallons of water removed and delivered to an onsite oil/water separator.

Installed in boring B-2-4

## CONSTRUCTION OF MONITORING WELL: ERM-6

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT	<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>			<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.		<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>	<b>Subase Vertical Datum</b>
<b>Surveyor</b> John Kopko Jr.		2/22/91	15:10	5.50'	<i>Ground elevation</i> 21.77 ft
		2/25/91	12:42	4.99'	<i>Top of protective steel casing elevation</i> 21.77 ft
		3/18/91	9:15	4.79'	
<b>Date and time of completion</b> Feb. 22, 1991, 15:40	<b>Geologist</b> Noah Levine	3/25/91	14:50	4.52'	<i>Top of riser PVC pipe elevation</i> 21.34 ft
		3/26/91	12:05	4.61'	

<u>GENERALIZED SOIL DESCRIPTION</u>	<u>ELEVATIONS</u> (ft above Subase Datum)	<u>DEPTHS</u> (ft below ground, <b>not to scale</b> )	<u>CONSTRUCTION DETAILS</u>
	21.77	0.00	
Sod	21.34	0.43	
Dark brown v.f. SAND			
	21.27	0.50	
Yellow brown, strong brown v.f.-coarse SAND	19.77	2.00	
	18.70	3.07	
Light olive brown v.f.-med. SAND			
Gray SILT			
Gray/dark gray v.f.-med. SAND	9.70	12.07	
	9.20	12.57	
Olive gray fine-med. SAND	5.77	16.00	

**REMARKS (Installation, development):**  
 2' x 2' Concrete pad surrounding a 9' diameter, 12" deep curb box  
 Secured with two 3/4" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 18, 1991.  
 About 15 gallons of water removed and delivered to an onsite oil/water separator.

installed in boring B-2-1

ERM-Northeast

375 Bridgeport Avenue, Shelton, CT 06484 (203) 929-8687

CONSTRUCTION OF MONITORING WELL: ERM-7

Project name & location U.S. Submarine Base, Groton, CT		Project No. 101.107		Ground water (ft below top PVC)			Elevation datum		
Drilling company Connecticut Test Boring Inc.		Date		Time		Water level(s)		Subase Vertical Datum	
Surveyor John Kopko Jr.		2/25/91		15:55		7.00'		Ground elevation	
Date and time of completion Feb. 25, 1991, 16:40		2/25/91		16:58		5.88'		21.85 ft	
Geologist Noah Levine		2/25/91		17:54		5.85'		Top of protective steel casing elevation	
		3/18/91		9:50		5.74'		21.85 ft	
		3/25/91		15:05		5.94'		Top of riser PVC pipe elevation	
		3/26/91		12:32		5.91'		21.38 ft	

GENERALIZED SOIL DESCRIPTION	ELEVATIONS (ft above Subase Datum)	DEPTHS (ft below ground, not to scale)	CONSTRUCTION DETAILS
	21.85	0.00	8" DIAMETER BOLTED PROTECTIVE STEEL CAP, FLUSH WITH GROUND
Sod	21.38	0.47	GROUND SURFACE
Dark brown v.f.-med. SAND			EXPANSION CAP WITH LOCK
Yellow brown fine-med. SAND			PROTECTIVE STEEL CASING CEMENTED IN PLACE
	20.85	1.00	RISER PIPE: 2 in I.D., schedule 40, threaded PVC
	19.35	2.50	ANNULUS GROUTED WITH: Portland cement
Dark brown v.f.-fine SAND	18.09	3.76	SEAL: 1.5 ft of bentonite pellets
Olive Gray v.f.-med. SAND			SCREEN: 9 ft of 2 in I.D., schedule 40, threaded PVC, 0.010 in slot
	9.09	12.76	SAND/GRAVEL PACK: Morie #1 sand
Dark gray v.f.-med SAND	8.59	13.26	BOTTOM OF SCREEN
	5.85	16.00	BOTTOM CAP
			SAND BACKFILL
			DIAMETER OF BOREHOLE: 6 1/2 in.

**REMARKS (Installation, development):**  
 2' x 2' Concrete pad surrounding a 8" diameter, 12" deep curb box  
 Secured with three 9/16" hex bolts and a padlocked expansion cap.

Well developed by pumping and surge block on March 18, 1991.  
 About 20 gallons of water removed and delivered to an onsite oil/water separator.  
 A sheen is evident on the purged water.  
 rubber piece of surge block lodged in well  
 installed in boring B-2-2

**ERM-Northeast**  
 375 Bridgeport Avenue, Shelton, CT 06484 (203) 929-8687

## CONSTRUCTION OF MONITORING WELL: ERM-8

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT	<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>			<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.		<i>Date</i>	<i>Time</i>	<i>Water level(s)</i>	<b>Subase Vertical Datum</b>
<b>Surveyor</b> John Kopko Jr.		2/25/91	12:55	7.50'	<b>Ground elevation</b> 22.04 ft
<b>Date and time of completion</b> Feb. 25, 1991, 13:55	<b>Geologist</b> Noah Levine	2/25/91	13:38	4.89'	<b>Top of protective steel casing elevation</b> 22.04 ft
		2/25/91	15:52	4.77'	
		3/18/91	9:50	4.55'	
		3/25/91	14:55	4.50'	<b>Top of riser PVC pipe elevation</b> 21.55 ft
		3/26/91	11:49	4.52'	

<b>GENERALIZED SOIL DESCRIPTION</b>	<b>ELEVATIONS</b> (ft above Subase Datum)	<b>DEPTHS</b> (ft below ground, <b>not to scale</b> )	<b>CONSTRUCTION DETAILS</b>
	22.04	0.00	<p align="center">8" DIAMETER BOLTED PROTECTIVE STEEL CAP, FLUSH WITH GROUND</p> <p align="center">GROUND SURFACE</p>
Macadam	21.55	0.49	
Yellow brown fine-med. SAND			
Olive gray fine-med. SAND	21.04	1.00	
	20.04	2.00	
	18.53	3.51	
Dark gray fine-med. SAND			
	9.53	12.51	
Olive Brown v.f.-med. SAND	9.03	13.01	
	6.04	16.00	

**REMARKS (Installation, development):**  
 2' x 2' Concrete pad surrounding a 8" diameter, 12" deep curb box  
 Secured with three 9/16" hex bolts and a padlocked expansion cap.

