REMEDIAL INVESTIGATION

SHORE REALTY SITE
Glenwood Landing, New York

Prepared for
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VOLUME II

1.0 EXECUTIVE SUMMARY

Roux Associates, Inc. has completed a Remedial Investigation of the Shore Realty Site in Glenwood Landing, New York. The site is listed on the NPL and the investigation was done on behalf of a group of third party defendants in a legal action regarding the Site. The methods of investigation and the results obtained are described in this report.

The Shore Realty Site is a 3.2 acre former fuel storage terminal that was reportedly used for liquid chemical storage and alternative fuels blending during the 1970s and early 1980s. Although all liquid chemicals stored in tanks and drums were removed from the Site by the NYSDEC in 1985, spills, leaks or other activities have left soil at the Site contaminated.

The Remedial Investigation described in this report included a reconnaissance program, installation and sampling of nine new wells, the collection and analysis of 38 soil and sediment samples, numerous air measurements for organic vapors and a ground-water contamination and flow assessment. The investigation was carried out by Roux Associates during the period October 1987 through January 1988.

Chemical analyses of soil, and of floating organics found in certain locations on the water table, show that ethylbenzene, toluene and xylene are the principal chemicals present. Only substantially lower levels of other compounds, including bis (2-ethylhexyl) phthalate, napthalene and several phenolic compounds, were found in the soils. Very shallow ground water was sampled from wells that bridged the water table and, in some cases contained layers of organic liquid. Some of these samples contained substantial levels of organic compounds and metals. Deeper ground water was generally uncontaminated with only a few compounds exceeding drinking water standards in three intermediate depth (15-25 feet below ground level) wells. Sediments from Hempstead Harbor and Motts Cove contained various levels of organic compounds and metals.

The Remedial Investigation found no ground-water or air pollution that could significantly impact public health or the environment. The principal threat from this Site, that of fire, explosion or direct contact with liquid wastes, was eliminated when the DEC removed all of the surface stored liquid chemicals. Based on The Remedial Investigation results, and subject to additional evaluation in the Feasibility Study, the only possible significant environmental impact at present is from organic liquids floating on the water table or sorbed on soil near the water table. The pathways for these liquids to reach human or environmental receptors are by seepage into the harbor and by direct contact by unauthorized personnel entering the site. Organic chemicals have been detected at low levels in the harbor sediments adjacent to the bulkheads. The significance of these levels, if any, will be addressed in the FS. The potential for impact from direct contact of unauthorized persons entering the Site is minimized by the fact that the organic chemicals are below ground and the Site is fenced with access restricted. Because there is a public boat ramp adjacent to the site, people could come into contact with contaminated sediments in this area.

The next step in the process of Site remediation is a Feasibility Study to evaluate and compare all available remedial options that may be applicable to the Shore Site. A Feasibility Study will be undertaken by Roux Associates as soon as the Remedial Investigation report has been approved by the appropriate regulatory agencies.

2.0 INTRODUCTION

In February 1987, Roux Associates, Inc. was retained by a group of third party defendants to conduct a Remedial Investigation/Feasibility Study (RI/FS) for The Shore Realty Site located at One Shore Road, Glenwood Landing, New York. The location of the Site is shown on Figure 1.

In May 1987, Roux Associates submitted a Work Plan for the RI/FS to the New York State Department of Law, the lead agency for this site. The Work Plan was approved in September 1987 and the Remedial Investigation was begun on October 13, 1987. Figure 2 is a Site map showing the locations of all tanks, buildings, bulkheads, wells, borings and other sampling points described in this report.

A description of the Shore Realty Site and its history are given in Section 3. As described in this section, all of the chemicals stored in tanks and drums at the Site have been removed. This Remedial Investigation is intended to define the nature and extent of subsurface contamination which may have resulted from Site operations, to identify all potential pathways for contaminant migration and potential receptors, and to determine, on a preliminary basis, if there are actual or potential human health or environmental impacts resulting from Site contamination.

Section 4 of this report describes the types of chemicals present in the subsurface at the Site, their physical and chemical characteristics, their behavior in the environment and their extent within the soil. Section 5 describes the Site hydrogeology, ground-water flow and ground-water quality. Section 6 is a preliminary discussion of public health and environmental concerns as a result of the contamination of the Site.

A Feasibility Study of possible remedial actions for the Shore Realty Site is the next step toward the ultimate clean-up of the Site. The Feasibility Study will utilize the data presented in this RI report and will follow the outline presented in the May 1987 Work Plan. A schedule for the Feasibility Study is given in Section 7.

3.0 SITE DESCRIPTION AND HISTORY

This section was prepared from documents and information provided by the NYSDEC and third party defendants, and has not been independently verified by Roux Associates. The information contained in this section is intended as a general overview of the physical setting and operating history of the Site to assist the reader in understanding the subsequent sections of this report. It is not intended to be a detailed or authoritative chronology.

The Shore Realty Site is located at One Shore Road, Glenwood Landing, New York. The Site is approximately 3.2 acres in size, and is surrounded on three sides by water; Motts Cove to the east and south, and Hempstead Harbor to the west. Both water bodies and associated intertidal areas are designated tidal wetlands by the NYSDEC. The Site is at an elevation of approximately 10-25 feet above sea level.

The Site is surrounded by industrial, commercial and residential areas (Figure 1). Directly north of the Site is a fuel oil terminal and directly northeast is a boat yard. Farther north along Shore Road is a LILCO power station with its own fuel oil storage tanks.

The first use of the Shore Realty property for fuel storage purposes was in 1939 by Texaco Oil Company. Texaco reportedly sold the property to Phillips Petroleum in 1964. Phillips used the property to store gasoline and fuel oil in above-ground tanks until 1972.

In 1974 Circle Terminal Corp. leased the facility from Phillips. The Circle lease was terminated in 1977 and the facility was subsequently leased to the Mattiace Petrochemical Company which used it for the storage and distribution of chemical solvents. Spills of organic chemicals reportedly occurred during this period, including a toluene spill in October 1978.

In October 1980, Mattiace Petrochemicals received 34 citations regarding the integrity of the storage tanks and for safety violations. Mattiace Petrochemical was then ordered by the New York State Department of Transportation and United States Coast Guard to initiate a clean up of the property but failed to comply with the order. Table 1 lists the chemicals reportedly stored at the Site by Mattice Petrochemical Company. The locations of the tanks referenced on Table 1 are shown on Figure 3.

In July 1980 Phillips sold the property to Messrs. Joseph Saleh and Ammon Bartur. The new owners leased the property to Applied Environmental Services (AES) later that same year.

AES operated the facility for the blending of various chemical waste materials that have a heat value to provide alternate fuel sources, as well as operating a hazardous waste storage facility. However, AES was subsequently cited for storing and handling hazardous wastes without a permit under part 360 of the New York State regulations. Table 2 lists the materials that were reportedly stored on the property during the AES tenure.

While AES occupied the site, a series of monitoring wells, a recovery trench, and a floating liquid chemical recovery pump were installed. The approximate locations of the wells and trench are shown on Figure 3. The trench is reported to have recovered approximately 500 gallons of liquid chemicals per month during 1981-82. However, ground water sampled in 1982 was found to contain volatile halogenated and non-halogenated chemicals.

In October 1984 the Site was purchased by the Shore Realty Corporation. In January 1985 New York State filed suit against Shore Realty Corporation and its owner, Donald Leogrande. As a result of that suit, Shore Realty and Donald Leogrande were ordered by the court to undertake certain remedial actions at the Site. Subsequent to that order, third party defendants, consisting mostly of companies who allegedly sent chemicals to the Site while it was an operating facility, were brought into the case by Shore Realty.

The Shore Realty Site is presently listed on the National Priorities List (NPL). In March, 1984 the NYSDEC inventoried and sampled chemicals contained on-site and collected surface-water samples from Hempstead Harbor. Since that time a NYSDEC contractor removed over 700,000 gallons of chemicals including all of the 55 gallon drums stored in the drum storage warehouse. All of the tanks containing liquids were reportedly emptied and decontaminated under DEC supervision. According to the DEC, the surface cleanup included removal of the following chemicals: toluene, bis (2-ethylhexyl) phthalate, naphthalene, ethylbenzene, xylenes, and sludges and liquids contaminated with up to 240 ppm PCBs.

In February 1987 a group of third party defendants retained Roux Associates, Inc. to conduct a Remedial Investigation/Feasibility Study. This report describes the Remedial Investigation portion of this project.

Cove, and six water samples from very shallow wells which bridge the water table. Each of these samples was analyzed for the 129 priority pollutants plus the 40 largest peaks to identify non-priority pollutants. The complete results of the chemical type determination from soil and water samples are given in Appendix C.

