19

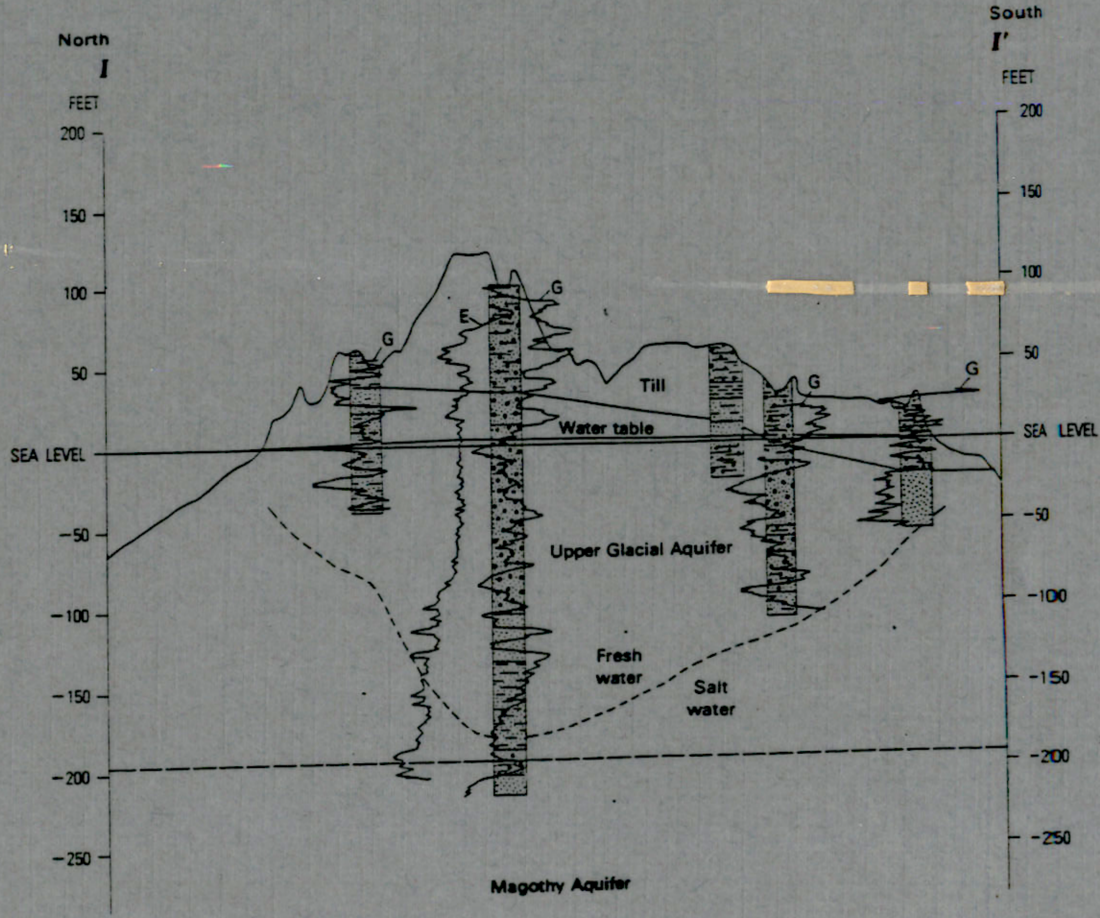
HYDROGEOLOGIC INVESTIGATION

FOR

THE MONTAUK LANDFILL

PREPARED FOR THE

TOWN OF EAST HAMPTON



JUNE 1991

fanning, phillips & molnar
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RONKONKOMA NEW YORK

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June 27, 1991

Mr. Michael O'Toole, Director
Division of Hazardous Waste Remediation
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233-7010

RE: Request for delisting of the Town of East Hampton Montauk Landfill

Dear Mr. O'Toole:

Concerning the petition to delist the Montauk Landfill from its present 2a classification, Fanning, Phillips and Molnar is submitting the Hydrogeologic Investigation Report which will provide the necessary information to evaluate the site. Based upon the information in this report, we recommend that the site be delisted from the New York State Department of Environmental Conservation Inactive Hazardous Waste Disposal Site Registry.

Should you require more information or clarification on this project, please call.

Very truly yours,

Martin O. Klein
Department Manager
Hydrogeology

Kevin J. Phillips, P.E. Ph.D.
Principal, Fanning, Phillips and Molnar

MOK/KJP:pc
Enclosure

cc: T. Bullock
C. Shea, Esq.
N. Nosenchuck
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June 27, 1991

Mr. Vincent Fay
Assistant Engineering Geologist
Bureau of Facility Management
Division of Solid Waste
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233-4016

RE: Montauk Landfill

Dear Mr. Fay:

Enclosed herewith, please find one copy of the report entitled Hydrogeologic Investigation For The Montauk Landfill for compliance with 6NYCRR Part 360, Section 360-2.11 and the New York State Department of Environmental Conservation Order on Consent (File No. 1-3699-89-06).

Please call if you have any questions.

Sincerely,

Martin O. Klein
Department Manager
Hydrogeology

Kevin J. Phillips

Kevin J. Phillips, P.E., Ph.D.
Principal, Fanning, Phillips
and Molnar

MOK/KJP:pc
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cc: T. Bullock
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N. Nosenchuck

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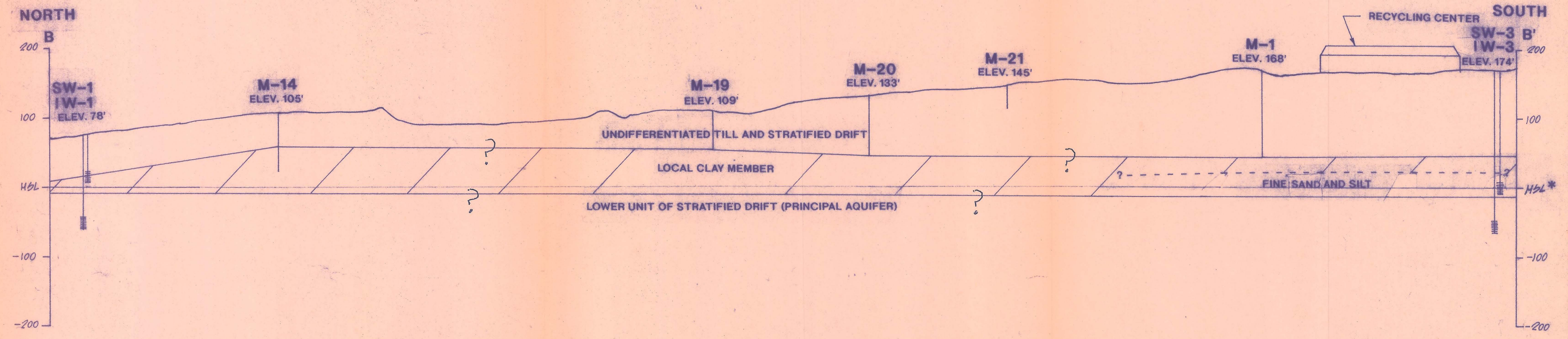
DISCLAIMER

These findings are based upon a detailed sampling procedure that has been formulated in accordance with NYSDEC approved procedures both for sampling and for laboratory analysis (USEPA where appropriate). Conclusions from this data are limited to those areas focused on in the study and represent our best judgment using analytical techniques and our past experience. Even though our investigation has been scientific and thorough, it is possible that certain areas of this site may pose environmental concerns that as yet are undiscovered. In addition, environmental regulations may change in the future and could have an effect on our conclusions.



VERTICAL & HORIZONTAL SCALE:
0 50 100 200

* MSL-MEAN SEA LEVEL

B-B'-TRACE OF GEOLOGICAL CROSS-SECTION SHOWN ON PLATE 2.2.1

M= METHANE WELL
W= WATER WELL
S= SHALLOW
I= INTERMEDIATE
D= DEEP

FIGURE 2.2.2
GEOLOGICAL
CROSS-SECTION B-B'

MONTAUK LANDFILL

EAST HAMPTON NEW YORK

fanning, phillips & molnar
ENGINEERS
RONKONKOMA NEW YORK

DR.BY. H.C.
SCALE: AS SHOWN
CK.BY. K.P.

* MSL-MEAN SEA LEVEL

A-A'- TRACE OF GEOLOGICAL CROSS-SECTION SHOWN ON PLATE 2.2.1

M= METHANE WELL

W= WATER WELL

S= SHALLOW

I= INTERMEDIATE

D= DEEP

FIGURE 2.2.1 GEOLOGICAL CROSS-SECTION A-A'	DR.BY H.C.
	SCALE: AS SHOWN
MONTAUK LANDFILL	CK.BY T.D. K.P.
EAST HAMPTON NEW YORK	
fanning, phillips & molnar ENGINEERS RONKONKOMA NEW YORK	

SECTION 1.0
INTRODUCTION

An investigation of hydrogeologic conditions at the Town of East Hampton Montauk Landfill, Montauk, New York was undertaken by Fanning, Phillips and Molnar from December, 1990 to April, 1991. The overall objectives of the investigation were to characterize hydrogeologic conditions and develop groundwater quality information for the purpose of compliance with 6NYCRR Part 360, Section 360-2.11 and the New York State Department of Environmental Conservation (NYSDEC) order on consent (File No. 1-3699-89-06).

This report summarizes all hydrogeologic and groundwater quality data obtained from the installation of an environmental monitoring system that was established to detect possible contaminant releases from the landfill. This data was utilized in conjunction with information from pertinent regional hydrogeologic studies that have been performed by various agencies in the vicinity of Montauk, New York.

1.1 Background

The Montauk Landfill, which is sometimes called the Hither Hills Landfill, is an inactive municipal landfill located north of Montauk Point State Parkway, and south of the Long Island Railroad (LIRR) approximately 1.3 miles west of Fort Pond in Montauk, Town of East Hampton, Suffolk County, New York (see Figure 1.1 for site location).

The landfill, which is owned and operated by the Town of East Hampton, was established in the early 1960s and is approximately 30 acres in size. It was closed to landfilling activities in December 1989 and a transfer/recycling station has been established at the

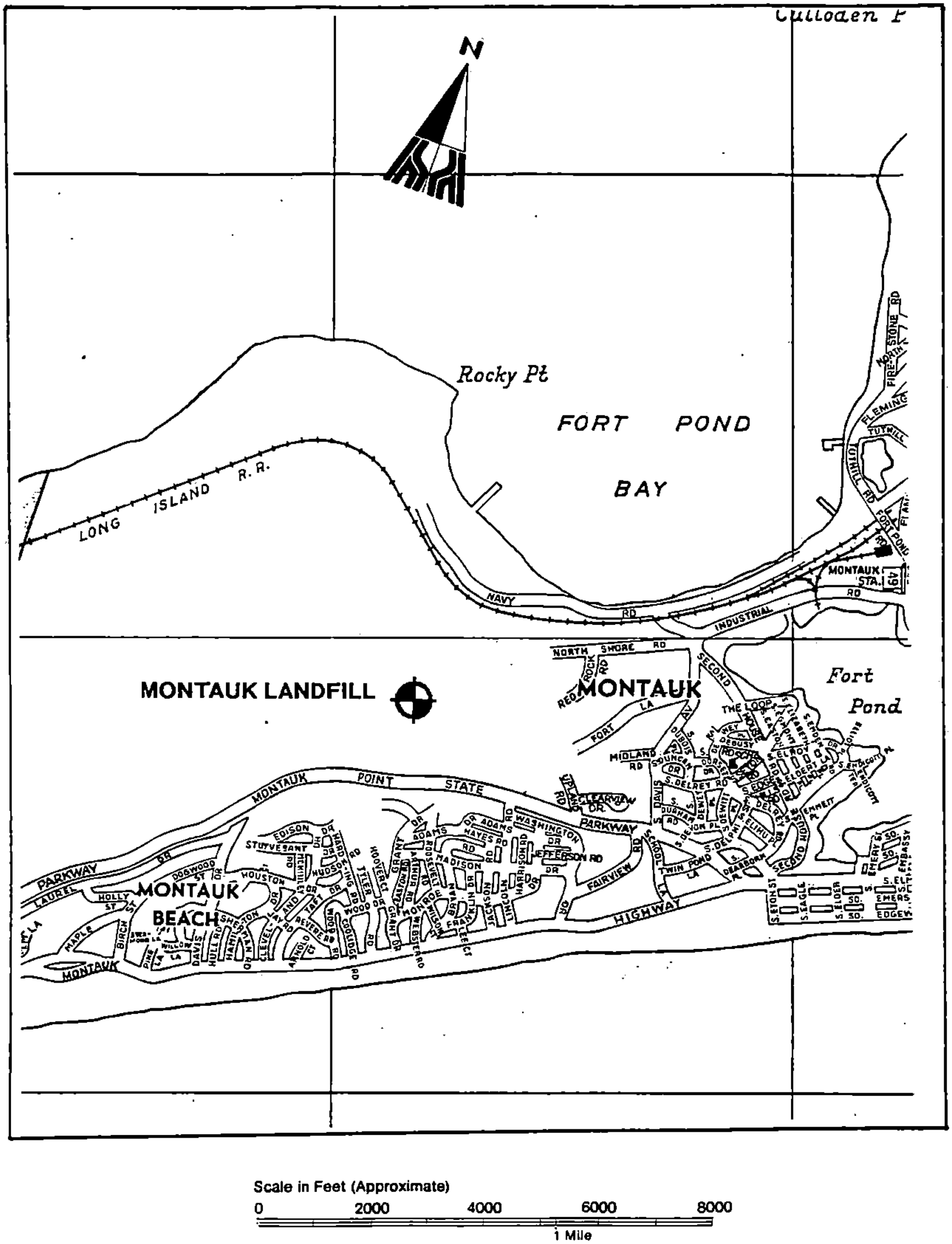


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FIGURE 1.1 – LOCATION OF THE MONTAUK LANDFILL

entrance to the former landfill area. The Town of East Hampton began sand mining operations around 1963 to provide cells for landfilling activities. The landfilling activities were conducted concurrently with the sand mining operations at the site (Bennett, 1991).

In accordance with NYSDEC's guidelines and requirements for hydrogeologic investigations for active and inactive municipal landfills (NYSDEC, 1988), the Town of East Hampton retained Fanning, Phillips and Molnar to prepare a work plan for performing a hydrogeologic investigation of the Montauk Landfill (Fanning, Phillips and Molnar 1990). The work plan received NYSDEC approval and the implementation of the tasks in the work plan commenced in December, 1991.

1.2 Objectives of the Hydrogeologic Investigation

The objectives for the hydrogeologic investigation are described in detail in the NYSDEC approved work plan (Fanning, Phillips and Molnar, 1990). Specifically, the objectives were to characterize the hydrogeologic conditions at the site and establish a water quality monitoring network, which can be modified as necessary based on the water level and water quality data obtained from the network.

To accomplish these objectives, field tasks were performed by or under the direction of Fanning, Phillips and Molnar between December, 1990 and April, 1991. Field tasks included the drilling of soil borings, installation of shallow, intermediate and deep monitoring wells, aquifer testing, the collection soil samples for geotechnical analysis, and analysis of groundwater samples to characterize groundwater quality.

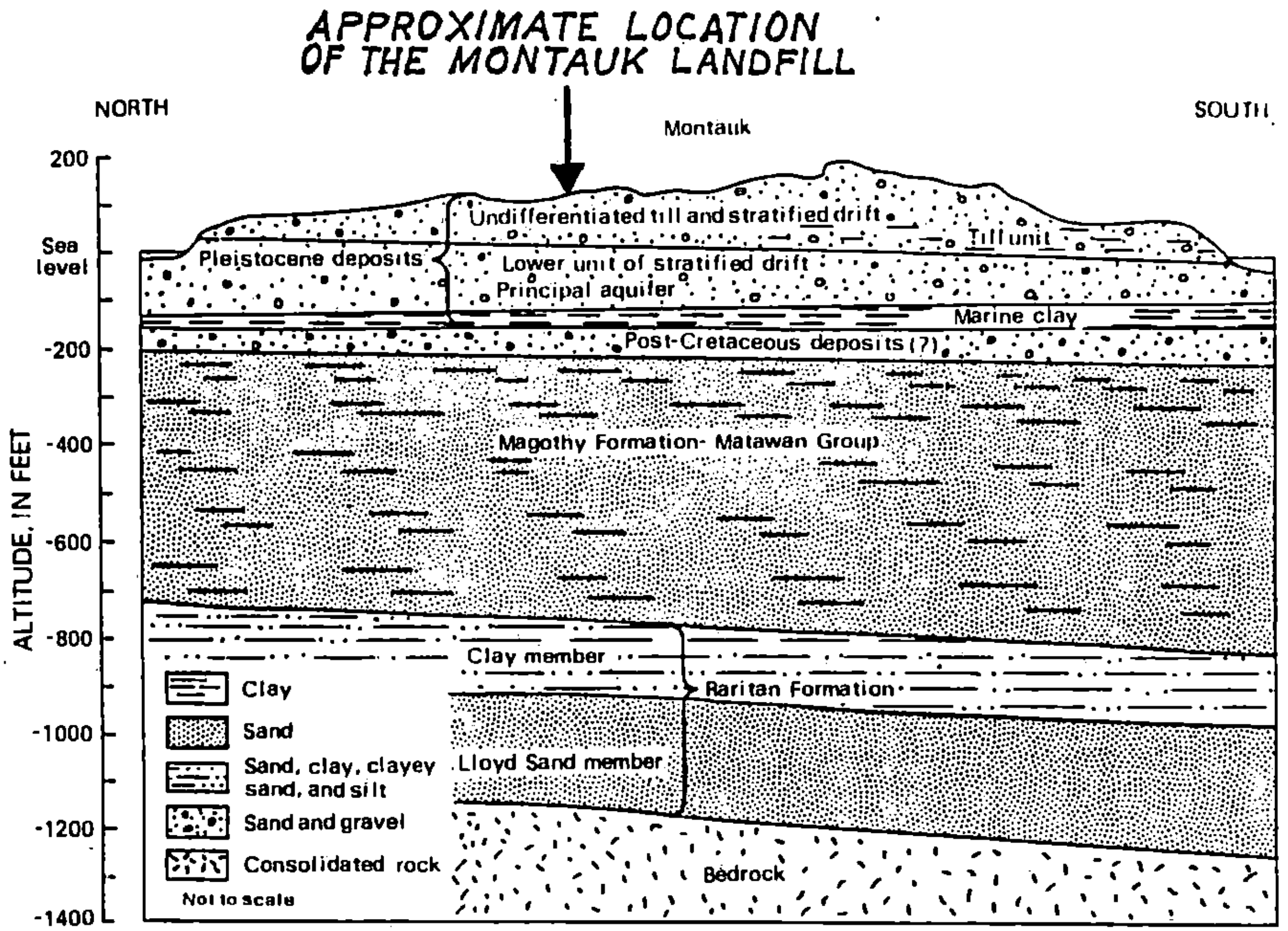
SECTION 2.0
GEOLOGY

2.1 Regional Geological Setting

The Montauk peninsula is underlain by unconsolidated deposits of Cretaceous and Quaternary age that rest unconformably on the pre-Cambrian and Paleozoic crystalline bedrock, depicted in Figure 2.1.1.