Well developed by pumping and surge block on March 18, 1991.  
 About 20 gallons of water removed and delivered to an onsite oil/water separator.

Installed in boring B-2-3

**ERM-Northeast**  
 375 Bridgeport Avenue, Shelton, CT 06484 (203) 929-8687

## CONSTRUCTION OF MONITORING WELL: ERM-9

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project No.</b> 101.107		<b>Ground water (ft below top PVC)</b>		<b>Elevation datum</b>	
<b>Drilling company</b> Connecticut Test Boring Inc.		<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>		<b>Subase Vertical Datum</b>	
<b>Surveyor</b> John Kopko Jr.		2/19/91	15:50	6.12'		<b>Ground elevation</b> 22.00 ft	
<b>Date and time of completion</b> Feb. 19, 1991, 15:40		2/20/91	15:53	4.84'		<b>Top of protective steel casing elevation</b> 22.00 ft	
<b>Geologist</b> Noah Levine		2/21/91	14:59	4.76'		<b>Top of riser PVC pipe elevation</b> 22.00 ft	
		2/25/91	9:37	4.88'			
		3/15/91	11:27	4.29'		<b>Top of riser PVC pipe elevation</b> 21.55 ft	
		3/25/91	12:15	4.82'			

<u>GENERALIZED SOIL DESCRIPTION</u>	<u>ELEVATIONS</u> (ft above Subase Datum)	<u>DEPTHS</u> (ft below ground, <b>not to scale</b> )	<u>CONSTRUCTION DETAILS</u>
	22.00	0	
Sod	21.55	0.45	
Dark brown v.f. SAND			
Brown fine-coarse SAND	21.25	0.75	
	20.50	1.50	
	18.44	3.56	
Brown fine-coarse SAND			
Gray v.f. SAND/ SILT			
	9.44	12.56	
Dk. brown/red brown v.f. SAND	8.94	13.06	
Gray SILT	5.00	17.00	

**REMARKS (Installation, development):**  
 2' x 2' Concrete pad surrounding a 9" diameter, 12" deep curb box  
 Secured with two 3/4" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 15, 1991.  
 About 30 gallons of water removed and delivered to an onsite oil/water separator.

installed in boring B-3-2

**ERM-Northeast**  
 375 Bridgeport Avenue, Shelton, CT 06484 (203) 929-8687

## CONSTRUCTION OF MONITORING WELL: ERM-10

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT	<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>			<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.		<i>Date</i>	<i>Time</i>	<i>Water level(s)</i>	<b>Subase Vertical Datum</b>
<b>Surveyor</b> John Kopko Jr.		2/20/91	12:00	2.91'	<i>Ground elevation</i> 22.00 ft
<b>Date and time of completion</b> Feb. 20, 1991, 12:00	<b>Geologist</b> Noah Levine	2/21/91	15:58	3.04'	<i>Top of protective steel casing elevation</i> 22.00 ft
		2/25/91	9:44	3.29'	<i>Top of riser PVC pipe elevation</i> 21.63 ft
		3/15/91	14:53	4.06'	
		3/25/91	12:27	2.80'	

<b>GENERALIZED SOIL DESCRIPTION</b>	<b>ELEVATIONS</b> (ft above Subase Datum)	<b>DEPTHS</b> (ft below ground, <b>not to scale</b> )	<b>CONSTRUCTION DETAILS</b>
	22.00	0.00	<p align="center">9" DIAMETER BOLTED PROTECTIVE STEEL CAP, FLUSH WITH GROUND</p> <p align="center">GROUND SURFACE</p>
Sod	21.63	0.37	
Dark brown/brown v.f. SAND			
	21.00	1.00	
Yellow brown fine-coase SAND			
	20.00	2.00	
Dark/olive gray v.f. SAND			
	19.34	2.66	
Black v.f. PEAT			
	10.34	11.66	
Black v.f.-fine SAND			
	9.84	12.16	
Gray black v.f. SAND			
	6.00	16.00	

**REMARKS (Installation, development):**  
 2' x 2' Concrete pad surrounding a 9" diameter, 12" deep curb box  
 Secured with two 3/4" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 15, 1991.  
 About 50 gallons of water removed and delivered to an onsite oil/water separator.

installed in boring B-3-3

# CONSTRUCTION OF MONITORING WELL: ERM-11

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT	<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>			<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.		<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>	<b>Subase Vertical Datum</b>
<b>Surveyor</b> John Kopko Jr.		2/20/91	13:50	9.65'	<b>Ground elevation</b> 23.29 ft
		2/20/91	16:02	6.94'	<b>Top of protective steel casing elevation</b> 23.29 ft
		2/21/91	15:07	5.63'	
		2/25/91	9:49	5.84'	
<b>Date and time of completion</b> Feb. 20, 1991, 13:45	<b>Geologist</b> Noah Levine	3/18/91	8:30	5.55'	<b>Top of riser PVC pipe elevation</b> 22.94 ft
		3/25/91	12:32	5.24'	

<u>GENERALIZED SOIL DESCRIPTION</u>	<u>ELEVATIONS</u> (ft above Subase Datum)	<u>DEPTHS</u> (ft below ground, <b>not to scale</b> )	<u>CONSTRUCTION DETAILS</u>
	23.29	0.00	
Sod	22.94	0.35	
Dark brown v.f.-fine SAND			
	22.29	1.00	
Yellow brown v.f.-fine SAND			
	20.79	2.50	
Olive brown v.f.-med. SAND			
	19.90	3.39	
Brown v.f.-coarse SAND			
	10.90	12.39	
Gray v.f. SAND			
	10.40	12.89	
Gray v.f. SAND			
	7.29	16.00	