The locations of the sampling points for the chemical characterization analyses are shown on Figure 4 and the analytical results are summarized on Table 3. The predominant chemicals found at the Site are ethylbenzene, toluene and xylene (ETX). These three compounds make up over 98 percent of the priority pollutant content of all samples analyzed. ETX (the sum of these three compounds) levels range from non detected up to 1% in one of the soil samples. Other compounds found include bis(2-ethylhexyl) phthalate, naphthalene and phenols. In addition, relatively low levels of numerous non priority pollutant chemicals that are typically associated with the high level priority pollutants as impurities or breakdown products were identified (Appendix C).

Most of the organic compounds present are detectable by purgable organic analysis (EPA Method 624). The compounds that are not detectable by this method, such as naphthalene and phenol, were found at levels much lower than ETX, and are less mobile in the environment. Therefore, with the agreement of the New York Department of Law and NYSDEC, analysis of samples for purgeable

4.0 HAZARDOUS SUBSTANCES INVESTIGATION

The Remedial Investigation of the Shore Realty Site was done in two parts: 1) a determination of the chemical types present, and an analysis of the characteristics and behavior of these chemicals; and 2) a determination of the nature and extent of contamination. For the first part of the investigation, water samples with floating organic liquids (if present) from wells bridging the water table, and samples of soil and sediments from areas most likely to be contaminated were collected and analyzed for the 129 priority pollutants plus 40 peaks. For the second part of the investigation, additional soil samples and ground-water samples from wells screened below the water table were collected and analyzed for volatile organics, RCRA metals and PCBs. The methods of sample collection are described in Appendix A. Analytical methods are discussed in Appendix B. The complete CLP Quality Assurance/Quality Control report is on file at Roux Associates. The results of the hazardous substances investigation for soils and floating organic liquids are described in this Section. The results of the ground-water quality investigation are discussed in Section 5.0.

4.1 Chemical Types

Samples analyzed to determine the chemical types present include two composite soil samples, four individual soil samples, four sediment samples from the floor of Hempstead Harbor and Motts organics by EPA method 624 was selected for determination of the extent of contamination at the Site. For this report the total of ETX in each sample was selected to depict the extent of soil contamination.

The thirteen priority pollutant metals, also analyzed as part of the chemical characterization of the Site, were detected in soils, sediments, and organic liquids floating on the water table, at levels that are typical of background in industrialized areas. The only potential impact from these metals would be if they were in a soluable form that could migrate away from the Site. The ground-water sample analyses, discussed in section 5.4.2., indicate that they are not migrating at significant levels. Based on these results, and subject to the Feasibility Study, metals at the Site are not considered an environmental or health threat. To further substantiate this, however, all soil and ground-water samples that were analyzed for purgable organics were also analyzed for metals.

Although DEC reported removing PCB contaminated wastes (up to 240 ppm PCBs) from the Site, the chemical characterization of soil samples did not detect levels of PCBs above 1 ppm. The current EPA soil clean-up guidance for PCB spills in populated areas is 10 ppm (NYSDEC has no published guidelines for PCB levels in soil). One sediment sample contained .099 ppm PCBs. The significance of this will be addressed in the Feasibility Study.

4.2 Chemical Component Characteristics and Behavior

Ethylbenzene, toluene and xylene are the principal compounds present in soil and organic liquid floating on the water table at the Shore Realty Site. 2-methylnapthalene, napthalene, bis(2-ethylhexyl) phthalate, 2,4-dimethylphenol, 2-methylphenol and 4-methylphenol were the other compounds found at relatively high levels. Some characteristics of the principal chemicals found at the Site are listed below. Factors given are: specific gravity (Sp. Gr.), which, if less than 1.0, indicates that the free liquid (if present) will tend to float on the water table; and solubility in water (sol.) which is indicative of mobility in the ground-water environment. Health effect data include carcinogenicity (ability to cause cancer), PEL (permissible exposure limit) as established by NIOSH for worker exposure, RMCL (recommended maximum contaminant level) for drinking water as established by EPA, TLV (threshold limit value) for worker exposure, TLm (median tolerance limit) for aquatic organisms, and any drinking water or aquatic environment standards or guidance values established by EPA or NYDEC. The data given below are only intended as a general overview. A much more thorough evaluation of possible health effects will be given in the Feasibility Study.

Toluene

Derived from coal tar distillation and petroleum refining.

Used in aviation gasoline and high octane blending stock, and as a solvent for paint, gums, resins, etc.

Sp. Gr. = 0.867 at 20/4°C
Sol. = 515 ppm at 20°C
Toxic - Not Carcinogenic
PEL (permissible exposure limit) = 200 ppb
EPA RMCL (recommended maximum contaminant level) = 2000 ppb
TLm (fish) = 24 - 1340 ppm (24 hr.)

6 NYCRR Part 701, water quality guidance value for drinking water = 50 ppb. No standards or guidance for aquatic environments are given by New York State.

Ethylbenzene

Used as an intermediate in the production of styrene and solvents.

Sp. Gr. = 0.867 at 20/4°C
Sol. = 152 ppm at 20°C
0.25 ppm can cause adverse taste in fish
Toxic - Not Carcinogenic
EPA RMCL = 680 ppb
TLm (fish) = 35-97 ppm (24 hr.)

6 NYCRR Part 701, water quality guidance value for drinking

water = 50 ppb. No standards or guidance for aquatic environments are given by New York State.

Xylene

Derived from coal tar and petroleum distillation. Used in manufacturing dyes, aviation gas, protective coatings, insecticides and pharmaceuticals. Also used as a solvent.

Sp. Gr. = 0.86-0.88 at 20/4^{o}C
Sol. = 175 ppm at 20^{o}C
Toxic - Not Carcinogenic
PEL = 100 ppm
EPA RMCL = 440 ppb
TLm (fish) = 24-36 ppm (24 hr.) p-xylene
6 NYCRR Part 701, water quality guidance value for drinking water = 50 ppb. No standards or guidance for aquatic environments are given by New York State.

2-methylnaphthalene
also:B-methylnaphthalene

Derived from coal tar, petroleum refining and coal processing. It is used in organic synthesis and insecticide manufacturing.

Sp. Gr. = 0.994

Sol. = listed as insoluable in water

Naphthalene

Most abundant single constituent of coal tar. Used in the manufacturing of acids which are used to make dyes, manufacturing of synthetic resins, solvents, lubricants, motor fuels, moth balls, pesticides, fungicides.

Sp. Gr. = 1.152 at 20/4°C

Sol. = 30 ppm

Toxic - Not Carcinogenic

TLV (human) = 10 ppm in air

TLm (fish) = 220 ppm (24 hrs.)

Bis (2 ethylhexyl) phthalate

also: dioctylphthalate, di 2 ethylhexyl phthalate.

Used as a plasticizer and in plastics manufacturing.

Sp. Gr. = 0.99 at 20/20°C

Sol. = insoluble in water

Toxic - Not Carcinogenic

PEL = 5 mg/m^3

2,4-Dimethylphenol

also: m-xylenol

Derived from cresylic acid or tar acid fraction of coal tar. Used in preparation of coal tar disinfectants, manufacturing of resins, plastics, solvents, insecticides. fungicides, rubber chemicals, pharmaceuticals and as additive to lubricants and gasolines.

Sp. Gr. = 1.036 at 20/4°C

1.0 ppm can cause adverse taste in fish

Toxic - Not Carcinogenic

TLm (fish) = 13-30 ppm (24 hr.)

2-Methylphenol

also: Hydroxytoluene, o-cresol.

Derived from coal tar and petroleum refining, constituent in wood. Used as disinfectant, plastic and resin manufacturing, herbicide manufacturing, etc.

Sp. Gr. = 1.041 at 20/4°C

Sol. = 31,000 ppm at 40°C

Toxic - Not Carcinogenic

PEL = 5 ppm air, 5 ppm skin

TLm (fish) = 2-50 ppm for 24 hrs.

4-Methylphenol

also: p-cresol

Derived from coal tar, toluene.

Sp. Gr. = 1.0347 at 20/4°C

Sol. = 24,000 ppm at 40°C

Toxic - Not Carcinogenic

PEL = 5 ppm air, 5 ppm skin

4.3 Soil Contamination

The soils investigation at the Shore Realty Site was intended to: 1) determine the approximate extent of contaminated soil; and 2) determine what contaminants are present. To accomplish these objectives, a Photovac Tip II photoionization meter was used to measure the level of total volatile organics in soil samples and in soil gas near the surface, and selected soil samples were submitted to the laboratory for chemical analysis.

4.3.1 Soil Vapor Survey -

The methods used to conduct the soil vapor survey and a listing of the results obtained are given in Appendix A. The results of the survey are illustrated on Figure 5.

As shown on Figure 5, the areas of the highest levels of volatile organics in shallow soil vapor is the low lying area along the western and southern portions of the Site. Based on these results, as well as the known operating history of the Site, the soil sampling program was focused primarily in this area. The tank area near the center of the Site had high, moderate and low levels of volatile organics in the soil vapor. The method was considered to be less effective in this area, however, because the higher ground elevation provided a much thicker unsaturated zone which could mask the presence of organics floating on the water table. The area of moderate readings at the north-eastern edge of the Site could not be explained since neither soil nor ground-water samples from this area showed the presence of volatile organic compounds.