The basement complex of Precambrian and Paleozoic gneiss and schist is estimated to lie at depths ranging from slightly less than 1,100 feet below sea level in the northeastern part of the Montauk area to approximately 1,300 feet in the southwestern part. The Cretaceous deposits overlying the basement are, in ascending order: 1) the late Cretaceous age Raritan Formation, which consists of the Lloyd Sand Member and an unnamed clay member, and 2) the Magothy Formation and Matawan Group, undifferentiated, which consists of sand and clay (Prince, 1986). There are reports (e.g., Nemickas and Koszalka, 1982) that indicate that parts of the Montauk peninsula may be underlain by the late Cretaceous age Monmouth Group, which unconformably overlies the Magothy-Matawan sequence and consisting predominantly of glauconitic sand and clay. However, Prince (1986) did not include this unit in his summary of geologic and hydrogeologic units in the Montauk Peninsula (see Table 2.1.1). The Prince report was the result of an extensive drilling program conducted to define the groundwater system which did not encounter the Monmouth Group. This report will follow the stratigraphy presented by Prince.

According to Prince (1986), the post-Cretaceous age deposits in the Montauk area consist of the following units: 1) post-Cretaceous (?) sand and gravel deposits, 2) a marine clay unit of Pleistocene



N.T.S.

SOURCE: FROM USGS WATER RESOURCES INVESTIGATION REPORT 85-4013, PRINCE 1986

FIGURE 2.1.1 – GENERALIZED GEOLOGIC CROSS-SECTION OF THE MONTAUK PENINSULA

F,P&M

<table>
<tr><th>System</th><th>Series</th><th colspan="3">Geologic unit</th><th colspan="2">Hydrogeologic unit</th></tr>
<tr><td rowspan="7">QUATERNARY</td><td>Holocene</td><td colspan="3">Recent shore, beach, salt-marsh deposits, and artificial fill</td><td rowspan="7">Glacial aquifer</td><td rowspan="3"></td></tr>
<tr><td rowspan="6">Pleistocene</td><td colspan="2">Moraine and outwash deposits (Ronkonkoma Drift)</td><td rowspan="3">Undifferentiated till and stratified drift</td></tr>
<tr><td rowspan="3">Manhasset Formation</td><td>Glaciofluvial deposits</td></tr>
<tr><td>Montauk Till Member</td><td>Confining unit (till unit)</td></tr>
<tr><td>Glaciofluvial deposits</td><td>Lower unit of stratified drift
unconformity?</td><td>Principal aquifer</td></tr>
<tr><td colspan="3">Marine clay (Gardiners Clay or 20-ft clay equivalent[?])
unconformity?</td><td>Marine clay confining unit</td></tr>
<tr><td colspan="3">Post-Cretaceous(?) deposits (Jameco Gravel equivalent[?])
unconformity?</td><td></td></tr>
<tr><td rowspan="3">CRETACEOUS</td><td rowspan="3">Upper Cretaceous</td><td colspan="3">Matawan Group-Magothy Formation undifferentiated
unconformity</td><td colspan="2">Magothy aquifer</td></tr>
<tr><td colspan="2" rowspan="2">Raritan Formation</td><td>Unnamed clay member</td><td colspan="2">Raritan confining unit</td></tr>
<tr><td>Lloyd Sand Member
unconformity</td><td colspan="2">Lloyd aquifer</td></tr>
<tr><td>PALEOZOIC and PRECAMBRIAN</td><td></td><td colspan="3">Crystalline bedrock</td><td colspan="2">Bedrock</td></tr>
</table>

SOURCE: FROM U.S.G.S. WATER RESOURCES INVESTIGATION REPORT 85-4013, PRINCE (1986)

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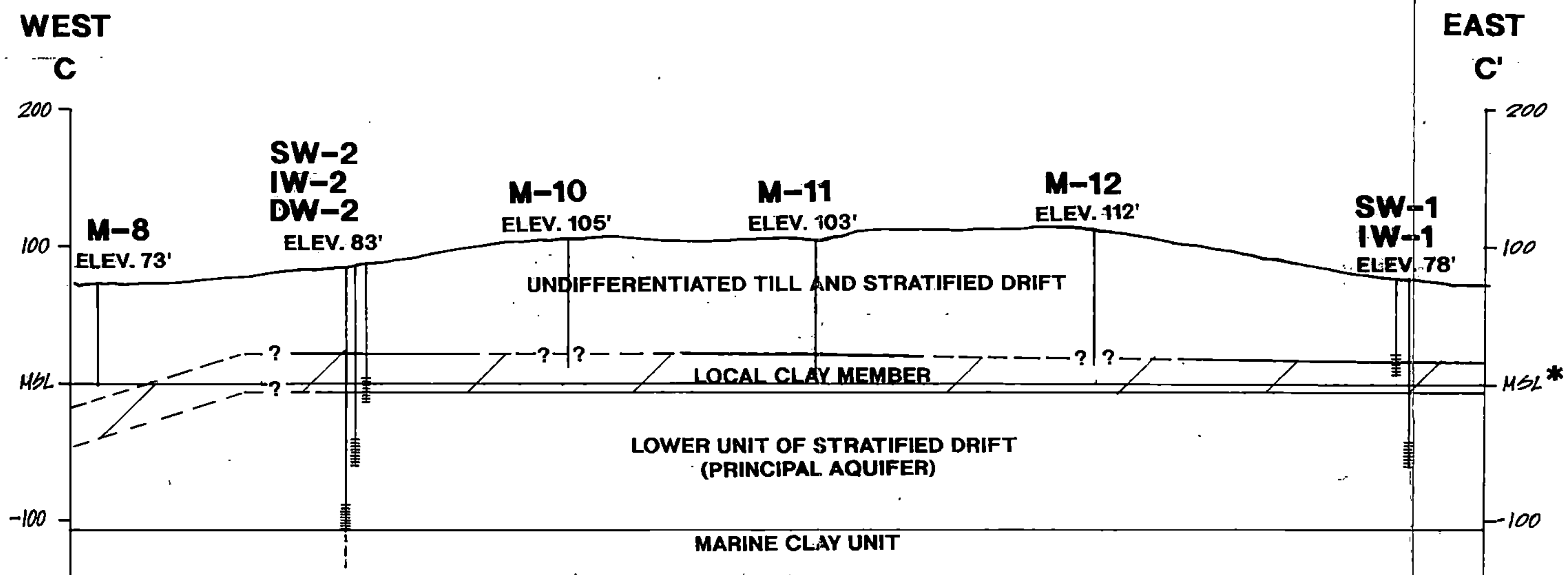
TABLE 2.1.1 SUMMARY OF GEOLOGICAL AND HYDROGEOLOGIC UNITS OF THE MONTAUK PENINSULA

age, 3) the Manhasset Formation, which consists of glaciofluvial deposits with the interbedded Montauk Till Member, and 4) moraine (mainly till) and outwash deposits of the Ronkonkoma Drift (Table 2.1.1). These post-Cretaceous units are described in detail for the Montauk peninsula by Prince (1986). The next two sections describe the units in detail in the area of the Montauk Landfill.

2.2 Subsurface Geology of the Montauk Landfill

A drilling program was conducted by Fanning, Phillips and Molnar to obtain additional information regarding the geology of the fresh groundwater reservoir beneath the Montauk Landfill site.

Following the regional geologic framework established by Prince (1986), the post-Cretaceous deposits at the Montauk landfill are subdivided, in ascending order, into 1) post-Cretaceous sand and gravel deposits, 2) marine clay (Gardiners ?), 3) the lower unit of stratified drift of the Manhasset Formation (which contains the principal aquifer) and 4) local clay and undifferentiated members of the upper till and stratified drift unit. Geological cross-sections of the landfill geology were constructed to depict the geologic framework beneath the landfill site in detail (Figures 2.2.1, 2.2.2, and 2.2.3). These cross-sections primarily utilize the data collected during the drilling of 7 groundwater monitoring wells at three separate locations (Plate 2.2.1) and 12 methane monitoring wells constructed at the landfill, as well as two Suffolk County monitoring wells (S-31735 and S-48577). The specific data used to construct these cross-sections included drill logs (Appendix A and Methane Monitoring Report for the Montauk Landfill), split spoon descriptions (see field reports in Appendix B) and geophysical logs (Appendix C).



VERTICAL & HORIZONTAL SCALE:

0 50 100 200

* MSL–MEAN SEA LEVEL

C–C' TRACE OF GEOLOGICAL CROSS–SECTION SHOWN ON PLATE 2.2.1

M= METHANE WELL
W= WATER WELL
S= SHALLOW
I= INTERMEDIATE
D= DEEP

FIGURE 2.2.3 GEOLOGICAL CROSS–SECTION C–C'	DR.BY. H.C. SCALE: AS SHOWN
MONTAUK LANDFILL	CK:BY: T.D. K.P.
EAST HAMPTON NEW YORK	
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Only the Suffolk County well S-31735, located approximately 1000 feet south of the landfill, penetrated the Cretaceous age Magothy Formation-Matawan Group (Magothy Aquifer). The contact between the top of the Magothy Formation-Matawan Group and overlying post-Cretaceous (?) deposits is located at approximately 216 feet below sea level in S-31735. The post-Cretaceous (?) sediments in this well consist primarily of fine gray sand with minor amounts of clay.

Overlying the post-Cretaceous (?) sediments is the marine clay unit (Gardiners ?). This unit was intersected by both S-31735 south of the landfill and groundwater monitoring well boring DW-2 (Figures 2.2.1 and 2.2.3) within the landfill. The marine clay was intersected in DW-2 at 106 feet below sea level and at 116 feet below sea level in S-31735. According to Prince (1986), the upper surface of this unit is undulating.

The marine clay identified by Fanning, Phillips and Molnar in well boring DW-2 is a dark green-gray clay which contains shell fragments and minor dark green sandy or silty interbeds. It extends to at least to 133 feet below sea level at DW-2. The clay is characterized by high natural gamma radiation counts with the clay averaging 110 counts/second.

Overlying the marine clay at DW-2 is approximately twenty feet of gray, mica-rich (biotite greater than muscovite) fine silty sand. This zone is characterized by relatively high natural gamma radiation counts, averaging 90 counts/second possibly reflecting the high mica content. The gray silty sand is interbedded with minor amounts of brown coarser sand. Although this silty sand is closely associated and may be gradational with the marine clay unit, it's hydrologic characteristics and geologic age appear to be more similar to those of the overlying unit of stratified drift. For this reason, it has been included in the lower unit of stratified drift rather than the marine clay unit.

The lower unit of stratified drift of the Manhasset Formation consists dominantly of medium to fine brown stratified sand with minor amounts of gravel. Prince (1986) also reported the presence of thin lenses of silt and clay; however, none were noted during drilling of the monitoring wells at the landfill. At DW-2, the lower stratified sand unit is approximately 100 feet thick (Figures 2.2.1 and 2.2.3); whereas, it is up to 141 feet thick at S-31735. The sand consists predominantly of quartz grains with sodium and potassium feldspar, muscovite, biotite, amphibole, red-brown garnet, and magnetite being the most common accessory minerals identified (see Appendix D). The gravel component of the samples is made up predominantly of subangular quartz and granitic clasts. The brown sand section of the lower stratified drift is characterized by relatively low natural gamma radiation counts averaging around 50 counts/second and ranging up to 90 counts/second.

The deposits overlying the lower unit of stratified drift were described by Prince (1986) as an undifferentiated unit of till, stratified drift and moraine deposits for the Montauk peninsula. This unit is made up of the upper units of the Manhasset Formation and Ronkonkoma Drift. At the Montauk Landfill, two distinct subdivisions of this unit were encountered, a lower clay-rich unit and an upper unit composed of mixed sand and gravel with minor till, silt and clay (Figures 2.2.1, 2.2.2, and 2.2.3). The lower clay-rich unit which immediately overlies the lower stratified drift unit is identified in this report as a local clay member. The local clay member consists of clay beds interbedded with silt, sand, cobbles and boulders and was encountered in all locations at the landfill where groundwater borings were conducted. The clay was depicted as a localized unit in the general area of the landfill in a cross section by Prince (1986) located 800 feet south of the landfill, indicating it extends past the landfill property boundaries.

The estimated elevations of the top and bottom of the clay member from the groundwater monitoring wells are given in Table 2.2.1 and Plate 2.2.2, which shows approximate areal extent. The bottom of the clay member is consistently around 8 feet below mean sea level. At well cluster site 3, the bottom of the unit was picked based on interpretation of the natural gamma radiation geophysical log. Subsequent drilling of the shallow well, SW-3, by hollow stem auger and further inspection of the resistivity - spontaneous potential geophysical log indicates that the lower portion (150-182 feet below land surface, 24 to -7 feet mean sea level) of the local clay member may be predominantly sand. This is depicted on Figures 2.2.1 and 2.2.2, its hydrologic significance will be discussed in Section 3.0. The top of the unit varies from around sea level north of the landfill to 50 feet above sea level south of the landfill (Plate 2.2.2).

Plate 2.2.2 shows the estimated surface altitude of the local clay member based on data from both groundwater and methane monitoring wells. The thickness of this unit is variable as seen in Figures 2.2.1 and 2.2.2. All the methane monitoring wells of appropriate depth intersected the clay member (see Table 2.2.2) with the exception

TABLE 2.2.1
ELEVATION OF THE TOP AND BOTTOM OF THE CLAY MEMBER OF THE UNDIFFERENTIATED TILL AND STRATIFIED DRIFT DEPOSITS DETERMINED DURING THE HYDROGEOLOGIC INVESTIGATION TOWN OF EAST HAMPTON - MONTAUK LANDFILL

Well Number	Surface Elevation (feet)	Depth from Land Surface to Top of Clay Member (feet)	Depth from Land Surface to Bottom of Clay Member (feet)	Elevation of Top of Clay Member (feet)	Elevation of Bottom of Clay Member (feet)	Thickness (feet)
SW-1	78.9	60	-	18.9	-	-
IW-1	78.0	56*	84*	22	-6.0	28
SW-2	82.6	72	91	10.6	-8.4	19
IW-2	82.4	60*	87*	22.4	-4.6	27
DW-2	82.7	60*	82*	22.7	-0.7	22
IW-3	173.8	125*	182*	48.8	-8.2	57
SW-3	173.3	135	-	38.3	-	-

* Based on the natural gamma radiation logging of the well

TABLE 2.2.2
ELEVATION OF THE TOP OF THE LOCAL CLAY MEMBER DETERMINED DURING THE METHANE INVESTIGATION
TOWN OF EAST HAMPTON - MONTAUK LANDFILL

Well Number	Surface Elevation (feet)	Depth of Well (feet)	Depth to Clay (feet)	Elevation of Clay (feet)
M-1	168.4	131	123	45.4
M-8	72.9	75	-	Deeper than -2.1
M-9	82.1	80	78	4.1
M-10	104.9	92	-	Deeper than 12.9
M-11	102.7	95	90	12.7
M-12	112.1	95	-	Deeper than 17.1
M-13	77.6	60	60	17.6
M-14	105.4	85	45	60.4
M-18	153.4	106	-	47.4
M-19	109.0	56	56	53
M-20	132.9	91	85	47.9
M-21	145.3	36	-	Deeper than 109.3

of 3 of the 6 methane wells occurring along the northern perimeter of the landfill (Figure 2.2.3). The reason for this is unclear but may reflect local thickness variations of the unit, the relatively shallow nature of the holes, and the difficulty inherent in logging by drill cuttings from hollow stem auger borings especially from the bottom of the boring or when a unit is thin. Boring M-8 did not appear to penetrate a recognizable clay unit at the stratigraphic horizon where it was encountered at nearby DW-2 (Figure 2.2.3). Its presence or absence at this location cannot be confirmed. There were no split spoon samples from this horizon from the methane well boring, only hollow stem auger cuttings. The unit may also be at a slightly lower horizon than the boring encountered.

The clay varies from gray to brown in color and forms sequences of layers that range in thickness from less to 1 inch to over 10 feet thick. This clay may represent deposits of marine or lacustrine origin deposited during an interglacial period, possibly mid-Wisconsian (Sirkin, 1991; Sirkin and Buscheck, 1977). Boulder zones were intersected in the unit in at least two of the locations where groundwater monitoring wells were installed. The boulder zones were interbedded with the clay and may represent Montauk Till. The sand interbedded within the local clay member varies from being brown to gray and commonly contains abundant silt and clay-sized material. The sand samples appear mineralogically similar to the underlying deposits of stratified till (see Appendix D). Dark brown silt was also found interbedded within the local clay member at the SW-1 location. The local clay member is characterized by high natural gamma radiation counts with average values ranging from 100 to 140 counts per second, and till deposits of the upper Manhasset Formation and Ronkonkoma Drift which dominantly consist of stratified sand deposits with lesser amounts of till and clay. (For a more detailed description of these deposits at the site, see the section on surficial geology.) Natural gamma radiation logs through this zone are generally characterized by low natural gamma radiation counts, averaging 50 to 60 counts per second although zones exhibiting greater than 100 counts/second are also intersected. The latter zones may correspond to till zones, as tills typically are unsorted with higher amounts of fine material including clay minerals.