**REMARKS (Installation, development) :**  
 2' x 2' Concrete pad surrounding a 9" diameter, 12" deep curb box  
 Secured with two 3/4" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 18, 1991.  
 About 15 gallons of water removed and delivered to an onsite oil/water separator.

installed in boring B-3-4

**ERM-Northeast**  
 375 Bridgeport Avenue, Shelton, CT 06484 (203) 929-8687

## CONSTRUCTION OF MONITORING WELL: ERM-12

<b>Project name &amp; location</b> U.S. Submarine Base, Groton, CT		<b>Project No.</b> 101.107	<b>Ground water (ft below top PVC)</b>		<b>Elevation datum</b>
<b>Drilling company</b> Connecticut Test Boring Inc.			<b>Date</b>	<b>Time</b>	<b>Water level(s)</b>
<b>Surveyor</b> John Kopko Jr.			2/19/91	15:00	8.38'
<b>Date and time of completion</b> Feb. 19, 1991, 13:45		<b>Geologist</b> Noah Levine	2/20/91	15:50	6.14'
			2/21/91	14:56	6.02'
			2/25/91	9:32	6.18'
			3/15/91	9:30	6.27'
			3/25/91	12:20	5.81'
					<b>Subase Vertical Datum</b>
					<b>Ground elevation</b> 22.92 ft
					<b>Top of protective steel casing elevation</b> 22.92 ft
					<b>Top of riser PVC pipe elevation</b> 22.56 ft

<u>GENERALIZED SOIL DESCRIPTION</u>	<u>ELEVATIONS</u> (ft above Subase Datum)	<u>DEPTHS</u> (ft below ground, <b>not to scale</b> )	<u>CONSTRUCTION DETAILS</u>
	22.92	0.00	
Sod	22.56	0.36	
Dark brown v.f. SAND			
	21.92	1.00	
Brown/gray brown fine-med. SAND, some gneissic gravel	20.42	2.50	
	20.09	2.83	
Gray brown.brown fine-med. SAND			
Gray medium SAND	11.09	11.83	
Gray v.f. SAND	10.59	12.33	
	6.92	16.00	

**REMARKS (Installation, development):**  
 2' x 2' Concrete pad surrounding a 9' diameter, 12' deep curb box  
 Secured with two 3/4" hex bolts and a pad locked expansion cap.

Well developed by pumping and surge block on March 15, 1991.  
 About 5 gallons of water removed and delivered to an onsite oil/water separator.  
 Very slow recharge

installed in boring B-3-1

**APPENDIX B**

**WELL DEVELOPMENT AND GROUND WATER SAMPLING LOGS**

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT		Well ID.	ERM-01	
Sampled by	N. Levine, L. Snyder	Date	3-26-91	Time	09:18
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer	<input checked="" type="checkbox"/>	Pump
	Temp ~ 15° C		Other		

**A. WATER TABLE:**

Well depth: (below top of casing) 13.04 ft.      Well elevation: (top of casing) 22.62 ft.

Depth to water table: (below top of casing) 5.62 ft.      Water table elevation: 17.00 ft.

Length of water column(LWC) 7.42 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	1.21	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =		gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =		gallons

3 x SV = 3.63 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Dark brown	Odor	No	Turbidity	Moderate
Was a film or layer present?			No	if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons    ~20 bails

Did the well go dry? no

**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Dark brown	Odor	no	Turbidity	Heavy
Was a film or layer present?			No	if yes, thickness	ft.

**E. CONDUCTIVITY** 480  $\mu$ mhos

**F. pH** 6.45

**G. TEMPERATURE** 12.9 ° C

**H. WELL SAMPLING NOTES:**

sketch map N

purging time Bailed 10:40-10:47    3-25-91

recharge rate good

sampling time 9:18

analysis TPH EPA method 418.1, BTEX, EPA method 602

Lock # \_\_\_\_\_

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT	Well ID.	ERM-02
Sampled by	N. Levine, L. Snyder	Date	3-26-91
		Time	9:50
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer <input checked="" type="checkbox"/> Pump <input type="checkbox"/>
	Temp ~ 15° C	Other	

**A. WATER TABLE:**

Well depth: (below top of casing) 13.21 ft.      Well elevation: (top of casing) 21.54 ft.

Depth to water table: (below top of casing) 5.27 ft.      Water table elevation: 16.27 ft.

Length of water column(LWC) 7.94 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = $0.163 \times (\text{LWC}) =$	<u>1.29</u> gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = $0.653 \times (\text{LWC}) =$	<u>        </u> gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = $1.469 \times (\text{LWC}) =$	<u>        </u> gallons

3 x SV = 3.88 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	No	Turbidity	None
Was a film or layer present?			No	if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 4.5 gallons          bails  
 Did the well go dry? no

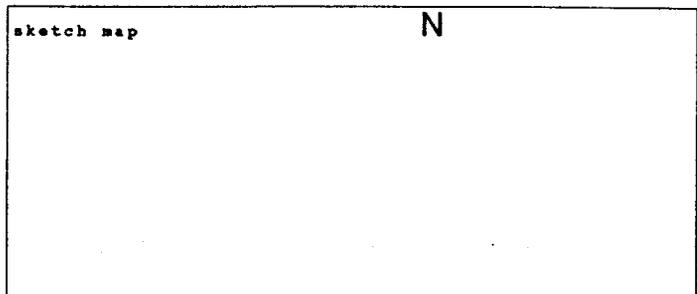
**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Dark brown	Odor	no	Turbidity	moderate
Was a film or layer present?			No	if yes, thickness	ft.

**E. CONDUCTIVITY** 405  $\mu\text{mhos}$

**F. pH** 6.52

**G. TEMPERATURE** 14.7 °C



**H. WELL SAMPLING NOTES:**

purging time Bailed 11:23-11:33 3-25-91

recharge rate good

sampling time 9:50

analysis TPH EPA method 418.1, BTEX, EPA method 602-

Lock #

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT		Well ID.	ERM-03
Sampled by	N. Levine, L. Snyder	Date	3-26-91	Time 10:09
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer X	Pump
	Temp ~ 15° C		Other	

**A. WATER TABLE:**

Well depth: (below top of casing) 12.72 ft.      Well elevation: (top of casing) 20.40 ft.