4.3.2 Soil Sampling -

The methods used for soil sample collection are described in Appendix A. Soil samples were screened for volatile organics with the photoionization meter and selected samples were analyzed in the laboratory. The results of the photoionization screening of soil samples are listed in Table 4. The distribution of volatile organic compounds in the soil, based on the maximum photoionization meter reading from each boring (regardless of depth below the surface), is shown on Figure 6.

A comparison of Figures 5 and 6 shows that the area of highest readings is more extensive using the soil samples from borings rather than the soil vapor readings at the surface. Also, as will be discussed in the next section, the results shown on Figure 6 agree much more closely with the laboratory analytical results than do the results of the soil vapor survey.

As illustrated on Figure 6, the area of highest photoionization meter readings for soil samples includes the entire western edge of the property, an area in the south central portion of the property and a portion of the elevated tank area. Moderate readings include the entire elevated tank area. The lowest readings include the entire eastern and northern areas of the property and most of the area in the southwestern corner of the property occupied by the two buildings and the trailer.

The vertical distributions of three ranges of photoionization readings are illustrated on a series of three cross sections, the locations of which are shown on Figure 7. The cross sections, shown on Figures 8, 9 and 10, depict ranges of greater than 1000 ppm, 100-1000 ppm, and less than 100 ppm. These ranges, discussed in the text as high, moderate and low, are general indicators of the relative levels of volatile organics present and cannot be related to specific levels of any particular chemical or chemicals. For reference purposes, ETX values for soil samples, as measured by the laboratory, are also shown on the cross sections. Actual photoionization readings are given on Table 5.

Figure 8 is a section that extends around the western, southern and eastern borders of the Site. The vertical extent of soil with high readings is limited to approximately the upper 6 to 10 feet at the northwestern portion of the section between B-1 and B-3, and then deepens to approximately 25 to 30 feet between B-6 and B-18. The high readings extend only to between 2 and 4 feet at B-19 and the remainder of the section from B-20 to SW-6 has no high readings. Moderate readings generally form a 2 to 10 foot wide band around the high readings except at DW-1 which has only moderate readings even though it cuts through the high reading zone as depicted on the cross section.

Figure 9 shows the vertical distribution of the three ranges of photoionization meter readings along a section through the center of the Site from north to south. As can be seen from this section, the area of high readings occurs in a 15 to 30 foot thick band extending from just northeast of SW-3 to southwest of P-4. Note that the extension of the high reading band through B-30 is based on a laboratory analysis for ETX rather than a photoionization reading. The band of moderate readings generally surrounds the high readings except in the northeast where it extends approximately 100 feet beyond the high reading area.

Figure 10 shows the vertical distribution of high photoionization readings along section C-C′ through the center of the Site from west to east. This section shows two separate areas of high readings separated by P-2. These areas are surrounded by a generally thick band of moderate readings, which extends to 45 feet below land surface at DW-1.

4.3.3 Soil Sample Analysis -

Thirty soil samples were submitted to Enviropact Laboratories for analysis. Of these, 6 were analyzed for 129 priority pollutants plus 40 peaks, (as previously discussed in Section 4.1) and 24 were analyzed for purgeable organics (EPA Method 624), toxic metals and PCBs. The results of these analyses are given in Appendix D. The results of the priority pollutant analyses are summarized in Table 3.

As previously discussed, ETX results are the best indicator of the extent of soil contamination at this Site. Table 5 lists the levels of ETX in each soil sample that was analyzed. Figure 11 shows the locations of the sampling points listed in Table 5 and the distribution of ETX in the subsurface at the Site. There is a clear similarity in the distribution of ETX and photoionization readings of soil samples (Figure 6) with the following exceptions. Soil samples from SW-3, B-17 and B-20 showed moderately high photoionization readings (Figure 6) but contained very low or non detectable levels of organics. A possible explanation for this is that these three points are located adjacent to an area of high volatile organic contamination and soil gas moving laterally through this area may contain sufficient levels of these compounds to give an elevated photoionization reading, but not enough to be detected in laboratory analysis. Also, one soil sample at B-3 had a relatively low ETX level (24 ppm) but gave a high (>1000) photoionization reading. This may be for the same reason as discussed above.

The soil samples generally did not contain other organic chemicals at the levels at which ETX is present. Napthalene and 2-methylnapthalene were present at levels up to 21 ppm and phthalates, especially bis-2-ethylhexylphthalate were present at levels up to 14 ppm. Other organic compounds which may be present in the contaminated soils were masked by the high levels of ETX and thus were not detected.

4.3.4 Sediment Sample Analysis -

Eight samples of bottom sediment were collected from Hempstead Harbor and Motts Cove at locations near the Site (Figure 11). Four of these samples (S-1, S-2, S-6, S-8) were analyzed for 129 pp + 40 peaks (Table 3) and four for purgable organics, toxic metals and PCBs. Table 6 lists the levels of ETX, lead and PCBs in all eight samples. The complete analytical results are given in Appendix D.

As can be seen from Table 6, volatile organic compounds are very low in all samples. (Semi volatile organic compounds were present at levels up to 1.7 ppm in S-2 and lower levels in other sediment samples (see Appendix C)). PCBs were detected in one sediment sample, S-6 at 99 ppb. Lead levels range up to 154 ppm, which is within the range typical of sediments and soils in industrial areas (Connor, 1975; National Academy of Science, 1977). Because of the very low levels of lead in the ground water under the site, the source of lead in the Harbor sediments does not appear to be from ground water flowing from the Site. Since there are no obvious sources of lead at the Site, the lead in the sediment samples probably originates largely from sources other than the Shore Realty Site.

5.0 HYDROGEOLOGIC INVESTIGATION

The hydrogeologic investigation at the Shore Realty Site included drilling nine new wells, installing six piezometers (water-level measurement tubes), drilling 27 soil borings, geologic logging of split-spoon samples, measurement of water levels in wells and piezometers during different portions of the tidal cycle, conducting specific capacity tests in selected wells and collection and analysis of ground-water samples.

The purpose of the hydrogeologic investigation was to understand the occurrence, movement and discharge of ground water beneath the Site; to determine the impact of the Site on ground-water quality; and to establish if drinking water resources are presently impacted, or have the potential to be impacted, by the Site. The methods used in the hydrogeologic investigation are described in Appendix A. The following sections discuss the geology beneath the Site as it relates to ground-water flow and ground-water quality at the Site.

5.1 Regional Hydrogeology

The Shore Realty site is located in the Atlantic Coastal Plain Physiographic Province. The subsurface geology consists of unconsolidated sand, silt, clay, and gravel deposits overlying crystalline bedrock. The strata in the area dip to the southeast following the contours of the bedrock surface.

The site is located in Glenwood Landing, Long Island, which is north of the ground-water divide that runs east-west across the middle of Long Island, and west of the principal divide that runs northwest-southeast from Locust Valley to Brookville, Long Island. Regional ground-water flow in this area is westward to discharge areas along Glen Cove Creek or into Hempstead Harbor (Kilburn and Krulikas, 1987).

The Shore Realty Site is underlain by unconsolidated material of Cretaceous and Quaternary Age. These deposits are over 500 feet thick under the Site and overlie crystalline bedrock. From oldest (deepest) to youngest (shallowest) these sediments have been identified and divided into a series of hydrogeologic units: the Lloyd aquifer; the Raritan clay confining unit; the Magothy aquifer (not present under the site); the Port Washington aquifer; the Port Washington confining unit; and the upper glacial aquifer (Figure 12). Only the upper glacial aquifer is of significance in this investigation and is described in some detail below.

The upper glacial aquifer consists of late Pleistocene and Holocene age sand, gravel, silt, and clay deposits that overlie the Port Washington confining unit. The upper surface of the upper glacial deposits comprise present day land surface except in areas such as the Shore Realty Site where they are overlain by recent Holocene deposits and/or fill materials. The water table at the Site is found in this aquifer.

The upper glacial aquifer can be divided into two geologic units of Holocene and upper Pleistocene age. The Holocene deposits are the more recent deposits and consist of sand, gravel, silt, and clay; organic mud, peat, loam, and shells. Colors are gray, green, black and brown. These deposits, which include undifferentiated artificial fill, salt-marsh and swamp deposits, stream alluvium and shore deposits, typically range in thickness from 10-50 feet (Kilburn and Krulikas, 1987).

The upper Pleistocene deposits are moraine (till), composed of unsorted clay, sand, gravel and boulders. These deposits may contain outwash deposits of stratified brown sand and gravel, and local lacustrine or marine deposits consisting of clay, silt, and sand. These were deposited by glacial action during the late Pleistocene age (Kilburn and Krulikas, 1987).

The average horizontal hydraulic conductivity of the upper glacial aquifer is 270 ft/day (2000 gpd/ft^2) and the average vertical hydraulic conductivity is 27 ft/day (200 gpd/ft^2) (Franke and Cohen, 1972). Several large-capacity public-supply wells screened in the aquifer have been reported to yield from 436 to 1,410 gal/min. The specific capacities of these wells range from 10 to 73 gal/min per foot of drawdown (Kilburn, 1979).