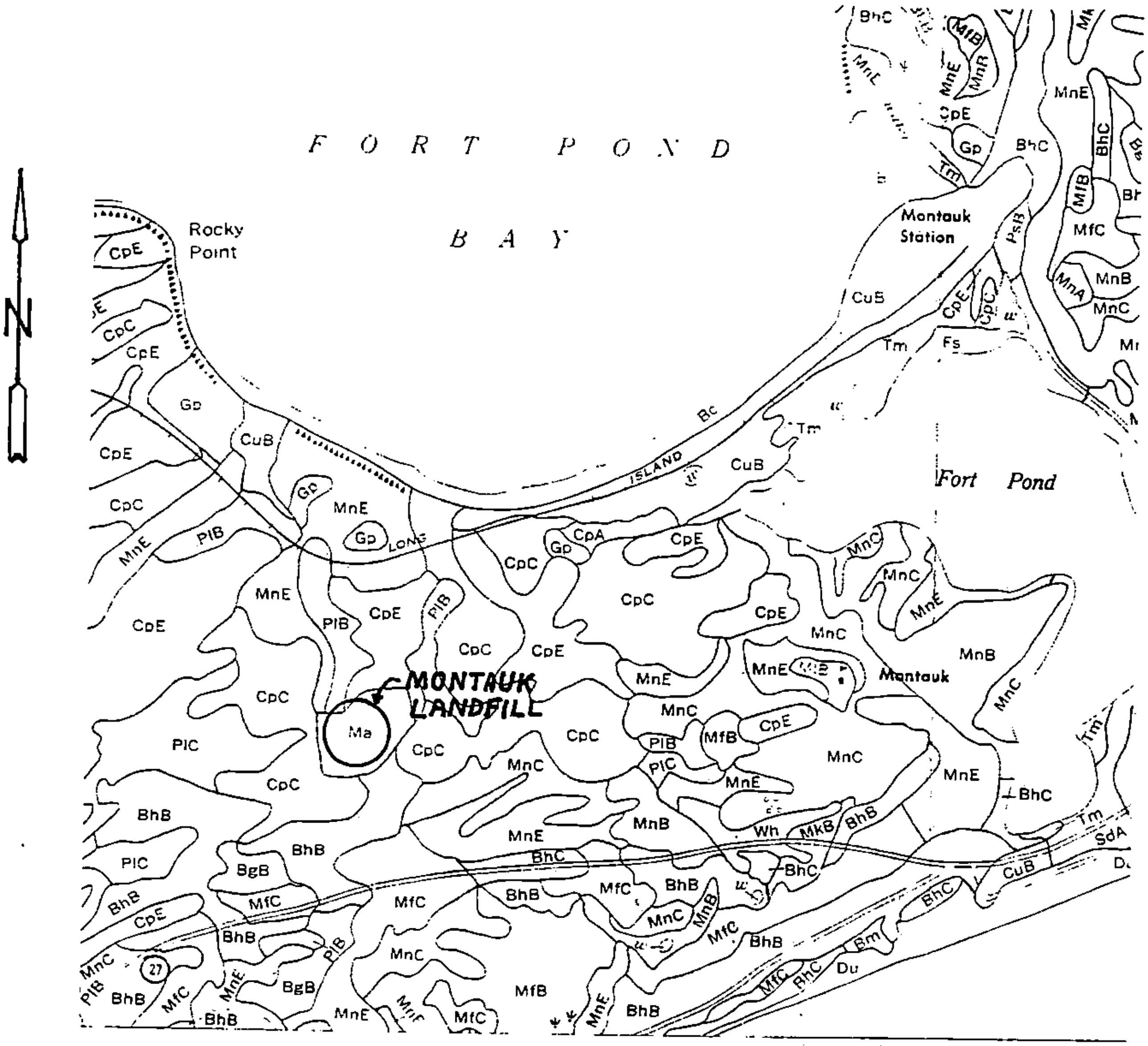
2.3 Surficial Geology of the Montauk Landfill

The surficial geology of the Montauk Landfill was studied through inspection of available published literature and on-site geological mapping. Geological mapping of the landfill was performed by measuring and describing slopes along which the unconsolidated units are exposed. Ten stratigraphic sections were described and are shown in Plate 2.3.1. The information from these stratigraphic sections was supplemented by information obtained from well boring logs.

The United States Soil Conservation Service (1975) identifies the presence of the following soil types in the vicinity of the landfill (Figure 2.3.1):

1) Carver-Plymouth sands (CpC, CpE) is found mainly in moraines and have 3 to 15 percent slopes for CpC and 15 to 35 percent for CpE. They consist of deep, highly permeable, excessively drained coarse textured soils which have low to very low available moisture capacity.

2) Plymouth loamy sand (Plb) is found on moraines and outwash



SOURCE: U.S.D.A., S.C.S., 1975

SCALE: 1:20,000

LEGEND OF SOIL TYPES CONTIGUOUS TO OR WITHIN THE MONTAUK LANDFILL

CpC – CARVER – PLYMOUTH (3 TO 15 % SLOPES)
CpE – CARVER – PLYMOUTH (15 TO 35 % SLOPES)
PlB – PLYMOUTH (3 TO 8 % SLOPES)
BhB – BRIDGEHAMPTON (2 TO 6 % SLOPES)
Ma – MADELAND

F,P&M

FIGURE 2.3.1 – SOILS MAP OF THE MONTAUK LANDFILL VICINITY

plains and have slopes of 3 to 8 percent. They are described as being deep, excessively drained coarse textured soils with a low to very low available moisture capacity. Permeability is rapid except in the silty substratum phase.

3) Bridgehampton silty loam, till substructure (BhB) is mainly found on the moraine in the vicinity of the Montauk Landfill and occurs on slopes of 2 to 6 percent. These soils are well drained to moderately well drained, medium textured and have a high available moisture capacity. Permeability is moderate in the silt loam layers, very rapid in the sandy substratum, and moderately slow in the till substratum of the till phases.

The surficial geology map of Nemickas and Koszalka (1982) shows that the Montauk Landfill is located in an area covered by Ronkonkoma Drift. Ronkonkoma Drift forms moraine deposits that are primarily foreset beds of sand and gravel with occasional lenses of till and clay. In the landfill, sand interbedded with gravel dominates the slopes exposed along its western margin. Outcrops are much more heterogeneous along the slopes of the eastern margin of the landfill with clay and till, as well as beds of sand and gravel being exposed.

The outcrops of sand and gravel represent glaciofluvial deposits. The sand in these deposits is bedded or cross-bedded, white to brown and fine to coarse-grained. The sand is mineralogically similar to the underlying sand deposits described in the previous section. Thin layers (less than 6 inches) of silt and clay are observed interbedded with the sand at some localities.

Till outcrops at the site as poorly-sorted, poorly stratified or unstratified deposits of sand, gravel, cobbles and boulders (up to 4 feet in diameter). The till occurs as lenses that are typically several tens of feet wide and is believed to represent ablation (flow) till. Unconformities between the till and underlying units are sometimes visible and appear to represent erosional contacts.

A large exposure of clay occurs at the location of stratigraphic section II (Plate 2.3.1). The gray-brown clay at this location is associated with a fine gray silty sand with biotite-rich beds. A similar association was intersected in DW-2 at the contact with the marine clay unit. Near surface clay was also intersected at a nearby methane well (M-14) and abandoned borings M-14A and M-14B. This clay forms smeared out layers or fragments in brown sandy matrix around its margins and is believed to represent a fragment(s) that was displaced from its site of original deposition by glacial shove. Other evidence for glacial tectonics includes changes in the magnitude and direction of the dip of the layers of stratified deposits, faulting and the deformed appearance of many of the thin clay layers. None of the clay deposits observed, as a result of the mapping of the surficial geology, are believed to be areally extensive with respect to the site property.

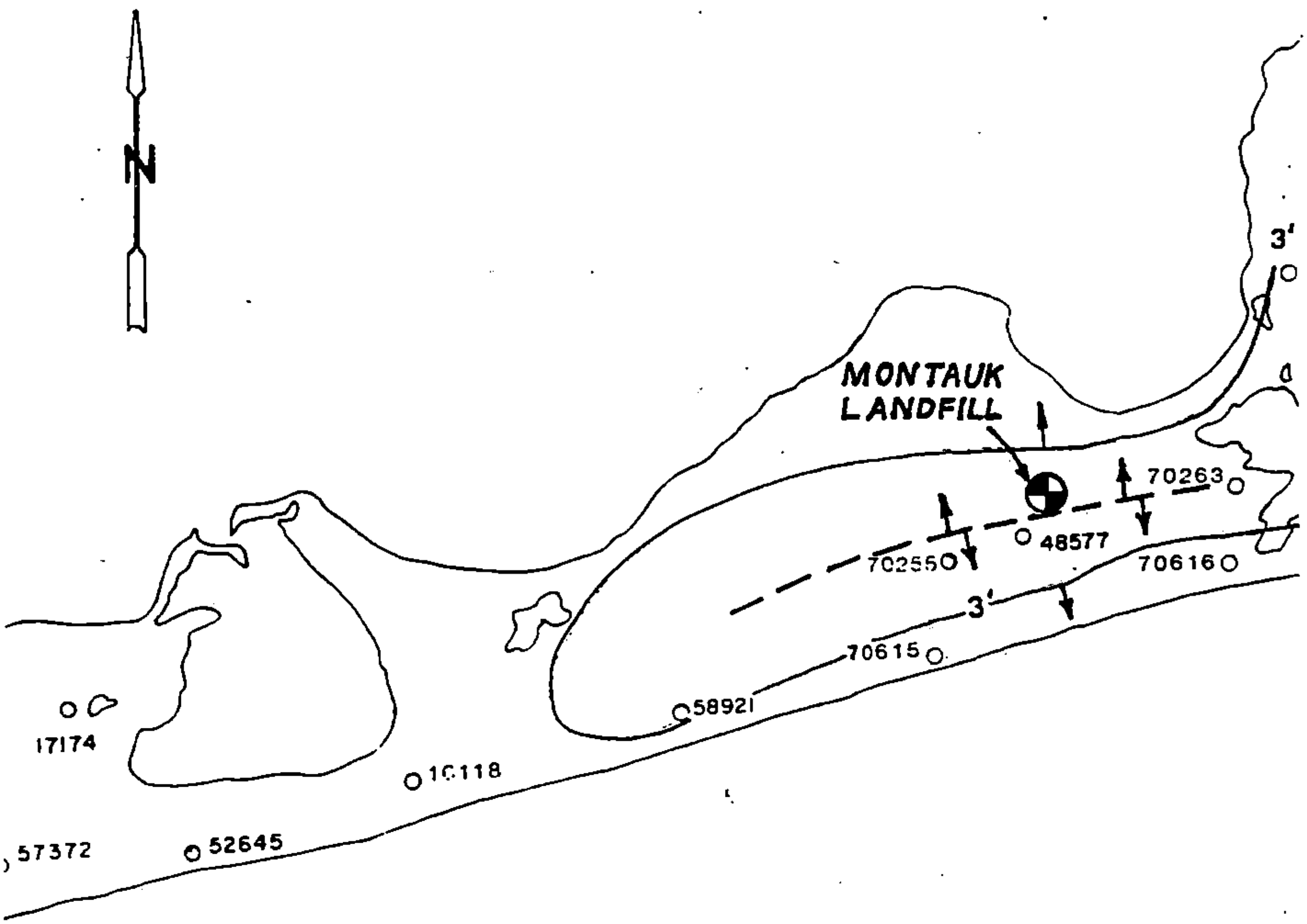
SECTION 3.0
HYDROGEOLOGY

3.1 Regional

The aquifers of the South Fork of Long Island are the sole source for public supply, agriculture, and industry. Groundwater accumulates above the bedrock in the unconsolidated sediments of Pleistocene and Cretaceous age. The upper glacial aquifer is the aquifer associated with Pleistocene deposits while the Magothy aquifer is associated with the Cretaceous deposits. Magothy deposits are not utilized as a water source in the Montauk area due to the fact that it contains only saltwater. The Raritan Formation is not utilized in the Montauk area due to the excessive depth and salt content. **Therefore, the aquifer of concern is the upper glacial aquifer.**

Recharge of the upper glacial aquifer occurs through precipitation. The average annual precipitation on the South Fork as recorded at Bridgehampton, New York, is 46 inches per year (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1984) of which approximately half is lost to evapotranspiration and runoff with the remaining half infiltrating and recharging the aquifer (Prince, 1986, p.26).

The March 1988 Water Table Contour Map (Suffolk County Department of Health Services, 1988) shows the water table elevation in the vicinity of the Montauk Landfill to be approximately 3 feet above MSL (see Figure 3.1.1). The depth to the freshwater-saltwater interface at the Montauk Landfill is approximately 120 feet below Mean Sea Level (MSL) based on the theoretical Ghyben-Herzberg ratio of 40 feet of freshwater below sea level for every foot of freshwater above sea



SCALE: 1" = 1 MILE

SOURCE: SCDHS 1988

LEGEND

○ 70255 - LOCATION OF SCDHS MONITORING WELL

—3'— - GROUNDWATER CONTOUR LINE

⟶ - HORIZONTAL GROUNDWATER FLOW DIRECTION

– – – - APPROXIMATE LOCATION OF GROUNDWATER DIVIDE

F,P&M	FIGURE 3.1.1 - GROUNDWATER ELEVATION DATA IN THE VICINITY OF THE MONTAUK LANDFILL IN 1988.

level. This is very close in elevation to what is thought to be a semi-confining layer of **marine clay**. These two facts limit the fresh water zone of interest.

The upper glacial aquifer in the Montauk area was divided by Prince (1986) into two hydrostratigraphic units, the underlying principal aquifer comprised primarily of sand and gravel and overlying undifferentiated till and stratified drift deposits. This division provided a more refined representation of the complex framework of the fresh groundwater reservoir in the Montauk area over previous hydrogeologic reports such as Nemickas and Koszalka (1982) and Fetter (1976, 1971). The principal aquifer as defined by Prince (1986) is the primary aquifer (as defined by NYSDEC Part 360-1.2(b) (10)) for the Montauk Peninsula.

The majority of the groundwater available for withdrawal at Montauk is in the principal aquifer. The base of the overlying till and drift unit in most areas of Montauk is at or near mean sea level. The elevation of the water table in the Montauk area generally ranges from mean sea level (MSL) to several feet above MSL. Only minor amounts of groundwater are found in the overlying till and drift deposits. These occurrences are usually in areas where the base of the unit extends below MSL. In some of the areas where this occurs, the water table develops an anomalous mound due to the low hydraulic conductivity of the unit. The groundwater yields from the undifferentiated till and drift deposits are generally low and the deposits are not considered a significant source of groundwater. The majority of groundwater flow on the peninsula appears to occur in the principal aquifer.

3.2 Local

Due to the regional scope of the SCDHS groundwater contour maps, the site specific groundwater flow direction had not been clearly established prior to this investigation. Fanning, Phillips and Molnar estimated that the landfill was located just north of the groundwater divide. This assumption was made by mapping the probable position of the groundwater divide on the regional scale map and noting that the landfill is on the north slope of the moraine and that topographic drainage is generally to the north.

The Montauk Landfill is located in Hydrogeologic Zone IV as defined in the Suffolk County Sanitary Code - Article 7, Groundwater Management Zones (SCDHS, 1986). This zone is characteristically deemed shallow flow on a regional scale. However, localized "deep flow" may be present in these zones with deep flow limited to the glacial aquifer.

Monitoring wells were constructed to obtain site specific groundwater flow data and aquifer characteristics. This construction was conducted by R&L Well Drilling for wells SW-1, IW-1, SW-2, IW-2, DW-2 and IW-3 and by Fenley & Nicol, Inc., for well SW-3 under Fanning, Phillips and Molnar's supervision. Table 3.2.1 provides a summary of the well construction details. The methods used to install these wells are described in Fanning, Phillips and Molnar's field reports in Appendix B. All IW and DW designated wells were installed using the mud rotary drilling method and all SW designated wells were installed using the hollow stem augering method. The well cluster site locations are on Plate 2.2.1. The screen depth and screen length of each are indicated in the cross sectional views depicted in Figures

TABLE 3.2.1
SUMMARY OF WELL CONSTRUCTION DETAILS
TOWN OF EAST HAMPTON
MONTAUK LANDFILL

Well Number	Well Depth	Screen Zone	Measuring Point Elevation
SW-1	74.83	60.03-74.53	80.83
IW-1	137.52	117.72-137.22	80.37
SW-2	94.03	79.23-93.73	84.70
IW-2	141.38	121.58-141.08	84.80
DW-2	191.45	171.65-191.15	84.93
SW-3	186.03	166.13-185.53	176.36
IW-3	236.04	216.24-235.74	176.24
S-48577	189	173-183	166.18

Note:
- All measurements are in feet.
- Well depths and screen zones are measured from top of PVC casing.
- Measuring point elevation is relative to mean sea level.
- Measuring point is the top of the PVC casing at mark (top of steel flange for S-48577).
- Completion reports in Appendix A provide the NYSDEC S-number for all SW, IW and DW wells.

2.2.1 and 2.2.2.