Depth to water table: (below top of casing) 5.88 ft.      Water table elevation: 14.52 ft.

Length of water column(LWC) 6.84 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	1.11	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =		gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =		gallons

3 x SV = 3.34 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	No	Turbidity	None
Was a film or layer present?			No	if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons    ~ 35 bails  
 Did the well go dry? yes

**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Dark brown	Odor	no	Turbidity	moderate light
Was a film or layer present?			No	if yes, thickness	ft.

**E. CONDUCTIVITY** 820  $\mu\text{mhos}$

**F. pH** 7.25

**G. TEMPERATURE** 20.6 ° C

sketch map N

**H. WELL SAMPLING NOTES:**

purging time	Bailed 11:20-11:30	3-25-91
recharge rate	slow	
sampling time	10:09	
analysis	TPH EPA method 418.1, BTEX, EPA method 602-	
Lock #		

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT	Well ID.	ERM-04
Sampled by	N. Levine, L. Snyder	Date	3-26-91
Weather	Cloudy AM, Sunny PM	Time	9:35
	Temp ~ 15° C	Sampling using	Bailer <input checked="" type="checkbox"/> Pump <input type="checkbox"/>
		Other	

**A. WATER TABLE:**

Well depth: (below top of casing) 13.03 ft.      Well elevation: (top of casing) 13.03 ft.

Depth to water table: (below top of casing) 5.30 ft.      Water table elevation: 7.73 ft.

Length of water column(LWC) 7.73 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	<u>1.26</u>	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =		gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =		gallons

3 x SV = 3.78 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	No
			Turbidity None
Was a film or layer present?	No	if yes, thickness _____ ft.	

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons    ~20 bails

Did the well go dry? no

**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Dark brown	Odor	no
			Turbidity moderate
Was a film or layer present?	No	if yes, thickness _____ ft.	

**E. CONDUCTIVITY**    200  $\mu\text{mhos}$

**F. pH**    6.65

**G. TEMPERATURE**    17.4 ° C

**H. WELL SAMPLING NOTES:**

N

sketch map

purging time      Bailed 10:43-10:47      3-25-91

recharge rate      good

sampling time      9:35

analysis      TPH EPA method 418.1, BTEX, EPA method 602

Lock # \_\_\_\_\_

**GROUND WATER SAMPLING FIELD LOG**

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT	Well ID.	ERM-05
Sampled by	N. Levine, L. Snyder	Date	3-26-91
Weather	Cloudy AM, Sunny PM	Time	12:21
	Temp ~ 15° C	Sampling using	Bailer X Pump
		Other	

**A. WATER TABLE:**

Well depth: (below top of casing) 13.02 ft.      Well elevation: (top of casing) 21.67 ft.  
 Depth to water table: (below top of casing) 3.97 ft.      Water table elevation: 17.70 ft.

Length of water column(LWC) 9.05 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	<u>1.48</u> gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =	gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =	gallons

3 x SV = 4.43 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Dark brown	Odor	YES	Turbidity	Moderate
Was a film or layer present?			No	if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons ~30 bails  
 Did the well go dry? no

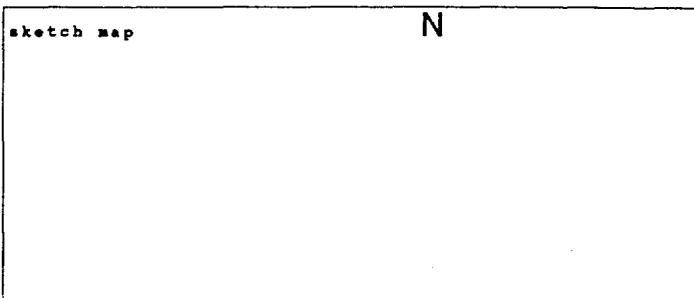
**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Dark brown	Odor	YES	Turbidity	moderate
Was a film or layer present?			No	if yes, thickness	ft.

**E. CONDUCTIVITY** 478  $\mu$ mhos

**F. pH** 6.69

**G. TEMPERATURE** 14.2 °C



**H. WELL SAMPLING NOTES:**

purging time      Bailed 11:42-11:55      3-25-91  
 recharge rate      good  
 sampling time      12:21  
 analysis      TPH EPA method 418.1, BTEX, EPA method 602.  
 Lock #      No sheen present. However, the water had a distinct petroleum odor

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT		Well ID.	ERM-06
Sampled by	N. Levine, L. Snyder	Date	3-26-91	Time 12:07
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer <input checked="" type="checkbox"/>	Pump <input type="checkbox"/>
	Temp ~ 15° C		Other	

**A. WATER TABLE:**

Well depth: (below top of casing) 12.57 ft.      Well elevation: (top of casing) 21.34 ft.

Depth to water table: (below top of casing) 4.52 ft.      Water table elevation: 16.82 ft.

Length of water column(LWC) 8.05 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	1.31	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =		gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =		gallons

3 x SV = 3.94 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	No	Turbidity	None
Was a film or layer present?			No	if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons ~ 30 bails

Did the well go dry? no

**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Dark brown	Odor	No	Turbidity	moderate
Was a film or layer present?			No	if yes, thickness	ft.

**E. CONDUCTIVITY** 478  $\mu$ hos

**F. pH** 6.75

**G. TEMPERATURE** 18.4 ° C

**H. WELL SAMPLING NOTES:**

N

sketch map

purging time Bailed 11:40-11:55 3-25-91

recharge rate \_\_\_\_\_

sampling time 12:07

analysis TPH EPA method 418.1, BTEX, EPA method 602

Lock # \_\_\_\_\_

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT	Well ID.	ERM-07	ERM-17
Sampled by	N. Levine, L. Snyder	Date	3-26-91	Time 12:07
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer X	Pump
	Temp ~ 15° C		Other	

**A. WATER TABLE:**

Well depth: (below top of casing) 13.26 ft.      Well elevation: (top of casing) 21.38 ft.

