TOWN OF SMITHTOWN

ENGINEERING DEPARTMENT
~~FRANCIS J. MOONEY, P.E.~~
TOWN ENGINEER

(516) 360-7550

RECEIVED
MAY 27 1992
DIVISION OF SOLID WASTE
NYSDEC REGION 1

May 11, 1992

Mr. Robert J. Mitrey, P.E.
Regional Solid Waste Engineer
N.Y.S. Dept. of Environmental Conservation
Building 40 - S.U.N.Y
Stony Brook, New York 11790

RE: Smithtown Municipal Services Facility
Phase I Landfill Hydrogeologic Work Plan

Dear Mr. Mitrey:

In accordance with your letter of April 16, 1992, enclosed please find three copies of our proposed hydrogeologic work plan for the above referenced site.

All elements of this work plan have been prepared in accordance with the methodology established in the Revised 6 NYCRR Part 360 Solid Waste Management Facilities (Revised March 1990). Section 2.11 In addition, the proposed site investigation plan was developed to satisfy the closure and post closure criteria that is outlined in Section 2.15 of Part 360.

Please be aware that the Town of Smithtown currently does not employ outside consultants on a continuous basis, but rather on an as needed, project by project basis.

As such, upon your review of these documents, I would suggest that a meeting be scheduled to discuss an appropriate course of action.

Very truly yours,

John T. Trent
Assistant Civil Engineer

JTT:mw

cc: Paul Schettini, P.E., Town Engineer

124 WEST MAIN STREET • SMITHTOWN, NEW YORK 11787

TOWN OF SMITHTOWN
SUFFOLK COUNTY, NEW YORK

RECEIVED
MAY 27 1992
DIVISION OF SOLID WASTE
NYSDEC REGION 1

MUNICIPAL SERVICES FACILITY LANDFILL

PHASE I - CELL NOS. 1-5

HYDROGEOLOGIC WORK PLAN FOR

INSTALLATION OF TEST BORINGS AND MONITORING WELLS

FEBRUARY 1991

R. E. PUSTORINO, P. C.
CONSULTING ENGINEERS

COMMACK, NEW YORK
VERO BEACH, FLORIDA

RECEIVED
MAY 27 1992
DIVISION OF SOLID WASTE
NYSDEC REGION 1

TOWN OF SMITHTOWN
SUFFOLK COUNTY, NEW YORK

MUNICIPAL SERVICES FACILITY LANDFILL

PHASE I - CELL NOS. 1-5

HYDROGEOLOGIC WORK PLAN FOR INSTALLATION OF TEST BORINGS AND MONITORING WELLS

FEBRUARY 1991

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

COMMACK, NEW YORK
VERO BEACH, FLORIDA

SECTION 1.0

PURPOSE AND OBJECTIVE

In response to the New York State Department of Environmental Conservation's (NYSDEC's) request for an upgrade to the existing Phase I monitoring wells at the Smithtown Municipal Services Facility (MSF) landfill site, this Work Plan presents the detailed specifications and procedures for the installation and analytical sampling of additional groundwater monitoring wells.

As part of the program, exploratory test borings will be used to evaluate the stratigraphy and hydrogeologic properties of the aquifer in the Phase I landfilling area. Subsequently, the proposed groundwater monitoring wells will be designed to effectively monitor the 3-dimensional flow paths in the landfill area. Groundwater samples from the monitoring wells will undergo baseline and routine chemical analysis for water quality as part of the quarterly monitoring well sampling schedule at the site. Finally, the analytical results will be used to evaluate the nature and extent of any current or future release of contaminants from the landfill.

In order to fulfill the objectives of the Work Plan, it is projected that a total of seven (7) groundwater monitoring wells will be needed: six (6) downgradient monitoring wells (3 shallow, 3 deep) along Old Northport Road north of the Phase I landfill area; and one (1) deep upgradient well located near existing monitoring well No. 9. When completed, the final monitoring well array will be composed of one (1) upgradient well cluster and three (3) downgradient clusters.

Geotechnical and geophysical data obtained during the initial exploratory drilling of test borings will be used to confirm specific design details of the monitoring wells. The deep well adjacent to Well No. 9 will be installed below the Smithtown Unit, to monitor ambient water quality in the Glacial Aquifer upgradient of the Phase I landfill area. The shallow (downgradient) wells will be installed so as to account for the fluctuations in static water table levels, and will monitor groundwater quality for the mobile components (floaters) of a plume, if present. The deeper (downgradient) wells will also be installed below the Smithtown Unit at a depth in the aquifer that is determined to be equal to the maximum vertical (downward) flow of the potential contaminant pathways. Consequently, these well screens will monitor for the heavier constituents in groundwater (i.e., sinkers), or the soluble constituents in a higher density slug.

Should the field testing program indicate that intermediate level wells are necessary to adequately monitor the potential contaminent flow paths in the aquifer, as required by 6 NYCRR Part 360, the monitoring well installation part of the program will be modified accordingly. The stratigraphic and hydrogeologic information that is obtained as part of the site investigation plans will be fully integrated into the existing engineering data base for the MSF site.

All elements of this Work Plan have been prepared in accordance with the methodology established in the Revised 6 NYCRR Part 360 Section 2.11 Solid Waste Management Facilities (Revised March 1990). In addition, the proposed site investigation plan was developed to satisfy the closure and post-closure criteria that is outlined in Section 2.15 of Part 360.

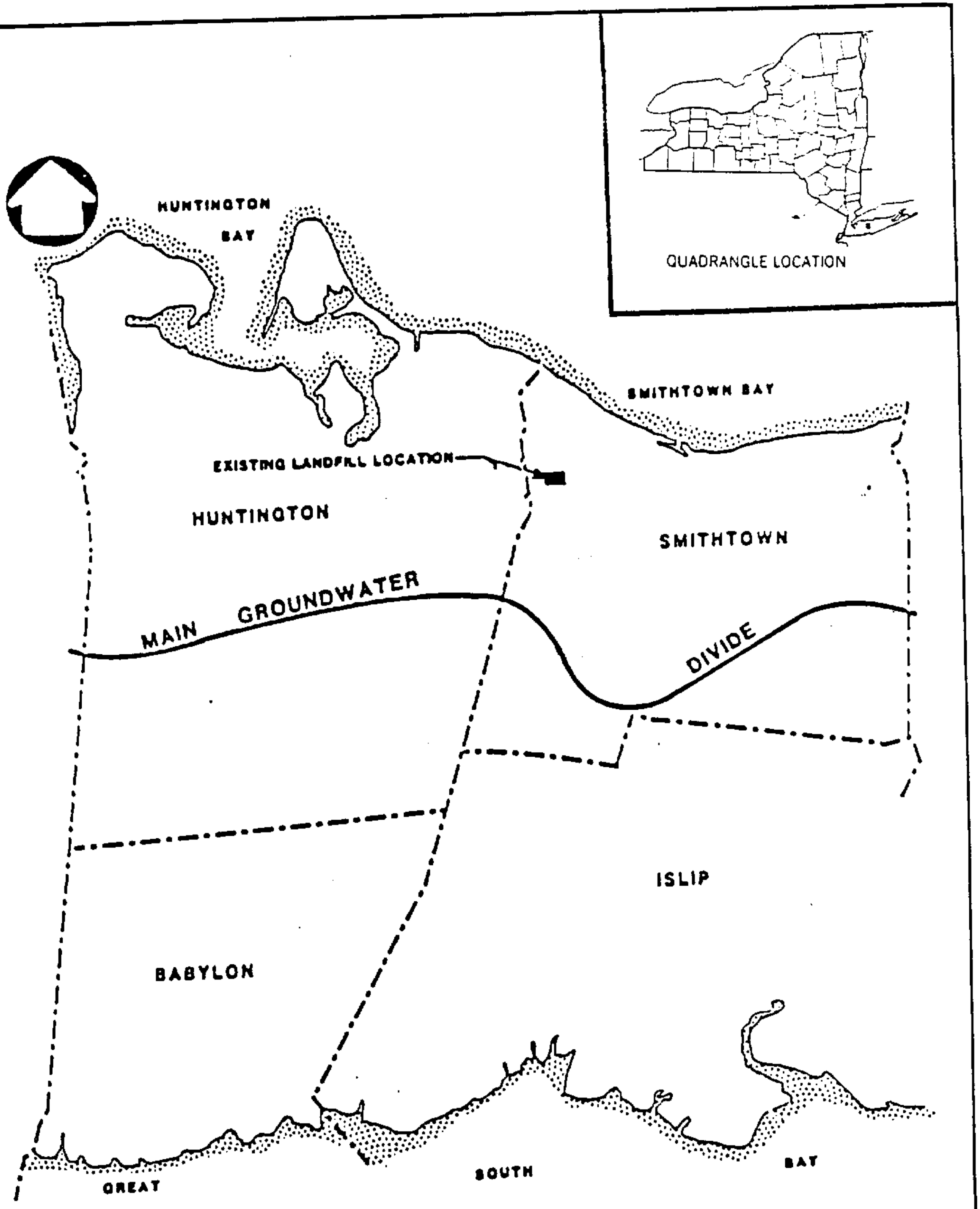
SECTION 2.0

INTRODUCTION

2.1 SITE LOCATION

The Town of Smithtown is situated in the northwesterly portion of Suffolk County, New York. The Town is bounded on the north by Smithtown Bay, on the east by the Town of Brookhaven, on the south by the Town of Islip and to the west by the Town of Huntington. Figure 2-1 is a Location Plan of the regional area, showing the position of the main groundwater divide.

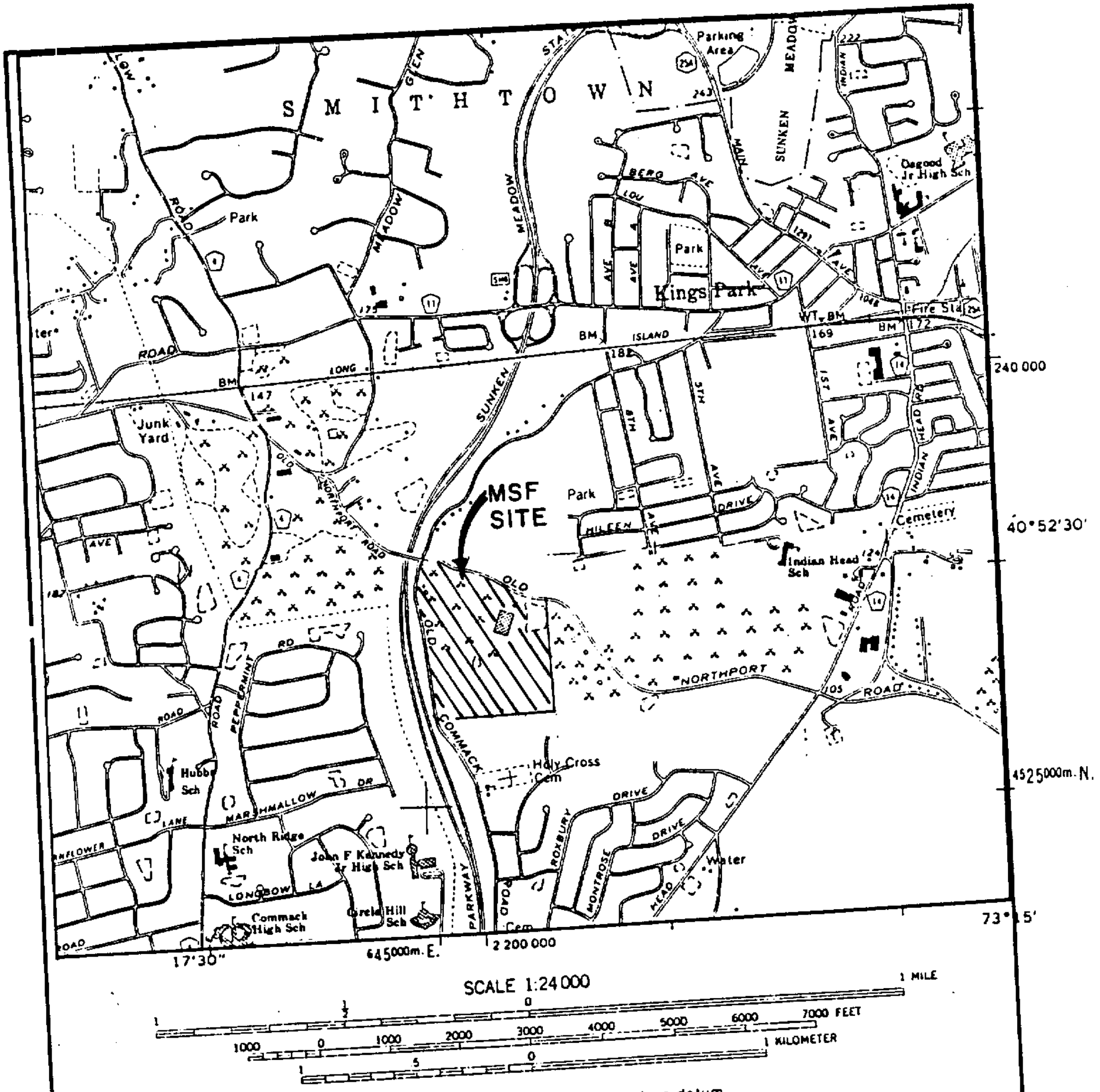
The Municipal Services Facility (MSF) Landfill is located in the unincorporated area of Kings Park on a 86 acre parcel in the northwesterly section of the Town of Smithtown. More specifically, the site is bounded by Old Northport Road on the north, Old Commack Road on the west, Pinetree Court on the south and heavy industrial use property on the east. Primary access to the MSF Landfill is from Indian Head Road (to the east) and Town Line Road (to the west), as indicated on the Geographic Location Plan in Figure 2-2.



SOURCE: U.S. GEOLOGICAL SURVEY, JENSEN & SOREN, 1974

FIGURE 2-1
REGIONAL LOCATION PLAN

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS



Polyconic projection. 1927 North American datum.

1000-meter ticks based on the New York Transverse Mercator grid. Between 72° and 78° West Longitude, this grid is identical to Zone 18 of the Universal Transverse Mercator grid. Areas east of 72° and west of 78° are direct mathematical extensions of Zone 18.

10,000-foot ticks based on the New York Plane Coordinate grid, Long Island Zone.

Magnetic declination for 1981 is approximately 13° West

FIGURE 2-2

GEOGRAPHIC LOCATION PLAN

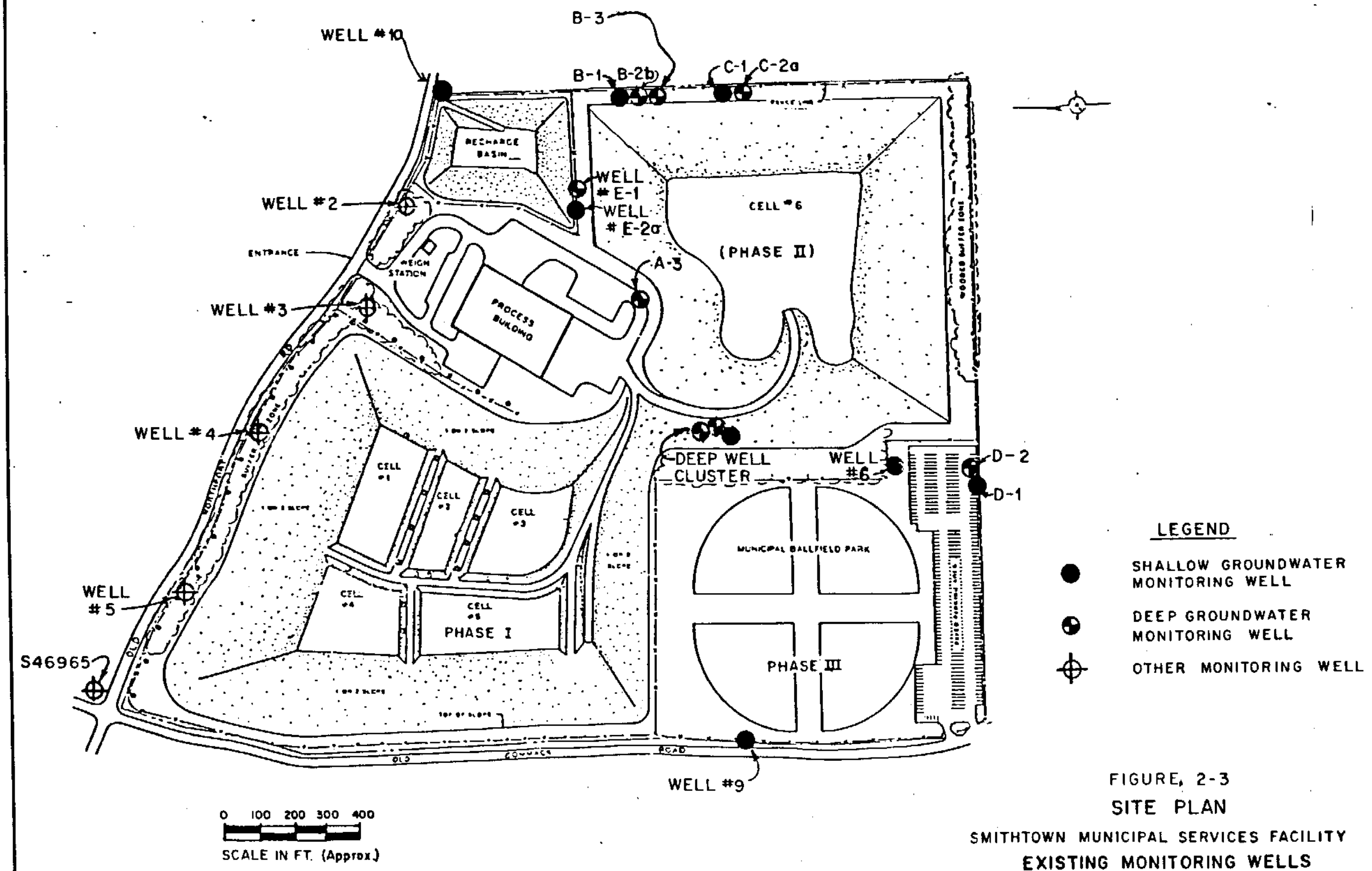
R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

2.2 SITE DESCRIPTION (CELLS 1 THROUGH 5)

The Municipal Services Facility (MSF) including landfill encompasses approximately 86 acres. About 70 acres of this site is designated landfill area and proposed to be developed in three (3) separate phases. The remaining 16 acres of the site are being utilized for buffer zones, recharge basin, process building and parking, and access roads. These areas are shown on the MSF Site Plan, Figure 2-3.

Phase I is the active landfilling section and occupies an area of about 23.5 acres. Cell No. 5 of this Phase I area has recently ceased accepting municipal solid waste for disposal. The recently constructed expansion for Cell No. 6 covers an area of approximately 23.1 acres and includes that segment of the site generally referred to as the Phase II area. The Cell No. 6 is contiguous to the Phase I and Phase III areas shown in Figure 2-3. Phase III is currently used for general municipal purposes (ball fields) and is available for future landfilling or related purposes.

Natural surface elevations in the Phase I area range from about 170 feet above MSL to the west of Cell Nos. 4 and 5, to 150 feet MSL east of Cells 1 through 3. This natural land surface slopes moderately to the east-northeast. The excavated bottom elevation



FIGURE, 2-3

SITE PLAN

SMITHTOWN MUNICIPAL SERVICES FACILITY

EXISTING MONITORING WELLS

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

of the Phase I cell areas is approximately 60 feet above MSL, and is 10-15 feet above the existing groundwater table (March 1990).

2.3 PRIOR INVESTIGATIONS IN THE SMITHTOWN MSF AREA

The U.S. Geological Survey, in cooperation with the Suffolk County Department of Health Services, Suffolk County Water Authority, and N.Y. State Department of Environmental Conservation, has published a number of reports on various aspects of Long Island's hydrogeology. The most extensive study devoted to the Town of Smithtown area was performed by Lubke (1964).

Groundwater flow studies were also performed by Jensen and Soren (1974), McClymonds and Franke (1972), Donaldson and Koszalka (1982), and Donaldson (1982). Krulikas, Koszalka, and Doriski (1983) investigated the areal extent of a significant glacial-age clay unit throughout the Smithtown-Brookhaven area. Hydrogeologic data from selected wells in the Smithtown area can be found in Jensen and Soren (1971) and Krulikas (1981).

The Long Island Comprehensive Waste Treatment Management Plan of 1978 (i.e., the 208 Study) was prepared pursuant to Section 208 of the Federal Water Pollution Control Act. The United States Environmental Protection Agency (EPA), as a result of this study, has designated Long Island as a sole source aquifer region.

The New York State Department of Environmental Conservation (NYSDEC) considers the Smithtown MSF Landfill to be within the sensitive deep flow recharge area, Hydrogeologic Zone I. The site is situated about 7500 feet (1.4 miles) southwesterly of the presently defined 208 line in the groundwater flow direction.

In 1985-86 the Town of Smithtown initiated a hydrogeological investigation at the MSF landfill to obtain information as to site geology and groundwater flow patterns beneath the landfill. To accomplish these objectives, a deep well cluster approximately 620 feet deep was drilled to the Raritan formation. In addition, information was obtained on other wells in the area including three well fields owned and operated by the Suffolk County Water Authority (SCWA). Results of this study were published in the report "Hydrogeologic Investigations - Kings Park Area and MSF Landfill" dated April 1986.

A hydrogeologic investigation was undertaken by R.E. Pustorino, P.C., in September 1988 which further defined the geology and hydrology at the MSF site. This program included the installation of five (5) shallow groundwater wells, both upgradient and downgradient of Cell 6, and ten (10) piezometers in the bottom of the Cell. Data from this investigation can be found in Vol. II, Site Investigation Report, of the Engineering Report and Plans for the Landfill Expansion (January 1989). Also, four (4) intermediate level groundwater monitoring wells were installed below the Smithtown Unit in April 1989, as part of the ongoing hydrogeologic investigation at the site.

In response to the NYSDEC Permit to Construct Cell 6 (Condition 25), a hydrogeologic field investigation was undertaken by R.E. Pustorino, P.C., in March and April of 1990. The purpose of that Phase II investigation was to delineate the boundary conditions in the Upper Glacial Aquifer, and to determine the potential contaminant flow-paths relative to the advective groundwater flow in the Cell 6 area. The results of the investigation were incorporated into the Hydrogeologic Investigations Report and Final Groundwater Monitoring Well Plan (FEMP)(R.E. Pustorino, P.C., June 1990).

2.4 EXISTING PHASE I & II MONITORING WELLS

Figure 2-3 (MSF Site Plan) shows the locations of all existing monitoring wells at the Smithtown MSF site. The Phase II groundwater monitoring wells (5 shallow/6 deep) are associated with the Cell 6 area and include the two (2) deep wells which were recently installed (MW A-3 & MW B-3). The Phase II wells are utilized for both analytical sampling and water level monitoring purposes. Other wells in proximity to Cell 6 include the Deep Well Cluster (Wells A, B, & C), and downgradient Well Nos. 1, 2, 3, and 6; these wells were designed for water quality and/or groundwater flow modeling.

Existing Phase I wells include upgradient Well No. 9, and downgradient Suffolk County Well S46965, and Smithtown MSF Wells No. 5 and No. 4 (see Apendix A). Well No. 9 is utilized as a shallow groundwater monitoring well and is currently part of the routine quarterly sampling schedule for the MSF site. Prior to 1988, Suffolk County Well S46965 had been sampled for groundwater quality by the Department of Health Services, and the last results showed a total dissolved solids content of 350 micromhos for the shallow aquifer. Well Nos. 4 and 5 were installed by the Town of Smithtown and are presently used for water level monitoring purposes only.

Table 2-1 is a Monitoring Well Completion Chart that summarizes the details of construction for the existing Phase I and II Monitoring Wells, along with any other wells in the study area. Included for each individual well is its phase of construction, if applicable, the location relative to groundwater flow direction, and the formation that was screened. All Well I.D. Nos. are compatable with those that were defined by the Final Environmental Monitoring Plan (FEMP), as prepared by R.E. Pustorino, P.C. (June 1990).