All construction was conducted to New York State Department of Environmental Conservation (NYSDEC) monitoring well specifications as detailed in the Fanning, Phillips and Molnar work plan (1990) that was approved by NYSDEC. The SW wells are screened to monitor the top of the water table with the upper portion of the screen extending into unsaturated materials. The IW wells are screened and monitor the -40 to -60 foot mean sea level (MSL) horizon. The DW well was installed to monitor the bottom of the fresh groundwater reservoir just above the marine clay unit (-90 to -110) beneath which the salt water interface is present based on calculations of freshwater-saltwater head relationships and interface field data from Prince (1986). The site chosen for the DW well was the site nearest the landfill in the estimated downgradient direction.

Water level measurements were obtained from February 27, 1991 to May 2, 1991 and are presented in Table 3.2.2. Water level measurements from several offsite wells were obtained on April 16, 1991 and are present in Table A of the April 16, 1991 field report in Appendix B. The seven wells installed during this investigation and the Suffolk County Department of Health Services' well, S-48577, were surveyed by Louis K. McLean Associates, P.C., to provide horizontal control to a grid and vertical control to mean sea level (MSL) datum. All wells were tested for being plumb to obtain the greatest accuracy possible in the groundwater elevation (The data are contained in Appendix E). The methodology for obtaining this data (Driscoll, 1986, p. 336-339) is also included in Appendix E. Three wells installed at the site (SW-1, IW-2 and IW-3) required small correction factors to be

TABLE 3.2.2
SUMMARY OF GROUNDWATER ELEVATION DATA
TOWN OF EAST HAMPTON
MONTAUK LANDFILL

(Depths to water corrected for wells SW-1, IW-2 and IW-3 using plumbness correction factors of 0.04, 0.01 and 0.02, respectively)

Date Measured:			February 27, 1991		February 28, 1991		March 13, 1991		March 21, 1991		March 22, 1991		March 26, 1991	
Well Number	Correction Factor	Measuring Point Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation
SW-1	0.04	80.83	68.19	12.64	68.60	12.23	68.55	12.28	68.69	11.94	68.79	12.04	68.72	12.11
IW-1	0.00	80.37	76.66	3.71	76.88	3.49	76.63	3.74	76.65	3.72	76.66	3.71	76.67	3.70
SW-2	0.00	84.70	80.87	3.83	81.10	3.60	80.86	3.84	80.91	3.79	80.91	3.79	80.93	3.77
IW-2	0.01	84.80	80.99	3.81	81.22	3.58	80.97	3.83	81.01	3.79	81.02	3.78	81.04	3.76
DW-2	0.00	84.93	81.55	3.38	81.83	3.10	81.49	3.44	81.56	3.37	81.51	3.42	81.05	3.88
SW-3	0.00	176.36	—	—	—	—	—	—	172.83	3.53	172.83	3.53	172.87	3.49
IW-3	0.02	176.24	172.68	3.56	173.01	3.23	172.68	3.56	172.81	3.46	172.75	3.49	172.78	3.46
S-48577	—	166.18	NM	NM	NM	NM	NM	NM	NM	NM	162.78	3.40	162.53	3.65

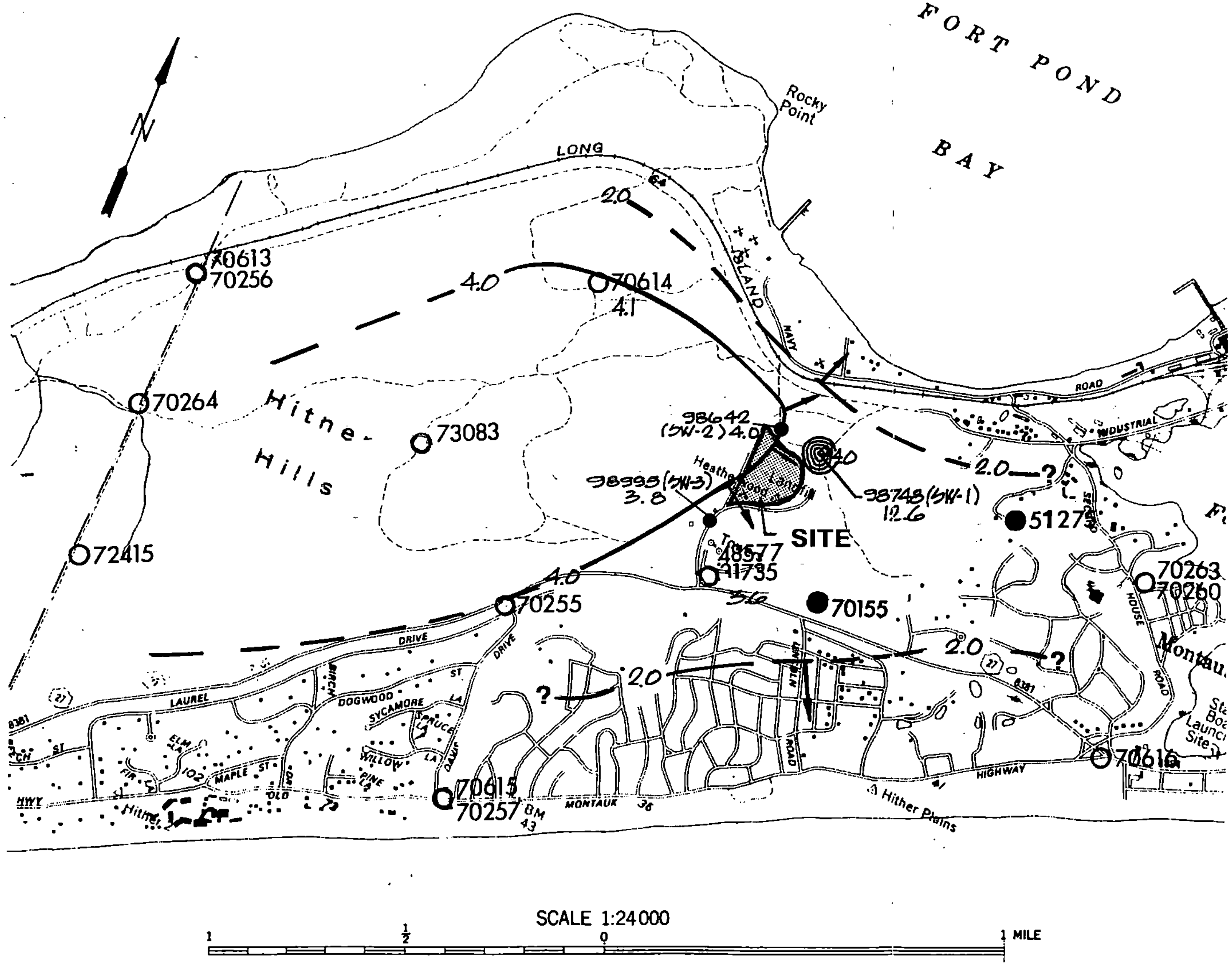
Date Measured:			March 27, 1991		April 3, 1991		April 4, 1991		April 6, 1991		April 15, 1991		April 16, 1991		May 2, 1991	
Well Number	Correction Factor	Measuring Point Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation	Depth to Water	Ground Water Elevation
SW-1	0.04	80.83	68.57	12.26	68.69	12.14	68.56	12.27	68.09	12.74	67.90	12.93	68.23	12.60	67.75	13.08
IW-1	0.00	80.37	76.44	3.93	76.69	3.68	76.63	3.74	76.41	3.96	76.43	3.94	76.53	3.84	76.37	4.00
SW-2	0.00	84.70	80.66	4.04	80.94	3.76	80.86	3.84	80.62	4.08	80.60	4.10	80.69	4.01	80.59	4.11
IW-2	0.01	84.80	80.75	4.05	81.04	3.76	80.95	3.85	80.71	4.09	80.71	4.09	80.80	4.00	80.70	4.10
DW-2	0.00	84.93	81.33	3.60	81.54	3.39	81.49	3.44	81.17	3.76	81.22	3.71	81.18	3.75	80.81	4.12
SW-3	0.00	176.36	172.39	3.97	172.85	3.51	172.70	3.66	172.43	3.93	172.41	3.95	172.53	3.83	172.46	3.90
IW-3	0.02	176.24	172.29	3.95	172.77	3.47	172.62	3.62	172.36	3.88	172.33	3.91	172.49	3.75	172.37	3.87
S-48577	—	166.18	162.48	3.70	162.82	3.36	162.89	3.29	162.46	3.72	162.42	3.76	162.55	3.63	NM	NM

NOTES:
- The measuring point is the top of PVC casing (black mark), in feet above mean sea level.
- The depth to water is measured in feet below the measuring point.
- The groundwater elevation is measured in feet above mean sea level.
- NM - Not measured.

used with the water level data due to deviation from being plumb monitoring points. All depths to water listed in Table 3.2.2 were corrected if necessary by the correction factor listed in the left side of the table. (Original depth to water measurements are documented in the field reports in Appendix B.) The depth to water at the site varies from 70 to 80 feet at well cluster sites 1 and 2 to 170 feet at well cluster site 3.

The elevation of the surface of the water table beneath the site is depicted in Plate 3.2.1. The potentiometric surface elevation of the -40 to -60 feet MSL horizon is depicted in Plate 3.2.2. These maps indicate a general groundwater flow direction of east-southeast based on the representation of these surfaces using site specific data. This is a deviation from previous estimates of north-northeast groundwater flow beneath the site based on the Phase I report on the site (E.A. Science, 1987) and inspection of regional groundwater contour maps. Based on Plates 3.2.1 and 3.2.2, it appears that the position of the Montauk peninsula groundwater divide is north of where it was estimated to be located using regional scale maps.

Water level measurements of groundwater level monitoring wells outside of the site boundaries was conducted on April 16, 1991 synoptic with water level measurements of the Town of East Hampton site monitoring wells. This was conducted to provide additional detail that might reveal a more accurate representation of the water table surface and potentiometric surface at the -40 to -60 foot MSL horizon at the site. Figures 3.2.1 and 3.2.2 indicate that groundwater contours bend near the site to conform to peninsula geometry and the influence of the water level mound in the middle of



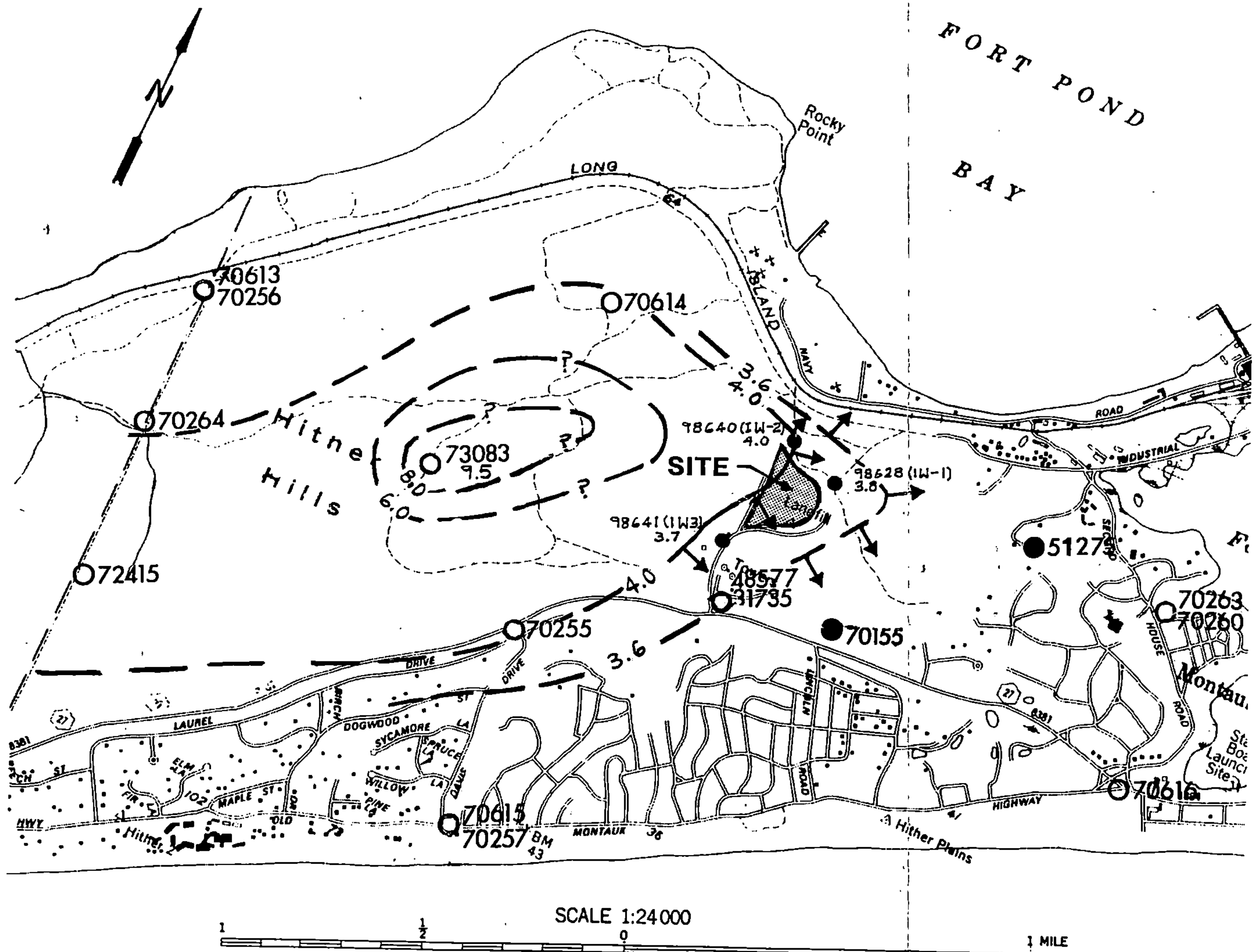
LEGEND:

- ● 98748 (SW-1) — GROUNDWATER WELL LOCATION
- ● 12.6 — WATER TABLE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL.
- — 4.0 - - — LINE OF EQUAL WATER TABLE ELEVATION, FT ABOVE MEAN SEA LEVEL. DASHED WHERE APPROX. CONTOUR INTERVAL IS 2.0 FEET.
- —→— DIRECTION OF GROUNDWATER FLOW

BASE MAP SOURCE: PRINCE (1986)

FIGURE 3.2.1
ELEVATION OF THE WATER TABLE SURFACE IN THE VICINITY OF THE SITE ON APRIL 16,1991.
TOWN OF EAST HAMPTON
MONTAUK, NEW YORK

fanning, phillips & molnar
ENGINEERS
RONKONKOMA NEW YORK



LEGEND:

- ● 98628 (IW-1) – GROUNDWATER WELL
- ● 3.8 – POTENTIOMETRIC SURFACE ELEVATION, IN FEET, ABOVE MEAN SEA LEVEL
- —3.6— — — – LINE OF EQUAL POTENTIOMETRIC SURFACE ELEVATION, IN FEET, ABOVE MEAN SEA LEVEL. DASHED WHERE APPROXIMATE. CONTOUR INTERVAL IS 2.0 FEET ABOVE 4.0 AND 0.4 FEET BELOW 4.0.
- → – DIRECTION OF GROUNDWATER FLOW

BASE MAP SOURCE: PRINCE (1986)

fanning, phillips & molnar
ENGINEERS
RONKONKOMA NEW YORK

FIGURE 3.2.2 – ELEVATION OF THE POTENTIOMETRIC SURFACE OF THE PRINCIPAL AQUIFER AT –40 TO –60 FEET MSL IN THE VICINITY OF THE SITE ON APRIL 16, 1991
TOWN OF EAST HAMPTON
MONTAUK, NEW YORK

Hither Hills State Park. These representations of groundwater surface elevations in the Hither Hills area indicate that groundwater flows eastward under the site primarily from Hither Hills State Park. The groundwater that leaves the site appears to flow eastward with some southeast groundwater flow also occurring.

One anomaly that is evident in the site groundwater elevation maps is a mound that exists in the water table surface at well cluster site 1. The SW well, designed to be the well at each cluster that bridges the water table, measures a hydraulic head that is in the range of 11 to 12 feet MSL. The hydraulic head at this site should be approximately 3 to 4 feet MSL based on water level data collected during this investigation and previous investigations in the Montauk area.

The drilling log from well cluster site 1 indicates that the SW-1 is screened in the local clay member of the undifferentiated till and stratified drift deposits detailed in Section 2.2 of this report. It appears that the water table at site 1 has mounded due to the low hydraulic conductivity of the local clay member. The 11 to 12 foot MSL water level measured in the SW-1 well does not appear to correspond to a perched water table as defined by Fetter (1988, p.102-105), Freeze and Cherry (1979, p.45, 48) and Driscoll (1986, p.64, 890) where there are unsaturated materials below the perched water, seperating it from the main water table.

Anomalous water table mounds occur in other areas of the Montauk peninsula. Water level monitoring wells S-70627 and S-70624 in the Prince (1986) report show water table mounding of 11 and 45 feet MSL. These wells are screened at -0.2 to -5.2 and -10.8 to -15.8 feet MSL, respectively. These wells are screened in the undifferentiated till and stratified drift deposits that overlie the principal aquifer. These deposits locally have a lower hydraulic conductivity than the underlying principal aquifer. The areas where these deposits extend below MSL and have low hydraulic conductivity appear to be the areas that develop anomalous water table mounds.

The drilling log from well cluster site 2 and water level measurements from the SW-2 well indicate that the water table intersects the local clay member at this location but does not mound. This may be the result of the local clay member unit having a higher hydraulic conductivity at this location than at site 1. No groundwater was detected in the clay in the 10 to 4 foot MSL zone (clay member top to present water table elevation) during the augering of the well boring. At well cluster site 3, the lower portion of the local clay member appears to be predominantly sand as detailed in Section 2.2 of this report. The water table surface is below the low conductivity clay and mounding does not occur at this site either.

Figure 3.2.2 and Plate 3.2.2 depict the potentiometric surface at the -40 to -60 foot MSL elevation. The potentiometric surface is similar to the water table surface. Groundwater appears to flow east and southeast on the site map (Plate 3.2.2) and east with northeast and southeast flow upon examination of the regional scale potentiometric surface (Figure 3.2.2).