Depth to water table: (below top of casing) 5.94 ft.      Water table elevation: 15.44 ft.

Length of water column(LWC) 7.32 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	<u>1.19</u>	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =		gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =		gallons

3 x SV = 3.58 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	YES	Turbidity	None
Was a film or layer present?	No			if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons    ~ 30 bails  
 Did the well go dry? no

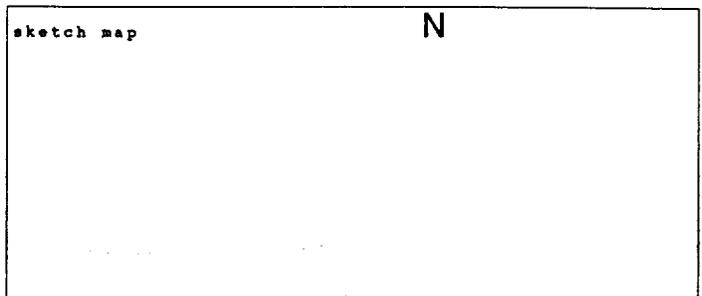
**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Brown-gray	Odor	YES	Turbidity	moderate light
Was a film or layer present?	No			if yes, thickness	ft.

**E. CONDUCTIVITY** 670  $\mu$ mhos

**F. pH** 6.92

**G. TEMPERATURE** 26 °C



**H. WELL SAMPLING NOTES:**

purging time      Bailed 12:15-12:32      3-25-91

recharge rate

sampling time      12:35 for ERM-07      12:44 for ERM-17

analysis      TPH EPA method 418.1, BTEX, EPA method 602-

Lock #      Clear at first, then brown, then clear towards the end of bailing

ERM-17 is a blind duplicate of ERM-07

Temperatures ranged from 21.7° C to 27.6° C

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT		Well ID.	ERM-08			
Sampled by	N. Levine, L. Snyder		Date	3-26-91	Time	11:51	
Weather	Cloudy AM, Sunny PM		Sampling using	Bailer	X	Pump	
	Temp ~ 15° C			Other			

### A. WATER TABLE:

Well depth: (below top of casing) 13.01 ft.      Well elevation: (top of casing) 21.55 ft.

Depth to water table: (below top of casing) 4.50 ft.      Water table elevation: 17.05 ft.

Length of water column(LWC) 8.51 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	<u>1.39</u> gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =	gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =	gallons

3 x SV = 4.16 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

### B. PHYSICAL APPEARANCE AT START:

Color	Dark brown	Odor	No	Turbidity	Mod. to heavy
Was a film or layer present?			No	if yes, thickness	ft.

### C. PREPARATION OF WELL FOR SAMPLING:

Amount of water removed before sampling 5 gallons ~20 bails

Did the well go dry? no

### D. PHYSICAL APPEARANCE DURING SAMPLING:

Color	Dark brown	Odor	No	Turbidity	Mod. to heavy
Was a film or layer present?			No	if yes, thickness	ft.

E. CONDUCTIVITY 650  $\mu\text{mhos}$

F. pH 6.81

G. TEMPERATURE 17.7 °C

### H. WELL SAMPLING NOTES:

sketch map

N

purging time Bailed 12:05-12:20 3-25-91

recharge rate

sampling time 11:51

analysis TPH EPA method 418.1, BTEX, EPA method 602-

Lock #

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT		Well ID.	ERM-09	
Sampled by	N. Levine, L. Snyder	Date	3-26-91	Time	11:21
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer	X	Pump
	Temp ~ 15° C		Other		

**A. WATER TABLE:**

Well depth: (below top of casing) 13.06 ft.      Well elevation: (top of casing) 21.55 ft.

Depth to water table: (below top of casing) 4.82 ft.      Water table elevation: 16.73 ft.

Length of water column(LWC) 8.24 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	1.34	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =		gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =		gallons

3 x SV = 4.03 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Brown	Odor	Yes	Turbidity	Moderate
Was a film or layer present?		Yes		if yes, thickness	sheen

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons    ~20 bails

Did the well go dry? no

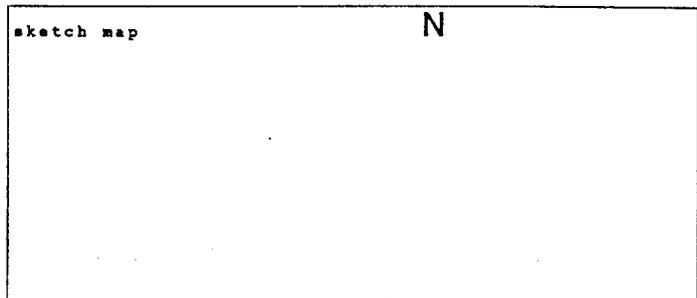
**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Brown	Odor	Yes	Turbidity	Moderate
Was a film or layer present?		Yes		if yes, thickness	sheen

**E. CONDUCTIVITY** 275  $\mu\text{mhos}$

**F. pH** 6.55

**G. TEMPERATURE** 16.9 °C



**H. WELL SAMPLING NOTES:**

purgig time	Bailed 12:45-12:52	3-25-91
recharge rate		
sampling time	<u>11:21</u>	
analysis	TPH EPA method 418.1, BTEX, EPA method 602-	
Lock #	Odor was detected as bails were pulled out of well. Odor was distinguishable from the odor coming from the tank vent. Sheen on the bailer and in the measuring bucket was evident.	

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT	Well ID.	ERM-10
Sampled by	N. Levine, L. Snyder	Date	3-26-91
Weather	Cloudy AM, Sunny PM	Time	10:50
	Temp ~ 15° C	Sampling using	Bailer <input checked="" type="checkbox"/> Pump _____
		Other	

**A. WATER TABLE:**

Well depth: (below top of casing) 12.16 ft.      Well elevation: (top of casing) 21.63 ft.

Depth to water table: (below top of casing) 2.80 ft.      Water table elevation: 18.83 ft.