T A B L E 2 - 1
MONITORING WELL COMPLETION CHART
PHASE I & II MONITORING WELLS
SMITHTOWN MSF SITE

Well I.D. #	Well Location	Total Depth*	Depth of Screen	Screen Length	Surface Elevation	Elevation Mid-Screen	Type of Screen	Formation Screened
		(feet)	(feet)	(feet)	(ft. MSL)	(ft. MSL)		
MW-E1	Dwngrd. PHASE II	140	120-140	20	148	18	4in. 18slot	Smithtown Unit
Well #2	Dwngrd. (NE)	145	121-131	10	147	21	4in. 25slot	Smithtown Unit
Well #3**	Dwngrd. (N)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Well #4	Dwngrd. (N)	145	113-123	10	158	40	4in. 25slot	Smithtown Unit
Well #5	Dngrd. (NW)	130	120-130	10	164	39	4in. 18slot	Smithtown Unit
S-46965	Dwngrd. PHASE I	Unknown	143-153	10	167	19	Unknown	Smithtown Unit
Well #6	Upgrd. PHASE II	Unknown	144-164	20	169	15	Unknown	Smithtown Unit
Well #9	Upgrd. PHASE I	145	118-138	20	172	44	4in. 20slot	Smithtown Unit
Well #1	Dwngrd. (NE)	104	77-97	20	122	35	4in. 20slot	Smithtown Unit
MW-E2a	Dwngrd. PHASE II	161	139-159	20	148	-1	4in. 20slot	Upper Pleistocene
MW-B1	Dwngrd. PHASE II	123	96-116	20	150	43	4in. 20slot	Smithtown Unit
MW-B2	Dwngrd. PHASE II	186	161-176	15	150	-20	4in. 20slot	Upper Pleistocene
MW-C1	Dwngrd. PHASE II	123	98-118	20	151	42	4in. 20slot	Smithtown Unit
MW-C2a	Dwngrd. PHASE II	162	139-159	20	151	1	4in. 20slot	Upper Pleistocene
MW-D1	Upgrd. PHASE II	141	117-137	20	168	41	4in. 20slot	Smithtown Unit
MW-D2	Upgrd. PHASE II	172	140-160	20	169	19	4in. 20slot	Upper Pleistocene
MW-B3	Dwngrd. PHASE II	250	197-207	10	150	-52	4in. 20slot	Upper Glacial
MW-A3	Dwngrd. PHASE II	220	157-177	20	128	-39	4in. 20slot	Upper Glacial
Deep Cluster	Upgrd. (Central)							
Well A	PHASE I & II	-	71-81	10	111	35	4in. 20slot	Upper Pleistocene
Well B	"	-	-190-200	10	111	-84	4in. 20slot	Upper Magothy
Well C	"	620	-405-415	10	111	-299	4in. 20slot	Lower Magothy

Test holes were drilled using auger and/or mud rotary methods; all Phase II Monitoring Wells were completed utilizing mud rotary drilling rigs; 8 in. casing was set in non-cohesive materials above the Smithtown Unit in: MW-B2, MW-D2, & MW-E1

All Phase II well screens and riser pipes were flush-joint Schedule 80 PVC except MW-D1 which was Schedule 40

* All depths are shown to the nearest foot; for example 1.5 ft. = 2 ft.; Total Depth includes the last split spoon that was taken

** Well #3 not currently used for monitoring purposes; Wells #5, #4, #2 are used for water level monitoring only;

S-46965 is not currently being monitored by the S.C.D.H.S. for water quality;

Deep Cluster Wells are monitored for water quality by the Town of Smithtown

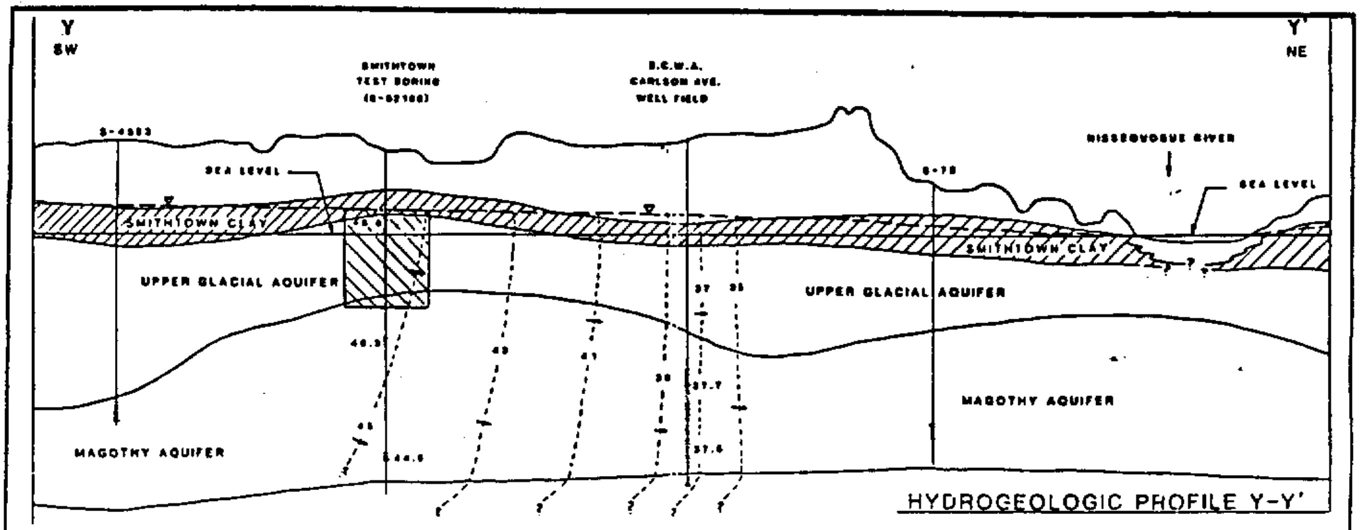
SECTION 3.0

SUMMARY OF GEOLOGY AND GROUNDWATER HYDROLOGY

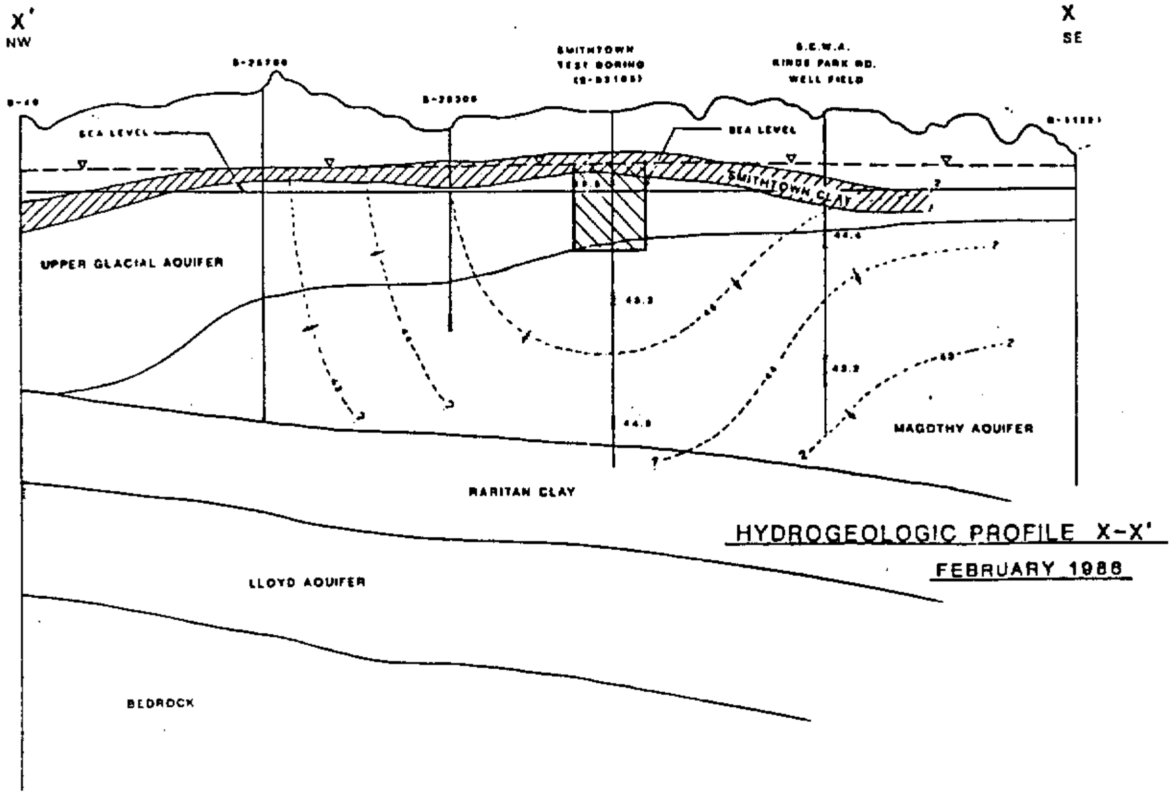
3.1 REGIONAL GEOLOGY AND SITE CORRELATION

The Harbor Hill Morraine is the dominant topographic feature in the Smithtown area and consists of a set of irregular shaped hills trending generally to the east at elevations between 200-300 feet above MSL. The MSF site lies near the southern edge of this glacial feature at elevations 160-170 above feet MSL, and is situated about 5 miles north of the Ronkonkoma Terminal Morraine. The uppermost medium and coarse sands and gravels of the Pliestocene-Formation at the MSF site were found to be highly permeable fluvio-glacial deposits associated with Harbor Hill Morraine. The major erosional feature of the area, the Nissequogue River Basin, lies about 3.5 miles to the northeast (downgradient) of the MSF site.

Regional sections that were developed for the report "Hydrogeologic Investigations-Kings Park Area and MSF Landfill", dated April 1986, are shown in Figure 3-1 and include an outline of the study area for site correlation. Total thickness of the Pliestocene/Pliocene (?) deposits vary relative to the elevation of the underlying Magothy



HYDROGEOLOGIC PROFILE Y-Y'

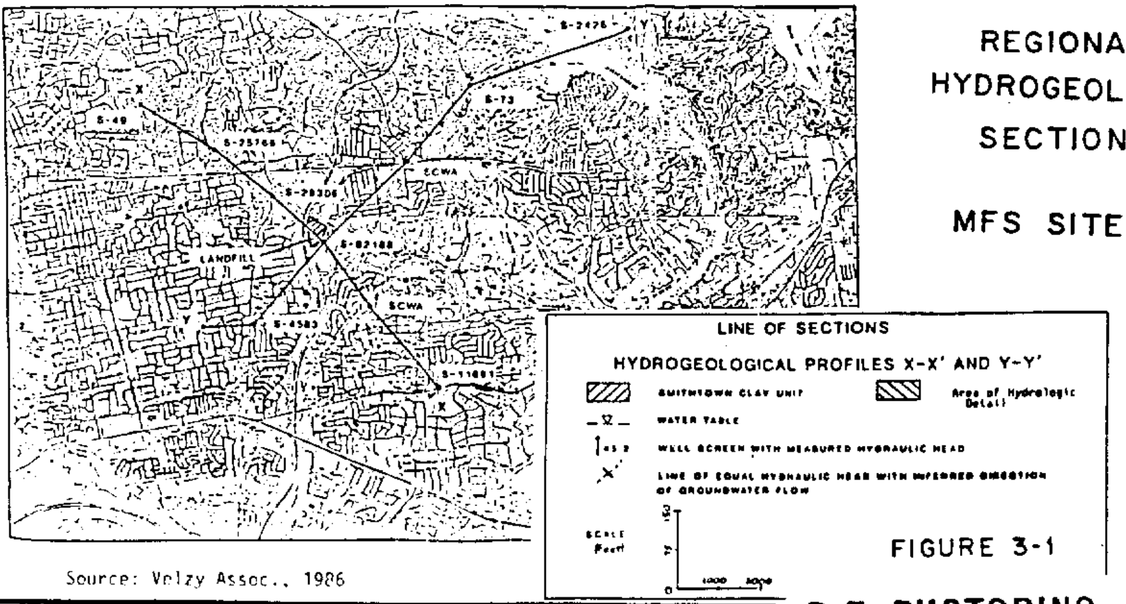


HYDROGEOLOGIC PROFILE X-X'

FEBRUARY 1988

REGIONAL HYDROGEOLOGIC SECTIONS

MFS SITE



Source: Velzy Assoc., 1986

FIGURE 3-1

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

surface, and with their position with respect to the morraines. In the MSF area, these "Upper Glacial" sediments are about 300 feet thick and were deposited over a regional divide (see Figure 3-1: Profile Y-Y[1]).

The sequence of outwash-clay-outwash identified in the Pleistocene deposits of the Smithtown area by Krulikas and Koszalka (USGS, 1983) was correlated to the Smithtown Unit at the MSF site. Under ideal (homogeneous) conditions, the groundwater in the Upper Glacial Aquifer is unconfined and can move freely from one part of the aquifer to another. However, the presence of the Smithtown Clay Unit can locally retard vertical movement (Lubke, 1964) and limit the degree of hydraulic connection within the aquifer. At the MSF site, the Unit was interpreted to grade laterally to the east (across Cell 6) from a clayey to a more silty/sandy facies. In the Phase I area (north and west of Cell 6), the Smithtown Unit was found to be dominated mostly by a clayey (stratified) facies.

Variations in the thickness of the Smithtown Unit were documented across the region (Krulikas & Koszalka, 1983) and could be attributed to primary deposition of the strata and/or erosional processes. At the MSF site, variations in thickness of the unit were mostly a result of gradations in the strata, or inhomogeneities, which made it difficult to delineate the lower boundary of the unit. Nevertheless, including these gradational strata, the bottom of the Smithtown Unit was interpreted to be at approximately Mean Sea Level across the site.

The "primary" structure of the Smithtown Unit was found to be trending to the northwest at the MSF site, and was generally compatable with the slope of the Magothy surface as shown on regional maps (see Figures 3-2 and 3-3). The top of the Unit varied from about 55 to 75 feet MSL in the Phase I and III areas, and may slope down as low as 35 feet MSL downgradient of the Phase I area. The test borings proposed as part of this Work Plan are needed to clarify the configuration of the Smithtown Unit in the area of investigation.

Soil boring logs from Soil Mechanics Corp., Well Completion Reports from Suffolk County (SCDHS) and R.E. Pustorino, P.C. Borehole Logs from select Town wells were utilized for the interpretation of contours on the Smithtown Unit in the Phase I area (See Figure 3-3 and Appendix A). The drillers logs from Delta Well Co. and two anomolous borings logs from Soil Mechanics were not used in the plot because of difficulties interpreting the data, or in correlating the logs across the area. Data points from the Phase II (Cell 6) borings were also incorporated into Figure 3-3, and an alternative interpretation of the data is presented for the northeast portion of the site.

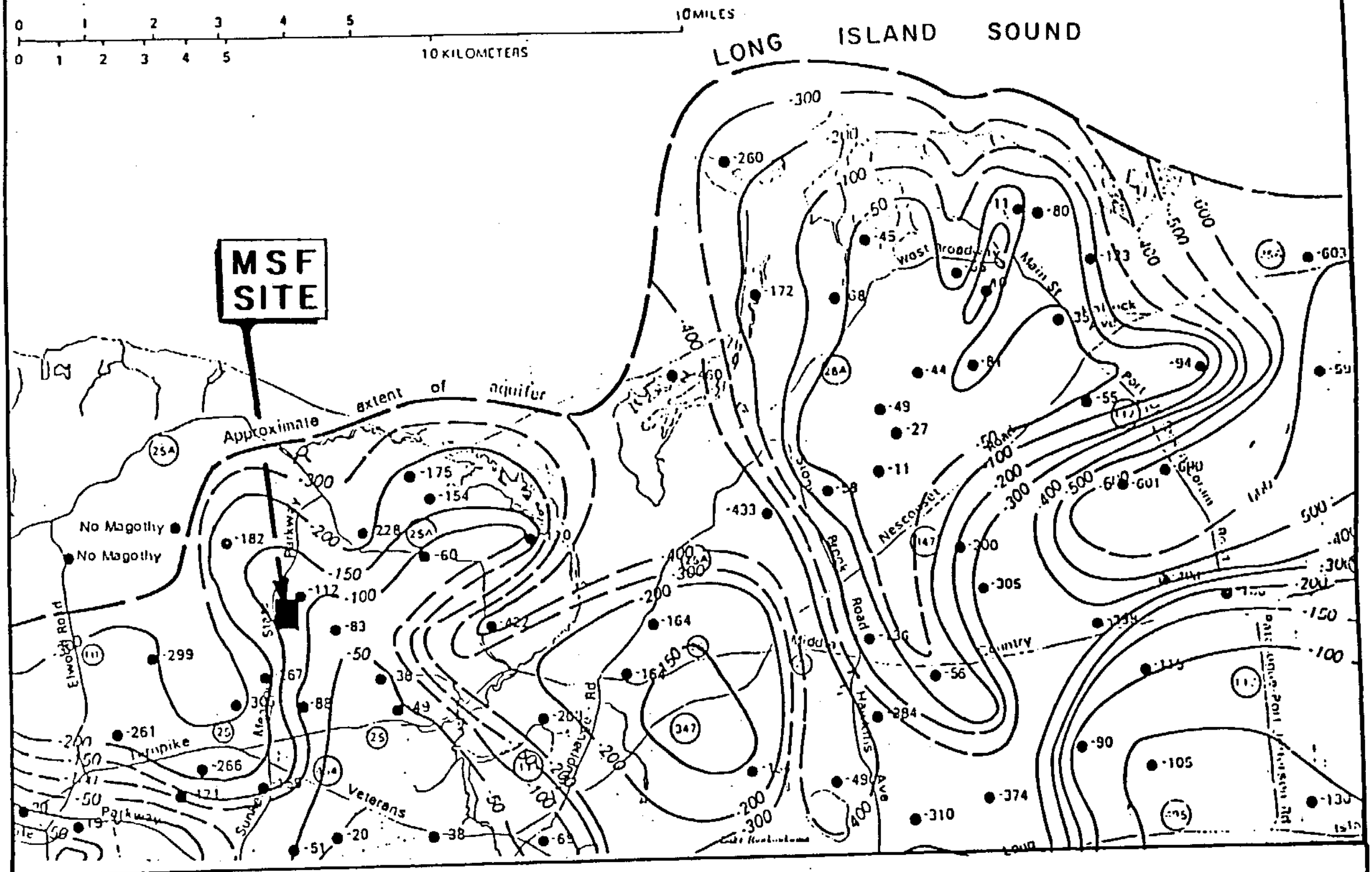
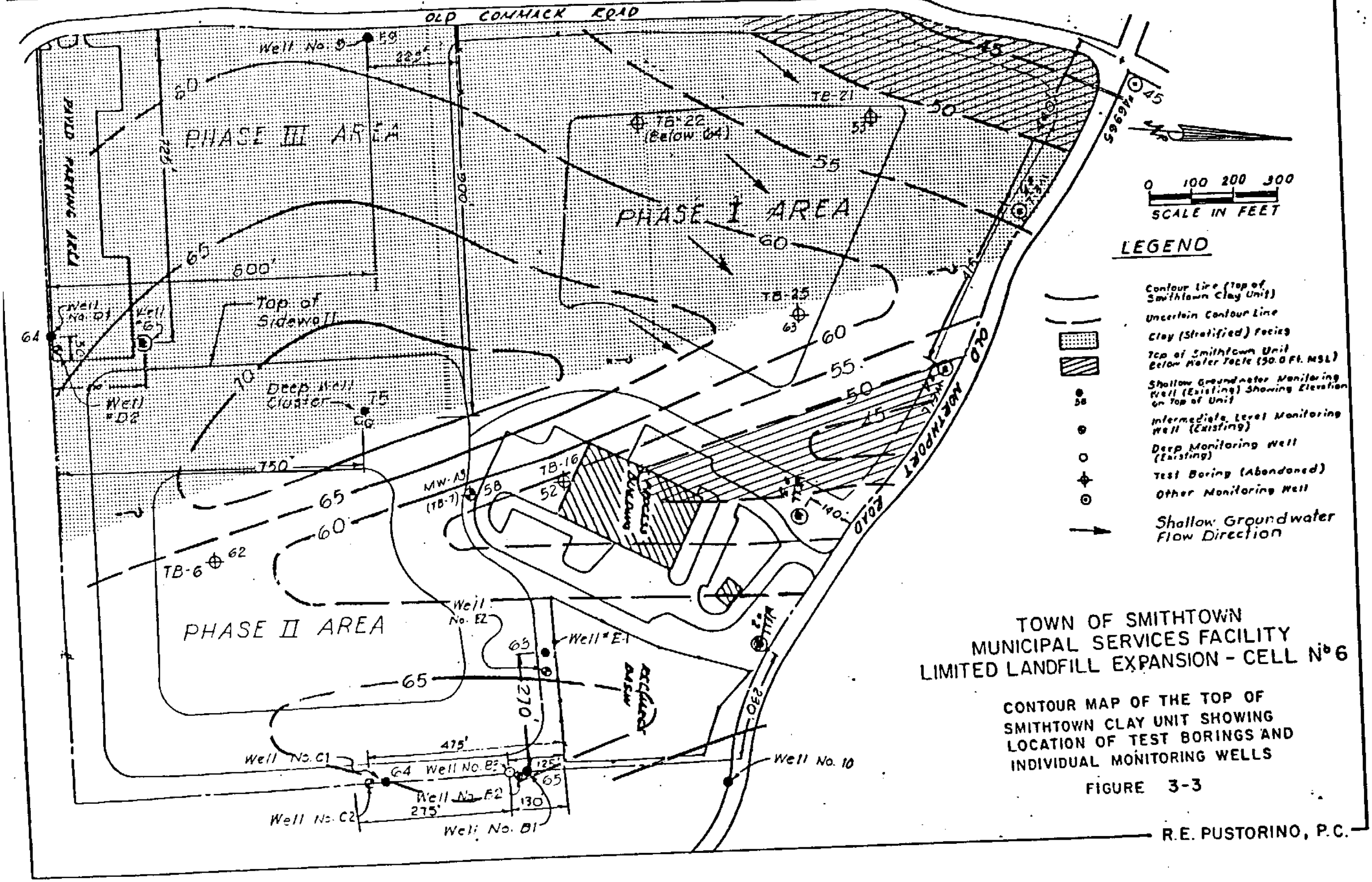


FIGURE NO. 3-2

Source: Krulikas, Koszalka, and Doriski

ALTITUDE OF THE TOP OF THE
MATAWAN GROUP-MAGOTHY FORMATION

R. E. PUSTORINO, P.C.



TOWN OF SMITHTOWN
MUNICIPAL SERVICES FACILITY
LIMITED LANDFILL EXPANSION - CELL No 6

CONTOUR MAP OF THE TOP OF SMITHTOWN CLAY UNIT SHOWING LOCATION OF TEST BORINGS AND INDIVIDUAL MONITORING WELLS

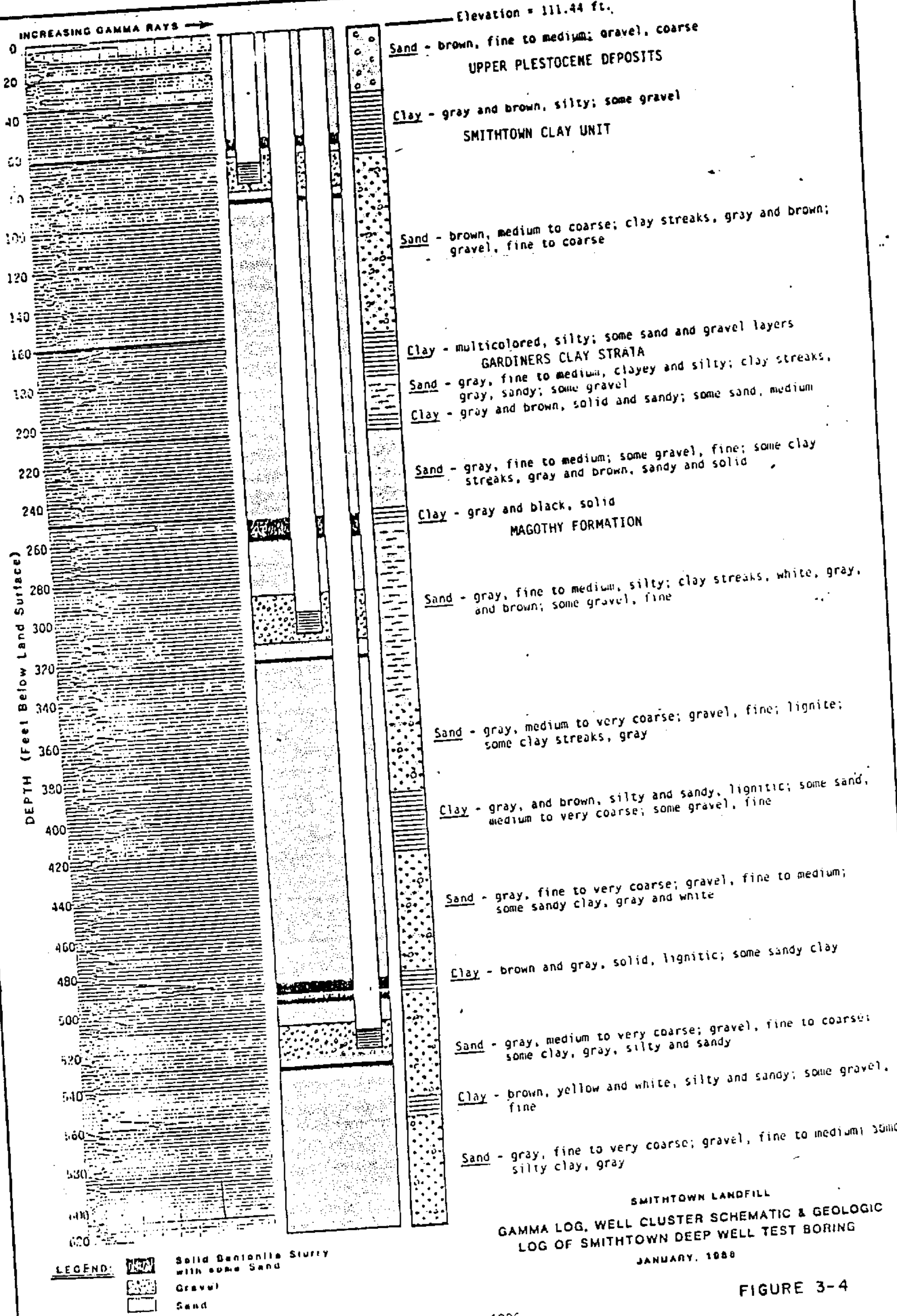
FIGURE 3-3

R.E. PUSTORINO, P.C.