The regional scale potentiometric surface shows a significant elevation in the area of well S-73083. In discussions with Prince (1983) the water level in this well appeared to be anomalously high based on peninsula geometry and hydraulic conductivity of the principal aquifer, which S-73083 is screened in and monitors. The well was subsequently tested (Doriski, 1984) for responsiveness and was found to be in good hydraulic connection with the aquifer. It is, therefore, assumed that the water level indicated by this well is a true representation of the potentiometric head in the center of Hither Hills and that a substantial gradient exists in the principal aquifer from the high area in Hither Hills to the lower heads observed at the landfill site.

Sediment samples taken from the screened intervals at each site were analyzed for grain size distribution. These distributions were then used to estimate the horizontal hydraulic conductivity of the portion of the aquifer that each well screens by use of the American Moretrench Method. Appendix F, Section 1, provides the sieve analyses and a summary table. Table 3.2.3 shows the resulting horizontal hydraulic conductivities estimated using the American Moretrench method. Table 3.2.3 also provides horizontal hydraulic conductivity estimates determined using two other methods.

The second method used was the slug test method. Data were interpreted using the analytical method developed by Bouwer and Rice (1976) and Bouwer (1989). The horizontal hydraulic conductivity of the tested aquifer was determined by measuring water level recovery following the instantaneous displacement of water in a well in this method. The test data and horizontal hydraulic conductivity calculations are provided in Appendix F, Section 2. The data was collected using a Telog Instruments, Inc., Water Level Recording System™, consisting of a data recorder (Model 2109-5) and a dedicated pressure transducer with a recording accuracy of 10 pounds per square

TABLE 3.2.3
SUMMARY OF SITE SPECIFIC HYDRAULIC CONDUCTIVITY DATA
TOWN OF EAST HAMPTON, MONTAUK LANDFILL

Well #	Aquifer	American Moretrench Method (feet/day)	Bouwer-Rice Method (feet/day)	Bradbury-Rothschild Method (feet/day), S = 0.3[2]
SW-1	UTSD[1]	(3)	0.05	-
IW-1	Principal	25.62	62.83	95.7
SW-2	UTSD/Principal	13.47	28.55	13.3
IW-2	Principal	35.59	14.41	30.9
DW-2	Principal	14.52	0.24[4]	8.6
SW-3	Principal	17.08	36.50	28.1
IW-3	Principal	12.81	20.55	31.1

(1) UTSD - Undifferentiated Till and Stratified Drift Deposits

(2) S - Storage Coefficient

(3) Most of formation in screen zone horizon is clay and silt which are materials for which the American Moretrench Method would not produce an accurate result.

(4) Well developed further after the slug test during sampling period.

inch.

A third method of horizontal hydraulic conductivity estimation was used to confirm the accuracy of the first two methods. Water level drawdowns in the wells were measured during purging activities conducted during water quality sampling to obtain specific capacity data. This data and pertinent well construction data were used in a computer program developed by Bradbury and Rothschild (1985) to determine horizontal hydraulic conductivities from specific capacity data (Appendix F, Section 3).

The horizontal hydraulic conductivities of the principal aquifer at the screened intervals of IW-1, SW-2, IW-2, DW-2, SW-3, and IW-3 range from 8.6 to 95.7 feet per day, excluding the anomalous value determined by the Bouwer-Rice method for DW-2. Subsequent pumpage of DW-2 during water quality sampling resulted in additional development of the well and improvement of the hydraulic connection of the well to the aquifer, exhibited by a large initial drawdown followed by a decreasing magnitude of drawdown as pumpage continued. Most of the horizontal hydraulic conductivities for the principal aquifer are in the range of 10-35 feet per day. Well SW-2, designed to monitor the water table surface, screens a small portion of the base of the local clay member of the till and stratified drift deposits where the water table surface extends into this unit and also screens the top of the principal aquifer. The horizontal hydraulic conductivity estimates determined from this well indicates that the well is hydraulically connected to the principal aquifer also.

The horizontal hydraulic conductivity estimates determined using the Bradbury-Rothschild method used a specific yield value of 0.3 for the principal aquifer. This was the highest value that has been cited for the unconfined area of the principal aquifer by various references regarding the South Fork of Long Island (Prince, 1986, p. 49). The Bradbury-Rothschild program was also run using a storage coefficient of 1.1×10^{-3} that was determined by Prince (1986) for a confined area of the principal aquifer 2.5 miles east of the landfill using a graphical analysis of aquifer test data. This was conducted to provide some indication of how the horizontal hydraulic conductivity estimates might vary with respect to this variable. The principal aquifer at well cluster site 3 appears to be unconfined but at well cluster sites 1 and 2 may be confined or semi-confined due to the water table surface intersection with the bottom of the local clay member of the overlying till and stratified drift deposits. Use of a storage coefficient at these 2 sites may be appropriate. It was determined that variation of the specific yield/storage coefficient value in the program did not result in a large variation in horizontal hydraulic conductivity estimates as shown in Table 3.2.4.

A horizontal hydraulic conductivity estimate was determined for the local clay member of the till and stratified drift deposits that overlies the principal aquifer. It was calculated from a slug test performed on SW-1. At this location, the water table surface extends into the local clay member and SW-1 is screened exclusively in the local clay member. A horizontal hydraulic conductivity estimate of 0.048 feet per day was calculated using the Bouwer-Rice method. The horizontal hydraulic conductivity estimate determined by the American Moretrench method was performed on the portions of the split spoon samples that were sieveable and excluded the clay portions of the

TABLE 3.2.4
HORIZONTAL HYDRAULIC CONDUCTIVITIES DETERMINED
BY THE BRADBURY-ROTHSCHILD METHOD
TOWN OF EAST HAMPTON
MONTAUK LANDFILL

Well Number	S = 0.0011	S = 0.3
IW-1	105.9	95.7
SW-2	14.3	13.3
IW-2	34.1	30.9
DW-2	9.5	8.6
SW-3	29.9	28.1
IW-3	34.3	31.1

aquifer samples that largely control the hydraulic conductivity of the unit.

Well cluster site 1 is the only location where a screenable thickness of groundwater was present in the local clay member of the undifferentiated till and stratified drift deposits and a hydraulic conductivity test could be performed. However, an indirect measure of the conductivity of this unit was obtained at well cluster site 3. The drilling log at this site indicated that there was 15 feet of unsaturated materials (primarily sand) beneath or in the bottom section of the local clay member and above the water table surface. The SW-3 well, designed to bridge the water table, screens a significant portion of this unsaturated zone. The base of the clay in this unit appears to drop below the water table surface north and south of site 3. Upon completion of the well, including resealing the borehole annulus, a significant positive (3.2 inches of water) or negative (3.8 inches of water) pressure differential was observed at the well head on different occasions and substantial air flow was noted exiting the 4 inch PVC casing when a positive differential was present.

The pressure differential observed in SW-3 is probably caused by pressure changes in the confined unsaturated zone (caused by water level fluctuations from tides and pumpage) or pressure changes in the atmosphere or a combination of these factors. It is evident that whatever the mechanism, the local clay member inhibits pressure equalization between the atmosphere and the confined portion of the unsaturated zone and that the conductivity of this clay layer is low. This phenomenon has not been observed at this magnitude at any of the

35 methane wells Fanning, Phillips and Molnar monitors at various sites. The conductivity appears to be more uniform in a vertical profile at these locations.

The horizontal hydraulic conductivity estimates of 8.6 to 95.7 feet per day determined for the principal aquifer at the landfill site are slightly lower than the horizontal hydraulic conductivities determined by Prince (1986) for the principal aquifer 2.5 miles east of the landfill site. Conductivity estimates of 270 feet per day using graphical analysis and 280 feet per day using numerical simulation analysis of aquifer test data were determined from an aquifer test conducted by Prince (1986) which utilized a public water supply well and an observation well network at the well field. The lower hydraulic conductivity estimates obtained at the landfill site are probably due in part to the lower well efficiency of the monitoring wells when compared to the efficiency of a water supply well and location within the peninsula due to the heterogeneity of the deposits.

The ratio of horizontal to vertical hydraulic conductivity (anisotropy) for the principal aquifer at the Prince (1986) test site was determined to range from 1:1 (graphical analysis) to 3:1 (numerical simulation analysis). Although these values are lower than other anisotropy estimates for the South Fork of Long Island (Nemickas and Koszalka, 1982), they are within the published range for other areas of Long Island (Lindner and Reilly, 1983). Using the anisotropy ratios developed by Prince (1986) and the horizontal hydraulic conductivity estimates calculated at the landfill site, the vertical hydraulic conductivity is estimated to range from approximately 3 to

96 feet per day.

Prince (1986) determined that the principal aquifer water levels at the pump test site experienced fluctuations of approximately 0.2 feet due to tidal fluctuation influences on the aquifer. A record of water level fluctuations in the principal aquifer at the landfill at well cluster sites 3 and 2 is provided in Appendix G, Section 1. It appears that groundwater level fluctuations caused by tidal fluctuations occur at the landfill and are of similar magnitude as those observed by Prince (1986). Although significant precipitation events tend to mask these fluctuations, the character of the fluctuations is similar to those observed at the pump test site east of the landfill (Prince, 1991).

These water level fluctuations caused by tide and precipitation events should not unduly influence the horizontal gradients determined from the water level maps. The water level maps were prepared from synoptic water level measurements conducted in a short time period, and these fluctuations appear to occur somewhat uniformly from the well cluster at the south side of the site to the well cluster at the north side of the site. These fluctuations are also not expected to have influenced the hydraulic conductivity calculations as the water level measurements used in the calculations were measured in time periods of less than 1 hour in length. Wells DW-2 and SW-1 did not appear to be greatly influenced by tides during the longer term slug tests on these wells.

The dynamics of the groundwater flow pattern for the Montauk peninsula have been described in detail in Prince (1986, p. 14-20). This discussion is included in Appendix G, Section 2. In general, groundwater in the central portion of the peninsula moves downward towards the salt water interface and then horizontally and upwards towards the groundwater discharge areas near the north and south shores of the peninsula.

At the landfill site, an evaluation of 13 rounds of water level measurements collected between February 1991 and May 1991 indicates that water levels and horizontal flow patterns remain relatively constant (Table 3.2.2). The water level data collected indicates:

1. The water table has an anomalous mound at well cluster site 1 where the groundwater surface extends into the bottom of the undifferentiated till and stratified drift deposits that overly the principal aquifer. The mound appears to have developed as a result of the low hydraulic conductivity of the local clay member that is present at the base of the deposits. Site 1 appears to be the only site where the water table is mounded due to this unit. At the other well cluster sites, the groundwater table surface is below, at or several feet into the bottom of the undifferentiated till and drift deposits.
2. Groundwater in the principal aquifer underlying the site flows in a easterly and southeasterly direction due to the position of the groundwater divide and the geometry of the Hither Hills groundwater mound.
3. Horizontal groundwater flow gradients range from 0.0003 to 0.0006 feet per foot with groundwater elevations varying less than 0.5 feet across the site, with the exception of an anomalous mound in the water table at site 1.

4. Groundwater in the principal aquifer at site 3 has a vertical flow gradient of 0.0004 feet per foot to 0.0017 feet per foot downward from the water table surface (approximately MSL) to the -50 foot MSL horizon.
5. Groundwater in the principal aquifer at well cluster site 2 has zero or a slight vertical flow gradient that is at times upward and at times downward. It ranges from 0.0005 feet per foot downward to 0.0002 feet per foot upwards.
6. The vertical groundwater gradient at well cluster site 1 ranges from 0.15 feet per foot to 0.16 feet per foot and is an indication of the vertical gradient that exists between the overlying undifferentiated deposits of till and drift and the underlying principal aquifer in areas where groundwater is present in the overlying till and drift.

Horizontal and vertical groundwater flow velocities for the principal aquifer at the landfill were calculated. These calculations are provided in Appendix G. The estimated horizontal velocity in the principal aquifer ranges from 0.02 to 0.56 feet per day and the estimated vertical velocity ranges from minimal (0.0) to 1.59 feet per day.

SECTION 4.0
GROUNDWATER QUALITY

The baseline groundwater monitoring parameters as outlined in New York State Department of Environmental Conservation (NYSDEC) Part 360 regulations were augmented with Target Compound List parameters to facilitate classification and possible delisting of the Montauk Landfill (Site Number 152073) with respect to New York State's list of inactive hazardous waste sites. The water quality monitoring program was conducted in accordance with NYSDEC guidelines and requirements for solid waste facilities. The field activities are documented in the field reports for the sampling period in Appendix B.

The monitoring wells installed at the site (SW-1, IW-1, SW-2, IW-2, DW-2, SW-3 and IW-3) and one nearby offsite monitoring well (S-48577) were purged and sampled from April 15 to April 17, 1991. Table 4.1 provides the data for the analytical parameters that were measured in the field during purging - pH, specific conductivity, temperature, turbidity and Eh. The groundwater samples collected after purging operations were analyzed by H2M Laboratories, Inc., Melville, New York.

Quality Assurance/Quality Control (QA/QC) procedures were conducted during the field sampling event by Fanning, Phillips and Molnar personnel. All purging and sampling equipment was decontaminated upon arrival at the site and between each well sampling using the procedures outlined in the work plan (Fanning, Phillips and Molnar, 1990). Field blanks were collected on each sampling day (April 16 and 17, 1991) using laboratory prepared water. The water was poured over and through all equipment and collected in appropriate

TABLE 4.1
SUMMARY OF ANALYTICAL PARAMETERS MEASURED
IN THE FIELD DURING PURGING (APRIL 15-17, 1991)
TOWN OF EAST HAMPTON

Analytical Parameters

Date	Well #	Time	pH units	Specific Conductivity (micromhos)	Temp (°F)	Turbidity	Eh (mV)
4/15/91	SW-1	3:30 p.m.	7.68	139	48	100+	356
		3:45	8.01	123	49	100+	351
		4:00	8.12	123	48	100+	358
4/16/91	IW-3	11:29a.m.	6.37	238	55	21	359
		11:35	6.43	274	55	25	188
		12:00p.m.	6.43	188	55	5	190
		12:12	6.12	137	55	4	190
		12:23	6.04	133	55	4	190
		12:38	5.94	130	55	4	188
	SW-3	1:59	6.38	262	55	>100	162
		2:03	6.33	272	55	54	168
		2:10	6.38	268	55	12	179
		2:15	6.38	264	55	6	184
		2:22	6.40	262	54	5	191
	S-48577	5:00	6.69	–	53	>100	50
		5:05	6.63	–	53	60	71
		5:10	6.48	–	52.5	34.5	80
		5:15	6.55	–	52.5	21	82
		5:20	6.56	–	52.5	19	74
		5:30	6.58	–	52.0	10	60
		5:40	6.60	–	52.5	7	55
4/17/91	DW-2	11:10 a.m.	7.58	–	52	100+	97
		11:18	6.62	–	52	100+	76
		11:27	6.54	–	52	100+	63
		11:34	6.51	–	52	100+	63
		11:50	6.42	479	52	100+	54
		12:05 p.m.	6.41	470	51.5	88	49
		12:18	6.44	467	52	32	46
		12:25	6.42	468	52	30	43
		12:45	6.37	468	52	18	38
	SW-2	1:11	6.40	–	55	13	-46
		1:26	6.57	–	53.5	5.5	-49
		1:35	6.52	303	53	1.5	-30
		1:44	6.54	284	53.5	1.0	-27
		1:50	6.44	282	53.5	1.0	-28
	IW-2	3:22	6.41	718	53	3	20
		3:35	6.22	676	52.5	40	65
		4:10	6.14	643	53	28	117
		4:25	6.03	632	53	20	133
		4:35	6.14	633	53	22	137
		4:54	6.01	635	53	10	144
	IW-1	6:17	6.68	190	50.5	100+	151
		6:25	6.75	129	50.5	100+	171
		6:36	6.78	123	50.5	100+	179
		6:50	6.72	120	50.5	100+	194
		7:00	6.74	118	50.5	100+	198
		7:08	6.65	117	50.5	100+ (≈ 110)	201

(–) Specific Conductivity meter not functioning.

containers provided by the laboratory for each analytical method. A trip blank prepared by the laboratory on April 15, 1991 when the sample containers were picked up was maintained during the sampling event.

Analysis of the field blanks and trip blank indicated that the QA/QC procedures performed by Fanning, Phillips and Molnar personnel were effective in the decontamination of all equipment placed into the monitoring wells. There were no detections of volatile organics in the trip or field blank water with the exception of vinyl chloride. This detection was the result of a malfunctioning organics removal filter in the laboratory's filtering system that prepares water for field and trip blanks. This is explained in an H2M Laboratories' Case Narrative Statement (Appendix H). The Montauk Landfill sampling event occurred during the period of time (April 5, 1991 to April 21, 1991) that the malfunctioning filter system was providing (subsequently documented) vinyl chloride contaminated blank water. All other analytes run on the field blanks were below detection limits or at the low levels expected for some inorganic analytes in blank water.