Length of water column(LWC) 9.36 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	<input type="text" value="1.53"/> gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =	<input type="text"/> gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =	<input type="text"/> gallons

3 x SV =  gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	No
		Turbidity	none
Was a film or layer present?	No	if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling  gallons  bails  
 Did the well go dry?  DTW in well lowered 3' immediately after bailing

**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Brown	Odor	No
		Turbidity	Moderate to light
Was a film or layer present?	No	if yes, thickness	ft.

**E. CONDUCTIVITY**   $\mu\text{mhos}$

**F. pH**

**G. TEMPERATURE**  ° C

**H. WELL SAMPLING NOTES:**

sketch map N

purging time	Bailed 12:45-12:55	3-25-91
recharge rate	Good	
sampling time	10:50	
analysis	TPH EPA method 418.1, BTEX, EPA method 602-	
Lock #		

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT	Well ID.	ERM-11
Sampled by	N. Levine, L. Snyder	Date	3-26-91
		Time	11:00
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer <input checked="" type="checkbox"/> Pump <input type="checkbox"/>
	Temp ~ 15° C		Other <input type="checkbox"/>

**A. WATER TABLE:**

Well depth: (below top of casing) 12.89 ft.      Well elevation: (top of casing) 22.94 ft.

Depth to water table: (below top of casing) 5.24 ft.      Water table elevation: 17.70 ft.

Length of water column(LWC) 7.65 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = $0.163 \times (\text{LWC}) =$	<u>1.25</u>	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = $0.653 \times (\text{LWC}) =$		gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = $1.469 \times (\text{LWC}) =$		gallons

3 x SV = 3.74 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	No	Turbidity	none
Was a film or layer present?			No	if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons ~40 bails  
 Did the well go dry?  yes  no < 1/4' of water in well after bailing

**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Light brown	Odor	No	Turbidity	Moderate
Was a film or layer present?			No	if yes, thickness	ft.

**E. CONDUCTIVITY** 350  $\mu\text{mhos}$

**F. pH** 6.62

**G. TEMPERATURE** 15.3 ° C

**H. WELL SAMPLING NOTES:**

N

sketch map

purging time Bailed 13:28-13:40 3-25-91

recharge rate slow

sampling time 11:00

analysis TPH EPA method 418.1, BTEX, EPA method 602

Lock # \_\_\_\_\_

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT		Well ID.	ERM-12	
Sampled by	N. Levine, L. Snyder	Date	3-26-91	Time	11:11
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer	X	Pump
	Temp ~ 15° C		Other		

**A. WATER TABLE:**

Well depth: (below top of casing) 12.33 ft.      Well elevation: (top of casing) 22.56 ft.

Depth to water table: (below top of casing) 5.81 ft.      Water table elevation: 16.75 ft.

Length of water column(LWC) 6.52 ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = $0.163 \times (\text{LWC}) =$	<u>1.06</u>	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = $0.653 \times (\text{LWC}) =$		gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = $1.469 \times (\text{LWC}) =$		gallons

3 x SV = 3.19 gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	No	Turbidity	none
Was a film or layer present?			No	if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling 5 gallons      bails  
 Did the well go dry? yes

**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Light brown	Odor	No	Turbidity	Moderate light
Was a film or layer present?			No	if yes, thickness	ft.

**E. CONDUCTIVITY** 440  $\mu\text{mhos}$

**F. pH** 6.54

**G. TEMPERATURE** 20.8 °C

sketch map N

**H. WELL SAMPLING NOTES:**

purgig time	Bailed 13:22-13:35	3-25-91
recharge rate	slow	
sampling time	11:11	
analysis	TPH EPA method 418.1, BTEX, EPA method 602	
Lock #		

# GROUND WATER SAMPLING FIELD LOG

ERM-Northeast

Job # 101.107

Sample Location	U. S. Submarine Base, Groton, CT	Well ID.	Rinsate	
Sampled by	N. Levine, L. Snyder	Date	3-26-91	Time
				9:00
Weather	Cloudy AM, Sunny PM	Sampling using	Bailer	X
	Temp ~ 15° C		Other	
			Pump	

**A. WATER TABLE:**

Well depth: \_\_\_\_\_ ft.      Well elevation: \_\_\_\_\_ ft.  
 (below top of casing)      (top of casing)

Depth to water table: \_\_\_\_\_ ft.      Water table elevation: \_\_\_\_\_ ft.  
 (below top of casing)

Length of water column(LWC) \_\_\_\_\_ ft.

Static volume of water in well:  $SV = (\text{radius} \times \text{radius}) \times 0.163 \times (\text{LWC})$

3 x SV ~ .5 gal/ft.	SV of 2" dia. wells = 0.163 x (LWC) =	<input type="text"/>	gallons
3 x SV ~ 2.0 gal/ft.	SV of 4" dia. wells = 0.653 x (LWC) =	<input type="text"/>	gallons
3 x SV ~ 4.4 gal/ft.	SV of 6" dia. wells = 1.469 x (LWC) =	<input type="text"/>	gallons

3 x SV =  gallons

3" x 3' diameter bailer ~ 1.1 gallons  
 1.25" x 3' diameter bailer ~ .11 gallons

**B. PHYSICAL APPEARANCE AT START:**

Color	Clear	Odor	No	Turbidity	none
Was a film or layer present?		No		if yes, thickness	ft.

**C. PREPARATION OF WELL FOR SAMPLING:**

Amount of water removed before sampling  gallons  bails  
 Did the well go dry?  N/A

**D. PHYSICAL APPEARANCE DURING SAMPLING:**

Color	Clear	Odor	No	Turbidity	none
Was a film or layer present?		No		if yes, thickness	ft.

**E. CONDUCTIVITY**   $\mu\text{mhos}$

**F. pH**

**G. TEMPERATURE**  °C

sketch map

N

**H. WELL SAMPLING NOTES:**

purging time \_\_\_\_\_  
 recharge rate \_\_\_\_\_  
 sampling time 9:00  
 analysis TPH EPA method 418.1, BTEX, EPA method 602-  
 Lock # Poured laboratory supplied water through a clean sampling bailer and then collected the rinsate from the bottom of the bailer in laboratory supplied containers. Samples were labeled Field Blank.