5.2 Hydrogeology of the Site

All monitoring wells, piezometers, and test borings for this study were finished in the moraine deposits of the upper glacial aquifer. The moraine deposits are estimated to be approximately 110 feet thick under the Site and are assumed to directly overlie the Port Washington confining unit. Most of the borings are approximately 15 feet deep. The deepest boring drilled was at DW-1. This boring was terminated at 66 feet below land surface after encountering a layer of clay at least five feet thick. Geologic logs for all of the borings are given in Appendix E.

The moraine (till) deposits at the site consist predominantly of well to moderately sorted fine to medium sand with some coarser sand. Also encountered were layers of coarser sand and gravel which are less sorted. At DW-1 the deeper sand deposits are medium to coarse and poorly sorted with silt and clay layers disseminated throughout, reducing the horizontal and vertical permeability of this unit.

Five general lithotypes, designated Unit A through E, were identified during the remedial investigation. The units are described below and their distributions are shown in cross section on Figures 13, 14 and 15. (See Figure 7 for cross section locations).

Unit A - (Artificial Fill) Brown, moderately sorted fine to medium sand with some coarse sand and gravel.

Unit B - Gray, well sorted fine to medium sand with dark brown and gray organic rich horizons with shell fragments.

Unit C - White, well sorted fine to medium sand and medium to coarse sand.

Unit D - Multi-colored, poorly sorted medium to coarse sand with silt and clay layers disseminated throughout.

Unit E - Gray silty clay.

Unit A is a moderately sorted brown colored fine to medium sand. There are several different colored sand and gravel units disseminated throughout this fill unit. Due to the moderate sorting and intermittent sand and gravel layers within the sand unit, the hydraulic conductivity of this fill deposit is visually estimated to be relatively high both vertically and horizontally.

Unit A was encountered at all of the borings and ranges in thickness from a maximum of 27.5 feet (B-24) to as little as 1.8 feet (B-14). The thickest deposits are found in the area of the storage tanks, and the thinnest deposits are found along the western edge of the site near Hempstead Harbor. This unit overlies Unit B throughout the Site (Figure 13-15).

Unit B is a gray, well sorted fine to medium sand with some coarse sand and gravel throughout. Thin silt, sand and clay layers, oriented parallel to bedding, are found throughout this unit and are more abundant with depth. The upper horizon of Unit B is characteristically a gray to brown fine to medium sand with silt, clay, shell fragments and organics throughout. Due to the finer grain sizes of the sediments making up Unit B, the horizontal hydraulic conductivity is visually estimated to be less than that of Unit A. The vertical hydraulic conductivity is also estimated to be lower than Unit A due to the thin, horizontally bedded silt and clay layers present throughout.

Unit B was encountered in all of the borings except those which terminated in unit A. Unit B ranges in thickness from 32 feet at DW-1 to 0.7 feet (or more) at B-13.

Unit C is a well sorted, white, fine to coarse sand that most often consists of medium to coarse sand. Unit C was encountered at six locations in thicknesses varying from 10 feet at DW-1 to 0.8 feet at B-27. Unit C is estimated to have a relatively high hydraulic conductivity both vertically and horizontally.

Unit D is a poorly sorted multi-colored medium to coarse sand with some gravel disseminated throughout. Unit D has a high degree of silt and clay in the deeper horizons. Silt and clay are found mainly in thin layers oriented parallel to bedding.

This unit was only encountered at two borings DW-1 and B-29. At DW-1 it was found to be 16 feet thick. At B-29 the boring was stopped before penetrating the total thickness of the unit. Due to the poor sorting of the grain sizes and the high degree of silt and clay present with depth, this unit is estimated to have a low hydraulic conductivity both horizontally and vertically.

Unit E is a gray silty clay unit that was encountered at 61 feet below land surface in DW-1. This unit is at least 5 feet thick and has an estimated very low hydraulic conductivity both horizontally and vertically. This unit will act to impede ground-water flow.

5.3 Ground-Water Flow

Water levels in selected pre-existing wells and in all wells and piezometers installed for this investigation have been measured several times. On November 17, 1987 water levels were measured every two hours for a twelve-hour period in both the wells, piezometers, and at two surface-water gauges set up to monitor tidal fluctuations in Hempstead Harbor. All water levels measured on this day are given in Table 7. On December 15, 1987 water levels were measured twice, approximately three hours apart, in the same wells, piezometers, and stream gauges. These measurements are given in Table 8.

The purpose of repeatedly measuring water levels over a twelve-hour period was to determine changes in ground-water flow patterns, both vertically and horizontally, during a full tidal cycle in Hempstead Harbor. A water-table contour map at mean tide for the water-table monitoring wells (WT-series) and piezometers is shown on Figure 16. This figure shows that shallow ground water enters the Site from the northeast, where it is eventually dispersed in three directions downgradient and discharges into Hempstead Harbor and Motts Cove. Horizontal ground-water flow directions in the shallow water table aquifer do not fluctuate significantly from this pattern during low and high tides.

Ground-water flow in the shallow wells (SW-series) at both low and high tide is from east to west across the Site. Figure 17 shows the piezometric surface contours for the SW-series wells at mean tide. The gradient is similar at low and high tide since the wells respond to tidal changes in a similar manner. This response is shown on a series of hydrographs in Appendix F. The hydrographs illustrate the effect of the tides on the wells and implies that the wells are under semiconfined conditions despite the absence of a clearly defined confining unit.

The principal effect of the tidal cycle on ground-water flow is that it reverses the vertical flow direction of the upper few feet of the shallow aquifer. The well clusters at SW-2, SW-3, and SW-6 show an upward component of ground-water flow between the shallow wells (screened 10-20 feet below the water table) and the water-table wells (screened above and below the water table) at high tide, and a downward component of flow at low tide. It should be noted that the deep well DW-1, constantly shows an upward component of flow when compared to SW-2, but does fluctuate with respect to the water-table well WT-6 (A-15), as shown in Appendix F. Thus, even though the Site is in a regional ground-water discharge area, at low tide it becomes a local recharge area over the upper few feet of the aquifer with discharge occurring off-shore. Wells SW-4 and SW-5 show a continuous upward component of flow during both low and high tide, and Well SW-1 shows a continuous downward component of flow during tidal changes. Based on data from other well clusters, the downward flow at this location appears to be only a very shallow and local condition.

For the water-table wells (WT-series) the ground-water gradient varies from .005 ft/ft (under the tank area) to as high as .05 ft/ft along the eastern perimeter. The average gradient south and west of the embankments is .02 ft/ft. The ground-water gradient for the SW-series wells ranges across the site from .010 to .015 ft/ft.

Short term specific capacity tests were conducted on four monitoring wells (SW-1, SW-3, SW-5 and DW-1). The purpose of these tests was to better estimate the hydraulic conductivity of the upper glacial aquifer opposite the screen zone of the four wells. The specific capacity tests were conducted for 30 minutes each, or until the water level in the well dropped below the suction limit of the pump. A variable speed peristaltic pump was used for the testing and water levels were recorded on a prescheduled basis according to the protocols in Appendix G. All water-level measurements and pumping rates are given on the pump-test forms in Appendix G, along with the appropriate graphs.

The results of the specific capacity tests show that hydraulic conductivity of the sediments at the Site is variable. Monitoring Well SW-5 has the highest hydraulic conductivity at 36 gpd/ft^2. At SW-3 the hydraulic conductivity is 6.3 gpd/ft^2. For SW-1 the hydraulic conductivity is 13 gpd/ft^2. For the deep part of the aquifer, Well DW-1 has a calculated hydraulic conductivity of .03 gpd/ft^2. These values for hydraulic conductivity are based on short term testing in partially penetrating wells, and are thus only estimates. In the event that more precise measurements of hydraulic conductivity are necessary for a possible remedial program, an aquifer test using observation wells will be conducted.

Based on the specific capacity tests, the eastern edge of the site is the most permeable. Using the hydraulic conductivity calculated from the specific capacity test of 36 gpd/ft^2, a gradient of .05 ft/ft as measured between the wells, and a porosity of .33 (the average porosity of the upper glacial aquifer for Long Island) the calculated ground-water flow rate is 0.72 ft per day. The least permeable area of the site is along the southern edge of the property. Using a hydraulic conductivity of 6.3 gpd/ft^2, a gradient of .01 ft/ft, and a porosity of .33, the ground-water flow rate is 0.03 ft per day. Along the western edge of the property the ground-water flow rate is calculated to be 0.2 ft per day.

5.4 Ground-Water Quality

The nine monitoring wells installed for this investigation and one existing monitoring well, WT-6(A-15),were sampled on two occasions, one month apart. All of these water samples were analyzed by EPA method 624 for purgable organics, 8 RCRA metals and PCBs. The only exception to this is the samples from DW-1 which were analyzed for the 129 priority pollutant analysis + 40 peaks. All ground-water and water-table well sample quality results are given in the laboratory reports included in Appendix H.