3.2 DEEP WELL CLUSTER/PHASE II TEST BORINGS

The Drillers Log and Gamma Ray Log of the Deep Well Cluster define the geology at the MSF site down to the approximate top of the Raritan Clay. Figure 3-4 shows the original Gamma Ray Log of the borehole, the Well Cluster detail, and the formation descriptions correlated to the gamma curve. Table 3-1 is a summary of Suffolk County's Stratigraphy and Hydrogeologic Units, and can be used for subsurface regional and site correlation.

Strata correlatable to the Gardiners Clay had been tentatively identified in the Deep Cluster from -50 to -100 ft. below MSL, and were described as multi-colored clay interbedded with gray fine-medium sand. Interpretation of the gamma curve indicated that the upper clays in this interval are stratified through a 20 ft. zone. Gardiners Clay strata was also encountered in each of the Phase II deep Test Borings (TB-6, 7 and 8), and the top of the Unit ranged from about -45 feet MSL in the Cell 6 area to 60 feet downgradient of the Cell (R.E. Pustorino, P.C., 1990). The lithology of the bed(s) was dominantly a dark gray or black (organic) silt and clay interbedded with fine silty sands, with gradational beds above and below the Unit. The clays of this interval have not been positively identifed as "Gardiners Clay" in other well logs of the area.



SMITHTOWN LANDFILL

GAMMA LOG, WELL CLUSTER SCHEMATIC & GEOLOGIC LOG OF SMITHTOWN DEEP WELL TEST BORING

JANUARY, 1986

FIGURE 3-4

Source: Velzy Assoc., 1986

System	Series	Geologic unit	Hydrogeologic unit	[illegible]	Geologic Description
Quaternary	present Holocene 12,000 yrs	Recent shore, beach, and salt-marsh deposits	Upper glacial aquifer	0-60	Sand, gravel, clay, silt, organic mud, peat, loam, and shells. Colors: gray, brown, green, black, and yellow. Recent artificial-fill deposits of gravel, sand, clay, and rubbish.
	Pleistocene	Moraine deposits Glaciofluvial deposits Smithtown clay (informal usage)		0-700	Till composed of clay, sand, gravel and boulders; forms Harbor Hill and Ronkonkoma terminal moraines. Outwash deposits consist of quartzose sand, fine to very coarse, and gravel, pebble to boulder sized. Glaciolacustrine deposits (Smithtown clay) consist of silt, clay, and some sand and gravel layers. Colors are mainly gray, brown, and yellow. Contains shells and plant remains generally in finer grained beds.
		Unconformity	Unconformity		
		Gardiners Clay	Gardiners Clay	0-75	Marine deposits of clay and silt with some interbedded sand and gravel. Color, greenish-gray and gray. Foraminifera and lignite present, and also locally glauconite.
		Unconformity	Unconformity		
	200,000 yrs	post-Cretaceous(?) deposits	Upper glacial aquifer	0-140	Sand, fine to coarse. Color is brown. Identified as a distinct unit only on South Fork to date.
		Unconformity	Unconformity		
Cretaceous	60 mil yrs Upper Cretaceous	Monmouth Group	Monmouth greensand	0-200	Interbedded marine deposits of clay, silt, and sand. Color, dark greenish-gray to black. Contains much glauconite and lignite.
		Unconformity	Unconformity		
		Magothy Formation – Matawan Group undifferentiated	Magothy aquifer	0-1000	Sand, fine to coarse, clayey in part; interbedded with lenses and layers of light- to dark-gray clay. Basal 100-200 feet is generally composed of coarse sand and gravel beds. Sand and gravel are quartzose. Lignite and pyrite are common. Colors are gray, white, red, brown, and yellow.
		Disconformity?	Disconformity?		
		Raritan Formation — clay member	Raritan confing unit	0-250	Clay, solid and silty; few lenses and layers of sand; little gravel. Lignite and pyrite common. Colors are gray, red, and white, commonly variegated.
		Disconformity	Disconformity		
	100 mil yrs	Raritan Formation — Lloyd Sand Member	Lloyd aquifer	0-550	Sand, fine to coarse, and gravel with intercalated beds and lenses of light- to dark-gray clay, silt, clayey and silty sand and some lignite and pyrite. Locally has gradational contact with overlying Raritan clay. Colors are yellow, gray, and white; clay is red locally.
		Unconformity	Unconformity		
Early Paleozoic to Precambrian(?)	400 mil yrs >550 mil yrs (?)	Bedrock	Bedrock	not known	Crystalline metamorphic and igneous rocks; muscovite-biotite schist, gneiss, and granite. Surface of bedrock is commonly highly weathered to a greenish-white residual clay.

SUFFOLK COUNTY STRATIGRAPHY AND HYDROGEOLOGIC UNITS (from S.C.C.W.R.M.P., 1987)

TABLE 3-1

R. E. PUSTORINO, P.C.

The contact between the Magothy Formation (Cretaceous) and the overlying Pleistocene/Pliocene(?) deposits is a major regional unconformity, and interpretation of the Gamma Log (Figure 3-4) shows an elevation of -140 below MSL. A 5 foot solid gray and black clay is described at this level and is overlain by about 40 feet of gray fine-medium sand with some gravel and clay. As the shape of the gamma curve reveals, the top part of the Magothy contains numerous thin water bearing zones. However, deep (Phase II) test boring TB-6 in the bottom of Cell 6 showed the Upper Magothy to be composed of dominantly silty sand, and was practically indistinguishable from the Upper Glacial deposits (R.E. Pustorino, P.C., 1990). Thus, variation in recharge potential to the Magothy Aquifer was documented across the site for this stratigraphic interval.

Although the Raritan Formation was not fully penetrated at the site, the April 1986 Hydrogeological Report describes Magothy material together with the solid clays of the Raritan in a "transition zone" at the 625 ft. depth. The Raritan Clay Member overlies the more permeable sands and gravels of the Lloyd Sand Aquifer, which holds its groundwater under true artesian pressure. These strata, in turn, rest unconformably on top of Pre-Cambrian (crystalline) bedrock, which is considered to be the lower limit of the aquifer system on Long Island. This "basement complex" slopes gently to the southeast at about 80 feet per mile, and controls the structure of the overlying Cretaceous Formations.

3.3 GROUNDWATER HYDROLOGY

According to the 208 Study and verified by the April 1986 Hydrogeologic Report, the MSF appears to lie within Long Island's sensitive deep flow (Magothy) recharge zone. This would indicate that the regional flow regime is influenced by a vertical component of flow, as shown on profile X-X in Figure 3-1. Theoretically, significant downward (vertical) flow can only take place where there are interconnected pores or pathways in the aquifer, and if the formation is relatively homogeneous and isotropic. Locally, however, the presence of the Smithtown Unit or other clay strata can cause the groundwater to flow more or less in a horizontal direction (paralleling the bedding planes). This was apparent from hydraulic heads that were measured in well clusters MW-D and MW-B in the Phase II area.

As a result of the site characterization investigations and studies that were undertaken for the Phase II (Cell 6) Landfill Expansion, the uppermost flow regime was found to have an average of 1 foot of vertical flow for every 12 feet of horizontal flow in the Smithtown Unit, and an average of 1:55 feet of V/H flow in the Upper Glacial Aquifer (below the Unit). Consequently, the aquifer was characterized as being anisotropic and dominated by a horizontal component of advective groundwater flow (R.E. Pustorino, P.C., 1990).

The character of the flow regime in the Phase II area is predominately the result of a significant clay zone in the aquifer from about -50 feet to -75 feet MSL. These "Gardiners Clay" or correlatable strata were interpreted as forming the basement of the flow regime underlying Cell 6. Because the Gardiners strata were found to be continuous across the Phase II area, it is projected that, for this Work Plan, these clay strata will also underlie the Phase I landfill area to the north and west of Cell 6.

Since the "primary" structure of the Smithtown Unit was interpreted to be continuous across the site (trending to the northwest; see Figure 3-3), the hydrological properties of the aquifer materials underlying the Phase I area can be extrapolated from the Phase II results. Hence, for the purposes of this Work Plan, the hydraulic conductivities of the materials (Hor. K) will be taken to range from 2 x 10(-3) to 7 x 10(-5) cm/sec, and aquitard vertical K to be 2 x 10(-4) to 5 x 10(-8) cm/sec. Utilizing estimated lateral and vertical gradients of .0008 and .002 for the non-mounding condition, average groundwater flow rates will range from about 17 to 188 feet/year, with a maximum possible rate of about 1 foot/day. Effective porosities will be in the range of 20-30% by volume.

Regional (shallow) groundwater flow has a bearing of about N 55 deg. E in the Smithtown MSF area, as shown in Figures 3-5 and 3-7, based upon SCDHS water level data from 1987 and 1988. A comparison of the two sets of data shows very little variation in the configuration of the water table surface in the area during that time. Figure 3-6 shows that the regional (deep) groundwater flow in the Magothy travels with a bearing of N 45 deg. E and is compatible with the regional direction of shallow flow in the MSF area. Using the SCDHS 1987 data shown in Figures 3-5 and 3-6, a comparison of the shallow and deep flow shows a significant negative or downward head differential (non-static condition) between the Upper Glacial and Magothy Aquifers.

The direction of shallow groundwater flow for the Phase I area is shown to have a bearing of about N 35 deg. E, based upon water table contours that have not been influenced by mounding from the Cell 6 area (Figure 3-8). Since the water table across most of the site is contained within the Smithtown Unit (except possible downgradient of Cells 1 through 5), shallow groundwater flow will be influenced by the local structure and lithology of the Unit. This may result in a flow differential between the shallow and deep directions of flow in the Phase I area. Water table levels in the MSF area are presently near their historic high levels of 51 feet MSL, according to the long-term groundwater fluctuations that are depicted in Figure 3-9.

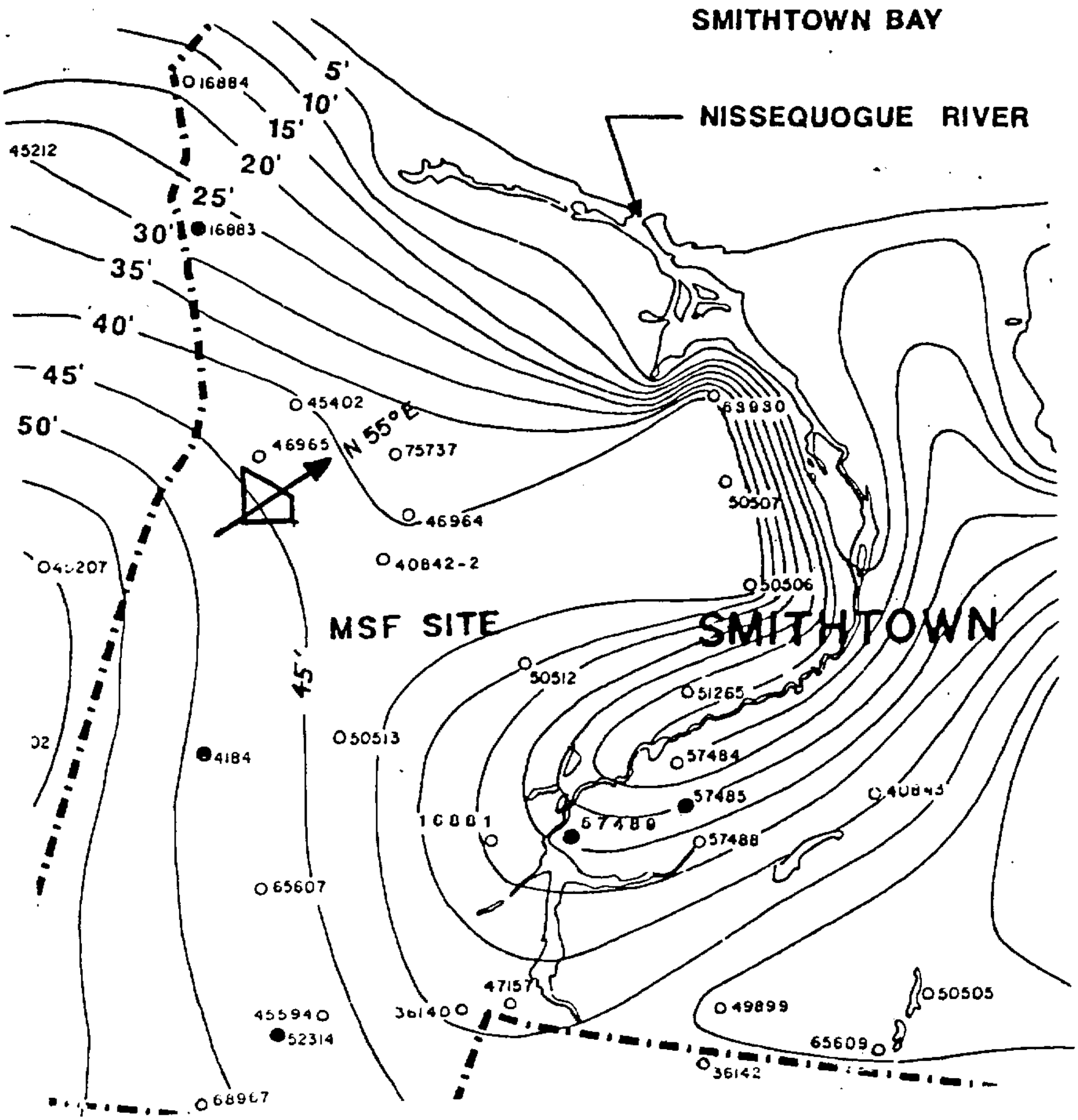


FIGURE 3-5

CONTOURS ON THE WATER TABLE
AND GROUNDWATER FLOW DIRECTION
(SCDHS MARCH 1987 DATA)

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

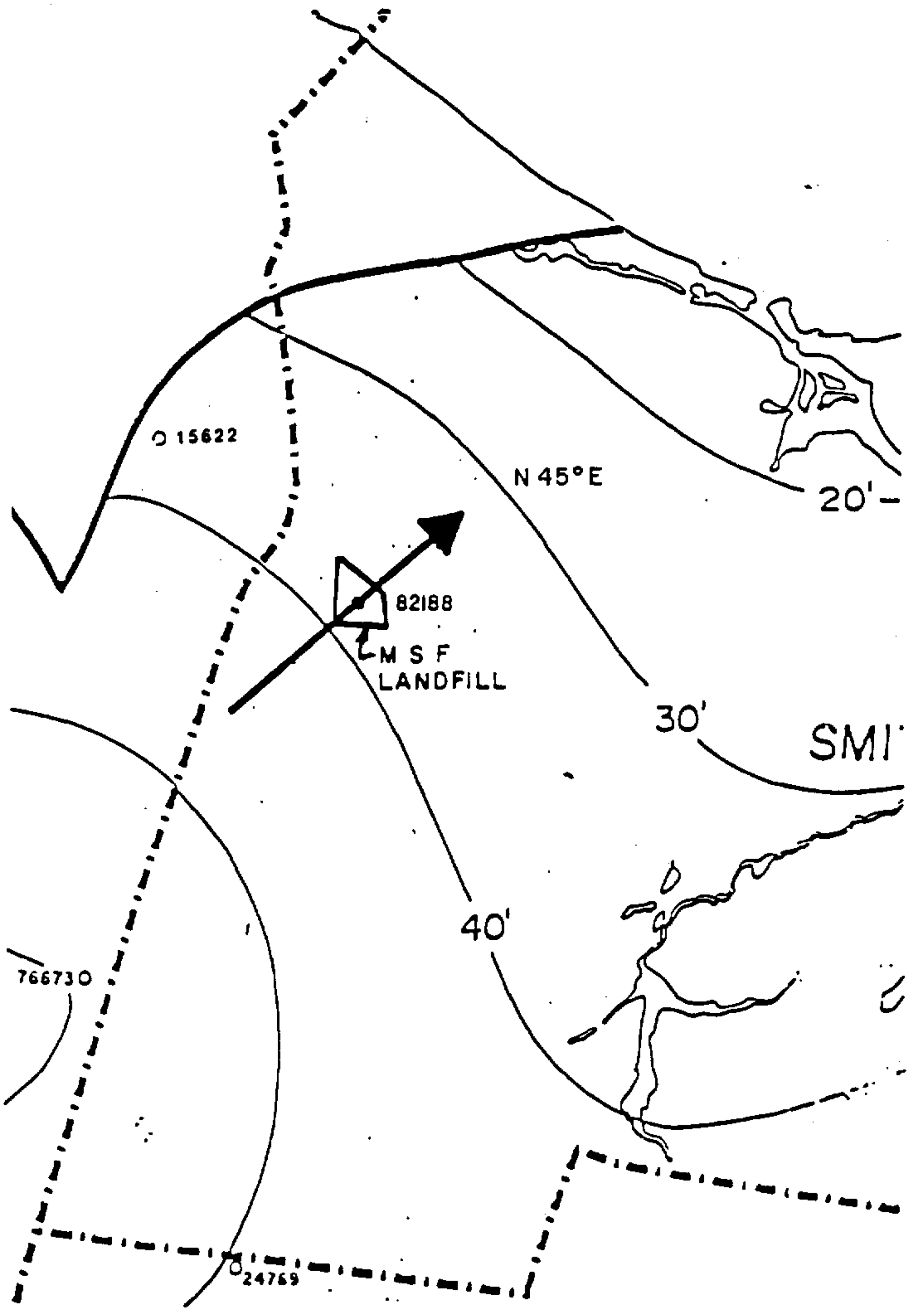


FIGURE 3-6
POTENTIOMETRIC SURFACE OF
THE MAGOTHY AQUIFER
AND FLOW DIRECTION
(SCDHS MARCH 1987 DATA)

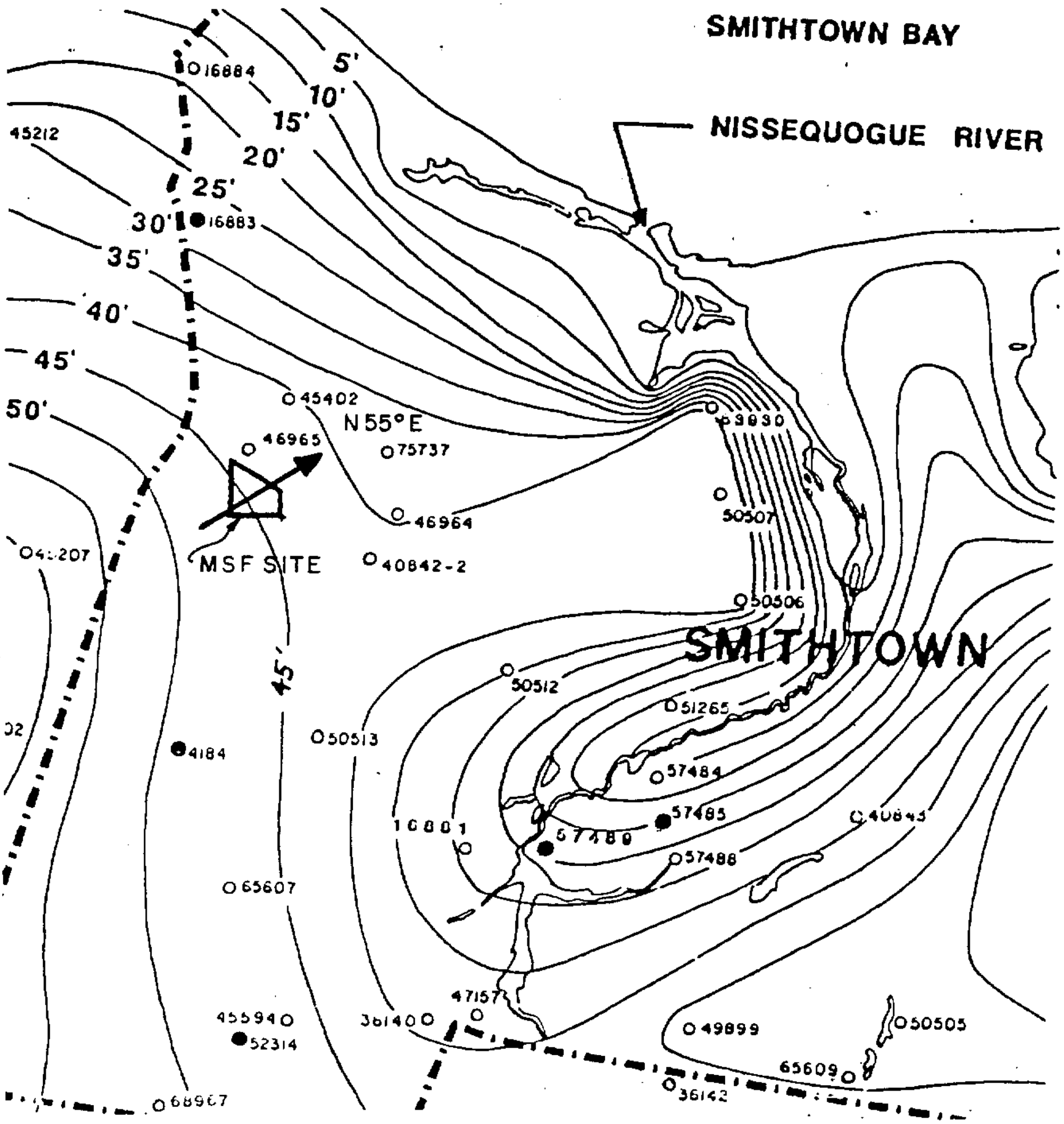
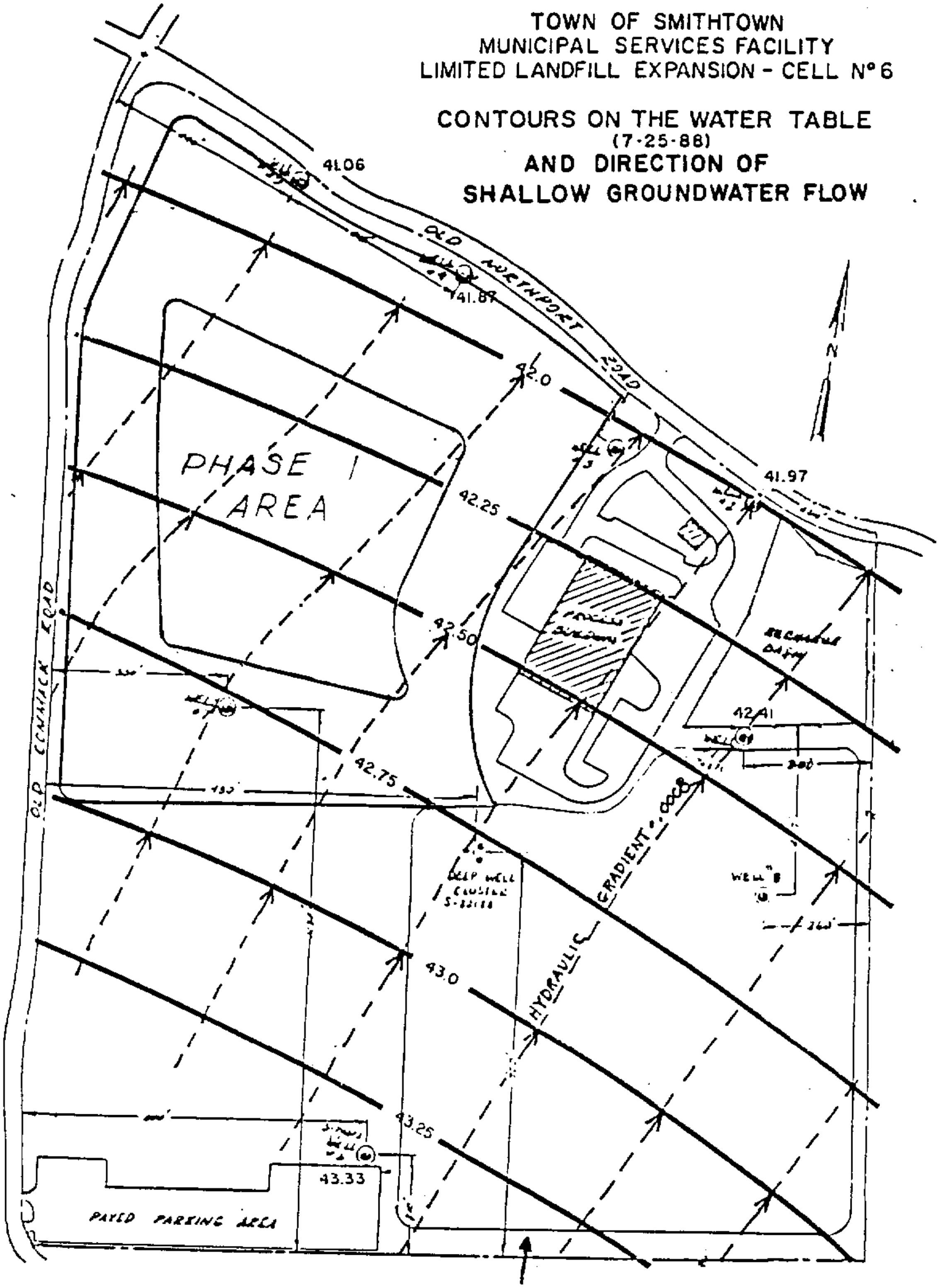