APPENDIX C

WELL ELEVATION SURVEY REPORT

# JOHN KOPKO, JR. & ASSOCIATES, INC.

*Surveyors / Engineers / Planners*

ONE BULKELEY PLACE  
NEW LONDON, CONNECTICUT 06320

TELEPHONE (203) 443-4597  
FACSIMILE (203) 447-0421

April 17, 1991

Mr. Noah Levine  
ERM-Northeast  
375 Bridgeport Avenue  
Shelton, CT 06484

RE: Vertical survey  
Submarine Base  
Groton, Connecticut

Dear Mr. Levine:

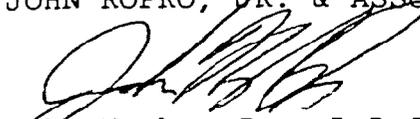
Pursuant to your request, on April 15, 1991, we performed a vertical survey of certain monitoring wells at the Submarine Base at Groton, Connecticut. Our results are listed below. The test well numbers are as marked in the field by you and the top elevation is the elevation of the larger outer pipe casing and the well top elevation is that of the smaller casing inside the outer pipe casing.

WELL NO.	TOP ELEVATION	WELL TOP ELEVATION
ERM 1	23.00	22.62
ERM 2	22.07	21.54
ERM 3	21.03	20.40
ERM 4	22.25	21.90
ERM 5	21.94	21.67
ERM 6	21.77	21.34
ERM 7	21.85	21.38
ERM 8	22.04	21.55
ERM 9	22.00	21.55
ERM 10	22.00	21.63
ERM 11	23.29	22.94
ERM 12	22.92	22.56
MW 5	22.09	21.38
MW 6	22.48	22.03
MW 7	22.06	21.57
MW 8	21.93	21.83

Should you have any questions concerning this project, please feel free to call at any time.

Very truly yours,

JOHN KOPKO, JR. & ASSOCIATES



John Kopko, Jr., L.L.S.  
President

kb

# DATUMS



Highest Observed	9/38	10.76
MH HW		3.08
M HW		2.78
M Tide		1.49
NGVD '29	67 adj	1.07
MLW		0.20
MLLW		0.00
lowest Observed	2/76	-3.82
SUBASE		-0.251

DJ 12/25/89

**APPENDIX D**  
**LABORATORY REPORTS**



*25 Years of Service*

One Research Drive  
Stamford, CT 06906  
(203) 325-1371  
Fax (203) 357-0166

Technical Report

prepared for

ERM-NORTHEAST  
375 Bridgeport Avenue  
Shelton, CT 06484  
Attention: Mr. Noah Levine

March 15, 1991

Project No. 91050

**Environmental Consulting & Air Quality Services**

• Emissions Measurement • Dispersion Modeling • Indoor Air Evaluations • CEM Mobile Van Capabilities •

March 15, 1991  
Project No. 91050  
ERM-Northeast  
375 Bridgeport Avenue  
Shelton, CT 06484  
Attention: Mr. Noah Levine

---

### Purpose and Results

Fourteen soil samples, one trip blank and one equipment rinse (blank) from ERM project no. 101.107, U.S. Sub Base were submitted to the YSC Laboratory for determination of BTEX(8020 volatiles) and total petroleum hydrocarbons (TPH).

The samples were analyzed according to the methods described in SW-846, 3rd edition.

The results of the analyses are shown in Tables 1.0 and 2.0 as follows.

Table 1.0- TPH Data

<u>Sample I.D.</u>	<u>Total Petroleum Hydrocarbons</u>
B1-1 2'-4'	< 25 ppm (mg/kg)
B1-2 4'-6'	< 25
B1-3 6'-8'	49 -
B1-4 6'-8'	< 25
B1-35 6'-8'	< 25 -
B2-1 2'-4'	< 25
B2-2 2'-4'	6,930
B2-3 4'-6'	< 25
B2-4 2'-4'	545
B3-1 4'-6'	< 25
B3-2 2'-4'	< 25
B3-3 4'-6'	< 25
B3-4 6'-8'	< 25
Equipment Blank Rinse	< 5 ppm (mg/L)

Table 2.0- Volatiles(8020)Data-PPB(continued)

PARAMETER (602/8020 list)	Sample Number					
	MDL	B1-1	B1-2	B1-3	B1-4	B2-1
Benzene	10	ND	ND	ND	ND	ND
Toluene	10	ND	ND	ND	ND	ND
Ethyl Benzene	10	ND	ND	ND	ND	ND
p- & m- Xylenes	10	ND	ND	ND	ND	ND
o-Xylene	10	ND	ND	ND	ND	ND

1. Minimum Detectable Limit (Practical Quantitation Limit) 2. Not Detectable

PARAMETER (602/8020 list)	Sample Number					
	MDL	B2-2	B2-3	B2-4	B3-1	B3-2
Benzene	10	ND	ND	ND	ND	ND
Toluene	10	ND	ND	ND	ND	ND
Ethyl Benzene	10	ND	ND	ND	ND	ND
p- & m- Xylenes	10	ND	ND	ND	ND	ND
o-Xylene	10	ND	ND	ND	ND	ND

1. Minimum Detectable Limit (Practical Quantitation Limit) 2. Not Detectable

PARAMETER (602/8020 list)	Sample Number					
	MDL	B3-3	B3-4	B1-35	EQ.BLK.	TRIP BLK
Benzene	10	ND	ND	ND	ND	ND
Toluene	10	ND	ND	ND	ND	ND
Ethyl Benzene	10	ND	ND	ND	ND	ND
p- & m- Xylenes	10	ND	ND	ND	ND	ND
o-Xylene	10	ND	ND	ND	ND	ND

1. Minimum Detectable Limit (Practical Quantitation Limit) 2. Not Detectable



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Stamford, CT 06906  
(203) 325-1371  
Fax (203) 357-0166

## *Technical Report*

*prepared for*

**ERM-NORTHEAST  
375 Bridgeport Avenue  
Shelton, CT 06484  
Attention: Mr. Noah Levine**

**April 9, 1991**

**Project No. 91087**

**Environmental Consulting & Air Quality Services**

• Emissions Measurement • Dispersion Modeling • Indoor Air Evaluations • CEM Mobile Van Capabilities •

April 9, 1991  
Project No. 91087  
ERM-Northeast  
375 Bridgeport Avenue  
Shelton, CT 06484  
Attention: Mr. Noah Levine

---

### Purpose and Results

Thirteen ground waters, one trip blank and one equipment rinse (blank) from ERM project no. 101.107, U.S. Sub Base were submitted to the YSC Laboratory for determination of BTEX(8020 volatiles) and total petroleum hydrocarbons(TPH).