The laboratory analytical data and chain of custody forms are provided in Appendix H. The detections are summarized in Table 4.2. Ten parameters slightly to moderately exceed New York State groundwater standards as established by the New York State Health Department and the Department of Environmental Conservation as noted in Table 4.2. These are nitrate at 10.4 milligrams per liter (mg/l) in IW-2; total phenols from 2.5 to 6 micrograms per liter (ug/l) in SW-1, IW-1, IW-2, DW-2, SW-3 and S-48577; iron at up to 44.2 mg/l in all wells; manganese at up to 1.3 mg/l, SW-2, DW-2 and S-48577; lead

TABLE 4.2
SUMMARY OF DETECTIONS IN GROUNDWATER SAMPLES, FIELD BLANKS AND TRIP BLANKS, APRIL 16-17, 1991
TOWN OF EAST HAMPTON - MONTAUK LANDFILL

Analyte	STANDARDS: 6 NYCRR Part 703.5	10 NYCRR Subpart 5.1 (MCL)	40 CFR Part 141 (MCL)	10 NYCRR Part 170.4	SAMPLES: SW-1	IW-1	SW-2	IW-2	DW-2	SW-3	IW-3	S-48577	4/16 Field Blank	4/17 Field Blank	Trip Blank
	Milligrams per Liter				Milligrams per Liter										
Nitrate (as N)	10.0			10.0	ND	ND	ND	10.4	ND	1.2	ND	0.8	ND	ND	NA
Sodium				<20.0	10.2	14.6	21.3	50.3	30.9	22.8	13.5	23.1	0.5	0.4	NA
Iron	0.3	0.3			24.2	5.14	3.4	0.60	7.15	7.9	0.79	44.2	0.09	0.25	NA
Manganese	0.3	0.3			0.94	0.11	1.3	0.07	1.0	0.20	0.04	0.84	ND	ND	NA
Potassium					4.8	1.2	1.8	2.7	4.1	2.7	0.7	2.0	ND	ND	NA
Magnesium					6.4	2.3	6.5	18.7	11.3	6.3	1.7	5.7	ND	ND	NA
Calcium					7.3	3.9	11.7	27.1	27.6	11	3.1	9.1	0.2	0.3	NA
Aluminum					17.3	2.6	0.4	0.4	0.8	4.7	0.3	3.1	0.05	ND	NA
Antimony					ND	ND	ND	ND	ND	ND	ND	ND	74	ND	NA
Chromium	0.05	0.05	0.05	0.05	0.05	0.03	ND	ND	0.02	0.02	ND	0.02	ND	ND	NA
Copper	1.0	1.0		<0.2	0.04	0.03	0.02	0.02	0.05	0.02	ND	0.02	ND	ND	NA
Silver	0.05	0.05	0.05	0.05	ND	ND	ND	ND	0.04	ND	ND	ND	ND	ND	NA
Zinc	5.0	5.0		<0.3	0.11	0.08	0.05	0.03	0.15	0.05	0.03	0.07	0.03	0.02	NA
Dissolved Oxygen				>4.0	9.5	10.3	3.4	4.1	3.6	11.8	6.7	5.2	6.3	8.3	NA
Total Kjeldahl Nitrogen (TKN)					ND	ND	ND	0.4	0.2	ND	ND	0.7	2.3	ND	NA
Ammonia (NH_3)				<2.0	0.02	ND	0.02	ND	0.20	ND	ND	0.60	ND	ND	NA
Chemical Oxygen Demand					90	30	ND	20	20	80	ND	20	20	ND	NA
Biological Oxygen Demand					ND	ND	ND	ND	ND	ND	ND	ND	ND	11	NA
Total Organic Carbon					1.9	11.4	7.9	14.1	7.8	4.7	3.4	7.1	ND	ND	NA
Total Dissolved Solids					71	76	140	366	258	134	83	150	ND	ND	NA
Sulfate	250			250	ND	20	8	102	36	11	10	8	ND		NA
Total Alkalinity					21.3	19.0	89.6	69.7	94.2	46.1	22.1	18.6	2.3	2.2	NA
Chloride	250			250	16	20	21	64	62	40	19	62	ND	ND	NA
Total Hardness					44	19	55	144	115	53	14	46	0	0	NA
	Micrograms per Liter				Micrograms per Liter										
INORGANICS															
Lead	25	50	50	50	10.3	7.9	ND	6.4	7.6	ND	41.1	440	ND	ND	NA
Cadmium	10	10	10	10	8	ND	ND	ND	ND	ND	ND	11	ND	ND	NA
Cyanide	200				ND	ND	12	ND	ND	ND	ND	ND	ND	ND	NA
ORGANICS															
Acetone		50			62	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	5.0				ND	ND	ND	ND	ND	ND	ND	ND	43	23	45
Total Phenols	1.0	50		1.0	3.8	2.5	ND	2.5	6.0	ND	6.0	ND	ND	ND	NA
Bis(2 ethylhexyl) phthalate		50			ND	ND	13	ND	ND	ND	ND	ND	ND	ND	NA
					Units										
pH	6.5 to 8.5				6.9	6.8	6.5	6.3	6.6	6.7	6.4	6.6	6.1	5.8	NA
Turbidity					10	2.5	5.5	5	8.5	10	3.0	3.0	ND	ND	NA
Color					20	120	50	5	50	5	0	0	ND	ND	NA

NA- Not analyzed.
ND - Analyzed for but not detected (See Appendix H for results and detection limits).
MCL - (Maximum Contaminant Level) - maximum permissible level of a contaminant in water which is delivered to the free flowing outlet of the ultimate user of a public system.
Bold face values indicate the result exceeds the most stringent standard.

Note: Laboratory analysis for all samples included TCL VOCs, TCL BNA/E, TCL pesticides and PCBs, and 6 NYCRR Part 360 baseline parameters.

48577; lead at 41.1 ug/l in IW-3 and 440 ug/l in S-48577; cadmium at 11 ug/l in S-48577; acetone at 62 ug/l in SW-1; dissolved oxygen lower than 4.0 mg/l at SW-2 (3.4 mg/l) and DW-2 (3.6); and pH lower than 6.5 at IW-2 (6.3) and IW-3 (6.4). Vinyl chloride exceeded the standard of 5.0 ug/l in the trip and field blanks but was not detected in the groundwater samples. This is explained by the contract laboratory in the appendix containing the analytical results.

As illustrated in Table 4.2, the detections were primarily limited to inorganic parameters. No pesticides PCBs or herbicides were detected. Only one volatile organic compound - acetone at 62 ug/l in SW-1 and one semi-volatile organic compound - bis (2 ethylhexyl) phthalate at 13 ug/l (detection limit 10 ug/l) in SW-2 were detected.

According to a statistical study of chemical analyses of leachate from 83 municipal solid waste landfills (MSWLF) carried out by the United States Environmental Protection Agency (1988), inorganic constituents are detected more frequently than organic constituents in leachate. Characteristics that have been shown to be indicative of leachate impacted groundwater immediately downgradient of landfills on Long Island include high specific conductivity, elevated concentrations of the anions chloride, sulfate and bicarbonate and elevated concentrations of the cations sodium, potassium, calcium, magnesium, ammonium, iron and manganese (Robbins, 1990; Kimmel and Braids, 1980).

The properties and levels of inorganic constituents determined at the Montauk Landfill well cluster sites appear to be lower than the levels determined to be present in leachate impacted groundwater at landfill sites on Long Island (Robbins, 1990; Kimmel and Braids, 1980) and across the United States (US Environmental Protection Agency, 1988). The results indicate groundwater quality consistent with ambient groundwater quality for the South Fork of Long Island that was determined by Nemickas and Koszalka (1982) and Nemickas, Koszalka and Vaupel (1977). Table 4.3 from Nemickas and Koszalka (1982) provides a summary of the water quality properties and levels of inorganic constituents at wells that monitor ambient groundwater quality on the South Fork of Long Island where Montauk is located. Comparison with Table 4.2 indicates that the quality of groundwater at Montauk Landfill well cluster sites 1, 2, 3 and S-48577 generally falls within the range for ambient groundwater quality.

There are three inorganic constituents that slightly exceed the maximum values for ambient groundwater quality listed in Table 4.3. These are iron, manganese and magnesium. Iron in S-48577 was a level of 44.2 mg/l, exceeding the highest value of 23.0 mg/l that has been determined for ambient groundwater. This may be the result of the construction material of the well (steel) and its age (1973). Manganese slightly exceeds the highest ambient value of 0.62 mg/l in several site wells, with a maximum value of 1.0 mg/l. Magnesium slightly exceeds the highest background water quality value of 9.4 at well IW-2 (18.7 mg/l) and DW-2 (11.3 mg/l). All other inorganic constituents that are present on both Table 4.2 (site data) and 4.3 (South Fork ambient data) are within the levels that represent background water quality. It should noted that iron, manganese and magnesium are not health based parameters and should pose little concern to the quality of this aquifer.

TABLE 4.3
CHEMICAL QUALITY OF WATER IN UPPER GLACIAL AQUIFER SOUTH FORK, SUFFOLK COUNTY, NY, OCTOBER 1976

[All concentrations are in milligrams per liter]

Constituent or Property	Concentration or value				
	Minimum	10th Percentile	Medium	90th Percentile	Maximum
Silica (SiO_2)	1.1	6.8	9.6	16.0	24.0
Iron (Fe)	.08	.18	.47	1.5	23.0
Manganese (Mn)	0	.10	.20	.11	.62
Calcium (Ca)	.7	1.2	4.0	33.0	64.0
Magnesium (Mg)	.7	1.3	2.6	7.4	9.4
Potassium (K)	.2	.5	1.0	6.6	16.0
Sodium (Na)	4.9	6.0	9.2	26.0	52.0
Bicarbonate (HCO_3)	12	14	18	28	65
Sulfate (SO_4)	.6	3.3	6.2	77.0	140.0
Chloride (Cl)	6.9	9.0	19.0	40.0	82.0
Fluoride (F)	0	0	0	0.1	0.1
Nitrate (NO_3)	0	.01	.62	5.80	11.0
Phosphate (PO_4)	.01	.01	.01	.03	.10
Dissolved Oxygen	.3	.7	6.7	9.6	10.9
Dissolved Solids	26	43	77	212	275
Noncarbonate Hardness	0	0	6	100	180
Total Hardness (as $CaCo_3$)	5	10	23	110	200
pH	5.5	5.6	6.0	6.5	6.8
Specific Conductance (μmho/cm at 25°C)	48	65	155	375	540

Source: Nemickas and Koszalka, 1982

Several groundwater quality properties were determined by the contract laboratory (H2M Laboratories) and were measured in the field. All values determined for the groundwater from the site wells were similar to the Table 4.3 background water quality with the exception of specific conductance in well IW-2. The highest specific conductivity determined by Nemickas and Koszalka (1982) was 540 micromhos. The level at IW-2 was approximately 630 micromhos.

The groundwater quality data presented in this section is the result of one (1) sampling event. The levels detected may vary with seasonal fluctuations of the water table and time elapsed since a significant precipitation event. The levels of each analyte will also vary from one sampling event to the next due to the precision of each analytical method. Based on the data from the one sampling event to date, there appears to be no conclusive evidence of an impact to groundwater at well cluster site 1, 2, 3 and S-48577 due to the Montauk Landfill. Inorganic water quality parameters at all wells are generally within background groundwater quality for the South Fork of Long Island where Montauk is located. Calcium, magnesium, chloride, total alkalinity, sulfate, total dissolved solids and sodium are slightly higher in wells IW-2 and DW-2 than other site wells but are within the background levels of groundwater quality for the South Fork and are low when compared to other landfill groundwater data. Calcium, magnesium, chloride, total alkalinity, total dissolved solids and sodium are generally 2.1 to 3.4 times higher in IW-2 and DW-2 than the other site wells. Sulfate is approximately 7 times higher in IW-2 and DW-2 than in the other site wells.

The detection of acetone (62 ug/l) at SW-1 and bis(2 ethylhexyl) phthalate (13 ug/l) at SW-2 may or may not be significant. Acetone is a common chemical present at water quality testing labs and bis(2 ethylhexyl) phthalate is a common plasticizer that may be used in the manufacture of PVC products such as well casings. Additional sampling events will provide data on the analytes at these monitoring locations.

The lead detected at IW-3 and lead and cadmium detected at S-48577 does not appear to be related to the landfill mass. This is based on: 1) the groundwater flow pattern definition that has been developed at this time; and 2) the higher level (440 ug/l) at S-48577 being more distant from the landfill than the lower level of 41 ug/l at IW-3. The detection of lead at these levels in groundwater may be anomalous because lead is only moderately to slightly mobile in Long Island soils (Ku and Simmons, 1986).

The water quality of the area immediately surrounding the site is discussed in Section 5.0. Some water quality data has been generated on private wells near the site. Substantial water quality data has been generated on Suffolk County Water Authority well S-70155 (location shown on Plates 3.2.1 and 3.2.2).

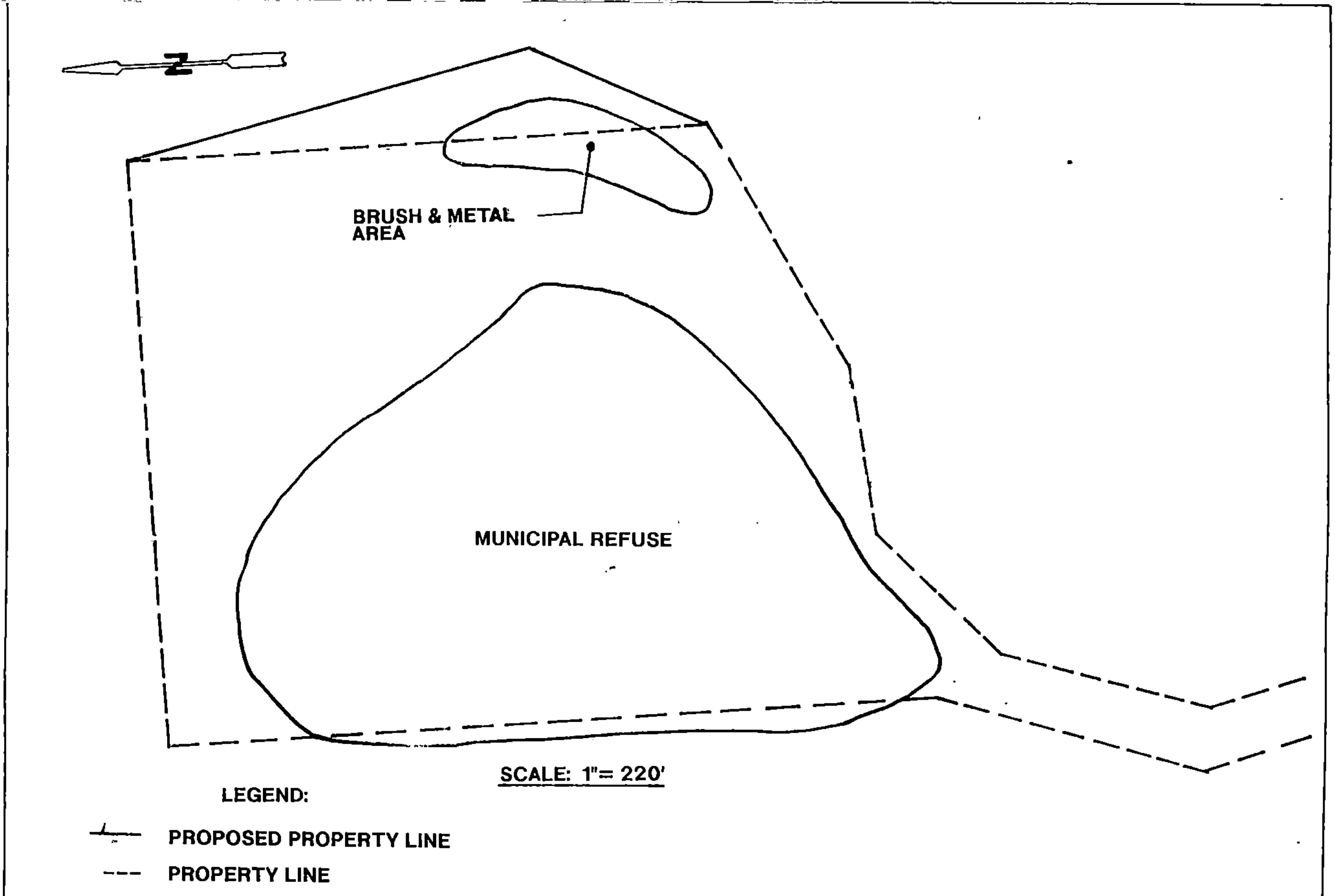
SECTION 5.0
SITE CHARACTERIZATION

5.1 Waste Mass Delineation

The Montauk Landfill is approximately 35 acres in size. The landfill was established in 1963 and was closed in December 1989. The site was operated as a sand mine by the Town of East Hampton concurrently with landfilling operations. The landfill received approximately 7000 tons per year of garbage including household garbage, construction debris, brush, cars, and scavenger septage wastes. In 1986, it was estimated that approximately 154,000 tons of garbage had been disposed at the landfill. The Long Island Community Right-To-Know follow up investigation report (Engineering-Science, 1991) was inspected to determine if there was documented disposal of hazardous waste at the Montauk Landfill. There were no reports of hazardous waste having been transported to and disposed at the Montauk Landfill.

Two waste piles currently cover the site (Figure 5.1.1). A small waste pile occurs along the eastern margin of the landfill. According to Mr. Thomas Bennett (1991), who was foreman at the landfill from 1963 to the mid-eighties, brush and metal including cars were buried at this location during the mid-sixties. At some later date, the garbage buried was re-exposed as a result of the sand mining operation. This waste pile is approximately 30 feet thick.

The municipal refuse pile (center and western portions of the site) is believed to be dominated by household garbage; however, brush, cars and construction debris are also present. According to Mr. Bennett, the garbage was buried in 12 foot wide trenches that were



F,P&M

FIGURE 5.1.1– SITE DIAGRAM OF THE MONTAUK LANDFILL

of the municipal refuse pile is believed to be approximately 100 feet.

The landfill was constructed so that at least 30 feet of sand would separate the garbage from the underlying water table. According to Mr. Bennett, the actual distance between the garbage and water table is greater than 30 feet. This implies that the bottom of the waste mass should be above the top of the local clay member. Evidence to support this was obtained from air quality measurements from SW-3.

Under certain conditions, air flow under positive pressure exits this well at a substantial rate from the unsaturated zone below the clay segment of the local clay member (phenomenon described in Section 3.2 of this report). Measurements of air quality parameters that might indicate the presence of landfill material were taken of the air flow at SW-3. This resulted in the following observations:

Combustible Gas Indicator Readings - April 6, 1991

Analyte	Calibration	Sample
% Lower Explosive Limit	0.0	0.0
Parts Per Million Toxic Gas	0.0	0.1
% Oxygen	20.8	20.2

A dräeger tube sample was collected of the air flow to test for the presence of hydrogen sulfide. There was no detection. The air quality in the materials below the top of the clay shows no indication of the presence of landfilled materials. The flow of air can be substantial due to the pressure differential of over 3 inches of water, as measured by a magnehelic gauge. The air quality measurements taken of this air flow should provide an indication of air quality below the clay.