FIGURE 3-7

CONTOURS ON THE WATER TABLE AND GROUNDWATER FLOW DIRECTION (SCDHS MARCH 1989 DATA)



TOWN OF SMITHTOWN
MUNICIPAL SERVICES FACILITY
LIMITED LANDFILL EXPANSION - CELL N°6

CONTOURS ON THE WATER TABLE
(7-25-88)
AND DIRECTION OF
SHALLOW GROUNDWATER FLOW

Outline of
Cell No.6

Horizontal
Direction ——→ N30°E
of Flow

FIGURE 3-8

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

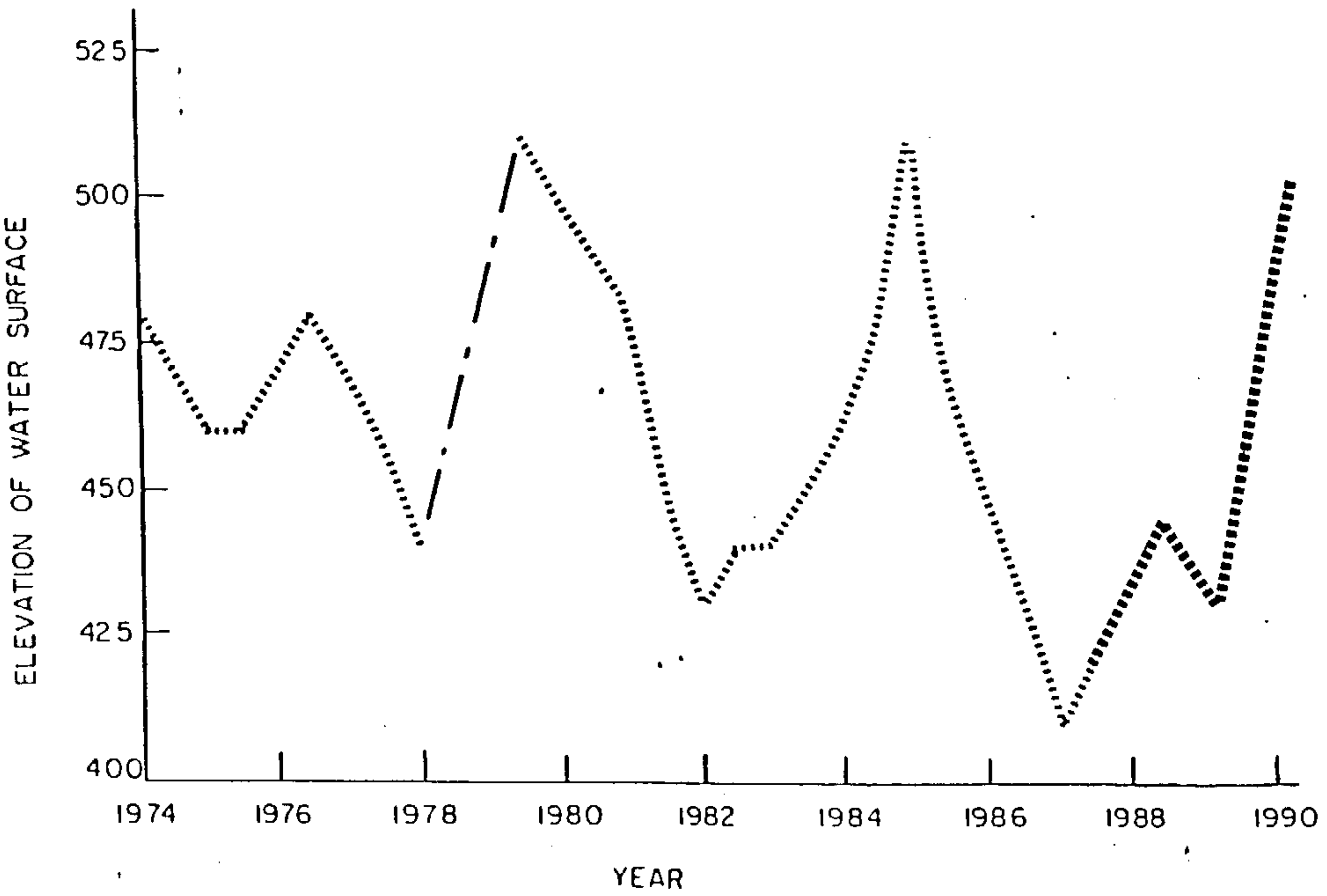


FIGURE 3-9

LONG-TERM SEASONAL GROUNDWATER TABLE FLUCTUATIONS

R. E. PUSTORINO, P.C.

SECTION 4.0

SCOPE OF WORK

4.1 WORK PLAN - GENERAL

Consistent with the requirements for a site investigation plan that are outlined in 6 NYCRR Part 360, Section 2.11(a), for Solid Waste Management Facilities, this Work Plan will define the methods of investigation and analysis that are needed for the design and installation of groundwater monitoring wells at the Smithtown Municipal Services Facility (Phase I landfilling area) site.

Of major concern is positive determination of the stratigraphy and hydrogeologic properties of the aquifer materials in the Phase I (Cells 1 through 5) area. However, because of the current extent of the refuse deposits at the Landfill, drilling for site investigation is restricted to the zones directly downgradient of the site along Old Northport Road, and to the east along Old Commack Road. In this context, the proposed Test Boring/Monitoring Well locations and depths were based on the interpolation and integration of existing Phase I and II data, and this will be subject to modification as the field implementation progresses.

The specific well completion details and final designs of construction will be predicated on the evaluation of the field (in-situ) test data from the exploratory borings.

The acquisition of the required hydrogeologic information, and the subsequent laboratory analyses, will follow accepted practices and operating procedures, as indicated in the detailed specifications presented in this Work Plan. In general, all field and laboratory testing procedures will be performed according to the appropriate American Society for Test Materials (ASTM) Standard.

4.2 OUTLINE OF MAJOR TASKS AND OPERATIONS

The following outline was developed to meet the goals and objectives of the monitoring well installation program, as defined in Section 1.0 of this Work Plan. More specifically, the individual elements of the program, which are arranged in approximate chronological order, include the following major tasks and operations:

1) Based upon current knowledge of site characterization in the Phase I area (see Section 3.0), estimate or determine the appropriate monitoring well specifications and procedures, i.e., boring/well locations and depths, drilling and testing methods, sampling and analysis plan, etc.;

2) Prepare documentation (Detailed Specifications), set dates, obtain proposals, and award drilling contract(s);

3) Perform site inspection of the proposed borehole location(s) to determine accessibility for drilling rigs; construct access, if necessary, and stake out final test boring/ monitoring well locations;

4) Implement exploratory drilling and testing at the one (1) deep (upgradient) well location to include split-spoon sampling and geophysical (borehole) logging for characterization of the lithology and relative water quality.

5) Based upon the above in-situ test results, design the specific well completion details; install the upgradient monitoring well;

6) Implement test boring/monitoring well installation procedures (as in "4" and "5" above) at the three (3) downgradient well locations, for the shallow (water table) and deep wells at each of those clusters.

7) Development of the completed monitoring wells;

8) Establish a reference point on each well casing and determine the elevation and planimetric (coordinate) locations for the monitoring well installations by standard surveying methods;

9) Obtain groundwater elevations in each of the monitoring wells (piezometers), to be used for hydrological mapping purposes, i.e., determination of hydraulic gradients, groundwater flow directions, and flow velocities in the Phase I area;

10) Perform variable head (slug) tests in each of the monitoring wells, for estimation of the hydraulic conductivity (K) of the materials in the screened intervals;

11) Obtain laboratory (grain-size) analyses of representative soil samples from split spoons, to include the standard gradation curves, for positive determination of the soils classifications;

12) Integrate the above collected Phase I hydrogeologic information into the engineering data base for the entire MSF site;

13) Develop baseline and ongoing groundwater quality data in the Phase I area, through the current quarterly and annual sampling and analysis program at the facility; and

14) Monitor the impact of the lined landfill (Cells 1 through 5) on groundwater quality, in conformance with the NYSDEC Part 360 requirements.

SECTION 5.0

TEST BORING AND MONITORING WELL INSTALLATIONS

5.1 GENERAL

The main purpose of the exploratory test borings is to identify the critical stratigraphic section in the uppermost flow zone, and to characterize the lithology and hydrogeologic properties of the aquifer materials. In general, data from the test borings will:

1) Identify the nature and extent of the Smithtown Clay Unit in the Phase I Landfill area, and the ability of that Unit to limit downward advective flow;

2) Characterize the lithology of the Upper Glacial Aquifer (below the Smithtown Unit), and, if applicable, define the boundary conditions of the uppermost aquifer, i.e., Gardiners Clay strata; and

3) Define the apparent changes in groundwater quality in the flow regime (i.e., dissolved solids content), by borehole resistivity measurements, for monitoring well placement.

In order to accomplish these objectives, split spoon samples will be taken, and standard (ASTM) field/laboratory methods of analysis will be used for soils identification and classification. Furthermore, geophysical (resistivity/SP) logging will be performed in the test borings to verify the depths, thickness, and other properties of the strata, including the relative groundwater quality.

5.2 TEST BORING/MONITORING WELL LOCATIONS AND DEPTHS

A total of eight (8) monitoring wells are proposed as part of this installation program: one (1) upgradient deep well, and three (3) downgradient well clusters. In addition, one deep well is proposed to be added to the existing SCDHS groundwater monitoring well (S46965) to form a lateral-downgradient well cluster. Each monitoring well cluster will be composed of:

1) One (1) shallow (water table) well; and
2) One (1) deep well

The proposed well identification numbers and their locations relative to Phase I-Cells 1 through 5 are as follows:

MW-9b	Upgradient SW
MW-F1	Downgradient NW
MW-F2	Downgradient NW
MW-G1	Downgradient N
MW-G2	Downgradient N
MW-H1	Downgradient NE
MW-H2	Downgradient NE
MW-I2	Downgradient NW (lateral)

Figure 5-1 shows the locations of the proposed test borings and monitoring wells. After the initial drilling of one (1) test boring at each of the proposed well cluster locations, the test bore will be utilized for installation of the deep monitoring wells, i.e., MW-9b, MW-F2, G2, H2 and I2. The shallow wells MW-F1, G1 and H1 will be installed adjacent to the deep monitoring wells (in a separate borehole) at each of the downgradient locations.

An estimate of the proposed well screen depths of placement, borehole elevations, and formations screened are given in Table 5-1. It should be emphasized that the estimated monitoring well depths are subject to change based upon a field evaluation of the in-situ test results.

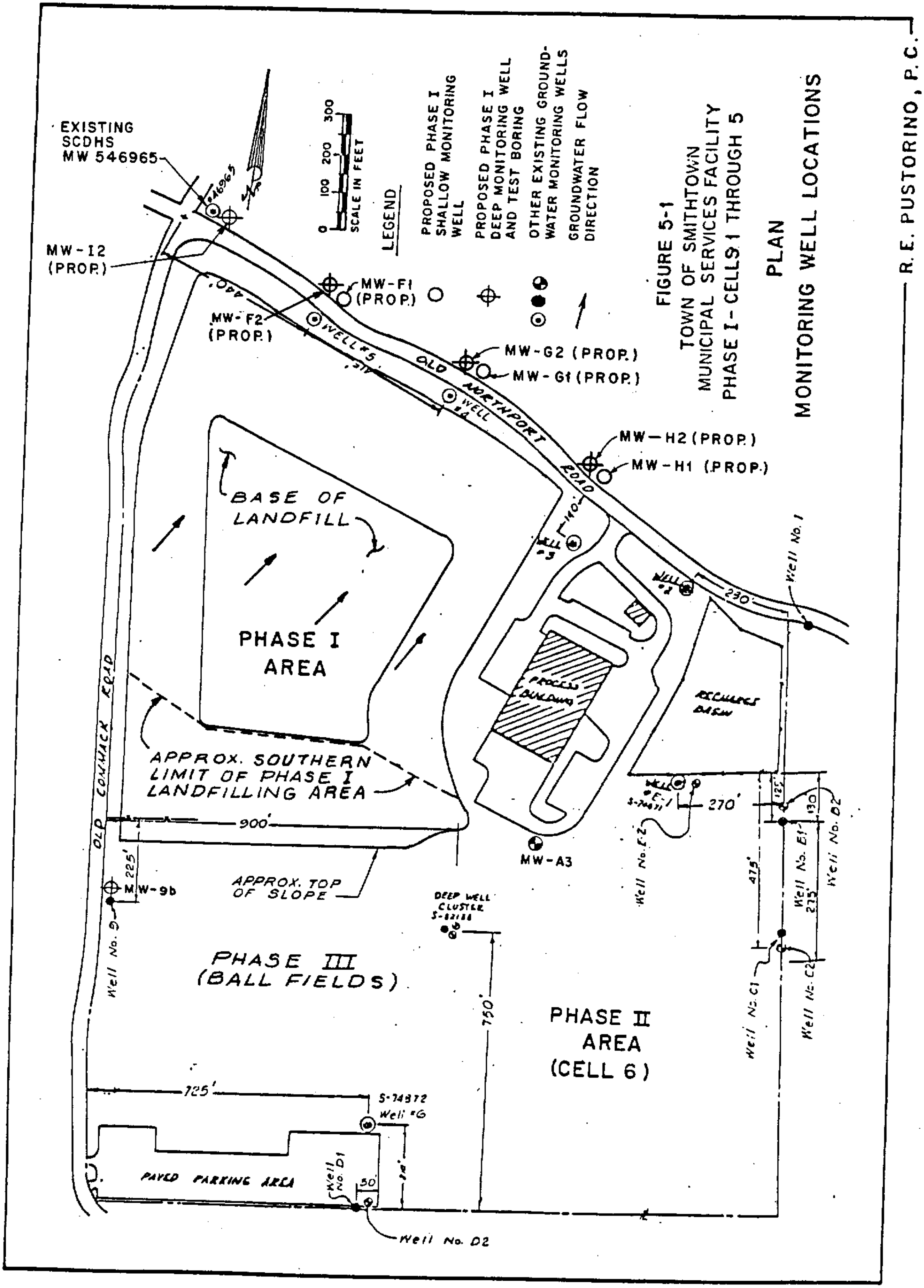


FIGURE 5-1
TOWN OF SMITHTOWN
MUNICIPAL SERVICES FACILITY
PHASE I - CELLS 1 THROUGH 5

PLAN
MONITORING WELL LOCATIONS

R. E. PUSTORINO, P. C.

TABLE 5-1

PROPOSED MONITORING WELL DEPTHS
(In Feet)

WELL NO.	WELL SCREEN INTERVAL* DEPTH	FT. (MSL)	BOREHOLE** ELEVATIONS	FORMATIONS SCREENED
MW-9b	150-170	22-2	172	Upper Glacial
MW-F1	110-130	55-35	165	Smithtown
MW-F2	140-155	25-10	165	Upper Glacial
MW-G1	105-125	55-35	160	Smithtown
MW-G2	145-160	15-0	160	Upper Glacial
MW-H1	100-120	55-35	155	Smithtown
MW-H2	150-165	5-(-10)	155	Upper Glacial
MW-I2	137-152	30-15	167	Upper Glacial

* Shallow well screen depths are based upon a +50 ft. MSL water table elevation.

** Approximate elevation at ground surface (top of borehole).

Note: For approximate total depth of drilling at each of the eight (8) well locations, add five (5) feet to the bottom of the well screen intervals.

5.2.1 Monitoring Well Placement

The horizontal locations of the three (3) proposed well clusters, MW-F, G, and H, were determined by following the groundwater flow direction downgradient of the basal area of the Phase I landfill, and then distributing the well locations evenly across the width of the flow paths. As was depicted in Figure 5-1, this procedure has resulted in a horizontal well spacing of about 425 feet, which is in accordance with the requirements of 6 NYCRR Part 360-2.11.

The proposed site of the deep upgradient well, MW-9b, was selected based upon the unique location of existing shallow (water table) well, MW-9. This upgradient well cluster will be situated roughly in the middle of the shallow groundwater flow paths below the Phase I area as they travel northeast through the site.

Vertical well spacing within the aquifer was established by using the representative horizontal to vertical permeability ratios (H/V K ratios) of the hydrostratigraphic units in the Phase I area (See Table 5-1). These values were extrapolated from the Phase II results which were outlined in Section 3.3 of this Work Plan.

The line of facies change delineated in Figure 3-3 was taken into account when computing the appropriate downgradient deep well screen depths. For example, the clay (stratified) facies of the Smithtown Unit was found to underlie most of the base of the landfill, and this would result in a very limited vertical component of flow in the aquifer under those areas.

Vertical placement of the deep well screen in proposed upgradient Well No. 9b was estimated by taking the median elevations of the four (4) downgradient (deep) well screens, and computing the appropriate depth from existing grade. The strata in the Upper Glacial Aquifer below the bottom of the Smithtown Unit (estimated at about 0 feet MSL) is assumed to be continuous across the Phase I area.

5.3 BORING INSTALLATION

Borehole construction at the site will be by Hollow-Stem Auger, Mud Rotary, Cable-Tool (cased hole), or other appropriate drilling method, or a combination of those methods. The contractor's method of borehole construction shall comply with the requirements of 6 NYCRR Part 360.

Drilling rigs that are utilized for boring installation shall be capable of drilling to a depth of at least 200 feet, and be suitable for the installation of 4" PVC well casings at those depths. The boring method(s) shall be appropriate for drilling under as much as 100 feet of saturated conditions.

Since the test borings will be utilized for installation of the groundwater monitoring wells, the drilling methods and procedures that are outlined in this Work Plan are designed to minimize impact (i.e., contamination) to the baseline water quality. Accordingly, drilling muds (if applicable) are required to be pure, high yielding bentonites with no additives. Portable mud pits shall be required for use with all mud rotary drilling rigs to preclude the potential for contamination from surface soils. In addition, only vegetable-based oils such as Crisco, or the equivalent, will be used as grease on the drill rods or on other downhole apparatus. It is required that only potable water be used in the preparation of drilling fluids during the bailing process (if applicable), for steam cleaning, washing, etc.. An on-site source of publicly supplied potable water is available for the Contractor's use during these operations.

All drilling operations which are conducted on-site will be performed in accordance with approved standard practices and procedures, such as ASTM Standards, and will be compatible with the NYSDEC Part 360, Section 2.11, requirements for such practices at Solid Waste Management Facilities.

See Detailed Specifications in APPENDIX B for more information concerning methods and procedure for borehole construction.

5.3.1 Cleaning of Drilling Equipment

All drilling and other contact equipment will be decontaminated by steam cleaning prior to starting work at the site, before each new boring or well installation, and as required by the Engineer during the field operations. The cleaning and sanitization will be witnessed by the Engineer, and be subject to his inspection before use. The steam generator shall be capable of producing steam at a minimum temperature of 200 deg. F. measured at the tip.

The cleaned and sanitized equipment will be stored on pallets, plastic, etc., in a manner acceptable to the Engineer, so as to prevent contamination of the borehole environment.

5.3.2 Monitoring of Drilling Muds (If Applicable)

As required by the NYSDEC during construction of groundwater monitoring wells (using mud rotary methods), the following properties of the mud should be monitored:

1) Mud Weight - in lbs. per gal. with a mud balance;
2) Fluid Viscosity - in seconds with a Marsh Funnel;
3) Ph - with litmus paper; and
4) Sand Content - %, with acceptable apparatus

The mud parameters will be determined by the Contractor at the beginning and end of the borehole construction, plus at least twice a day, to assure the most optimum (efficient) mud design for the local geologic conditions. If possible, mud weights should be reduced while drilling in the proposed screen intervals in order to facilitate the development of the well.

5.3.3 Environmental Monitoring

Due to the proximity of the proposed groundwater monitoring well locations to the existing Phase I landfill area, the Contractor shall be responsible for monitoring ambient air and borehole gases/vapors for methane gas.

Environmental monitoring will take place both prior to and during the drilling operations. Should positive readings be registered in the open air or the borehole environment, the appropriate precautionary measures will be taken (See Health and Safety Plan - Section 8).

5.3.4 Abandonment of Wells

Any borehole or test boring which is not used for the installation of a monitoring well shall be abandoned so as to prevent any leakage of contaminants down into the aquifer. In general, the method of abandonment will be compatible with the geologic conditions, and be approved by the Engineer.

Typically, the well screen (if any) is removed to the greatest extent possible, and the borehole filled (tremied) with a cement-bentonite mix; the top five feet of the borehole is backfilled with the native materials, and the abandonment checked 24 hours later to check for settlement.

In the event the borehole is advanced beyond the intended screened interval, a pure bentonite grout material will be used to fill the bore below the screened interval, up to the top of an impermeable bed below the screen or up to 2' below the screened interval.

5.4 GEOLOGIC SAMPLING AND ANALYSIS

In general, the main goal of the geologic sampling plan is to help characterize the hydrogeologic conditions at the landfill site, and to facilitate the design and placement of the Phase I landfilling area groundwater monitoring wells. Consequently, geologic (soil) sampling will be performed in each of the test borings by utilizing the split spoon barrel and apparatus. The split spoon (penetration) testing will start in the critical zone below the base of the landfill at approximately 60 feet MSL, and will continue until the critical stratigraphic section is adequately defined.

In-situ (split-spoon) samples will be collected that are representative of 1) the Smithtown Unit; 2) the Upper Glacial Aquifer (mostly below the Unit); and if applicable; 3) the Gardiners clay strata. Results from the field sample identifications and descriptions will be used to "calibrate" the resistivity and SP logs that are run in the initial test borings, as was described in Section 5.2. Subsequently, laboratory analysis of samples from the screened intervals, and from other critical strata, will be used to characterize the grain-size distributions (gradations) of the materials, and to verify the field classifications.