The samples were analyzed according to the methods described in SW-846, 3rd edition.

The results of the analyses are shown in Tables 1.0 and 2.0 as follows.

Table 1.0- TPH Data

<u>Sample I.D.</u>	<u>Total Petroleum Hydrocarbons</u>
ERM-1	< 5 ppm (mg/l)
ERM-2	< 5
ERM-3	< 5
ERM-4	< 5
ERM-5	< 5
ERM-6	< 5
ERM-7	< 5
ERM-8	< 5
ERM-9	< 5
ERM-10	< 5
ERM-11	< 5
ERM-12	< 5
ERM-17	< 5
Equipment Blank Rinse	< 5

Table 2.0- Volatiles (8020) Data-PPB (continued)

Parameter	Sample Number					
	MDL	ERM-1	ERM-2	ERM-3	ERM-4	ERM-5
(602/8020 list)						
Benzene	1	ND	ND	ND	ND	1700
Toluene	1	ND	ND	ND	ND	ND
Ethyl Benzene	1	ND	ND	ND	ND	106
p- & m- Xylenes	1	ND	ND	ND	ND	780
o-Xylene	1	ND	ND	ND	ND	ND

1. Minimum Detectable Limit (Practical Quantitation Limit) 2. Not Detectable

PARAMETER	Sample Number					
	MDL	ERM-6	ERM-7	ERM-8	ERM-9	ERM-10
(602/8020 list)						
Benzene	1	ND	25	1470	ND	ND
Toluene	1	ND	29	115	ND	ND
Ethyl Benzene	1	ND	ND	990	ND	ND
p- & m- Xylenes	1	ND	16	1180	ND	ND
o-Xylene	1	ND	ND	ND	ND	ND

1. Minimum Detectable Limit (Practical Quantitation Limit) 2. Not Detectable

PARAMETER	Sample Number					
	MDL	ERM-11	ERM-12	ERM-17	EQ.BLK.	TRIP BLK
(602/8020 list)						
Benzene	1	3	ND	23	ND	ND
Toluene	1	9	ND	24	ND	ND
Ethyl Benzene	1	ND	ND	ND	ND	ND
p- & m- Xylenes	1	9	ND	15	ND	ND
o-Xylene	1	4	ND	ND	ND	ND

1. Minimum Detectable Limit (Practical Quantitation Limit) 2. Not Detectable

○ 175 Froehlich Farm Boulevard • Woodbury • New York 11797 ☎ (516) 921-4300

Project No. / I.D. 101.107 Sheet No. 1 of 2  
 Sampler(s) N. LEVINE L. SNYDER Bottles Supplied By \_\_\_\_\_  
 Date Sampled 3-26-91 Bottle Batch No. \_\_\_\_\_

Sample I.D.	Sample Description	Sample Type	Sampling Method	Time	No. Of Containers	Analysis Requested	Remarks
ERM-1	GROUND WATER	AQUEOUS	BAILER	9:18	3	TPH BTX 418.1 602	
ERM-2	↓	↓	↓	9:50	3	↓	
ERM-3	↓	↓	↓	10:09	3	↓	
ERM-4	↓	↓	↓	9:35	3	↓	
ERM-5	↓	↓	↓	12:21	3	↓	PROBABLE HIGH TPH & BTX
ERM-6	↓	↓	↓	12:07	3	↓	
ERM-7	↓	↓	↓	12:35 <del>12:44</del>	3	↓	PROBABLE HIGH TPH & BTX
ERM-8	↓	↓	↓	11:51	3	↓	
ERM-9	↓	↓	↓				

Relinquished By (Signature)	Received By (Signature)	Date/Time	Reason For Transfer
<i>[Signature]</i>	<i>Robert Brady</i>	3/27/91	TRANSPORT TO LAB
<i>NORMAN LEVINE</i>	<i>Robert Brady</i>	3/27/91 11:08	RECEIVED FOR LAB

○ 175 Froehlich Farm Boulevard • Woodbury • New York 11797 ☎ (516) 921-4300

Project No. / I.D. 101107 Sheet No. 2 of 2  
 Sampler(s) N. LEVINE L. SNYDER Bottles Supplied By \_\_\_\_\_  
 Date Sampled 3-26-91 Bottle Batch No. \_\_\_\_\_

Sample I.D.	Sample Description	Sample Type	Sampling Method	Time	No. Of Containers	Analysis Requested	Remarks
ERM-9	GROUND WATER	(GROUND WATER) AQUEOUS	BAILER	11:21	3	TPH 418.1 BTEX 602	PROBABLE HIGH TPH & BTEX
ERM-10	↓	↓	↓	10:50	3	↓	
ERM-11	↓	↓	↓	11:00	3	↓	
ERM-12	↓	↓	↓	11:11	3	↓	
ERM-17	↓	↓	↓	12:44	3	↓	PROBABLE HIGH TPH & BTEX
FB-1	RINSEATE BLANK	↓	↓	9:00	3	↓	
TRIP	TRIP BLANK	↓	↓		1	↓	

Relinquished By (Signature)	Received By (Signature)	Date/Time	Reason For Transfer
<i>[Signature]</i>	<i>[Signature]</i>	3/27/91	TRANSPORT TO LAB
NOAH LEVINE	ARON Q. BRADLEY	3/27/91 11:00 AM	141 v. 6 per lab