5.4.1 Water-Table Wells -

Of the ten wells sampled, three bridge the water table and are designed to monitor any free organic liquid which may be floating on the water table. Thus, these wells are not suitable for monitoring actual ground-water quality under the Site. The results of these analyses are summarized on Table 9. Two of these wells, WT-13 and WT-14, contained only one organic compound, tetrachloroethylene, above the New York State guidance levels for drinking water of 0.7 ppb. Tetrachloroethylene was found in wells WT-13 and WT-14 at maximum levels of 13 and 2 ppb respectively.

The third water-table well sampled, WT-6 (A-15), contained elevated concentrations of benzene, toluene, ethylbenzene, xylene, and PCBs. This well has been observed to contain as much as 1 1/2 inches of free organic liquid. Since PCBs are much more soluble in organic liquids than in water, the elevated PCBs in this sample were probably dissolved in the organic rather than the aqueous phase. Water-table wells WT-13 and WT-14 also contained lead levels exceeding New York State drinking water guidelines.

5.4.2 Ground-Water Monitoring Wells -

The remaining seven wells, which were also sampled twice, were all shallow ground-water monitoring wells. These are designed to monitor actual ground-water quality at the Site. Only three of these wells contained compounds above New York State drinking water guidance levels (Table 10). Wells SW-1 and SW-3 had maximum concentrations of tetrachloroethylene of 280 and 18 ppb. Well SW-6 contained 1,1 dichloroethylene at 2.0 ppb, exceeding the New York State drinking water guidance level for this compound in ground water of 0.07 ppb. All of the remaining wells sampled at the Site met drinking water guidelines for all compounds analyzed. None of this water is used as drinking water or has the potential to migrate to drinking water wells.

Only two of the ground-water monitoring wells contained elevated levels of any of the RCRA hazardous metals. Wells SW-1 and SW-3 contained lead above the New York drinking water guidance level of 25 ppb. Lead levels measured were 45 ppb in SW-1, and 75 ppb in SW-3. Resampling of these wells, however, showed all lead levels below the drinking water standard. It should also be noted that these samples were analyzed for total metals, and therefore include metals from sediment in the ground-water sample. The metals and PCB results from all the ground-water monitoring wells are given on Table 10. No ground-water monitoring wells showed any detectable PCBs or any metals (other than lead in the initial sampling round) above drinking water standards.

6.0 PUBLIC HEALTH

As part of this Remedial Investigation, the actual and potential effects of this Site on public health and the environment have been preliminarily evaluated. Health effects and environmental impacts will be addressed in greater detail in the Feasibility Study. The following section discusses the pathways for contaminant migration and the potential receptors. The next section discusses public health impacts as a result of the Site. Finally, environmental impacts, or impacts not directly relating to public health are discussed.

6.1 Pathways and Potential Receptors

In evaluating potential receptors, the various pathways of contaminant migration have been evaluated. Possible pathways include air, ground water, surface water and direct contact with chemicals and contaminated soil.

> Air - based on numerous measurements of volatile organic levels in air during the course of this investigation, the only detectable levels above background occurred inside well casings and tanks or directly above open boreholes. All readings in the breathing zone were non detectable (background). The Site is fenced and access restricted to prevent inadvertent breathing of vapors in tanks or well casings. The potential for the presence of very low vapor

levels, not detectable by the equipment used for the RI, will be addressed in the Feasibility Study.

Ground Water - seven properly designed ground-water monitoring wells were installed around the perimeter of the property as part of this investigation. Ground-water samples representative of actual aquifer conditions (i.e. not influenced by organics floating on the water table) were collected and analyzed on two occasions. In addition, several rounds of water levels were measured to determine flow directions throughout the tidal cycle. Based on these data, ground-water flow is upward beneath the Site and contains only very low levels of dissolved chemicals. The discharge of this ground water is into Hempstead Harbor and there is no pathway for this water to reach any drinking water well. Thus, there are no direct receptors of the ground water. Indirect receptors would be via the surface-water pathway discussed below. However, because of the relatively minute volume of ground-water discharging relative to tidal flushing, and the very low levels of contaminants, this pathway is considered to be insignificant.

Surface water - Since the Site is adjacent to Hempstead Harbor (and Motts Cove which is an arm of the Harbor) the Harbor itself can be a pathway for contaminants to reach receptors. Direct pathways to the Harbor are ground-water discharge, discharge of organic chemicals floating on the water table and contaminated surface runoff of precipitation. As previously discussed, ground-water discharge does not appear to represent a significant potential impact on the Harbor. For surface runoff of precipitation to be a pathway, significant levels of contaminants must be present on the surface in a form that will be carried with the water. Erosion of contaminated soil is one possible source of contaminants. However, since the site is bulkheaded, erosion of contaminated soil directly into the harbor appears to be minimal. Contamination of surface runoff by solution of chemicals present on the surface of the site also appears to be minimal. This is because organics on the surface will be quickly volatilized or otherwise degraded. Metals on the surface will tend to remain attached to the soil rather than dissolve in surface runoff. Therefore, surface runoff is probably not a significant pathway of contaminants to the Harbor. However, this pathway will be further addressed in the Feasibility Study.

Organics floating on the water table can migrate through or beneath the bulkheads. Contaminated soil that may act as a source of free organic liquid as the water table rises and falls, and some small residual of organic liquids observed on the water table during this investigation, apparently represent the only potentially significant pathways of contaminants to the harbor.

Potential direct receptors for contaminants in the Harbor are fish and other aquatic organisms, and possibly persons using the boat ramp adjacent to the Site. Two samples, S-2 and S-4, contained detectable levels of ETX, the principal chemicals at the Site. In both cases these levels were less than 1 ppm. Sample S-2 contained up to 1.7 ppm of other organics. The potential impact of these will be addressed in the Feasibility Study. It is believed that natural decay of organics in the Harbor mud along with tidal flushing and resultant dilution will further reduce the concentrations currently found.

Direct Contact - potential receptors of contaminants from direct contact are limited to persons going onto the Site or using the boat ramp. Since the liquid chemicals stored at the Site have been removed, even unauthorized personnel on-site would not likely be exposed to harmful levels of any contaminant. Since the Site is fenced and access is restricted, the direct contact pathway is considered minimal at the present time. Long term solutions to potential direct contact problems will be discussed in the Feasibility Study.

6.2 Public Health Impacts

Based on the results of this investigation, and subject to the FS analyses, there appear to be no significant imminent public health impacts related to this Site. As discussed above, there are presently no significant ongoing air releases to directly impact the public. Contaminated ground water is limited to a very shallow zone near the water table and flows directly into the harbor. Thus there is no potential for impact on drinking water resources. Potential impact to the Harbor is very limited and should not result in any imminent threat to public health. Since the Site is fenced and access restricted , with the exception of the adjacent boat ramp, and since the surface-stored chemicals have been removed, the possibility of public health impacts from direct contact are remote. The FS will evaluate potential long term impacts, if any, resulting from conditions at the site.

6.3 Environmental Impacts

The only potential significant environmental impact as a result of the Shore Realty Site is to the portion of Hempstead Harbor and Motts Cove adjacent to the Site. Sediment samples from these areas indicate that organic contaminant levels are quite low and probably decreasing since the source (stored liquid) has been removed. The environmental impact of the Site on the Harbor will be evaluated in the Feasibility Study.

7.0 RECOMMENDATIONS AND FEASIBILITY STUDY SCHEDULE

Based on the results of the Remedial Investigation, a Feasibility Study is required for this Site. The Feasibility Study should follow the outline and format presented in the May 1987 Work Plan. The areas of impact and potential impact to be addressed by the Feasibility Study include discharge of organic chemicals floating on the water table to Hempstead Harbor and Motts Cove, the potential for direct contact by unauthorized personnel entering the Site or using the boat ramp, any impact that might result if the site were to be developed for future use, and the potential for impact on other future developments or other activities that may occur adjacent to the Site.

At the present time, the need for additional Site Investigations has not been determined. It is anticipated that some additional investigations, including on-site and/or bench testing, may be identified during the initial screening of alternative steps of the Feasibility Study. A proposed schedule for the Feasibility Study is given in Figure 18. A detailed description of tasks to be accomplished by the Feasibility Study is given in the Work Plan for this RI/FS.

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APPENDIX A.

Methods of Investigation

METHODS OF INVESTIGATION

On October 13, 1987 Roux Associates, Inc. initiated the Remedial Investigation phase of the Remedial Investigation/Feasibility Study (RI/FS) at the Shore Realty Site. The purpose of the Remedial Investigation was to obtain all data needed to evaluate various remedial alternatives.

The investigation consisted of a detailed subsurface study directed at identifying and defining the nature and extent of both ground-water and soils contamination at the Site. In addition, the Site was inspected for the possible presence of remaining chemicals left behind after the initial clean-up operations conducted by Shore Realty and NYSDEC.