5.4.1 Split Spoon Sampling Points

Split spoon sampling will begin at about 60 feet MSL in each of the test borings, and continue at 5 foot intervals or as dictated by changes in the lithology, as determined by the Engineer. Split spoon sampling will continue until a depth is reached which is determined to be equal to the maximum downward flow of the potential contaminant pathways. For the purposes of this Work Plan, this bottom depth was estimated to be from 160-170 feet below the existing land surface (in the Upper Glacial Aquifer), based upon the procedure that was outlined in Section 5.2. At each borehole location, the sample interval will encompass the critical stratigraphic section below the floor of the landfill, and will, at a minimum, delineate the full extent of the Smithtown Unit.

The tentative split spoon sampling points are presented for each of the test borings in Table 5-2. However, because the proposed bottom depths are based upon interpretations of the existing Phase I data (See Appendix A), and on extrapolations of Phase II-Cell No. 6 data which characterized a heterogeneous formation, they may be subject to changes as the field sampling and analyses progresses.

5.4.2 Sampling Methods and Procedures

Split spoon samples will be collected by the drilling contractor according to the ASTM Designation D1586-67 "Standard Method for Penetration Test and Split Barrel Sampling of Soils". According to the Standard, a representative soil sample is collected by mechanically driving a 2 inch O.D. spoon twenty-four inches into undisturbed material with a 140 lb. hammer. During the procedure, the drill rods are marked in 6 inch increments, and the blow counts recorded in order to gauge the relative resistance of the soil to penetration.

Field examination and description of the sample will be undertaken by the Contractor's geologist/geotechnical engineer, with special reference to the nature and degree of stratification, and to the hydrogeologic properties of the material(s). ASTM D2488-69 (reapproved 1975) outlines the "Standard Recommended Practice for

TABLE 5-2

SUMMARY OF SPLIT SPOON SAMPLING POINTS

TEST BORING I.D.	SPLIT SPOON* INTERVALS (DEPTH IN FT.)	ELEVATION AT GRADE (FT. MSL)
MW-9b	105 - 175	172
MW-F1	-	-
MW-F2	100 - 160	165
MW-G1	-	-
MW-G2	95 - 165	160
MW-H1	-	-
MW-H2	90 - 170	155
MW-I2	105 - 160	172

*The split spoon sample interval is 5 ft., unless otherwise determined by Engineer, based upon changes in lithology.

Description of Soils (Visual-Manual Procedures)" which should be used for the sample identification. The Unified Soil Classification System (USCS) or other standard system, approved by the Engineer, shall be used for the field classifications.

With regards to split spoon preparations, mason jars (if applicable) should be of the tephlon-lined screw-capped variety, and be prelabeled with the job name, well and sample number, and depth of the sample interval. If after analyses, the sample is found to contain two (2) distinct lithology types, the sample label should indicate from which part of the spoon the specimen was collected.

From each split-spoon, a minimum of two (2) separate samples, or three (3) when the spoon contains two distinct lithology types, will be placed into the sample jars for the following:

- o Sample 1 - for the Consultant's documentation and verification
- o Sample 2 - for laboratory geotechnical analyses
- o Sample 3 (if any) - also for geotechnical analyses

Refer to the Detailed Specifications at the end of the Work Plan for more information on split spoon sampling specifications and operating procedures.

5.4.3 Split Spoon Cleaning

All split spoons will be wire brushed and steam cleaned prior to use in the borehole environment. Furthermore, the cleanliness of the spoon (and the downhole apparatus) will be subject to routine inspection by the Engineer, and must meet with his final approval.

A dedicated or sanitized staging area should be prepared at each well-site, for the purpose of isolating all downhole sampling equipment from contaminated surfaces.

In lieu of steam cleaning the split-spoon apparatus, the following recommended NYSDEC protocol may be used:

1) Non-phosphate detergent wash
2) Rinse with potable water
3) Acetone wash
4) Hexane wash
5) Rinse with deionized water

5.4.4 Record of Field Data

All raw data compiled in the field by the Contractor's geologist/soils engineer should be recorded in a bound Field Record Book. This field document should contain a chronology of the daily events, as well as a summary of the following technical information:

- Name and Location of Job
- Name of Contractor/Subcontractors, crew members
- Date of Borings - start, finish
- Boring I.D. Numbers
- Surface Elevation, if available
- Sample No. and Depth
- Method of Advancing Sampler, blow counts per 6", and recovery length
- Type and Size of Sampler
- Description of Soils
- Thickness and nature of Strata
- Depth to Water, Time of Measurement
- Type, Make, Specifications of Drilling Rig
- Size of Borehole, Casing (if any)
- Description of Construction Materials, volumes used
- Diagram of Well Completion Details
- Well Development Data
- Results of Aquifer Testing
- Weather Conditions During Operations

Data from the test borings and monitoring well installations should be compiled onto a final Log of the Well and be submitted to the Engineer upon completion of the project. The final Log Form to be used must meet with the approval of the Engineer. Finalized Resistivity/SP logs showing at a minimum depths from the ground surface, must also be submitted. Finally, the Field Record Book must be surrendered to the Consultant upon fulfillment of the Contract.

Also see Detailed Specifications in Appendix B for other requirements concerning Boring Logs and Field Records.

5.5 LABORATORY ANALYSIS OF SOIL SAMPLES

The geologist/soils engineer for the Contractor will be responsible for the handling, delivery, and shipment of all soil samples to the laboratory for analysis. A qualified geotechnical laboratory familiar with the Standard ASTM methodology and procedures will be used. In the case that the Contractor uses his own geotechnical laboratory, the laboratory must meet with the approval of the Engineer.

Representative split spoon (soil) samples from the well screen intervals and all other critical strata will undergo geotechnical analysis for grain size distribution.

Where the silt and clay (fines) content of the soil exceeds 20% by weight (as outlined in ASTM 2487), the sample will undergo hydrometer analysis for the % of fines; the liquid/plastic limit will also be performed on the fines fraction of those samples. The results of the above analyses will be indicated on a Gradation Curve and Plasticity Chart, if applicable, and will include the USCS classification of the soil based upon the results. The grain-size distributions and plasticity index will be used to verify the water-bearing properties of the soils, as determined by the field analysis.

5.6 GEOPHYSICAL BOREHOLE LOGGING

Resistivity (electric logs) and SP Logs will be run in each of the test borings - MW-9b, F-2, G-2, H-2 and I-2 to verify the depths, thickness, and other hydrogeological properties of the aquifer, including relative water quality. The logging of the boreholes will be the responsibility of the Contractor, and should commence soon after the test boring is completed. The Engineer shall have access to the geophysical record of the borehole (prior to monitoring well installation) as an aid to determining the optimum well screen placement.

Resistivity/SP logging is effective in uncased boreholes filled with drilling fluids or water and, therefore, should be appropriate for use in this investigation. Should field analysis of the above geophysical logs reveal variations in the water quality in the aquifer, i.e., relatively high dissolved solids content in water bearing materials, that data will be preferentially used for determining the monitoring well screen depths.

5.7 GROUNDWATER MONITORING WELL INSTALLATION

The purpose of the proposed monitoring well installation program is to establish the nature and extent of any release of contaminants from the Phase I landfill. This will be accomplished through the collection and analysis of baseline and ongoing (routine) water quality data from the eight (8) proposed monitoring wells.

The analytical sampling parameters will be those which have been previously established at the MSF site through the Quarterly Groundwater Monitoring Well Sampling Schedule (See Section 6.2). All of those baseline and routine sampling parameters are compatible with the Part 360 requirements for the analysis of groundwater quality and leachate and with the NYSDEC's Target Compound List (TCL).

As required by 6 NYCRR Part 360 (Section 2.11), the well screens will be installed so as to intercept the most likely three-dimensional contaminant pathways within the uppermost aquifer. The proposed monitoring well placement (and the criteria used to determine the placement) was described in Section 5.2 of this Work Plan. In general, monitoring well construction procedures and techniques which minimize the introduction of contaminants into the wells will be used.

5.7.1 Monitoring Well Details

The proposed shallow and deep Monitoring Well Details are shown in Figures 5-2 and 5-3, respectively. Major variables in the design of the monitoring well details, as shown, are: 1) the depth of the well screen; 2) the length of the screen; 3) the type and size of the well screen slots; and 4) the filter pack size and grade. The depth of placement of the screen has already been discussed in Section 5.4 and outlined in Table 5-1. PVC riser pipe and other construction materials specifications are discussed in the Sections below.

The estimates of well screen lengths, slot sizes, and filter pack have been based upon the stratigraphy and physical properties of the soils found at the site, as well as the projected contaminant pathways. Also taken into account for the proposed well designs was the observed response of the existing Phase II monitoring well construction to the aquifer system. Should the nature of the materials deviate significantly from what is expected, the Engineer will make the appropriate changes in the design of the monitoring well(s). All modifications to the proposed design shall be submitted to the NYSDEC for approval.

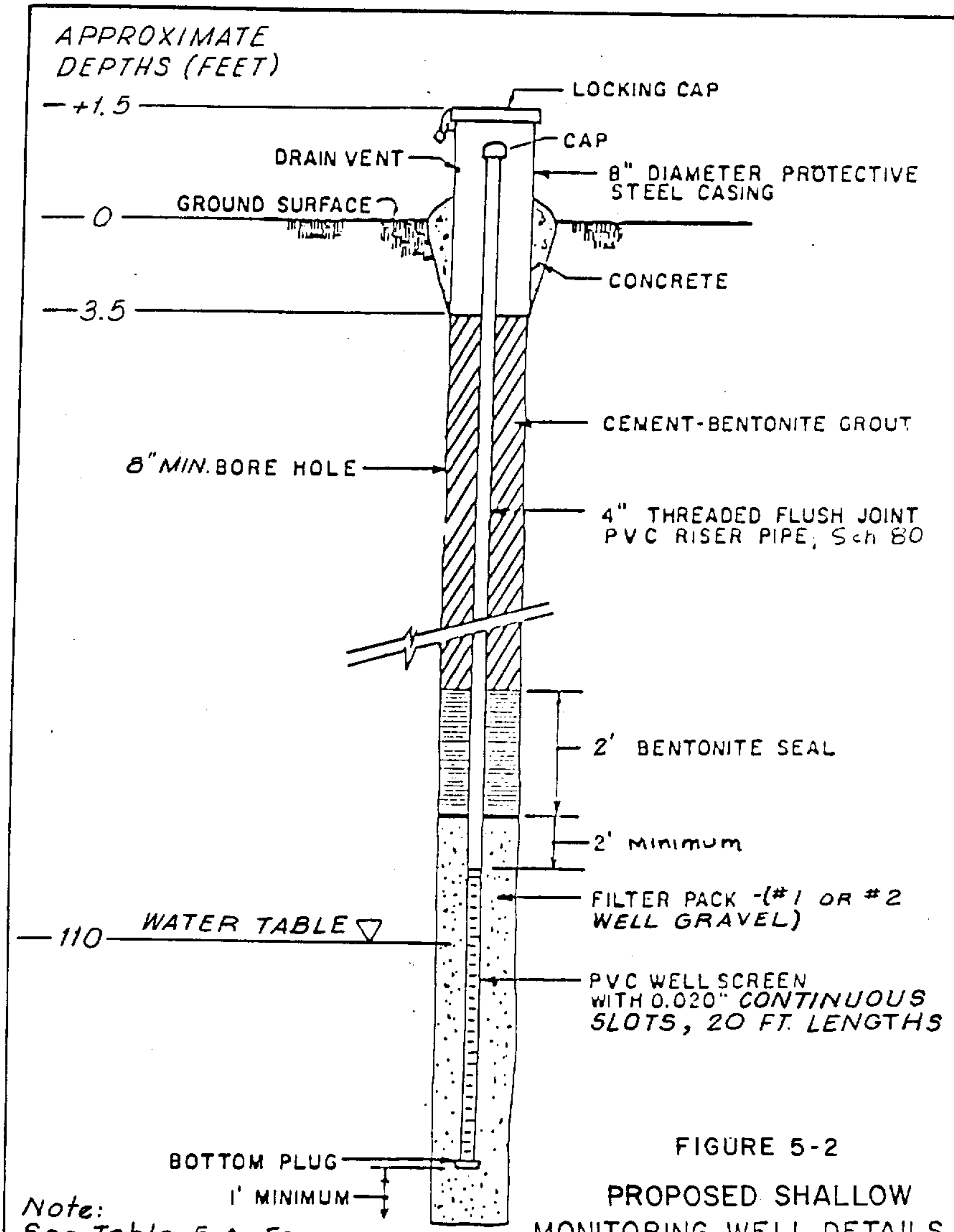
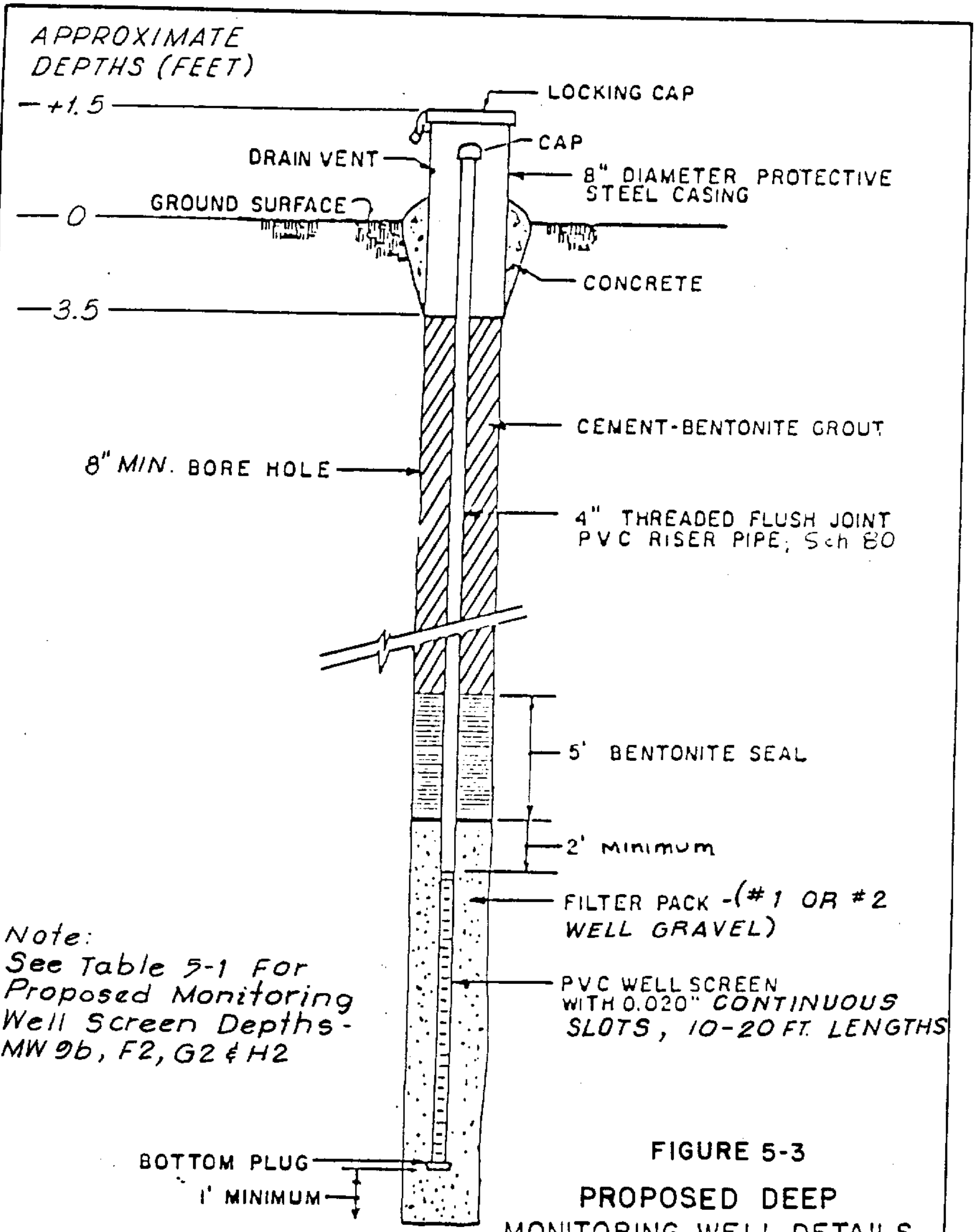


FIGURE 5-2

PROPOSED SHALLOW MONITORING WELL DETAILS

Note:
See Table 5-1 For Proposed Monitoring Well Screen Depths - MW F1, G1 and H1

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS



Note:
See Table 5-1 For Proposed Monitoring Well Screen Depths - MW 9b, F2, G2 & H2

FIGURE 5-3

PROPOSED DEEP MONITORING WELL DETAILS

R. E. PUSTORINO, P. C.
CONSULTING ENGINEERS

A twenty (20) foot well screen length was chosen for the shallow wells in order to incorporate the fluctuations in the water table level. A 10, 15 or 20 foot well screen may be installed in the proposed deep wells, depending upon the observed thickness of the stratigraphic interval to be screened. Ideally, deep wells installed on top of an aquifer boundary (i.e., above an impermeable clay bed) should have a 10 or 15 foot well screen, in order to limit the dilution of potential contaminants during sampling. All well screens will be continuously slotted so that they contain a large percent of open area for the best possible well efficiency.

According to the standard recommended practice for design of filter pack wells, the filter pack should be compatible with the natural materials (it should retain most of the formation), and the screen slot size should retain 90% of the filter pack. With this in mind, a clean, siliceous Morie Sand (#1 or similar Well Gravel) coupled with a 20 slot well screen (.02" nominal width) should be used for the well construction. The determination of this filter pack and slot size is based upon an analysis of Gradation Curves for representative materials (as shown in Appendix A) and, therefore, may be subject to change, as determined by the Engineer, based upon field data.

Other variables that are incorporated into the design of monitoring wells include the borehole diameter, the depth of sand above and below the screened interval, the thickness of the bentonite seal, the depth of the concrete surface seal, and the length of the surface casing.

5.7.2 Construction Materials

Where applicable, the construction materials that are used during drilling or well completion should conform to the appropriate American Society for Testing Materials (ASTM) Standard. If the specific brand names that are mentioned below are not readily available to the Contractor, materials of similar type and design must be used. All materials will be inspected and approved by the Engineer prior to their use in any field operation or procedure. The recommended and required materials are as follows:

- Pure high yielding Bentonite Mud (no additives), such as Baroids "Aquagel" or ACC's "Premimum Gell", (50 lb. bag).
- Vegetable-based oils for pipe threads, such as "Wesson" or "Crisco"oil.
- A clean, well-sorted medium grade Morie Sand for filter pack (#1 or similar well gravel); sand should be composed of 90-95% well-rounded Quartz.

- Baroids "Benseal" or other granular/powdered bentonite for an impermeable seal when pumped as a slurry, and for mixing in a cement-bentonite grout.
- Portland Cement, Type I or equivalent, for bentonite grout mix and surface seal, ASTM C150; (94 lb. bag).
- 8" diameter steel protective casing, with hasp and padlock, and drain vent.
- 4" Schedule 80 PVC Type I, Grade I riser pipe, threaded flush joint, ASTM Standard 1785, with threaded cap; no solvent or glue on couplings.
- 20 slot continuous slot well screen, Schedule 80 PVC as above, 5 and 10 foot lengths, as available, with stainless steel stabilizer for alignment.
- Potable water (from on-site hydrant) for use with drilling muds, slurry mixes, etc.

5.7.3 Installation Procedures

Well installation methods and procedures are covered in full in Section 12 of the Detailed Specifications. In general, the methods used shall be capable of installing monitoring well screens in the specific stratagraphic intervals, as determined by the Engineer, and capable of preventing leakage of groundwater or contaminants along the annulus of the well.

PVC well screens and riser pipes should be thoroughly steam cleaned (and inspected) before being lowered into the bore. Care should be taken at all times to isolate the PVC casings from possible sources of contamination during the installation procedure.

The sand (filter) pack should be placed in the annular space around the well screen, as shown in Figures 5-2 and 5-3, with a tremie or other approved method to avoid bridging. Measurement of the depth to the filter pack should take place throughout the procedure, as needed, to assure that at least 2 feet of sand is placed above the screen.

A minimum of 5 feet of impermeable bentonite seal must be placed above the filter pack to effectively isolate the well screen interval. The seal shall be composed of a bentonite slurry (40% potable water), and be tremied down through the annulus in the appropriate measured volume. Other applicable seal materials and procedures must be approved by the Engineer prior to placement of the seal. In the case of a slurry, the Contractor must wait at least one (1) hour before placing any grout in the well, in order for solidification of the bentonite seal to take place.

A cement bentonite grout mix must be tremied down through the annulas (up to the surface seal) in a manner which assures a continuous, non-diluted, low permeable seal. Auger flights or casing must be left in the hole during the grouting, and incrementally pulled out after placing the apportioned amount of grout, to prevent caving of the bore below the auger or casing. The composition of the grout mix should be measured to assure that the mix satisfies the following NYSDEC requirements.

1 - 94 lb. bag cement/6-7 gals. of water/5% bentonite

As shown in Figures 5-2 and 5-3, a protective steel casing (min. 6" diameter) must be placed over the PVC riser, and a cement surface seal used to permanently fix the casing. The suface seal must be formed to slope down and outward from around the well for adequate surface drainage.

Finally, a weather-resistant locking cap (w/padlock) must be placed on the steel casing to secure the well, and a duplicate set of keys provided to the Engineer. The outside of each protective steel casing will be permanently and clearly marked with the appropriate Well I.D. Number.

5.7.4 Well Development

After installation of the monitoring wells, the wells will be developed by pumping, surging, jetting, etc., or other appropriate method(s), as approved by the Engineer. Typically, above ground suction or displacement pumps, submersible pumps, or air driven techniques (i.e., Geogard Pump) are used. The well will be developed until clear, sediment-free water is produced, with a turbidity of 50

NTU or less, as determined by a field nephelometer. The water quality of the outflow will be continuously monitored by the Contractor during the development of each well.

All downhole equipment (i.e. pumps) and accessory parts (i.e., tubing, ropes, etc.) will be either dedicated or thoroughly steam cleaned prior to the development of each well. Appropriate sanitary conditions will be maintained at the wellhead in order to minimize the introduction of stray contaminants into the well. Such precautionary measures include placing clean plastic over the staging area, wearing protective (dedicated) gloves, etc.

Outflow (formation water) purged from the wells during the development will be tested on-site for conductivity, temperature and Ph, as an indication of the general water quality. Should the parameters indicate dissolved solids content or Ph/temperature values substantially outside the normal range of the native groundwater, appropriate containment and disposal methods for the discharge water will be enacted.

5.8 SURVEY AND STATIC WATER ELEVATIONS

Planimetric well locations will be established to the nearest foot, and top of casing elevations to the nearest .01 foot, by a licensed land surveyor. A notch should be cut in the top of the PVC to identify the vertical survey point. The final depth of each well screen interval (below finished grade) shall be measured by the Contractor with a weighted tape and recorded in the Field Record Book.

Static groundwater elevations will be measured in the completed wells prior to development, and before and after the aquifer testing (See Section 5.9). Water elevation data from the proposed wells (piezometers) will be used for hydrogeologic mapping purposes, such as, for determining the horizontal and vertical hydraulic gradients, and for monitoring any change in flow patterns in the Phase I area.

5.9 AQUIFER TESTING

Aquifer or "slug" testing will be performed in each of the monitoring wells after the well development. The slug test should consist of a "rising head" test in which a measured volume of water is pumped or bailed from the well and the rise in water level measured over a period of time, or a comparable "falling head" test.

To assure the accuracy of the measurements, a transducer or other appropriate device should be placed in the well to obtain continuous and direct readings of the water level changes. Other methods or procedures the Contractor may elect to use must meet with the approval of the Engineer.

All data from the aquifer testing will be recorded in the Field Record Book or on other appropriate forms, as requested by the Engineer. The water level data will be used to calculate the average hydraulic conductivity (horizontal K) of the materials in the screened intervals, and the test results should document the integrity of the well.

SECTION 6.0

GROUNDWATER SAMPLING AND ANALYSIS PLAN

6.1 GROUNDWATER SAMPLING

After each of the monitoring wells is developed, a minimum period of two weeks will be allowed prior to sample collection to permit stabilization of the groundwater system in the area of the wells. The types of water samples to be collected include:

1. Field Testing
2. Screened Interval Water Quality Parameters

The various aspects of groundwater sampling and analysis will be described in the Sections below.

6.1.1 Decontamination of Sampling Equipment

Prior to use in the field, it is desirable that all sampling equipment and devices will be laboratory or shop/office cleaned and wrapped before delivery to the site.