Three unlined septage lagoons were formerly located in the northwestern corner of the landfill. According to Mr. Bennett, these lagoons were initially 25 feet deep. The lagoons were filled in during the last five years by sand and brush and are not presently visible.

5.2 Potential Receptors

A study of potential receptors of groundwater flow from the Montauk Landfill area was performed, focusing on public and private wells within one mile of the landfill. Documents of the Well Records Unit of the NYSDEC, Suffolk County Department of Health Services (SCDHS) and the Suffolk County Water Authority (SCWA) were examined. Figures 5.2.1 and 5.2.2 show the locations of potential receptors.

The highest density residential areas within the one-mile radius of the landfill occur in one area south of the site on the south of the Montauk Point State Boulevard (Area I, Figure 5.2.2) and another area east of the site and west of Fort Pond (Area II). The receptors closest to the landfill are two residences that occur just north of the Montauk Point State Boulevard, approximately 800 feet south of the landfill (Area III). Six or seven residences are present along Fort Pond Bay approximately 1500 feet north of the landfill (Area IV). Area III also contains the closest public supply well S-70155 and three planned public supply wells HH1, HH2 and HH3.

According to the SCWA, water mains supply water to the residential areas east of the landfill (see Figure 5.2.1 and Area II on Figure 5.2.2). There are no water mains supplying the residential area south of the Montauk Point State Boulevard (Area I). It should be noted that some people may still be using private wells even in areas supplied by public water, such as Area II. The residences

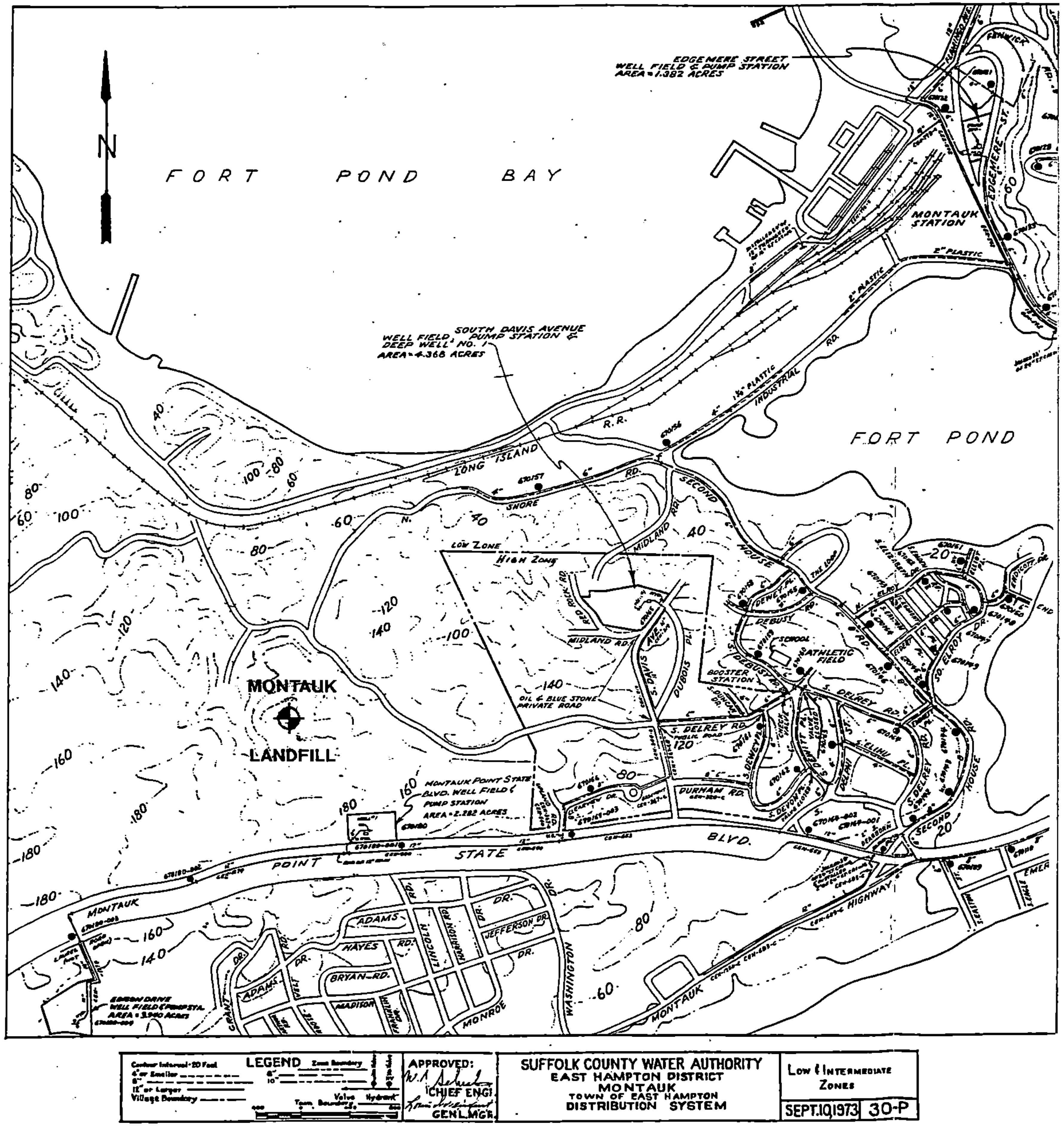


FIGURE 5.2.1 – SCWA WATER DISTRIBUTION SYSTEM IN THE VICINITY OF THE MONTAUK LANDFILL

TOWN OF EAST HAMPTON, MONTAUK LANDFILL

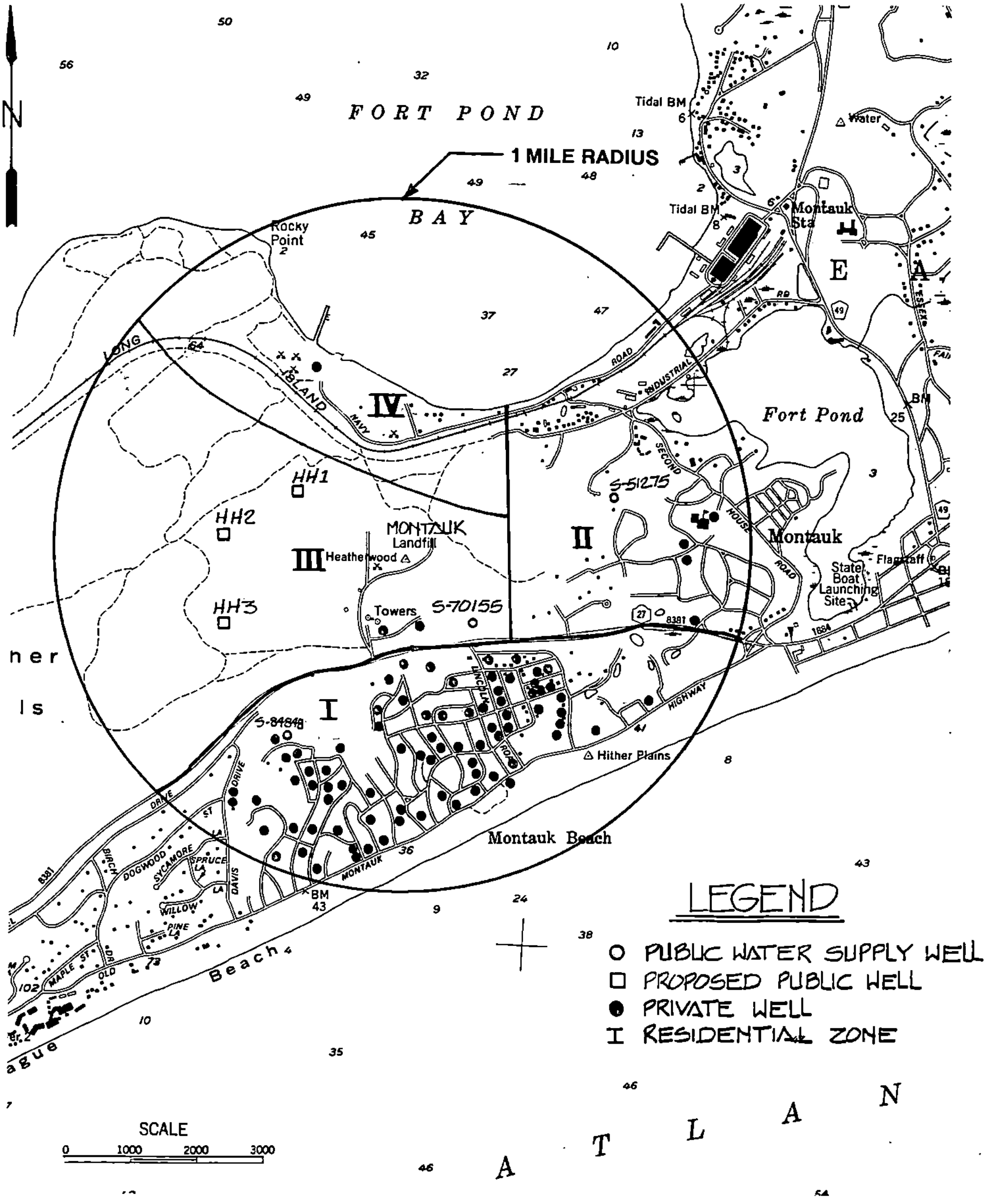


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FIGURE 5.2.2 – PUBLIC AND PRIVATE WELLS WITHIN 1 MILE RADIUS OF THE MONTAUK LANDFILL

occurring north of the Montauk Point State Boulevard (Area III) and along Fort Pond Bay (Area IV) are all believed to be supplied by private wells.

An inspection of records maintained by the NYSDEC Well Record Unit indicated that approximately 100 wells were installed between 1954 and 1990 within a one-mile radius of the Montauk Landfill (Figure 5.2.2). The majority of these wells are private wells constructed south of the Montauk Point State Boulevard (see Appendix I, Section 1 for a summary of information collected from completion reports for wells occurring in the vicinity of the landfill).

The private wells are all relatively shallow (less then 200 feet deep) and are screened in the principal aquifer. Water quality data obtained from the SCDHS for private wells located south of the landfill (Table 5.2.1) indicate that only iron (up to 5 mg/l) and zinc (up to 12.4 mg/l) have been shown to exceed New York State potable water standards and that no organic compounds have ever been detected. The owner of one of the houses located 800 feet south of the landfill indicated that his well had been tested twice in the last five years and that no contaminants had been detected. It should be noted that iron normally occurs at slightly high concentration in the groundwaters of Long Island (e.g., Nemickas and Koszalka, 1982). Furthermore, all groundwater samples collected at the landfill were characterized by zinc concentrations of less than 0.12 mg/l. Therefore, there is no evidence that contamination migrating from the landfill has contaminated any of the private wells.

Three SCWA public well fields occur within a one-mile radius of the landfill (Figure 5.2.2). These are the Edison Drive (S-84848),

TABLE 5.2.1
LOCAL PRIVATE WELL WATER QUALITY DATA

Last Name	Address	Date	Number Inorganics Exceeding MCL	Number Organics Positive	Number Organics Exceeding MCL	Parameters Exceeding MCL
Esptein	Franklin Dr.	11/14/79	0	0	0	
Belits	Grant Dr.	8/3/81	1	0	0	Iron (5.0 mg/l)
Stein	Washington Dr.	6/16/82	1	0	0	Iron (1.05 mg/l)
Pierson	Wood Dr.	5/29/85	1	0	0	Iron (0.41 mg/l)
Powers	Wood Dr.	10/15/85	1	0	0	Iron (0.59 mg/l)
Fioresi	25 Lincoln Rd.	4/17/86	0	0	0	
Flynn	8 Washington Dr.	10/8/86	0	0	0	
Masi	15 Jefferson Dr.	3/30/87	2	0	0	Iron (0.69 mg/l) Zinc (6.8 mg/l)
		11/14/88	1	0	0	Iron 1.29 mg/l)
Rowse	Bryan Rd.	6/22/87	0	0	0	
Collins	10A Lincoln Rd.	4/19/88	2	0	0	Iron (0.71 mg/l) Zinc 12.4 mg/l)
Haulik	Twin Pond La.	12/20/88	0	0	0	

Montauk Point State Boulevard (S-70155) and the South Davis Avenue (S-51275) well fields. All 3 of these wells are screened in the principal aquifer. In 1990, 6,092,000 gallons were pumped from S-51275, 57,256,000 gallons were pumped from S-70155 and 13,905,000 gallons were pumped from S-84848 (Appendix I - Section 2). The authorized capacity of each well is 300 gallons per minute (gpm).

Water quality data was obtained from the SCDHS that covered from 1988 to 1990 for S-84848, 1983 to 1990 for S-70155 and from 1977 to 1990 for S-51275 (see Appendix I - Section 3). The data indicates that the iron standard is commonly exceeded in S-51275 and S-70155; however, no other parameters exceed any of the other groundwater standards. Furthermore, no organic compounds were detected in these wells. S-84848, which is located approximately 2700 feet southwest of the landfill, does not exceed the iron standard; however, low concentrations of chloroform (up to 11 ug/l) and in one case toluene (1 ug/l) were detected. The landfill is not believed to be the source of these contaminants as this well is not considered to be downgradient of the landfill and neither of these compounds were detected in the groundwater samples collected at the landfill.

It is believed to be significant that the water quality at S-70155 shows no indication of impact from the landfill. The well is heavily pumped with respect to the size and geometry to the groundwater reservoir in this area and is located approximately 1300 feet downgradient of the landfill.

Installation of three (3) public supply wells has been proposed by the SCWA for the Hither Hills. These wells are shown on Figure 5.2.2 as HH1, HH2 and HH3. The exact location and the maximum permitted discharge for these wells are still in the planning stage. These wells, if constructed, may be potential receptors if the apparent gradient from Hither Hills towards the landfill site is reversed. The proposed well locations are upgradient from the landfill site at the present time.

SECTION 6.0
SUMMARY AND CONCLUSIONS

There is no indication of a leachate plume in groundwater or of a release to groundwater from the landfill site. Groundwater appears to flow from the site in a east-southeast direction. This flow is monitored by well cluster sites 1 and 2 and Suffolk County Water Authority well S-70155. Well cluster site 3 and Suffolk County Department of Health Services well S-48577 do not appear to be in the path of groundwater flow from beneath the landfill site nor are these sites directly upgradient of the landfill mass based on the information developed during this investigation. A well in the principal aquifer would need to be located due west of the landfill mass in Hither Hills to obtain data directly upgradient of the site.

The following specific conclusions are made concerning this landfill site based on the information obtained at this time:

1. A lower permeability zone or layer is present in the unsaturated zone slightly above or at the water table beneath the landfill mass. The approximate strike of this layer is east-west and it dips northward. The thickness of the layer varies from approximately 20 to 30 feet at sites 1 and 2 to approximately 55 feet at site 3, where the lower 25 to 30 feet of the unit may be composed of silt and fine sand.
2. A horizontal conductivity of 0.048 feet per day was determined for this lower permeability layer at site 1 where the water table surface is anomalously mounded due to this layer.

layer.

3. Groundwater is present primarily in the principal aquifer that is below the lower permeability layer. The horizontal component of groundwater flow shows northeast, east and southeast flow from beneath the landfill site at a gradient of 0.0003 to 0.0006 feet per foot at the water table surface and potentiometric level of -40 to -60 feet MSL.

4. Horizontal hydraulic conductivity estimates of 8.6 to 95.7 feet per day were determined for the principal aquifer at the well cluster sites.

5. Vertical hydraulic conductivity probably ranges from 3 to 96 feet per day based on aquifer anisotropy values determined by an aquifer test run by the US Geological Survey at a site 2.5 miles east of the landfill site.

6. A vertical component of groundwater flow combines with the horizontal flow component at site 3 as measured by a downward gradient of 0.0004 to 0.0017 feet per foot between SW-3 and IW-3.

7. There is a small to non-existent vertical component of flow that combines with the horizontal flow component at site 2 as measured by the slight upwards (0.0002 feet per foot), downwards (0.0005 feet per foot) or zero gradient between SW-2, IW-2 and DW-2).

8. Horizontal flow velocities of 0.02 to 0.56 feet per day were calculated using the range of site specific hydraulic conductivity estimates and gradients.

9. Vertical flow velocities of minimal (0.0) to 1.59 feet per

day were calculated using estimate of the range of vertical hydraulic conductivity based on published aquifer anisotropy data and the vertical gradients measured at the well cluster sites.

10. There is no clear indication of a leachate contaminated groundwater plume downgradient of the site as monitored by well cluster sites 1, 2 and public supply well S-70155.

11. No pesticides/herbicides or polychlorinated biphenyls were detected in groundwater at the site.

12. One volatile organic compound (acetone) was detected at 62 ug/l at SW-1 where the water table is anomalously mounded. Semi-volatile organic compound (bis (2 ethylhexyl) phthalate) was detected at SW-2 at 13 ug/l, just above the detection limit of 10 ug/l. Sem-volatile organic compound phenol was detected at levels of 2.5 to 6.0 ug/l at well sites 1,2 and 3. Acetone is a common laboratory chemical and bis (2 ethylhexyl) phthalate is a plasticizer used in many plastic products. The levels at which these compounds and the phenols were detected will need to be confirmed by subsequent sampling events.

13. The levels of some inorganic constituents are slightly elevated at IW-2 and DW-2 when compared to the levels detected at other site wells. These constituents are total dissolved solids, sulfate, total alkalinity, chloride, sodium, magnesium and calcium. The levels detected are below the levels detected at other landfill sites on Long Island that have leachate impacted groundwater. The levels

have been published for wells on the South Fork of Long Island that monitor background or ambient groundwater quality.