The remedial investigation was composed of a multi-task study as follows:

- reconnaissance program;
- hydrogeologic investigation;
- soil and sediment investigation;
- ground-water sampling and analysis; and
- data analysis and report.

The methods used and results obtained for the reconnaissance program, along with the methods used to complete the following three tasks, are described in this Appendix. The results obtained (from the entire program) are discussed in the text of this report.

Reconnaissance Program

The first task of the remedial investigation was a reconnaissance program that included the following:

- preliminary air sampling;
- characterization of any surface hazardous chemicals;
- field checking the accuracy of base maps;
- A magnetometer survey to determine the presence of buried drums, pipes, and tanks;
- measurement of water levels, checking integrity of existing wells, redevelopment and collection of water samples from pre-selected wells; and
- determination of the areal extent of volatile organic vapors in the unsaturated zone across the entire site.

- Preliminary Air Sampling

Prior to any onsite work, a preliminary air sampling survey was conducted by Roux Associates. This was done by walking over the entire site and continuously monitory air quality with a Photovac Tip II photoionization meter. While the air monitoring survey was being conducted, personnel involved in the survey were wearing level C protection at all times.

As part of the air monitoring survey all above ground storage tanks, buildings, and any other possible sources or collection areas for volatile organic vapors were surveyed. The results of the air sampling survey were recorded and plotted on a base map.

The results of the air-monitoring survey revealed that ambient air readings for the site are <1.0 ppm. Only a few tanks, drums and a cistern gave above background readings on the Tip II meter. The air inside the cistern for the collection trench gave a range of readings from 3.5-9.8 ppm with the instrument held 1 foot above the access hole. Inside the solidification building a 55 gallon drum approximately 1/4 full of used speedy dry gave a reading of 1.2 ppm. The air inside of two above ground storage tanks gave above background readings; tank 019 read 94.8 ppm and tank 018 read 2.4 ppm. Further inspection of these two tanks revealed that they are both empty and that tank 019 was probably not decontaminated at the time the other tanks were emptied and cleaned.

- Characterization of Any Surface Hazardous Chemicals

Following the preliminary air sampling investigation, a complete site walkover was conducted in an attempt to locate and identify any possible surface hazardous chemicals that might have been left behind by the clean-up contractor. Also as part of this investigation an attempt was made to check the contents of all underground storage tanks.

All the underground tanks that could be opened were found to be empty, or had small amounts of water in them. The two underground gasoline storage tanks on the east side of the solidification building could not be opened. On the northwest side of Storage Tank No. G.H.U., in the vicinity of OW-20, a pipe (UO3) sticking out of the ground was opened and found to contain a black, oily, low viscosity organic liquid.

As part of the surface hazardous waste characterization program, several drums found in the solidification building were inventoried. A total of 46 cans and drums of various capacity and integrity were accounted for at this time. The inventory list is as follows:

24-full 5 gallon	sealed containers with no markings. Two containers were open and contained a dry powder fire extinquishing agent.
4-full 5 gallon	cans labeled; Code - 222, Lot - 943, Single Unit, Foam Generation, and Extinquishing Agent.
5-full 5 gallon	cans labeled; National Fomon, Foam Chemical and National Foam System Inc.
3-full 5 gallon	cans labeled; Fire Extinquishing Chemical (Dry), 2 in 1, National Foam System Inc.

1-5 gallon green can, 1/4 full of liquid labeled; Thomas

Scientific, I 404, Waste Conversion, 2869
Sandstone Dr., Hatfield, PA 19440.
Thomas No: 853500084-002
Cust. No: L-P3655

Also labeled: Malinckrodt, Acetone and Flammable Liquid.

Contents are not acetone, but a black, low viscosity liquid appears similar to the liquid in pipe U03.

1-Red 35 gallon drum, 1/2 filled with speedy dry.

1-Yellow 55 gallon drum, 1/4 filled with used speedy dry - strong odor.

1-Unidentified 5 gallon can, contents is a light brown powder.

5-1 gallon paint cans.

1-1 pint paint can.

- Field Check of Base Maps

Since a field check of existing Site maps found them not to be accurate enough for this investigation, Roux Associates subcontracted Storch Associates, Westbury, NY to survey the site and prepare a base map (Figure 19 in pocket). The map is at a scale of 1"-20', and shows all existing monitoring wells, piezometers, buildings, above ground storage tanks, movable tanks, and the fence line and bulkhead surrounding the site. In addition, a topographic map with 5 foot contour intervals was also prepared by Storch (Figure 19). All new monitoring wells and piezometers installed were surveyed vertically along with all of the existing monitoring wells and were located on the base map by Storch Associates.

- Magnetometer Survey

A magnetometer survey was conducted using a Schonstedt Heliflux Model GA-52B magnetic locator. A continuous sweep of the Site was done to determine if any metal drums or unknown buried tanks were present. In areas were metal was detected, a stake was used to mark the location and the location mapped on the base map.

At six locations (MS-1 to MS-6 on Figure 2) metal objects were found to be buried in the subsurface. Four of these areas (MS-1 to MS-4) were found to be running in a north south line parallel to and just east of the collection trench. A fifth area (MS-5) is in the south of the site. At these five locations a hand auger was used to probe below the surface to determine that underground pipelines are present.

In a sixth area (MS-6) in the northeast section of the Site a backhoe was used to dig three test pits. The backhoe work was done by John J. O'Keefe, Inc. under the supervision of a hydrogeologist from Roux Associates. The test pits revealed an approximately 1 foot thick surface layer of sand, slag, cinders and other various types of metal debris (no drums). This layer was underlain by a well sorted clean sand fill. Detailed test pit logs are given in Appendix E.

Based on the results of the magnetometer survey Roux Associates concluded that there are no buried drums or unidentified buried storage tanks at the site. Buried pipes, some probably containing waste organic liquids, are present.

- Well Inspection

All existing monitoring wells were inspected by Roux Associates for integrity and the presence and thickness of any organic liquid layer. When each well was initially opened the Tip II photoionization meter was used to measure volatile organics both in the well and approximately 2 feet above the well. All the results of the Tip II monitoring are given on the well inspection forms in Appendix I. Level C protection was worn for this task.

The next step was to use a calibrated clear acrylic bailer to determine the presence of free organic liquid in each well. The results of this revealed that three wells had organic liquid, and two wells had an oil sheen on the water table. The results are as follows:

Well No.	Thickness of Organic Liquid (inches)
A-1	Sheen
A-14	0.4
A-15	1.5
A-16	Sheen
A-20	0.5

To avoid cross contamination of the wells, the bailer was decontaminated according to the protocols in Appendix K between each use.

Each well was also sounded with a steel tape to measure the bottom of the well and to check the integrity of the well casing. The screen zone of each well was determined and the condition of the well at the surface was noted. This information is given on the Well Inspection forms in Appendix I. The results of the well inspection are that all wells are intact except as follows:

Well No.	Comments
A-2	Broken screen.
A-4	Casing cracked at 2.0 ft. below grade.
A-5	Obstructed at 2.4 ft. below grade.
A-7	Casing cracked in several places.

A-10	Filled in with roots and dirt.

- Preliminary Well and Soil Sampling for Chemical Characterization

After the well inspection was completed, 12 monitoring wells were selected, redeveloped, and surveyed vertically by Roux Associates. Water levels were then measured in these 12 wells and a preliminary water-table map constructed. The water-table map was used to determine which wells were to be sampled as part of the preliminary chemical characterization program.

Six monitoring wells were selected for priority pollutant + 40 peaks analysis following Contract Laboratory Procedures (CLP). The wells that were selected are OW-6, OW-10, OW-14, OW-19, A-8 and A-13 (Figure 4 in text). All of these wells have screens which bridge the water table and therefore will allow the collection of any floating organic liquid that might be present. The wells were sampled using a stainless steel bailer with a screw cap bottom plug. All wells were sampled following protocols in Appendix J. To avoid cross contamination, the bailer was decontaminated following the protocols in Appendix K.

Once the samples were collected they were immediately placed on ice and sent to the laboratory via Federal Express overnight delivery. The laboratory selected to do the analysis is Enviropact Inc., Jacksonville, Florida. Enviropact Inc. is certified by New York State to do superfund analysis. A chain-of-custody was maintained through sample delivery. Chain-of-custody forms are in Appendix L.

In addition to the preliminary well sampling, two soil samples were collected for priority pollutant + 40 peaks analysis. These samples are designated CS-1 and CS-2 (Figure 2). CS-1 is located along the western border of the property adjacent to Hempstead Harbor. The sample is a composite of three soil samples collected along the trench from 2.0-2.5 feet below grade. Sample CS-2 is also a composite sample and was collected at three locations around the above ground storage tank number 151 (Figure 4 in text). This sample was collected from 0.5-1.0 feet below land surface.