For laboratory, shop/office, or at the site, samplers and related equipment will be cleaned and prepared for field use according to the following protocols:

Bailers -

1. Non-phosphate detgergent and potable water wash.
2. Rinse with potable water.
3. Rinse sampling device with distilled or deionized (DI) water.
4. Rinse with Methanol (laboratory grade).
5. Final rinse with distilled or deionized (DI) water.

Pumping Equipment -

1. Non-phosphate detgergent and potable water wash.
2. Rinse with potable water.
3. Rinse pumping device with distilled or deionized (DI) water.

Adequate size drums will be available for complete submersion of the pumping equipment so as to insure proper cleaning and rinsing.

6.1.2 Removal of Well Casing Water

Prior to sample collection, at least three (3) casing volumes of water will be removed from the well. Because of the anticipated liquid volume at each monitoring well, pumping will be required prior to the sample collection. The sample collection will be performed within 48 hours of the pumping operation.

The volume of casing water to be removed will be calculated prior to the pumping operation. Static water levels will be taken prior to and after purging with a steam-cleaned water level meter or other appropriate measuring device.

6.1.3 Sample Collection

Formation water samples will be brought to the surface by use of a dedicated, decontaminated bailers. The bailer rope (polypropylene or nylon) will be replaced between each well location and before each sample collection. It will be required that the sampling equipment be delivered to the site and maintained at the site in such fashion to preclude the contamination of the sampling equipment.

Samples will be collected by lowering the appropriate bailer into the well and allowing the bailer to fill from the bottom to the top. Remove the bailer from the well and discard the first three (3) bailer volumes. The fourth or final full bailer will be tipped to allow the water to flow and fill the sample storage container.

Since the sample storage containers are prepared with appropriate preservatives installed prior to sampling, care shall be taken to prevent the containers from overflowing when filling them, to prevent loss of preservative.

Sample containers will be labeled before samples are taken. Labels will be taped on to ensure that they do not come off.

All sample containers will be immediately sealed and placed in an insulated ice chest and maintained at a temperature of approximately 4 deg. C. Field sampling logs shall be completed. Chain-of-custody procedures shall be followed as described in subsequent sections.

Quality assurance samples and laboratory protocols are described in following paragraphs and sections.

The protocol to be followed for pumping to obtain a groundwater monitoring well sample is outlined as follows:

1. Clean pump by procedures outlined in Section 5.4.1.
2. Clean Pump Hoses - Clean hoses of all foreign matter, and follow decontamination procedures.
3. Pump Well - Pump each well a minimum of three well volumes, or until the well runs dry.
4. Remove pump hoses from well.
5. Remove dedicated bailer from packaging.
6. Replace bailer rope.
7. Bail out three bails of water.
8. On fourth bail, begin to take sample.
9. After samples have been taken, secure well with cap.
10. Proceed to next well and repeat steps 1 to 9.

6.1.4 Field Testing Parameters

Prior to sample collection and performing field tests, water levels will be taken in each well.

After all the groundwater sample containers have been filled and properly stored, field testing will be performed. This will be done at the site because of the low holding time on some parameters and to screen the sample for formation water quality.

The parameters to be measured in the field are:

pH
temperature
specific conductance
Eh

Temperature must be measured immediately upon pouring the sample from the bailer into the glass beaker, as it is subject to the most rapid change. Conductivity, pH and Eh will be measured with electronic probes, which are cleaned between each sample. During the sampling and field testing, a sampling record will be maintained. Samples will be brought to the laboratory in ice filled coolers.

Calibration of Field Meters

Meters shall be full calibrated in the laboratory before leaving for the sampling site. Recalibration will be performed in the field between sampling at each well cluster and in the morning at the beginning of each sampling round.

Temperature probe will be calibrated in the laboratory prior to and post sampling by an MBS certified thermometer. pH probe will be calibrated in the laboratory and in the field by a laboratory provided pH 7 buffer. The pH probe will then be checked against No. 4 and No. 10 buffer solutions. Field calibrations for the specific conductance meter will be conducted as recommended by the equipment manufacturers.

Care should be taken in the field to protect the probes during the sampling program and in transportation between sampling sites.

6.1.5 Preservation, Storage and Shipment of Samples

All field sample containers will be tightly capped, labeled, and stored in an insulated ice chest from the time of collection until delivery to the laboratory and refrigerated at the laboratory until analysis. Samples will be transferred to the analytical laboratory within 24 hours of sample collection.

Sampling events will be logged into a field notebook and Chain-of-Custody forms will be completed and transferred to the laboratory personnel upon delivery of the samples.

6.1.6 Quality Assurance Samples

Quality assurance samples including trip blanks and field blanks, will be used to verify the quality of the field sampling and laboratory results. A brief description of each follows:

Field Blanks - A sample of distilled and deionized water will be run through the bailer and into a bottle(s) in the required volume(s), and handled in the same manner as the actual samples. This can be an indicator of sample contamination during the entire sampling process. Field blanks will be taken for each day's sampling.

Trip Blanks - A sample of distilled and deionized water will be prepared by the laboratory and will accompany the sample containers from the laboratory to the field and back again. The trip blank will serve as an indicator of sample contamination during the entire sampling process, including handling and transportation.

6.2 ANALYTICAL SAMPLING PARAMETERS

In general, the laboratory analyses will focus on chemical screening techniques to determine the type and range of concentration and migration of contaminants in groundwater. The analytical parameters will consist of those which have been previously established for the ongoing Groundwater Monitoring Well Analysis at the Municipal Services Facility site, as listed in Table 6-1. Those parameters include:

1. All baseline parameters for groundwater, including: Field Parameters, Metals, Volatiles, and Leachate indicators, as indicated in Part 360 Section 2.11(c)(6); and

2) Most other analytes as defined by the NYSDEC's TCL+30 including: Volatile (halogenated) Organics, Neutral/Acid Extractables, Pesticide/PCB's, and Inorganics.

For reference, the Part 360 Water Quality Analysis Table is included in Table 6-2.

After the installation of the groundwater monitoring wells, the initial two (2) rounds of sampling from each well will characterize the existing "baseline" water quality at the site. During this sampling round, groundwater from the critical flow regime will be analyzed for the constituents as shown in Table 6-1, which is consistent with the "baseline parameters" defined by 6 NYCRR Part 360.

Each well will be incorporated into the current quarterly sampling sequence being practiced at the site. As stated, the initial sampling shall analyze for "baseline parameters". The remaining three quarterly samplings shall be analyzed for "routine parameters" in accordance with Table 6-2. Annually thereafter, the wells will continue to be sampled quarterly with one sampling being for "baseline parameters" and the remaining three being for "routine parameters". This sampling sequence will continue through the closure and post-closure periods.

TABLE 6-1

Town of Smithtown
Municipal Services Facility
Groundwater Monitoring Well Analysis

CONSTITUENT

Alkalinity (Total)
Aluminum
Ammonia
Antimony
Arsenic
Barium
Beryllium
BOD
Boron
Cadmium
Calcium
Chlorides
Chromium
Chromium Hex
Copper
Color (units)
COD
Cyanide
Detergents
Fluorides
Hardness (Total)
Iron
Kjeldahl Nitrogen (Total)
Lead
Magnesium
Manganese
Mercury
Nickel
Nitrate
Nitrite
Odor (units)
Phenol
pH (units)
Potassium
Phosphate
Sodium
Silver
Selenium
Spec Conductivity (mhos)
Sulfate
Silicon
Thallium
TOC
Tot Dissolved Solids
Tot Volative Solids
Turbidity (NTU)
Zinc
MBAS
Acrolein
Acrylonitrile

VOLATILE HALOGENATED

Chloromethane
Bromomethane
Dichlorodifluoromethane
Vinyl Chloride
Chloroethane
Methylene Chloride
Trichlorofluoromethane
1,1 Dichloroethene
1,1 Dichloroethane
1,2 Dichloroethene
Chloroform
1,2-Dichloroethane
1,1,1 Trichloroethane
Carbon Tetrachloride
Bromodichloromethane
1,2-Dichloropropane
Trans-1,3-Dichloropropene
Trichloroethylene
Chlorodibromomethane
1,1,2 Trichloroethane
Cis-1,3-Dichloropropene
2 Chloroethylvinylether
Bromoform
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Chlorobenzene
1,3 Dichlorobenzene
1,2 Dichlorobenzene
1,4 Dichlorobenzene

Benzene
Toluene
Ethylbenzene
m Xylene
o+p Xylene
Tetrachloroethylene
1,1,2 Trichloroethylene
Bromochloromethane
1,1 Dichloroethylene
Trans-1,2-Dichloroethylene
1,1,2,2-Tetrachloroethylene
1-Chloro-2-Bromopropane
1,2 Dichlorobutane
Methanol
Xylene
1,2-Dichloropropylene

TABLE 6-1
(Continued)

Town of Smithtown
Municipal Services Facility
Groundwater Monitoring Well Analysis

BASE NEUTRAL EXTRACTABLES

1,3 Dichlorobenzene
1,4 Dichlorobenzene
Hexachloroethane
Bis(2-Chloroethyl)ether
1,2-Dichlorobenzene
Bis(2-chloroisopropyl)ether
N-nitroso-di-n-propyl-amine
Nitrobenzene
Hexachlorobutadiene
1,2,4-Trichlorobenzene
Isophorone
Naphthalene
Bis(2-chloroethoxy)methane
Hexachlorocyclopentadiene
Chloronaphthalene
Acenapthalylene
Acenapthene
Dimethyl phthalate
2,6-Dinitrotoluene
Fluorene
4-Chlorophenyl phenyl ether
2,4-Dinitrotoluene
1,2-Diphenyl hydrazine
Diethyl phthalate
N-Nitrosodiphenylamine
Hexachlorobenzene
4-Bromophenylphenylether
Phenanthrene
Anthracene
Di-n-butyl phthalate
Fluoranthene
Pyrene
Benzidine
Butyl benzyl phthalate
Bis(2ethylhexl)phthalate
Chrysene
Benzo (a) anthracene
3,3-Dichlorobenzidine
Di-n-octyl phthalate
Benzo (b) fluoranthene
Benzo (k) fluoranthene
Benzo (a) pyrene
Indeno (1,2,3-c,d) pyrene
Dibenzo (a,h) anthracene
Benzo (g,h,i) perylene
n-nitrosodimethylamine
4,6-Dinitro-o-cresol
2-Chloronaphthalene
Parachlorometa cresol
3,4-Benzofluoranthene

ACID EXTRACTABLES

2-Chlorophenol
2-Nitrophenol
Phenol
2,4-Dimethylphenol
2,4-Dichlorophenol
2,4,6-Trichlorophenol
4-Chloro-3-methylphenol
2,4-Dinitrophenol
2-Methyl-4,6-dinitrophenol
Pentachlorophenol
4-Nitrophenol

PESTICIDES

Lindane
Heptachlor
Aldrin
Heptachlor Epoxide
p,p-DDE
Dieldrin
Endrin
p,p-DDD
p,p-DDT
Chlordane
Toxaphene
Endrin Aldehyde
a BHC
b BHC
d BHC
Endosulfan 1
Endosulfan 2
Endosulfan Sulfate
Arochlor 1016
Arochlor 1221
Arochlor 1232
Arochlor 1242
Arochlor 1248
Arochlor 1254
Arochlor 1260

TABLE 6-2

WATER QUALITY ANALYSIS TABLE [1]

	GROUND AND SURFACE WATER		
	Baseline Parameters	Routine Parameters	Expanded Parameters
FIELD PARAMETERS			
Static water level (in wells and sumps)	x	x	x
Specific Conductance	x	x	x
Temperature	x	x	x
Floaters or Sinkers[1]	x		x
pH	x	x	x
Eh	x	x	x
Dissolved Oxygen[2]	x	x	x
Field Observations[3]	x	x	x
LEACHATE INDICATORS			
Total Kjeldahl Nitrogen (TKN)	x		x
Ammonia	x	x	x
Nitrate	x	x	x
Chemical Oxygen Demand (COD)	x	x	x
Biochemical Oxygen Demand (BOD_5)	x		x
Total Organic Carbon (TOC)	x	x	x
Total Dissolved Solids (TDS)	x	x	x
Sulfate	x	x	x
Alkalinity	x	x	x
Phenols	x	x	x
Chloride	x	x	x
Total hardness as $CaCO_3$	x	x	x
Turbidity	x	x	x
Color	x		x
Boron	x		x
METALS			
Potassium	x	x	x
Sodium	x	x	x
Iron	x	x	x
Manganese	x	x	x
Magnesium	x	x	x

TABLE 6-2
(Continued)

	GROUND AND SURFACE WATER Baseline Parameters	Routine Parameters	Expanded Parameters
Lead	x	x	x
Cadmium	x	x	x
Aluminum	x		x
Calcium	x	x	x
Toxic metals[4] and cyanide	x		x
Volatile organics[5]	x		x
All constituents listed in 6 NYCRR Part 373-2, Appendix 33[6]			x

The department may modify this list as needed.

All samples must be whole and unfiltered except as otherwise specified by the department.

[1] Any floaters or sinkers found must be analyzed separately for baseline parameters.

[2] Surface water only.

[3] Any unusual conditions (colors, odors, surface sheens, etc.) noticed during well development, purging, or sampling must be reported.

[4] Toxic metals include: Antimony, Arsenic, Beryllium, Barium, Cadmium, Chromium (total and hexavalent)*, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium and Zinc.

[5] Volatile organics are to be analyzed using EPA methods 601 and 602 as described in 40 CFR Part 136 (see section 360-1.3 of this Part).

[6] Upon request of the applicant, the department may waive the requirement to analyze for dioxins and furans (suggested method 8280), where appropriate.

*The department may waive the requirement to analyze Hexavalent Chromium provided that Total and Hexavalent and Trivalent Chromium values do not exceed 0.05 mg/l.

1) NYSDEC 6 NYCRR Part 360 Solid Waste Management Facilities, Section 2.11(c)(6), effective December 31, 1988.

SECTION 7.0

QUALITY ASSURANCE/QUALITY CONTROL
(QA/QC)

7.1 GENERAL

QA/QC covers all aspects of the field and laboratory investigations, and is designed to ensure that the data generated is of the highest possible quality. To this end, the Work Plan employs many of the standards and guidelines that are required by the NYSDEC and the USEPA. During the design of the Work Plan, conformance to the NYSDEC's regulations for Solid Waste Management Facilities were monitored by referring to the appropriate Sections of 6 NYCRR Part 360 (effective December 31, 1988).

Specific aspects of field QA/QC have already been incorporated into the Work Plan, and are described in the following Sections:

- Work Plan - General
- Monitoring Well Placement
- Boring Installation
- Geologic Sampling
- Laboratory Analysis of Soil Samples

- Geophysical Borehole Logging
- Groundwater Monitoring Well Installation
- Survey and Static Water Elevations
- Aquifer Testing
- Groundwater Sampling
- Analytical Sampling Parameters
- Health and Safety Plan (Section 8.0)
- Detailed Specifications (Appendix B)

7.2 QA/QC IN THE FIELD ENVIRONMENT

QA/QC in the field environment will be concerned with assuring the appropriateness of all operating practices that are used and, hence, will act to support the integrity of the data. Special items of concern include equipment specifications, test boring/monitoring well constructions, geologic and analytical well sampling, and on-site sanitary, health, and safety conditions.

With regards to the test boring and geologic (soil) sampling parts of the program, the applicable ASTM Standard is referenced for field guidance. An experienced representative of the Engineer will be on site at all times during the field investigations to monitor compliance with the QA/QC protocols.

7.2.1 Chain-Of-Custody Procedures

Chain-of-Custody forms shall be utilized and maintained for all collected samples. The chain-of-custody format provides a vehicle for tracking each sample from its origin (sampling) through the transportation and handling and ultimately through the completion of analysis. This method of tracking enhances the ability to determine if extraneous contamination of the sample has occurred.

A sample is defined as being in someone's "custody" if:

- It is in one's actual possession, or
- It is in one's view, after being in one's physical possession, or
- It is in one's physical possession and then locked up so that no one can tamper with it, or
- It is kept in a secured area, restricted to authorized personnel only.

The number of persons involved in collecting and handling samples will be kept to a minimum. Guidelines established for sample collection, preservation, and handling will be adhered to by field personnel. Field records will be completed at the time the sample is collected and signed or initialed, including the date and time, by the sample collector(s).

Field records will contain the following information:

- Unique sampling or log number.
- Date and time.
- Source of sample (including name, location and sample type).
- Preservative used.
- Analysis required.
- Name of collector(s).
- Pertinent field data.

Each sample will be labeled using waterproof ink and sealed immediately after it is collected. Labels will be filled out before collection to minimize handling of sample container.

Labels and tags will be firmly affixed to the sample containers. Field personnel will be sure that the container is dry enough for a gummed label to be securely attached. Tags attached by string are acceptable when gummed labels are not applicable.

The sample container will be placed in a transportation case, along with the CHAIN-OF-CUSTODY record form, pertinent field record, and analysis request form as needed. A copy of these forms will be retained by the originating office (either carbon or photo copy. The transportation case should be sealed or locked. A locked or sealed chest eliminates the need for close control of individual samples. However, on those occasions when the use of a chest is inconvenient, the collector should seal the cap of the individual sample container with tape in a way that any tampering would be easy to detect.

When transferring the samples, the transferee must sign and record the date and time on the chain-of-custody record, as presented in Figure 10, or its equivalent. Custody transfers made to a sample custodian in the field should account for each sample, although samples may be transferred as a group. Every person who takes custody must fill in the appropriate section of the chain-of-custody record. To minimize custody records, the number of custodians in the chain-of-possession should be minimized.

All packages sent to the laboratory will be accompanied by the chain-of-custody record and other pertinent forms. A copy of these forms will be retained by the originating office (either carbon or photo copy).

7.3 QUALITY ASSURANCE DOCUMENTATION

All field books, correspondence, data, etc., that are prepared by the project team will receive a unique Document Control number. This will provide an accurate record of what documents were produced, where the documents were sent and who received them.

Field notebooks will be serialized and field reports accurately recorded. Separate copies of the field report forms will be maintained in the project files.

7.4 ANALYTICAL LABORATORIES QA/QC

In order to assure that data generated is of the highest quality, an independent laboratory familiar with requirements of both the NYSDEC and the EPA guidelines will be used. The laboratory selected will be from the NYSDEC current Technically Acceptable List, or as updated by the State. Prior to selection, we will review the laboratories' QA/QC manual to insure their techniques meet the highest possible standards of accuracy, precision and sensitivity by using the best available technology. Other factors to be evaluated as part of the laboratories' QA/QC program include:

- Establishment of method performance criteria for routine samples in accordance with standard EPA Methods and other regulatory protocols based on those methods.
- Determination and implementation of changes necessary to meet those performance criteria.
- Establishment of criteria for procedures not previously validated.
- Estalishment of an in-house task force for independent reviews of quality assurance/quality control data and reports.
- Participation in interlaboratory proficiency evaluation and proficiency analytical testing programs initiated by federal, state and local regulatory agencies.
- Participation in interlaboratory method validation programs.
- All quality control information (i.e., precision, percent recoveries. duplicates and spikes), are recorded in laboratory log books.

7.5 DATA QUALITY REQUIREMENTS AND ASSESSMENT

The minimum detection levels required will be those published by the USEPA for the method. The precision of the analyses will be assessed from laboratory control charts or equivalent data representing the periodic variation in the results of analysis of a single concentration of analyte. Upper and lower control limits will be set at two standard deviations above and below the line representing mean recovery.

Accuracy will be assessed by accuracy control charts or equivalent data representling the variation between spiked or check samples and found concentrations. Check sample concentration ranges should bracket the expected range of environmental sample concentrations. Upper and lower control levels will be established at 3 standard deviations of the slope value, respectively above and below the mean slope value, or equivalent.

7.6 DATA VALIDATION

Analytical data will be validated by reviewing all check samples and laboratory spike samples for acceptable levels of recovery. Laboratory duplicates and blind sample duplicates will be reviewed for consistency and acceptable precision levels. Detection limits will be reviewed for acceptability. Chain-of-custody forms will be examined for documentation or transmittal errors.

7.7 SYSTEM AUDITS

A system audit of the analytical laboratory will be conducted during the period of actual sample analysis. This audit will include an on-site review of the laboratory's operational systems and physical facilities. Particular attention will be paid to the laboratory's calibration and analysis protocols. During the system audit, laboratory documentation will be extensively examined. The use of documented operating procedures will be inspected, and the existence and use of equipment log books will be noted. The purpose of the audit is to verify that the laboraory QA plan is implemented and to determine that corrective actions are taken when problems are detected.

7.8 CORRECTIVE ACTIONS

Deficiencies, errors and significant defects discovered during system audits or data validation will require corrective action. Corrective action will be implemented by revision of the analytical procedure, re-calibration of instrument systems or re-instruction of analysts where indicated. Corrective action will include, where possible, the re-analysis of samples which remain within published holding times. Such reanalysis will occur under strict adherence to the analytical protocols specified.

7.9 QA/QC REPORT

The final project report will contain a section addressing significant findings discovered during system audits or data validation, and the corrective actions taken. The overall quality of the data will be assessed and the comparability and representativeness of the results will be discussed.

SECTION 8.0

HEALTH AND SAFETY PLAN

8.1 GENERAL

Because of the health and safety concerns that may be encountered on the job site during implementation of the Work Plan, Personnel Protective Equipment (PPE) is required during the major field activities; drilling and monitoring well installation, and groundwater sampling. The most important hazards which may exist and, therefore, will be monitored closely during the field operations are:

- Safety Hazards
- Fire and Explosion
- Personnel Exposure
- Electrical Hazards
- Heat Stress or Cold Exposure
- Noise Pollution

Any of these conditions, or a combination of conditions, result in hazards that may pose an immediate danger to life or health; may not be immediately obvious or identifiable, and may change as the on-site work location and field activities vary.

8.2 PERSONAL PROTECTION - LEVEL D

EPA's Level D protection was chosen for field work at the site. The criteria that was used to determine Level D protection include:

1) the atmosphere contains no known hazards
2) work functions preclude splashes, immersion, or the potential for unexpected inhalation, or contact with hazardous levels of chemicals.

Because the landfill has only been used for the disposal of municipal solid waste (MSW), and no known quantities of hazardous chemicals have been deposited at the site, the toxicity of the materials encountered is expected to be minimal.

Discussed below is a review of the criteria for justification, the proposed response to changes in the criteria, and equipment requirements for a Level D site.

8.2.1 Justification and Response Criteria

The Town of Smithtown currently operates a positive methane migration and control system along the eastern side of the Phase I landfilling area. This system has proven sufficient to control the migration of landfill gas from Phase I area towards the Municipal Services Facility complex. The Town has recently completed the installation of 17 methane monitoring/migration control wells along western and northern boundaries of the Phase I area, Old Commack Road and Old Northport Road, respectively. These wells will be incorporated into a positive migration control system in the near future.

In addition, a private vendor, Energy Tactics, is operating a methane recovery/energy generating system in the Phase I area. This recovery system utilizes a series of recovery wells in the fill area. Energy Tactics has temporarily incorporated a majority of the seventeen perimeter migration wells into their system until the permanent, positive migration/control system is in place.

The proposed locations of the groundwater monitoring wells have been selected to ensure that the areas will be protected from the migration of landfill gas by the positive methane migration/control systems.

During the course of the drilling operations and installation of the groundwater monitoring wells, the Contractor shall be responsible to monitor for the presence of combustible gas in the ambient air and also the borehole. This monitoring will be required to ensure the health and saftey of the Contractor's employees.

If positive readings of methane gas and/or petroleum are found at the site during any of the field operations, one of the following responses will be implemented:

<10% LEL Methane Gas	Continue investigation
10-50% LEL Methane Gas	Continue site activities with extreme caution
>50% LEL Methane Gas	Approaching Explosion Hazard: Cease operations; withdraw from area; remediate problem

8.3 PERSONNEL PROTECTIVE EQUIPMENT (PPE)

The purpose of personnel protective clothing and equipment (PPE) is to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered during the drilling and groundwater sampling activities.

Personnel will wear appropriate PPE as the field conditions and activities require. The EPA's sample protective ensembles and Level D protection is outlined in Table 8-1.

8.4 DECONTAMINATION

Decontamination is critical to health and safety because it acts to protect workers from potentially harmful substances. Toxic substances may be assimilated through direct contact, and they may permeate through the outer garments, or be transferred to other materials. Relative to the site conditions, the decontamination procedures that are required deal with preventing and minimizing contact with potentially hazardous substances. Adherence to the Level D protective ensemble (PPE) addresses these concerns. Decontamination and sanitization of drilling and sampling equipment was outlined in Sections 5.3.1, 5.4.3 and 6.1.1.