14. The lead detections at IW-3 and S-48577 appear to be from a source separate from the landfill mass. These wells do not appear to be downgradient of the landfill mass based on the groundwater flow data developed at this time. The levels at which these compounds were detected will need to be confirmed by subsequent sampling events.

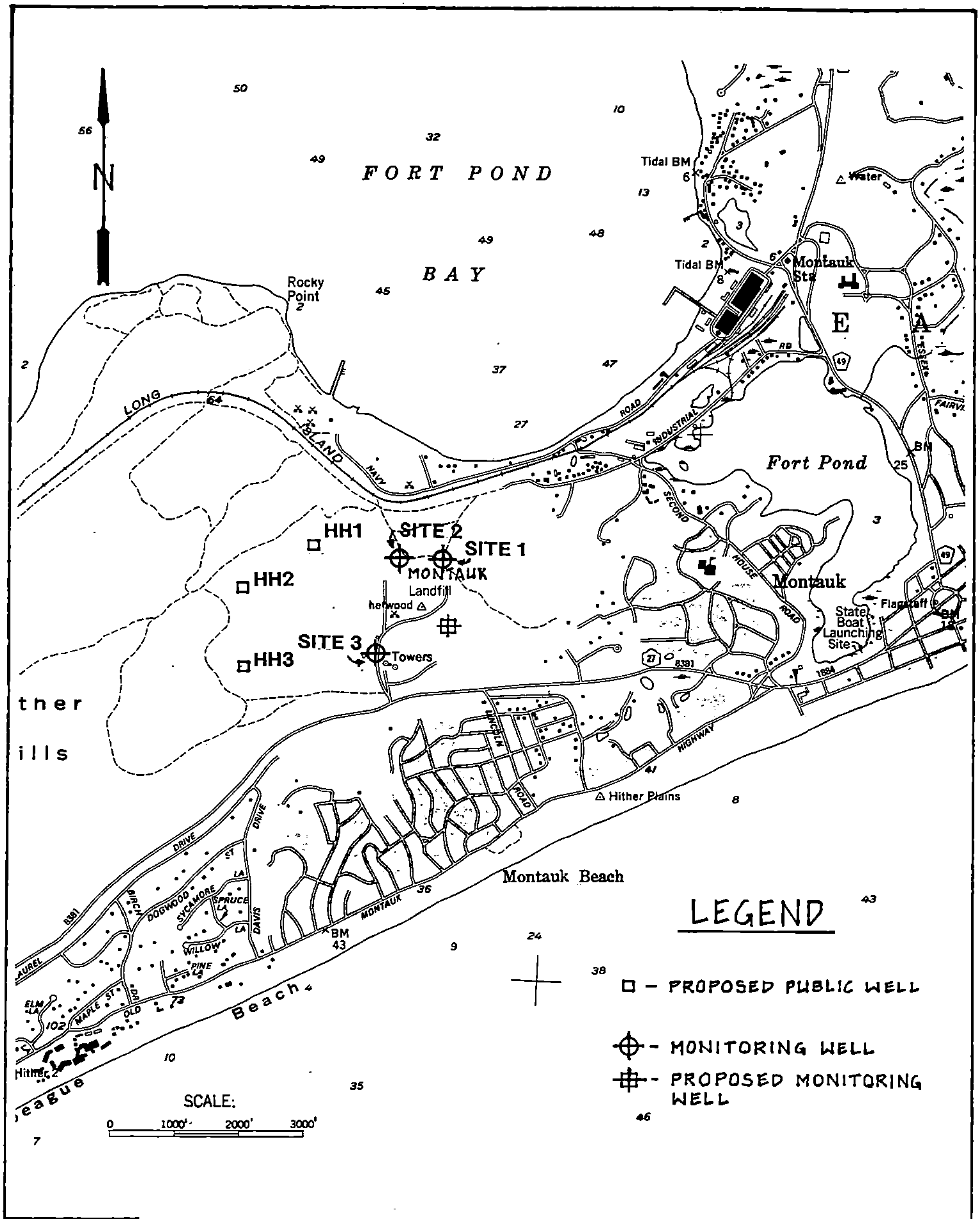
15. Quality Assurance/Quality Control (QA/QC) measures were used during the investigation as indicated in the project workplan. The analytical laboratory's QA/QC program determined that the field blank and trip blank water was contaminated with vinyl chloride as the result of a malfunctioning filter unit. Vinyl chloride was not detected in any of the groundwater samples analyzed. The field and trip blanks indicate that the field QA/QC procedures utilized were adequate and successful in preventing contamination of the samples from field procedures.

As indicated in the beginning of this section, there is no clear indication of a leachate plume in groundwater or of a release to groundwater from the landfill site. The lower permeability layer in the unsaturated zone present near the water table surface may influence leachate migration from the landfill mass by limiting its downward migration. Leachate generated by precipitation percolating through the landfill mass will encounter this layer which appears to exist under the entire site based on the geologic information exist under the entire site based on the geologic information developed to date. The top of the layer dips or slopes northward. Leachate may migrate to some extent along the upper surface of this layer. It is not known if this layer continues to dip north of the north boundary of the site. There is little geologic information in the area from well cluster sites 1 and 2 northward (downgradient) to Fort Pond Bay on Block Island Sound - a distance of approximately 2000 feet. The layer may also have some capacity to retain some of the leachate constituents through time in exchange capacity of the clay materials present in the layer.

SECTION 7.0
RECOMMENDATIONS
(PROPOSED ENVIRONMENTAL MONITORING PLAN)

The following recommendations regarding monitoring groundwater at the Montauk Landfill site are forwarded based on the groundwater flow pattern and groundwater quality information that has been developed to date.

1. Suffolk County Department of Health Services well S-48577 should be dropped from any network. The well is no longer as deep as originally reported and the integrity of the well screen interval is suspect based on well soundings. The well also monitors the general groundwater flow path that is monitored by newly constructed monitoring well SW-3.
2. An additional observation well should be installed in the vicinity of methane monitoring well M-18 (see Plate 2.2.1 for location). This well should be screened with a 20-foot screen located halfway between the water table surface (approximately 3 feet MSL) and the bottom of the aquifer (approximately 110 feet MSL).
3. Sampling of the network of wells around the landfill should be conducted in the Fall. This autumn season sampling will provide an indication of groundwater quality during lower groundwater level elevations. It will also provide verification of the groundwater quality data from the April, 1991 (Spring) sampling event.
4. The capture zones of the planned Suffolk County Water Authority (SCWA) wells HH1, HH2, and HH3 (Figure 7.1) in Hither Hills should be calculated when the SCWA has a final



FP&M **FIGURE 7.1 – ENVIRONMENTAL MONITORING NETWORK** decision on pumping rates and pumping intervals planned for each well. This will provide an indication of the influence the wells will have on the natural gradient that exists between the higher groundwater elevations in Hither Hills and the lower groundwater elevations at the landfill site. Water levels in well cluster sites 2 and 3 will be monitored by continuous water level recording devices when the proposed SCWA wells are placed in service to assess any possible impact to groundwater flow direction.

SECTION 8.0
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PLATE 2.2.1

LOCATION OF MONITORING WELLS	Drawn By: JDS
	Scale: AS SHOWN
MONTAUK LANDFILL TOWN OF EAST HAMPTON NEW YORK	Date: 6-20-91
	Drawing No:
Fanning, Phillips & Molnar Engineers Ronkonkoma New York	Sheet ____ Of ____

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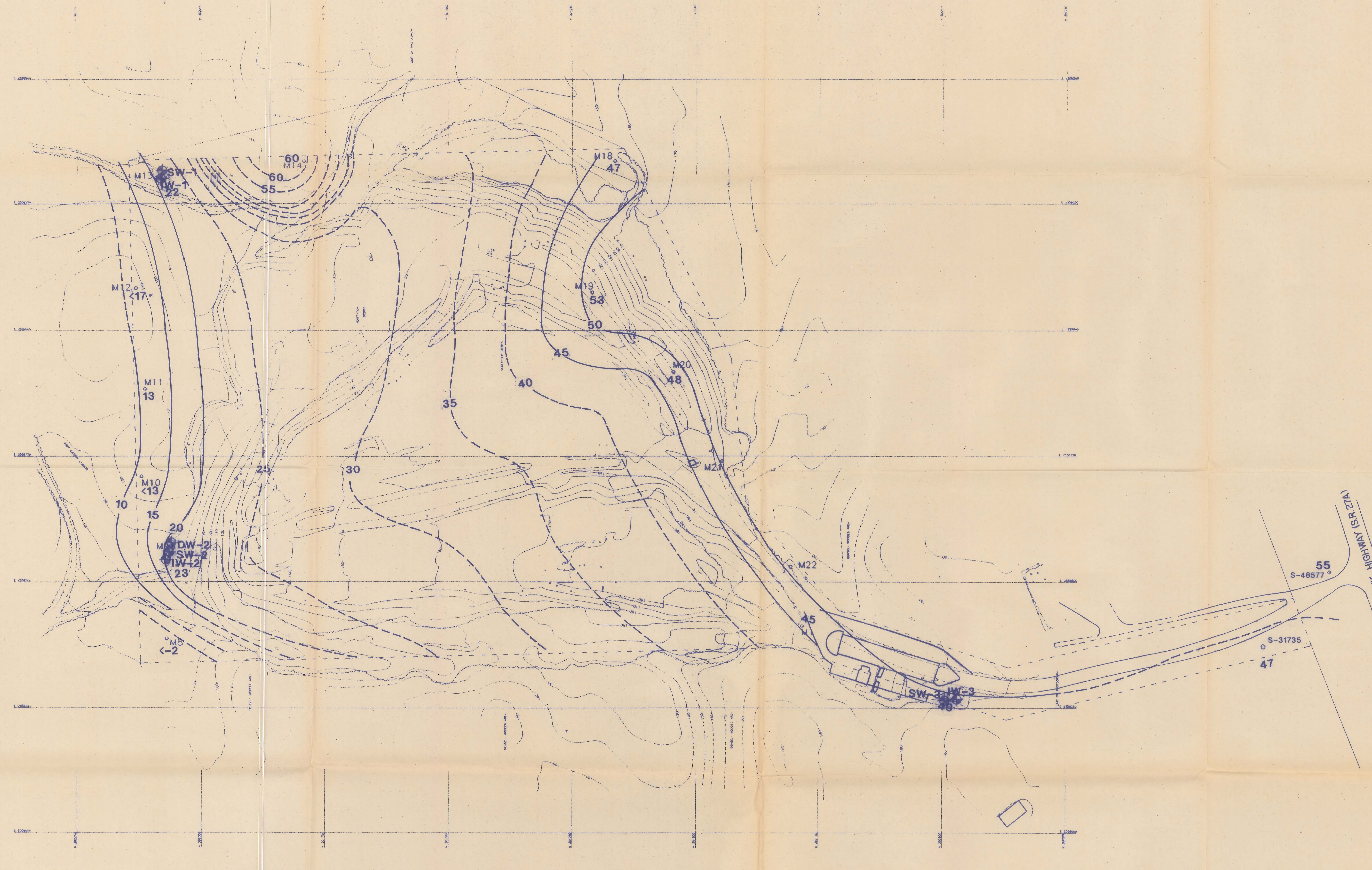

LEGEND

- - - - PROPERTY LINE
.... PROPOSED PROPERTY LINE
—— 40 —— APPROX. ELEVATION OF TOP OF THE LOCAL CLAY MEMBER. DASHED WERE INFERRED
⊕ 49 METHANE OR GROUNDWATER WELL. NUMBER IS ELEVATION OF THE TOP OF THE LOCAL CLAY MEMBER
D = DEEP
I = INTERMEDIATE
S = SHALLOW
W = WELL

BASE FROM: LOUIS K. McLEAN ASSOCIATES.

GRAPHIC SCALE
100 0 100 200
1 INCH = 100 FEET

PHOTOGRAPHY BY GEOMAPS INTERNATIONAL
DATED DECEMBER 14, 1989

PLATE 2.2.2

SURFACE ALTITUDE OF THE LOCAL CLAY MEMBER	Drawn By: HAIA CKD BY: TD,MK,GM,KP Scale: 1" = 100
MONTAUK LANDFILL TOWN OF EAST HAMPTON NEW YORK	Date: 4-23-91 Drawing No:
Fanning, Phillips & Molnar Engineers Ronkonkoma New York	Sheet 1 of 1

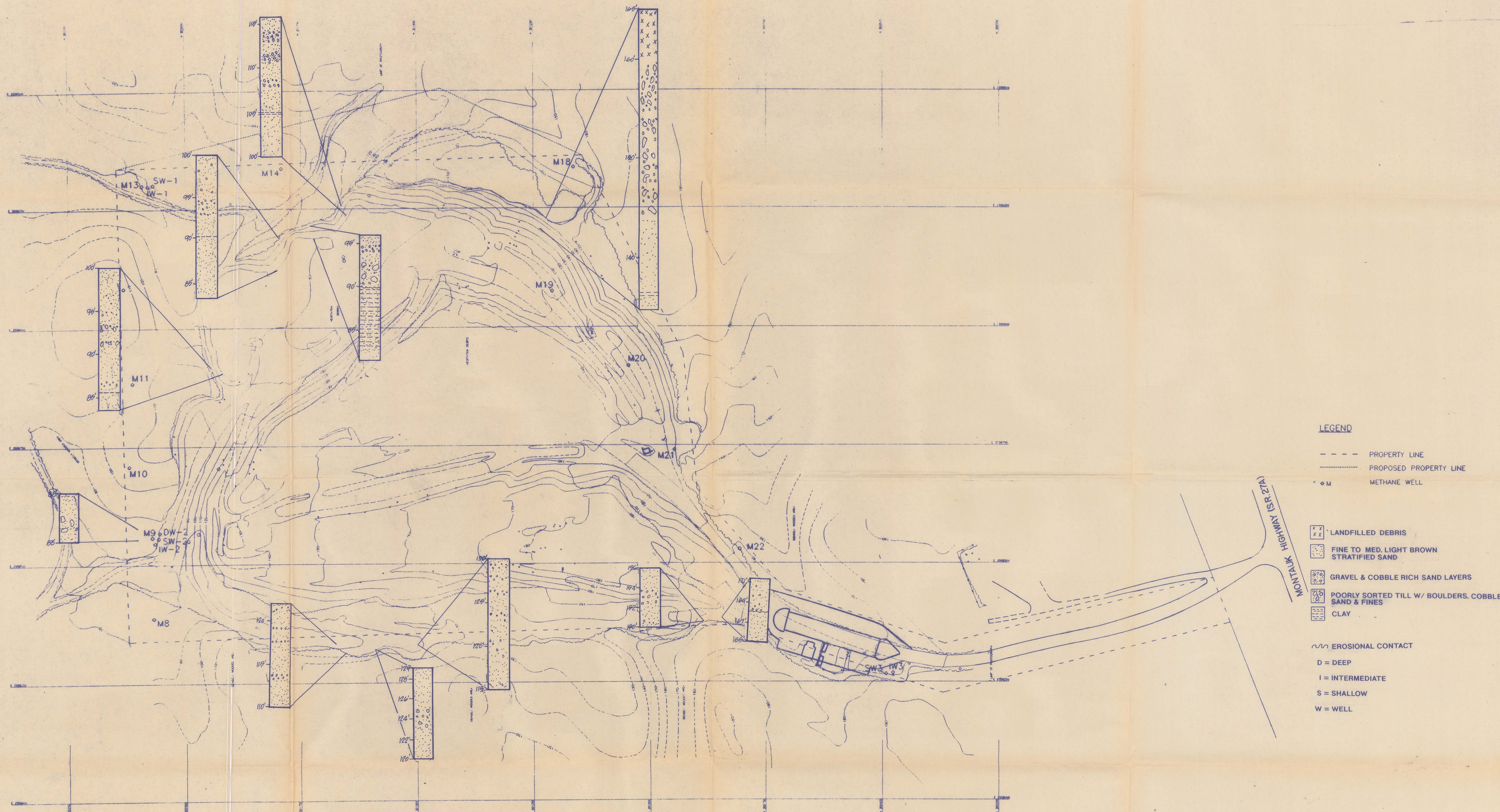

PLATE 2.3.1

BASE MAP FROM: LOUIS K. McLEAN ASSOCIATES

GRAPHIC SCALE

100 0 100 200

1 INCH = 100 FEET

PHOTOGRAPHY BY GEOMAPS INTERNATIONAL
DATED DECEMBER 14, 1989

SURFICIAL GEOLOGY OF THE MONTAUK LANDFILL	Drawn By: JDS CKD BY: GM
	Scale: AS SHOWN
MONTAUK LANDFILL EAST HAMPTON, NEW YORK	Date: 6-12-91
	Drawing No:
Fanning, Phillips & Molnar Engineers Ronkonkoma New York	Sheet ____ Of ____

158-88-01 (1373)

BASE FROM: LOUIS K. McLEAN ASSOCIATES.

GRAPHIC SCALE

1 INCH = 100 FEET

PLATE 3.2.1

ELEVATION OF THE WATER TABLE SURFACE ON APRIL 16, 1991

MONTAUK LANDFILL

TOWN OF EAST HAMPTON NEW YORK

Fanning, Phillips & Molnar Engineers

Ronkonkoma New York

Drawn By: JAG

Scale: AS NOTED

CKD BY: TD,MK,KP

Date: 5-21-91

Drawing No:

Sheet 1 of 1

PLATE 3.2.2

ELEVATION OF THE POTENTIOMETRIC SURFACE OF THE PRINCIPAL AQUIFER AT -40 TO -60 FEET MSL ON APRIL 16, 1991	Drawn By: J.A.G. CKD BY: TD,MK,KP Scale: AS NOTED
MONTAUK LANDFILL TOWN OF EAST HAMPTON NEW YORK	Date: 5-21-91
Fanning, Phillips & Molnar Engineers Ronkonkoma New York	Drawing No: Sheet 1 Of 1

158-89-01 (1381)