The samples were collected using a stainless steel hand auger. Once the hole was dug to the desired sampling depth, the hand auger was decontaminated thoroughly according to the protocols in Appendix K. The sample was then collected, placed on clean plastic sheeting and logged by the hydrogeologist. A portion of the sample was then placed in precleaned jars for volatile organic analyses. The remaining two locations were sampled in the same way and mixed thoroughly with the sample from the first hole. The composited sample was then placed in the remaining prelabelled laboratory supplied jars needed to complete the non-volatile organic portion of the priority pollutant analysis. After the soil samples were collected they were immediately placed on ice and sent to Enviropact Inc.

- Unsaturated Zone Volatile Organic Screening

In an attempt to obtain a preliminary definition of the extent of organic contamination, a unsaturated zone volatile organic vapor screening program was conducted. A grid with 50 foot centers was marked out over the Site (Figure 5 in text). Vapor probes, consisting of 5 foot long 1/2 inch diameter, stainless steel pipe with small holes over the bottom one foot, were installed at each grid point (Figure A-1). The probes were installed to 2-3 feet below grade with a sledge hammer. A rotary hammer was used to drill a hole in cemented and asphalted areas. After the probe was driven to the desired depth, the top was fitted with a cork which had a length of copper tubing through the middle. Once the cork was in place, a hand held vacuum pump was fastened to the copper tubing and the probe evacuated for 15 seconds to cause soil vapors to enter through the holes in the tube. The vacuum pump was then disconnected and the probe of the Tip II photoionization meter was inserted into the copper tubing. Once the meter had stabilized the reading was recorded.

- Hydrogeologic Investigation

Nine monitoring wells were installed at the Site as part of this investigation. The wells were located and designed to maximize the use of the existing monitoring wells. The wells are located in clusters so that free product on the water table and ground water below the water table can be monitored throughout the site. Each cluster is composed of one water table well (WT-series) in which the screen zone bridges the water table, and a slightly deeper well (SW-series) in which the top of the screen zone is set 10 to 15 feet below the water table. The water-table wells are intended to monitor any free organic liquid on the water table, and the SW-series wells are designed to obtain representative ground-water samples.

In addition to the WT and SW-series monitoring wells, one deeper well (DW-1) was installed. The deep well was installed adjacent to existing water table well WT-6 and shallow well SW-2 (Figure 2 in text). This location was selected because the reconnaissance program found monitoring well WT-6 to contain the thickest level of free product and also to have the highest down hole reading on the Tip II photoionization meter. Based on these results it was determined that the area surrounding well WT-6 was apparently the most contaminated.

- Shallow Monitoring Well Installation

All monitoring wells were installed by Parratt Wolff, Inc. of East Syracuse, NY, under the direct supervision of a hydrogeologist from Roux Associates. A truck mounted hollow stem auger rig was used to install the wells. Split-spoon core barrel samplers were used to collect soil samples continuously (every two-feet) from land surface to the bottom of the boring.

The split-spoon samples were collected ahead of the auger flytes in undisturbed sediments using a standard 140 lb. hammer with a 30 inch fall. While the split-spoon sampler was being driven, the number of blows required to drive the sampler each six inches was noted and logged. Once the sample was collected, the split-spoon sampler was opened on clean plastic sheeting by the hydrogeologist and logged in detail paying particular attention to the presence of contamination (odor, texture, staining, etc.) Detailed geologic logs are given in Appendix E. Once the sample was logged, it was placed in a clean sample jar, the jar was then covered with aluminum foil and a screw type lid. All soil samples were screened in the field using a Photovac Tip II photoionization meter, for volatile organic content. The protocols for field screening of soil sample for volatile organics is given in Appendix M.

As part of the health and safety plan ambient air quality in the breathing zone was monitored throughout the drilling program using a portable photoionization meter. These results were recorded separately and are given in Appendix N.

After a sample was collected, the hole was advanced two feet with power driven, eight inch diameter, hollow stem auger flytes and the next sample collected. To prevent dilution of any contaminants that might be present, water was not normally used in the hole during drilling. Water was only used in the hole when running sand was encountered during drilling and the auger flytes had to be washed out so that the next sample could be collected.

Cross-contamination of sediments within the boring was minimized as samples were collected ahead of the auger flytes. In addition, several split-spoon samplers were used and each sampler was decontaminated by washing with soap and water followed by a high pressure water rinse and then finally steam cleaned. To avoid cross-contamination between holes all drilling equipment, including auger flytes, rods, and any other tools and equipment used for drilling, were steam cleaned between each use.

As part of the soil and sediment investigation several split-spoon samples were collected for analysis during the well drilling program. When collecting soil samples for analysis, larger 3 inch diameter split spoon samplers were used. These samplers were decontaminated following the protocols in Appendix K. In addition to these protocols after the methanol rinse and potable water wash, the samplers were steam cleaned and then rinsed with distilled water. Each larger split-spoon sampler used to collect soil samples for analysis was decontaminated in this manner prior to use. After a split spoon sampler was decontaminated it was wrapped in aluminum foil or plastic sheeting until needed.

After a soil sample intended for analysis was collected, the split spoon sampler was opened and logged by the hydrogeologist in the same manner as the other soil samples. After the sample was logged, using clean latex gloves, it was placed in appropriate prelabelled, pre-cleaned EPA approved sample jars. The sample was then placed immediately on ice. All soil samples were shipped via Federal Express to Enviropact, Inc., Jacksonville, FL and a chain-of-custody maintained. Chain-of-custody forms for the soil samples are given in Appendix L.

Upon completion of the soil boring a 10 foot long, 2-inch diameter, schedule 40 PVC, slotted (.010 slot) section and appropriate length of blank PVC riser pipe were installed in the annular space of the hollow stem augers. Prior to installation of the well, all well materials (screen, riser,and caps) were steam cleaned, and all personnel handling the materials wore clean rubber gloves to minimize cross contamination. A suitable sized graded sand was then used to sand pack the annular space around the screen zone and to at least 2-3 feet above. Once the sand pack was in place a two foot thick bentonite pellet seal was installed on top of the sand pack. For shallow wells where the bentonite pellet seal was placed in the unsaturated zone, the pellets were hydrated with potable water. The remainder of the annular space was then pressure grouted with a cement/bentonite slurry at a ratio of 6:1 to two feet below land surface. The wells were then completed by cementing in a 5 foot long, 4-inch diameter steel casing with locking lid. Detailed well completion diagrams are given in Appendix O. In areas of high traffic flow the wells were finished flush with land surface using a locking steel cover and curb box. Well construction details are given on Table A-1.

- Deep Monitoring Well Installation

The deep monitoring well (DW-1) was installed adjacent to existing well WT-6. The purpose of this well is to monitor deeper ground-water quality at the Site. The bottom of the well is at 61 feet below grade. The clay layer immediately underlying the well is a minimum of five feet thick and acts as a confining unit. The deep well was installed at this depth to monitor for the presence of any contaminants that are heavier than water and may have sunk in the aquifer. If this had occurred the clay unit would have restricted the downward movement of the contaminants, which would then be detected when DW-1 was sampled.

The two criteria used to determine the final depth of the deep well were; 1) when four consecutive soil samples yield readings of less than 10 ppm for volatile organics on the photoionization meter, and 2) if volatile organic contamination is found to persist with depth, then the hole will be drilled to the top of the first confining layer encountered of at least 5 feet in thickness.

In the case of well DW-1, both conditions were met, except that a soil sample taken at 60-62 feet, at the clay surface, gave a reading of 23.8 ppm. The subsequent two soil samples from 62-66 feet (in the clay) had photoionization readings of less than 0.5 ppm.

The well was drilled with a hollow stem auger rig and split spoon samples collected in the same way in which they were for the shallow wells. Split spoon core samples were collected continuously (every 2-feet) from land surface to 41 feet, and then at five foot intervals from 41 feet to the bottom of the boring.

To avoid cross contamination all split spoon samplers were decontaminated between each use with soap and water, high pressure potable water rinse, and then finally steam cleaned. One soil sample was collected for analysis while drilling DW-1. That sample was collected from 1.0 - 1.7 feet below land surface with a 3 inch diameter split spoon that was decontaminated in the same manner as was done for all other samples being collected for analysis.

Upon completion of the borehole, the well was installed in the same manner as the shallow wells, with a 10 foot long slotted (.010 slot) section and appropriate length blank PVC riser. Since this well was designed to monitor water quality in the deeper horizon of the aquifer, teflon tape was used on the casing threads to prevent possible leakage of groundwater into the well from the upper horizons of the aquifer.

All well materials were steam cleaned, and personnel handling the well materials wore clean rubber gloves to prevent cross contamination. Upon completion of the shallow and deep monitoring wells, all of the drill cuttings brought up during drilling were stockpiled in a designated area of the Site. Since none of the drill cuttings appeared to contain free product, it was not necessary to contain any in drums.

- Piezometer Installation

In addition to the nine new monitoring wells, seven piezometers were installed around the site. Piezometers are small diameter wells with short screens designed for water level measurement only. One piezometer A-10A (also called WT-4) was installed to replace a monitoring well (A-10) that was found to be destroyed during the well inspection survey. The remaining six piezometers (P-1 to P-6) were installed on the embankment where the vertical tanks are located (Figure 2 in the text).