Table Sample Protective Ensembles[a]

LEVEL OF PROTECTION	EQUIPMENT	PROTECTION PROVIDED	SHOULD BE USED WHEN:
D	RECOMMENDED: • Coveralls. • Safety boots/shoes. • Safety glasses or chemical splash goggles. • Hard hat. OPTIONAL: • Gloves. • Escape mask. • Face shield.	No respiratory protection. Minimal skin protection.	• The atmosphere contains no known hazard. • Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

[a] Based on EPA protective ensembles.

TABLE 8-1

Procedures that will be used to minimize the contact with the products of the drilling operations include:

- o Using remote sampling, handling, and container/well opening techniques wherever practical.
- o Protecting monitoring and sampling equipment by placing it in bags.
- o Stressing work habits that minimize contact with the drilling cuttings.
- o Wearing disposable outer garments, i.e., protective gloves, masks, work suits, etc.
- o Using dedicated and disposable equipment when appropriate.

8.4.1 Personnel Hygiene

Hygiene is an integral part in the prevention of contamination to personnel, and to the transfer of such contamination. Therefore, proper personnel hygiene should be exercised at the job site, including the following restrictions and/or actions:

- o Eating, drinking, chewing gum or tobacco, smoking, or any other practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited on the job site.
- o Hands and face must be thoroughly washed upon leaving the work area and before eating, drinking, or any other activities.

- Should decontamination or disposal of the outer garments be required, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

- No excessive facial hair, which interferes with a satisfactory fit of the mask-to-face-seal, is allowed on personnel when they are required to wear respiratory protective equipment.

- Contact with contaminated or suspected contaminated surfaces will be avoided. Whenever possible, walking through puddles, mud and other discolored surface; kneeling on ground; leaning, sitting, or placing equipment on drums, containers, vehicles, or the ground will be avoided.

- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. Prescribed drugs will not be taken by personnel on site where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Alcoholic beverage intake will be prohibited during all on-site field operations.

8.5 EMERGENCY PROCEDURES

The on-site representative of R.E. Pustorino, P.C., will be responsible for implementing the Medical Emergency Plan in the case a critical situation arises. The representative will be thoroughly familiar with the emergency procedures and will carry them out according to the Plan. In addition, all field personnel must be familiar with the standard operating safety procedures and additional requirements contained in the Health and Safety Plan. A copy of the Plan will be made available to all personnel.

In the event an emergency situation arises in the field and/or medical care and treatment of field personnel is necessary, the Safety Officer will be contacted immediately and the emergency procedures will be implemented as defined below.

The designated Safety Officer will be:

Robert J. Burgner
R.E. Pustorino, P.C.
2171 Jericho Turnpike
Commack, NY 11725
Tel. (516) 499-1888

The location of the telephone(s) nearest to the field activities are:

R.E. Pustorino, P.C.
Field Office Trailer
Flynn Park
Old Commack Road

Main Gate House
Smithtown MSF Landfill
Old Northport Road

8.5.1 Off-Site Emergency Medical Care

In the case of a medical emergency, the representative for R.E. Pustorino, P.C. will arrange for medical services at the nearest facility. Pre-emergency travel routes to those facilities have been established as shown in Figures 8-2 and 8-3. A list of the medical facilities and telephone numbers are as follows:

Primary Medical Facility

St. John's Episcopal Hospital
Route 25
Smithtown, NY
(See Figure 8-2)
Tel. (516) 866-3000

Secondary Medical Facility

Community Hospital of Western Suffolk
(formerly Smithtown General)
Smithtown Bypass & Route 111
(See Figure 8-3)
Tel. (516) 979-9800

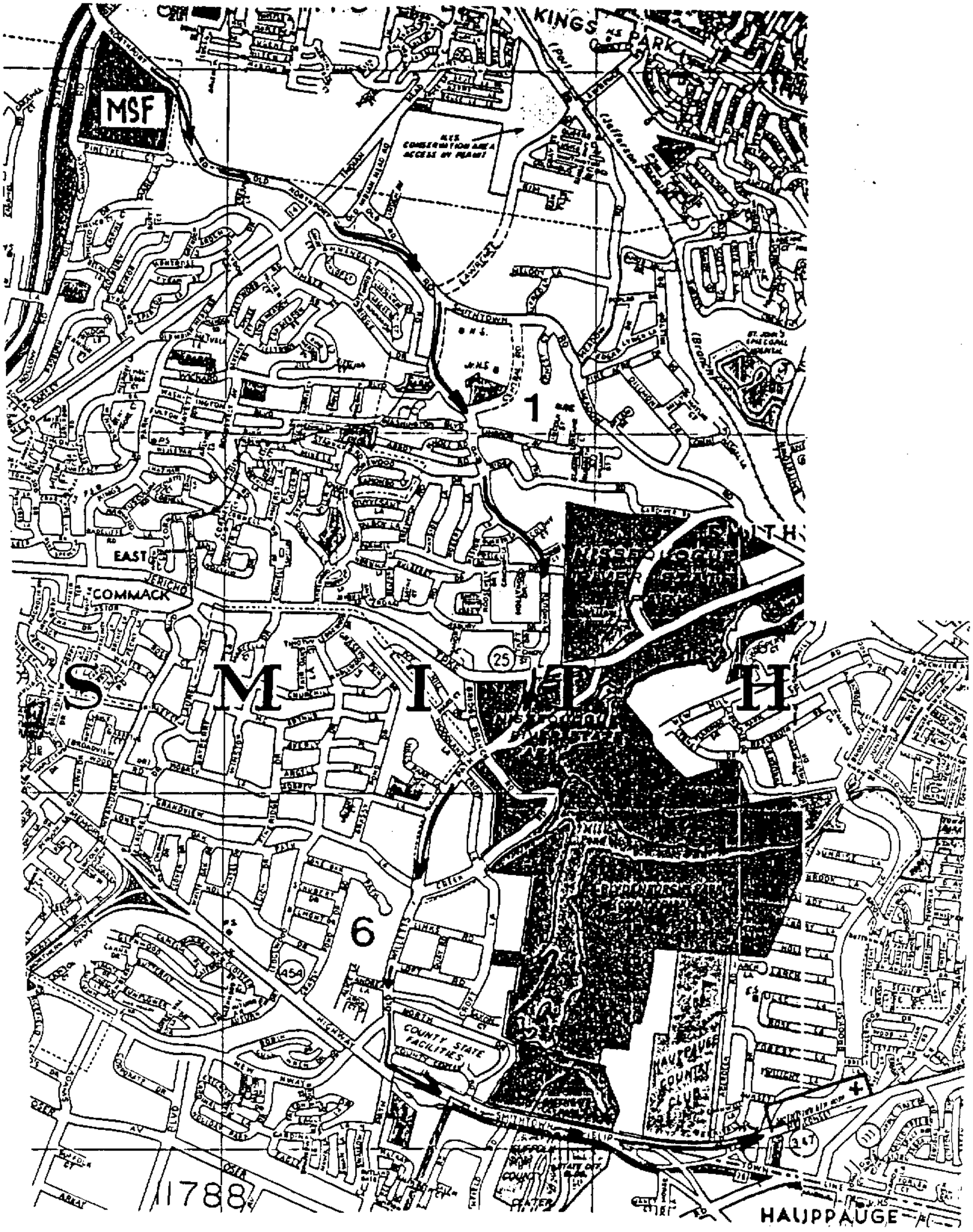
8.5.2 Personal Injuries

Physical injuries which occur because of accidents on-site can range from sprained ankles to serious fractures or minor cuts to major bleeding. Depending on the seriousness of the injury, treatment may be given on-site by qualified personnel. For more serious injuries the victim may have to be treated at a medical facility. When an injury occurs the following actions will be taken:

→ Emergency Medical Route (Primary)

FIGURE 8-2

R. E. PUSTORINO, P. C.
CONSULTING ENGINEERS



→ Emergency Medical Route (Secondary)

FIGURE 8-3

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

- Depending upon the nature and extent of the injury, the individual will be administered first aid utilizing an on-site emergency kit.
- If appropriate, transport employee to hospital or phone "911" for local first aid squad rescue unit, or paramedic unit, and continue applying first aid and keep person warm.
- Contact the local hospital (see Section 8.6.1) and the Safety Officer (Section 8.6) as to the nature of the injury.
- The injured employee shall be transported by the local emergency rescue unit to the hospital.
- A written report should be submitted to the Health and Safety Officer detailing the event within 24 hours.

8.5.3 Personnel Exposure

In the event of overt personnel exposure (skin contact, inhalation, ingestion), the following procedure will be undertaken:

- Disposable clothing contaminated with observable amounts of chemical residue is to be removed and replaced immediately.
- In the event of direct skin contact in Level D, the affected area is to be washed immediately with soap and water. Sanitary facilities are located on the ground floor, south side of the MSF Process Building.
- The Health and Safety Officer or other individuals who hold a current first aid certificate will be notified to determine the immediate course of action to be undertaken. This may involve using the first aid kit and/or eyewash, and/or contact an emergency response unit.

8.5.4 Extreme Weather Exposure

Field work may occur under winter or summer conditions at the site. As a result, persons working outdoors may experience frostbite in cold weather or heat stress in hot weather.

Exposure to extreme cold for short periods of time, or prolonged cold under lower temperatures, and/or wind chill may cause serious injury.

Frostbite of the extremeties can be characterized into:

> Frost Nip of Incipient Frostbite. Characterized by suddenly blanching or whitening of skin.
>
> Superficial Frostbite. Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
>
> Deep Frostbite. Tissues are cold, pale and solid, extremely serious injury.
>
> Hypothermia. Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages: 1) shivering, 2) apathy, listlessness, sleepiness and (sometimes) rapid cooling of the body to less than 95 degrees F., 3) unconsciousness, glassy stare, slow pulse and slow respiratory rate, 4) freezing of the extremities, and finally, 5) death.

Heat stress is a general term for bodily injuries that may result from exposure to excess heat and/or humidity. Table 8-2 summarizes the signs and symptons of heat stress.

In the event of local injuries due to adverse weather conditions, as described above, appropriate procedures for notifications and transport to medical facilities will be followed.

8.5.5 Fire or Explosion

The local fire department will be made aware of all field work in case of emergency. All emergency numbers will be posted somewhere on site at all times, the location of which will be known to all field personnel. The locations of the two closest telephones that are available to field personnel shall also be posted.

In the event of a potential or actual fire or explosion, the following actions will be taken by R.E. Pustorino, P.C., field personnel:

- Evacuate all unnecessary personnel from the vicinity of the fire to a safe area, utilize on-site fire extinguisher, if appropriate.
- Phone "911" to contact the local fire/emergency units and police department informing them of the potential or actual fire/explosion, and injuries, if they have occurred.

Table Signs and Symptoms of Heat Stress[1]

- *Heat rash* may result from continuous exposure to heat or humid air.
- *Heat cramps* are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:
  - — muscle spasms
  - — pain in the hands, feet, and abdomen
- *Heat exhaustion* occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:
  - — pale, cool, moist skin
  - — heavy sweating
  - — dizziness
  - — nausea
  - — fainting
- *Heat stroke* is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:
  - — red, hot, usually dry skin
  - — lack of or reduced perspiration
  - — nausea
  - — dizziness and confusion
  - — strong, rapid pulse
  - — coma

1) USEPA, Sept., 1985

TABLE 8-2

- If appropriate, contact the Suffolk County Police Department Hazardous Waste Unit and the New York State Department of Environmental Conservation (NYSDEC).

- Contact the Health and Safety Officer.

SECTION 9

SECTION 9.0

REFERENCES

R.E. Pustorino, P.C., May 1990, Hydrogeologic Investigations Report and Final Environmental Monitoring Well Array and Program, MSF Landfill, Phase II-Cell 6.

R.E. Pustorino, P.C., January 1990, Hydrogeologic Work Plan for Supplemental Test Borings and Monitoring Wells-Phase II-Cell 6, MSF Landfill Expansion.

R.E. Pustorino, P.C., 1989. Engineering Report and Plans for Landfill Expansion, Municipal Services Facility, Volume II, Site Investigation Report.

Annual Book of ASTM Standards, 1989, Part 19, Soil & Rock; Building Stones.

R.E. Pustorino, P.C., June 1988. Hydrogeologic Work Plan - Phase II-Municipal Services Facility Landfill, Proposed Expansion-Cell No. 6.

Driscoll, F.G., 1986, Groundwater and Wells, 2nd Edition; Johnson Filtration Systems, Inc.

Charles R Velzey, Inc., April 1986. Hydrogeologic Investigation-Kings Park Area and MSF landfill.

USEPA, September 1985, Protecting Health and Safety at Hazardous Waste Sites: An Overview, Technology Transfer EPA/625/9-85/006.

Krulikas, R.K., and Koszalka, E.J., 1983, Geologic Reconnaissance of an Extensive Clay Unit in North-Central Suffolk County, Long Island, New York: U.S. Geological Survey Water-Resources Investigations 82-4075, Syosset, New York.

Krulikas, R.K., Kosalka, E.J., and Doriski, T.P., 1983, Altitude of the Top of the Matawan Group-Magothy Formation, Suffolk County, Long Island, New York: U.S. Geological Survey Open-File Report 83-137.

Donaldson, C.D., and Koszalka, E.J., 1982, Potentiometric Surface of the Magothy Aquifer, Long Island, New York, in March 1979: U.S. Geological Survey Open-File Report 82-160.

Krulikas, R.K., 1981, Hydrogeologic Data From Selected Wells and Test Holes in Suffolk County, Long Island, New York, 1972-80: U.S. Geological Survey Open-File Report 81-500.

Jensen, H.M., and Soren, Julian, 1974, Hydrogeology of Suffolk County, Long Island, New York: U.S. Geological Survey Hydrologic Investigations Atlas HA-501.

Jensen, H.M., and Soren, Julian, 1971, Hydrogeologic Data From Selected Wells and Test Holes in Suffolk County, Long Island, New York: Long Island Water Resources Bull. 3.

Lubke, E.R., 1964, Hydrogeology of the Huntington-Smithtown Area, Suffolk County, New York: U.S. Geological Survey Water Supply Paper 1669-D.

APPENDIX A

APPENDIX A

BOREHOLE LOGS

AND

SUPPORT DATA

R.E. PUSTORINO, P.C.

BOREHOLE LOG

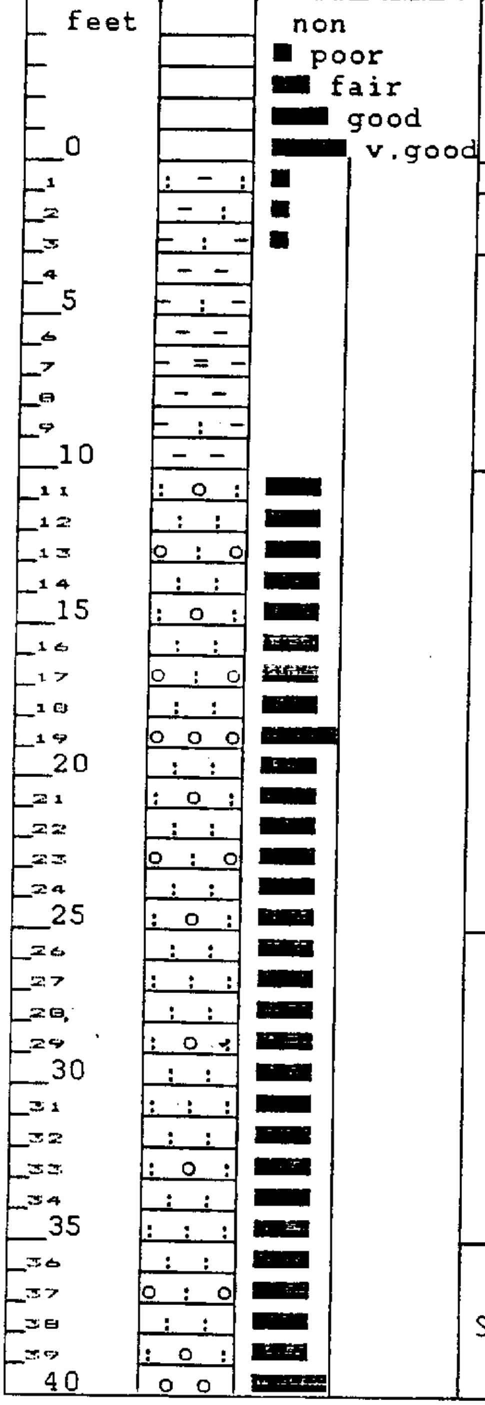
Sheet 1 of 3

BORING # 9 PROJECT NAME Smithtown Landfill, Cell #6
OWNER OF WELL Town of Islip
OWNERS REPRESENTATIVE(if any) John Trent, Town Engineer
LOCATION OF BOREHOLE 1840' so of C/L Old Northport-Commack Rd., 20' east
DRILLING CONTRACTOR R & L Drilling Co.
WELL LOGGED BY Ray Glover, Hydrogeologist DATE COMPLETED 10/07/88
BOREHOLE DIAMETER 9 in. TOTAL DEPTH 145 ft.
ELEVATION AT SURFACE(MSL) 172.4 ft. RISER PIPE ABOVE GRADE 12 in. below
DEPTH TO GROUND WATER 127.63 ft. DATE OF LAST MEASUREMENT 12/3/88
SCREENED INTERVAL 118-138 ft. TYPE OF PVC USED 4"OD, Sch.80, 20 Slot

*Unified Soil Classification System

SEDIMENT TYPES [: :] sand [=] silt [-] clay [o o] gravel

DEPTH LITHO PERM SAMPLE USCS* DESCRIPTION PERTINENT DATA



USCS*	DESCRIPTION (See List of abbreviations)
1	
SC-CL (fill)	Topsoil, clay Loam Brn w/red clay and clay Sand, f-c grn
CH (fill)	Dkbrn slty to sndy Clay+organics, tr of gravel, compact
10	
SW & GW	Ltbrn Sand+Gravel m-c grn, f-m gravel, mod srtd, rnd-sbrnd Quartz pebbles, <10% Igneous +other rock fragments, loose
25	
SW	Ltbrn grvlly Sand, m-c grn, some fine grn, mod-p srtd, sbrnd milky-yel Quartz+rock fragments, fine gravel, loose
35	
SP & GP	Ltbrn Sand+Gravel m-c grn, fine pebbles, mod-w srtd

Elevation

TYPE OF RIG:
Direct Mud Rotary

172.4

10/05/88

171

169

MUD DATA @ 0 ft
Weight 8.6 lbs
Visc. 32 sec
PH 8
Sand .5%

162

DRILL RATE:
20 sec/ft

Drilled in 20 foot increments then circulated out

147

137

R.E. PUSTORINO, P.C.

Sheet 2 of 3

BOREHOLE # 9 PROJECT NAME Smithtown Landfill, Cell #6

DEPTH	LITHO	PERM	SAMPLE	USCS	DESCRIPTION	PERTINENT DATA
40	: o :	■				Elevation 132
41	: :	■			As above	
42	o : o	■		42		130
43	: :	■				
44	: : :	■				
45	: :	■			Ltbrn-gry Sand, m-c grn, some f grn mod-w srtd, sbang yel stn Quartz + rock fragments, loose-m dense	DRILL RATE: 25 sec/ft
46	: : :	■				
47	: :	■		SP		
48	: o :	■				
49	: :	■				Drilled in 20 ft increments then circulated out
50	: : :	■				
51	: :	■				
52	: : :	■			Increasing grade	
53	: :	■		53		119
54	: o :	■				
55	: :	■				
56	: : :	■			Ltgry-brn Sand, f-c grn, some f Gravel, mod-p srtd, clear sbang-sbrnd Quartz+rock fragments, loose-m dense	
57	: :	■				
58	o : o	■				
59	: :	■		SW		
60	: : :	■				
61	: :	■				
62	: o :	■				
63	: :	■				
64	: : :	■		64		108
65	: :	■				
66	o : o	■				
67	: :	■			Ltgry-brn Sand, f-c grn, some fine Gravel, mod-p srtd sbrnd predom clr Quartz, m dense	
68	: : :	■		SW		
69	: :	■				
70	: o :	■		w/GP		
71	: :	■				
72	: : :	■				
73	o o	■			Gravel from 72-73'	
74	: : :	■				DRILL RATE: 30-40sec/ft
75	: :	■		75		97
76	: : :	■				
77	: :	■			Ltgry-brn Sand, m-c grn, some fine Gravel, mod srtd	
78	: o :	■		SW/SP		
79	: :	■				
80	o : o	■				LAG TIME: 90 sec
81	: :	■		81	Increasing Gravel	91
82	: : :	■				
83	: :	■				
84	: – :	■			Ltbrn-gry Sand, f-c grn, p-mod srtd, some fine Gravel, dense, laminated with gray sandy Clay	Drilled in 10ft. increments then circulated out
85	: :	■				
86	: o :	■		SW		
87	: :	■				
88	: – :	■		w/CL		
89	: :	■				
90	: o :	■				
91	: :	■				
92	: – :	■				
93	: :	■				
94	: : :	■				
95	: :	■		95		DRILL RATE: 40-50sec/ft 77
96	: o :	■				
97	: :	■		SW	As above but without clay laminations	
98	: : :	■				
99	: :	■		99		73
100	: o :	■				

R.E. PUSTORINO, P.C.