The piezometers are constructed of 1-1/4 inch diameter, 4 foot long .010 slot long stainless steel well points. The remainder of the piezometer is constructed of an appropriate length of 1-1/4 inch diameter black steel pipe. Two piezometers A-10A and P-3 are constructed of 2 inch diameter PVC pipe, with 5 foot long slotted sections (.010 slot), and an appropriate length of blank

PVC riser pipe.

The borings for piezometers A-10A and P-3 were drilled with the hollow stem auger rig, the remaining borings were drilled using a portable tripod rig. Split spoon core samples were collected continuously (every 2 feet) at all borings in the same manner as the wells, decontamination of sampling equipment was also done using the same protocols as for the monitoring wells. The boring for A-10A was drilled without collecting any soil samples. Once the borehole was complete, the piezometer was installed in the hole and the remaining annular space was backfilled with cuttings brought up during drilling. The piezometers were set so that the screen zone is only 2-3 feet into the water table, and thus water levels of the upper horizon of the water table are being monitored. For the two piezometers (A-10A and P-3) in which the hollow stem auger rig was used to drill the hole, a bentonite pellet seal was placed above the screen zone. This was done because the hole created by the auger rig is 8 inches in diameter and therefore creates a larger pathway for vertical flow from precipitation, as opposed to the small tight fitting hole created with the tripod rig.

- Well Development

All monitoring wells and piezometers were developed after installation. The monitoring wells were developed by pumping and then surging with a centrifugal pump. The piezometers were developed in the same manner except a peristaltic pump was used to pump and surge. All wells and piezometers were developed for a sufficient amount of time so that relatively sediment free water could be obtained from the discharge. Development insures a good hydraulic connection between the aquifer and well/piezometer and also removes fine sediments from around the screen zone that could eventually clog the slots and reduce well efficiency. When developing the wells and piezometers, any discharge water that contained free organic product was contained in 55 gallon drums and stored in a plastic lined bermed area.

- Surveying

After all monitoring wells and piezometers were installed they were surveyed both horizontally and vertically by Storch Associates, Westbury, NY, a professional land surveyor licensed in the state of New York. Prior to surveying, all wells and piezometers, were labeled, and a designated measuring point clearly marked. All new data points and elevations were then plotted on the base map by Storch Associates. The measuring point elevations for all wells and piezometers is given on Table A-1.

- Aquifer Testing

To determine the aquifer coefficients of transmissivity and hydraulic conductivity at the site, short term specific capacity tests were conducted. Four monitoring wells were selected around the entire site, three shallow monitoring wells and the deep well (DW-1) were chosen. The deep well was selected to aid in determining the aquifer coefficients of the deeper horizons of the aquifer. The three shallow wells (SW-1, 3, and 5) were selected based on their locations, so that a wide area of the site would be included.

Each well was pumped for 30 minutes or until the maximum extent of drawdown for the pump was reached, and water levels measured on a prescheduled basis. Protocols for short term specific capacity tests and for water level measurement frequencies are given in Appendix G. In addition to monitoring water levels in the pumping wells, nearby wells or piezometers were also monitored to determine the influence of pumping beyond the immediate area of the well.

All water level measurements and pumping rates are given on the pump test forms in Appendix G, along with the appropriate graphical representations. The results of the specific capacity test are discussed in the report text.

- Water Level Measurements

Since the site is located in an area that is subject to tidal changes from Hempstead Harbor, water levels in selected monitoring wells and all piezometers were monitored over a 12 hour period. In addition two staff gauges that were previously surveyed in by Storch Associates, were also measured over the 12 hour period. This was done to determine what affects, if any, the changing tidal cycle has on both vertical and horizontal flow patterns at the site.

All water levels were measured to an accuracy of ± .01 feet using a weighted chalked tape. All water-level measurements are given in Table 8 of the text. Individual hydrographs were made for each well cluster showing the tidal effects on the vertical flow patterns around the site (Appendix F). Before any water levels were measured in a well that was to be sampled for ground-water quality, the tapes were thoroughly decontaminated following the protocols in Appendix K.

- Soil and Sediment Investigation

In conjunction with the monitoring well installation program, 27 soil borings were drilled to define the areal and vertical extent of soil contamination. Most of the soil borings were drilled using the truck mounted hollow stem auger rig, but in some difficult access areas it was necessary to use the portable tripod rig. In a few very limited access areas a stainless steel hand auger was used to collect soil samples.

Split spoon core samples were collected continuously (every 2 feet), logged in detail, and screened with the photoionization meter, as they were during the monitoring well installation program. All equipment was decontaminated between each use, and when soil samples were collected for analysis the sampling equipment was cleaned according to the protocols in Appendix J, with the exception that the split-spoon sampler was also steam cleaned before the final distilled water rinse.

In areas where access was extremely difficult, the stainless steel bucket type hand auger was used. Soil samples were collected at six inch intervals, laid out on a piece of plastic sheeting, logged in detail, placed in sample jars and then screened with the photoionization meter. The results of the field screening with the photoionization meter are given on Table 6. After a boring was completed it was backfilled with the cuttings brought up during drilling, and the upper 1/2 foot of the hole filled with a cement/bontonite seal.

In addition to the six soil samples collected during the monitoring well installation program, twenty two additional soil samples were collected for analysis during the soil boring program. All soil samples were collected and placed in prelabelled, precleaned sample jars following the protocols in Appendix P.

After the soil samples were collected, they were packed on ice and shipped to Enviropact, Inc. for analysis, with a chain-of-custody maintained. Chain-of-custody forms are given in

Appendix L. As a minimum, all soil samples were analyzed for the EPA method 624 purgeable organics, 8 RCRA metals, and PCBs following contract laboratory procedures (CLP) and QA/QC. The few exceptions to this are the four soil samples (B-29, 11, 3, and 2) that were split in the field with NYSDEC. These samples were run for the full priority pollutant list + 40 peaks.

The final step in the soils investigation involved collecting eight sediment samples from Hempstead Harbor and Motts Cove (Figure 2 in text). These samples were collected at low tide by digging a hole until water was encountered and then collecting sediment from the sides of the hole by hand, using new latex gloves for each sample. These samples were also kept on ice and shipped by Federal Express to Enviropact, Inc. Four samples (S-3, 4, 5, and 7) were analyzed for EPA method 624 purgeable organics, 8 RCRA metals and PCBs following CLP protocols. The remaining four sediment samples (S-1, 2, 6, and 8) where split with NYSDEC and analyzed for the full priority pollutant + 40 peaks.

- Ground-Water Sampling and Analysis

The nine new monitoring wells and one existing monitoring well (WT-6) were sampled by Roux Associates on two separate occasions, one month apart. Prior to sampling each well was purged with a peristaltic pump or teflon bailer to remove at least 5 casing volumes of water. For wells purged with the peristaltic pump, new polyethylene tubing was used for each well. Monitoring Well DW-1 was bailed dry with a teflon bailer twice prior to sampling, which resulted in a total removal of 3 casing volumes of water. After purging all wells were given enough time to recover to near static levels before sampling. The exception to this is the 3 wells (WT-6, WT-13, and WT-14) that are designed to monitor the presence of organic liquid on the water table, these wells were given 24 hours after purging to allow organic liquid to reaccumulate before being sampled.

The wells were sampled with a teflon bottom loading bailer following the protocols in Appendix J. At the time of sample collection the pH, conductivity, and temperature of the sample was noted. This data and all observations made during purging pertaining to discharge turbidity, color, etc. are noted on the well sampling sheets in Appendix Q.

The bailer was decontaminated between each use following the protocols in Appendix K. When sampling the three organic liquid monitoring wells, special care was taken to make sure that the sample was collected from the top of the water column to ensure that if any organic liquid was present in the well, it would be sampled. The deep well (DW-1) was sampled from the very bottom of the well, and the remainder of the wells were sampled from the top portion of the well. All of the ground-water samples collected were sent to Enviropact, Inc. via Federal Express and a chain-of-custody maintained (Appendix L). The samples were analyzed for EPA method 624 purgeable organics, 8 RCRA metals, and PCBs, Well DW-1 was analyzed for the full priority pollutant + 40 peaks analysis. Four of the wells being sampled were also sampled by NYSDEC on both occasions. These samples were split evenly by Roux Associates from the same bailer volumes. NYSDEC collected the samples for the full Hazardous Substance List analyses.

As part of the QA/QC program two duplicate samples and one bailer blank sample were also collected on both occasions and sent to the laboratory blind for analysis. The duplicates were collected from a single volume of water in the bailer and splitting evenly each time for the various jars that were required. The bailer blank was collected by filling a decontaminated bailer with distilled water and then filling the appropriate sample jars. During the initial sampling round of December 8 and 9, 1987, one additional bailer blank was collected to be split with NYSDEC for EPA method 624 and PCB analysis.