Sheet 3 of 3

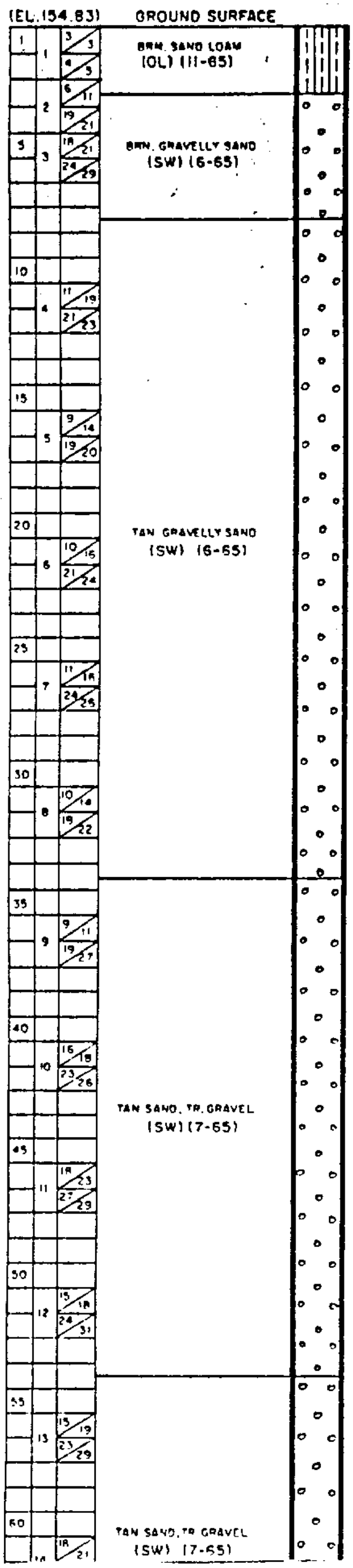
BOREHOLE # 9 PROJECT NAME Smithtown Landfill, Cell #6

DEPTH	LITHO	PERM	SAMPLE	USCS	DESCRIPTION	PERTINENT DATA
100	: :	■				Elevation 72
101	: : :	■				10/6/88
102	: :	■			Ltbrn Sand, m grn,	
103	: o :	■		SW/SP	some c grn & fine	MUD DATA:
104	: :	■			pebbles,sbrnd yel	Weight 8.8lbs
105	: : :	■		w/GW	stn Quartz, dense	Visc. 37 sec
106	: :	■			increasing fines	PH 7
107	: o :	■			and grade below	Sand 1.8%
108	: :	■				
109	o o o	■		109	Gravel from 63-64'	TOP OF SMITHTOWN 63
110	: =	■				@ 59' elev.
111	: = :	■		SM	Ltbrn-gry silty	SPLIT SPOONS:
112	= :	■			Sand, m-c grn,	Blows per 6 inches
113	: = :	■		113	p srtd, tr clay	8 57
114	– –		9-1	CH	Gry slty Clay with	SS#1 20 (12"recovery)
115	– : –	■		115	sndy strks, stiff	30 57
116	: –	■				
117	: – :	■			Ltgry-brn clayey	
118	: =	■		SC/CL	Sand,f-m grn, tr	25 54
119	: – :	■	9-2	&SM	c grn, grading to	SS#2 47 (11")
120	– :	■			sndy Clay & slty	60+ 52
121	: – :	■			Sand; streaks of	TOP OF SCREEN @
122	: –	■			gry,pnk,& wh clay	54' elev.
123	: = :	■		123		12 49
124	o –	■	9-3			SS#3 62 (7")
125	: – :	■			Gry&pnk clay Sand	60+ 47
126	: –	■			intbd sndy Clay	DRILL RATE:
127	: – :	■		SC&CL	w/Gravel on top,	20-35 ft/sec
128	: –	■			ornge sndy strks,	28 44
129	: : :	■	9-4	w/SW	laminates of CH,	SS#4 100+ (5")
130	: :	■			Gray Sand, f grn,	
131	: – :	■			tr of fines, wet,	WATER TABLE @
132	– :	■			v dnse @ 130-132'	43.67'above MSL
133	: –	■		133		61 39
134	– : –	■	9-5			SS#5 100+ (5")
135	: :	■				
136	: : :	■			Gry Sand w/orange	BOTTOM OF SCREEN
137	: :	■			strks, f grn,some	@ 34' elev.
138	: – :	■		SP	silt,w srtd, lam-	24 34
139	: : :	■	9-6		inations of white	SS#6 70 (9")
140	: : :	■		w/CL	pink & gray sndy	
141	: :	■			clay, v dnse, wet	
142	: – :	■				
143	: :	■				
144	: : :	■				
145	: :	■				BOTTOM ELEV. 27 ft

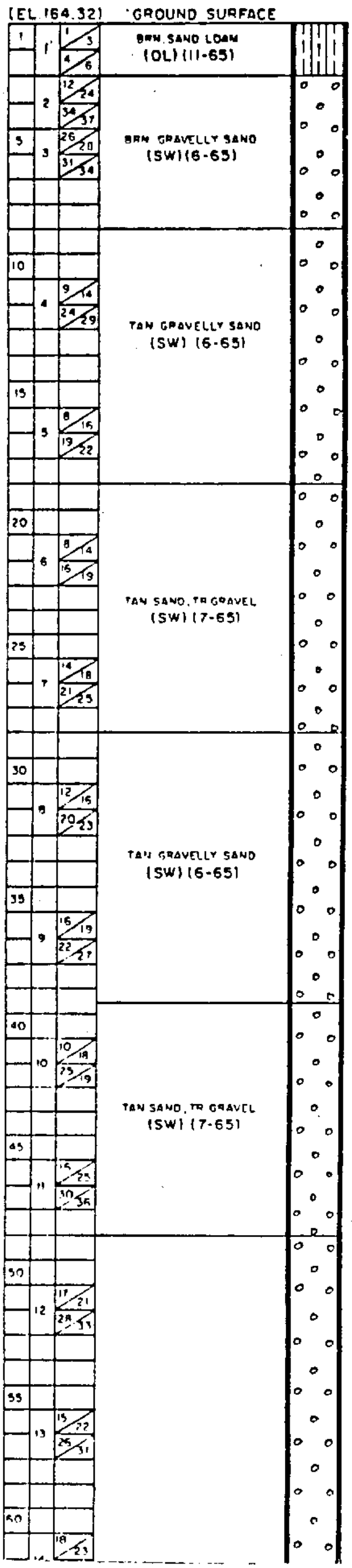
SOIL MECHANICS
TEST BORINGS
PHASE I
AREA

1974
(PRE-CONSTRUCTION)

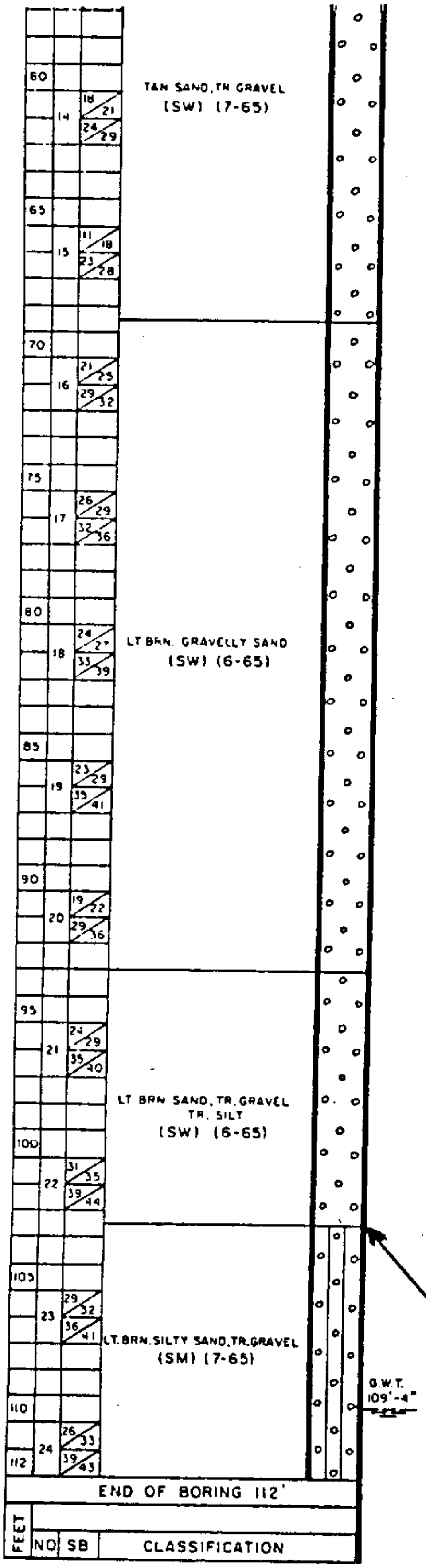
B-21



B-22

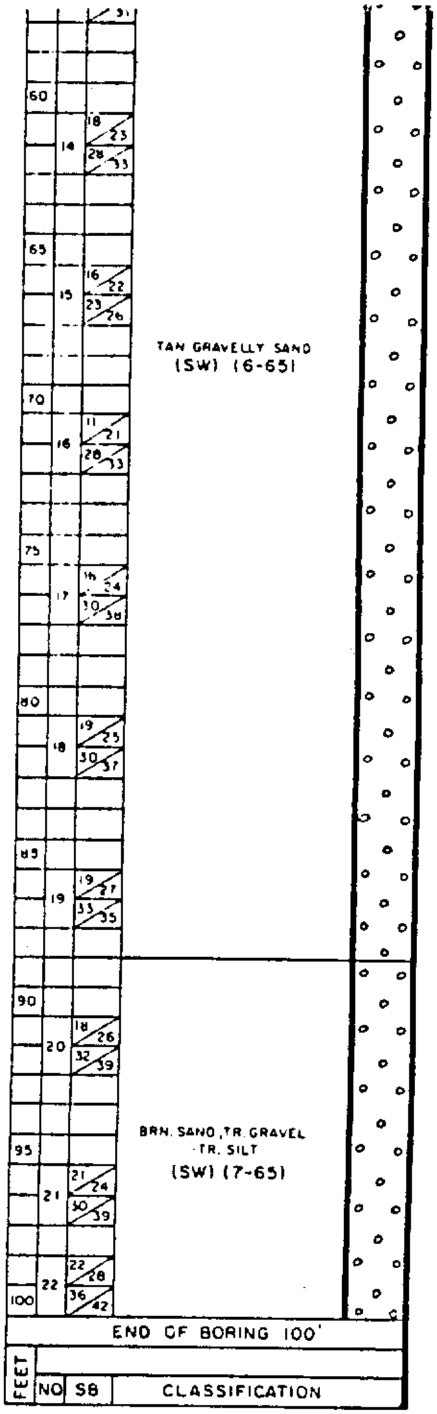


B-21 Cont.



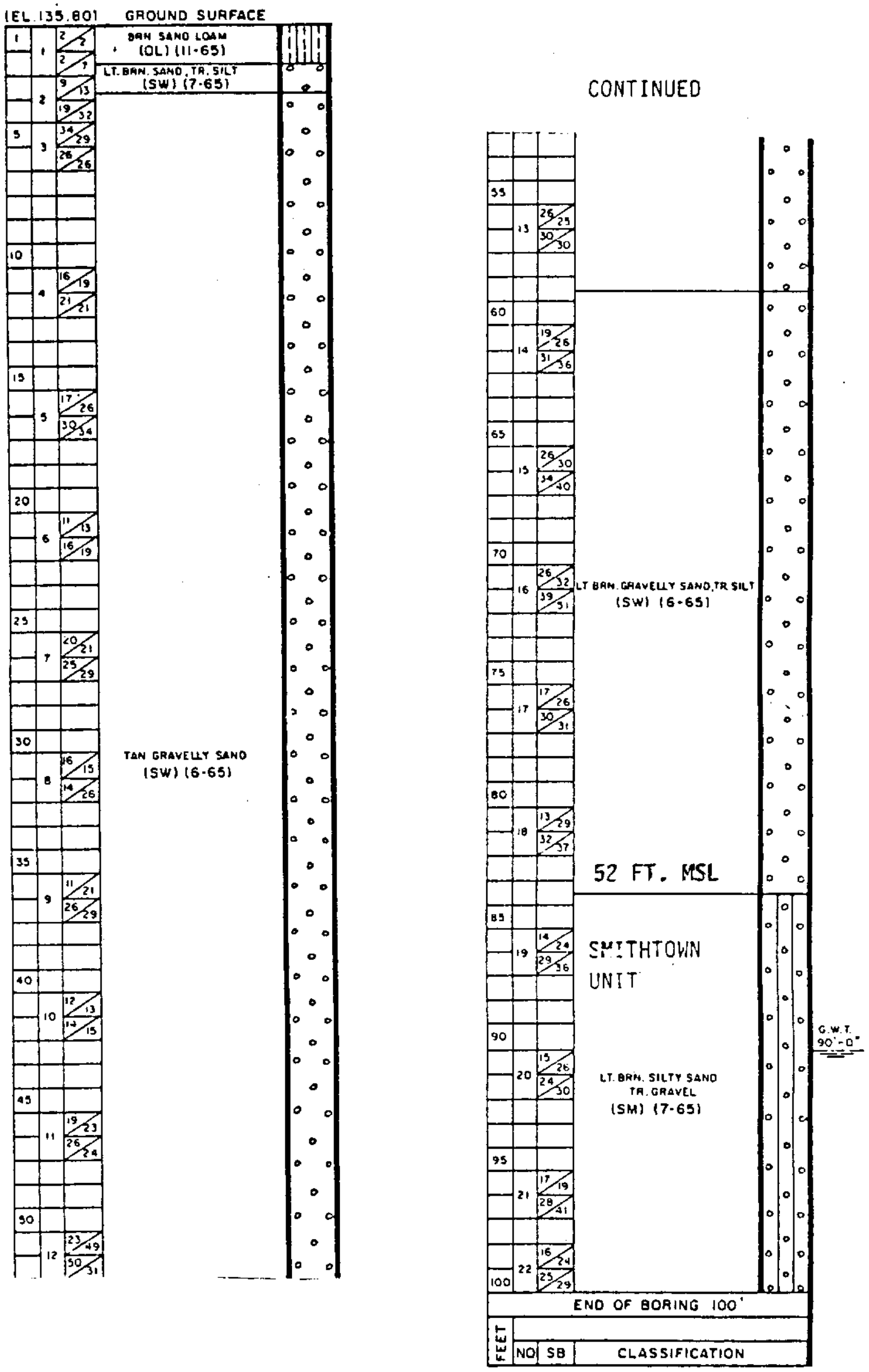
TOP OF SMITHTOWN UNIT
52 FT. MSL

B-22 Cont.



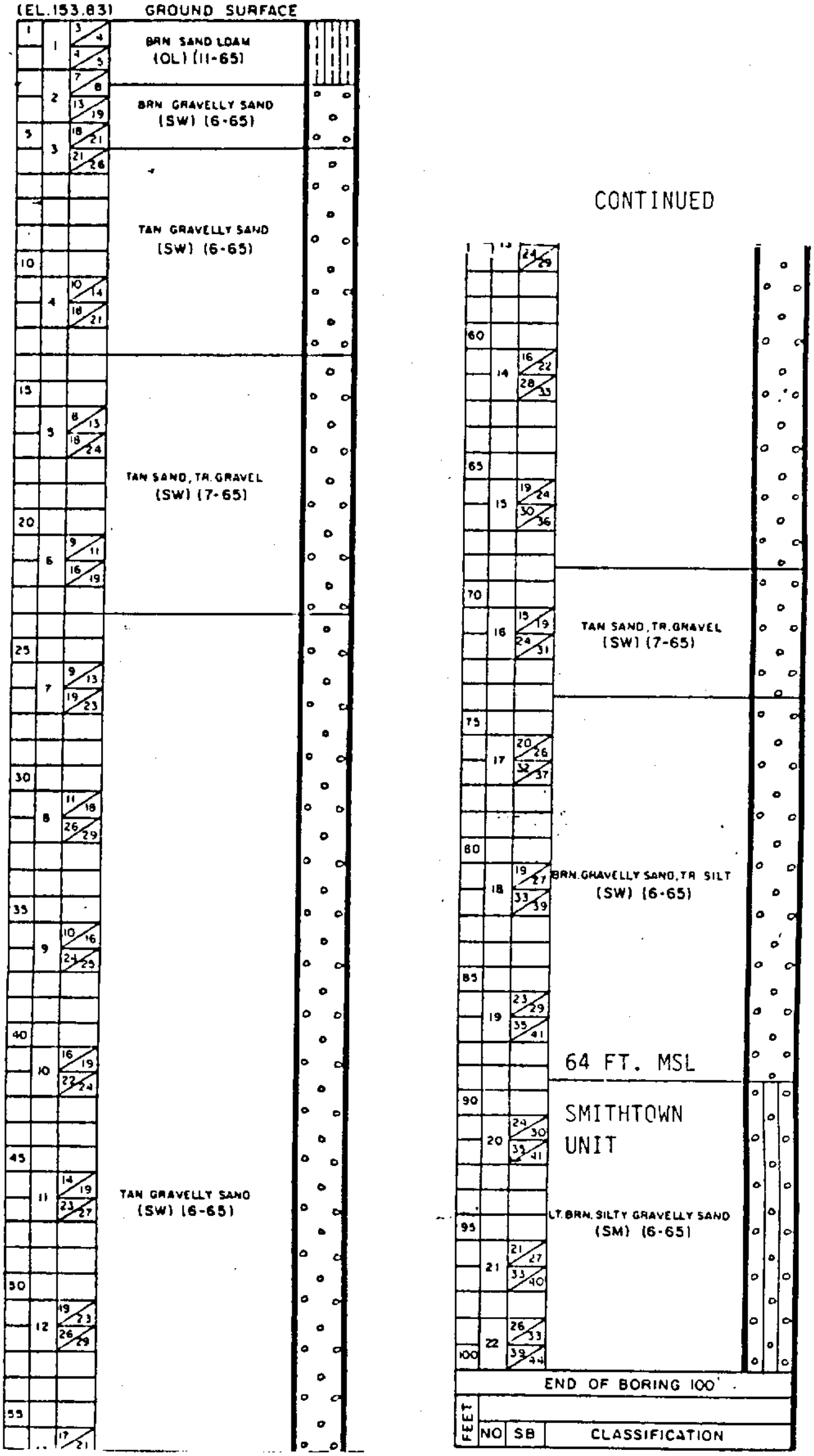
SOIL MECHANICS BOREHOLE LOG

B-16



SOIL MECHANICS BOREHOLE LOG

B-25



AGI DATA SHEET 26.1

Unified Soil Classification System

Compiled by B. W. Pipkin, University of Southern California

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS More than half of material is larger than no. 200 sieve size.	GRAVELS More than half of coarse fraction is larger than no. 4 sieve size.	Clean gravels	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than no. 4 sieve size.	Clean sands	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands, gravelly sands, little or no fines.
		Sands with fines	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS More than half of material is smaller than no. 200 sieve size.	SILTS AND CLAYS	Low liquid limit.	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
		High liquid limit.	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
Highly organic soils			Pt	Peat and other highly organic silts.

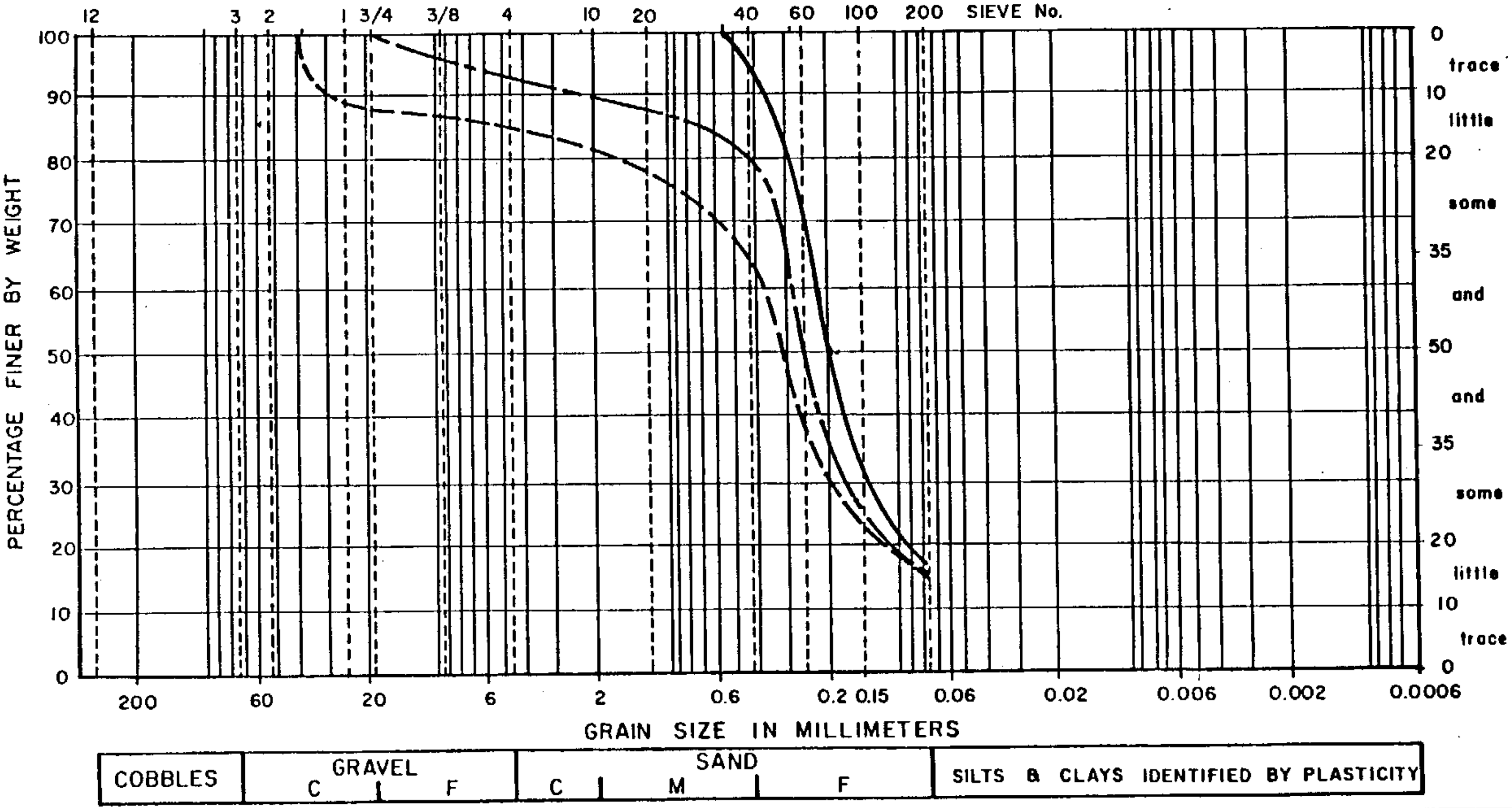
NOTES:

1. Boundary Classification: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example, GW-GC, well-graded gravel-sand mixture with clay binder.
2. All sieve sizes on this chart are U.S. Standard.
3. The terms "silt" and "clay" are used respectively to distinguish materials exhibiting lower plasticity from those with higher plasticity. The minus no. 200 sieve material is silt if the liquid limit and plasticity index plot below the "A" line on the plasticity chart (next page), and is clay if the liquid limit and plasticity index plot above the "A" line on the chart.
4. For a complete description of the Unified Soil Classification System, see "Technical Memorandum No. 3-357," prepared for Office, Chief of Engineers, by Waterways Equipment Station, Vicksburg, Mississippi, March 1953. (See also Data Sheet 17.)

Source: AGI DATA SHEETS,
American Geological Institute

Converse Consultants East
Caldwell, N.J. Fairfield , CT.

GRAIN SIZE DISTRIBUTION



SYMBOL	BORING	SAMPLE	DEPTH	IDENTIFICATION	
———	B-1	S-13	39'0" - 41'0"	Light gray silty sand	(SM)
— — —	B-2	S-3	9'0" - 11'0"	Light brown silty sand with gravel	(SM)
- —— -	B-2	S-8		Light yellow brown silty sand	(SM)

PROJECT LOCATION Town of Smithtown, N.Y. BY WM DATE 11/24/88 PROJECT No. 88-67156-01

ORIGINAL—TO COMMISSION

County Suffolk

Well No. S-46965
(on preliminary report)

State of New York
Department of Conservation
Division of Water Resources

LOG
Ground Surf., El.........ft. above sea
^
.........ft.
v
Top of Well

COMPLETION REPORT—LONG ISLAND WELL

Site 231

Owner Suffolk County Dept.of Environmemtal Control

Address 1324 Motor Parkway, Hauppauge, N.Y. 11787

Location of well Corner of Old Northport&Old Commack Rd.

Depth of well below surface 151-6 feet

Depth to ground water from surface 121-7 feet

CASINGS:
Diameter 6 in. ..... in. ..... in. ..... in.
Length 138-1 ft. ..... ft. ..... ft. ..... ft.
Sealing lead Packer
Casings removed

SCREENS: Make Johnson Openings 12
Diameter 6 in. ..... in. ..... in. ..... in.
Length 10 ft. ..... ft. ..... ft. ..... ft.
Depth to top from top of casing 136-9 ft.

PUMPING TEST: Date 2/23/73 Test or permanent pump? Test
Duration of Test ..... days 2 hours
Maximum Discharge 30 gallons per minute
Static level prior to test 121 1 ft. 7 in. below top of casing
Level during Max. Pumping 128 ft. 7 in. below top of casing
Maximum Drawdown 7 ft.
Approx. time of return to normal level after cessation of pumping ..... hours ..... minutes

PUMP INSTALLED:
Type ..... Make none Model No. .....
Motive power ..... Make ..... H.P. .....
Capacity ..... g.p.m. against ..... ft. of discharge head
No. bowls or stages .... ft. of total head

DROP LINE: SUCTION LINE:
Diameter none in. ..... in.
Length ..... ft. ..... ft.

Method of Drilling (Rotary, cable tool, etc.)

Use of Water

Work started 2/15/73 Completed 2/23/73

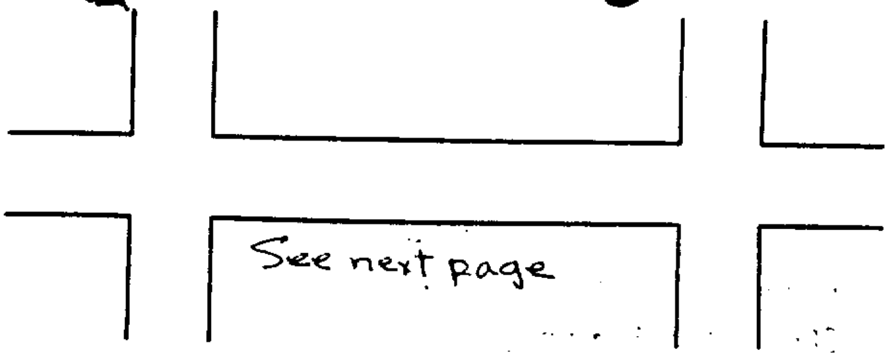
Date 3/26/73 Driller East Coast Well Drilling & Supply Co, Inc.

License No. 52

NOTE: Show log of well—materials encountered, with depth below ground surface, water bearing beds and water levels in each, casings, screens, pump, additional pumping tests and other matters of interest. Describe repair job.

See Instructions as to Well Drillers' Licenses and Reports—pp. 5-7.

SKETCH OF LOCATIO[illegible]



Locate well with respect to at least two streets or roads, showing distance from corner and front of lot.

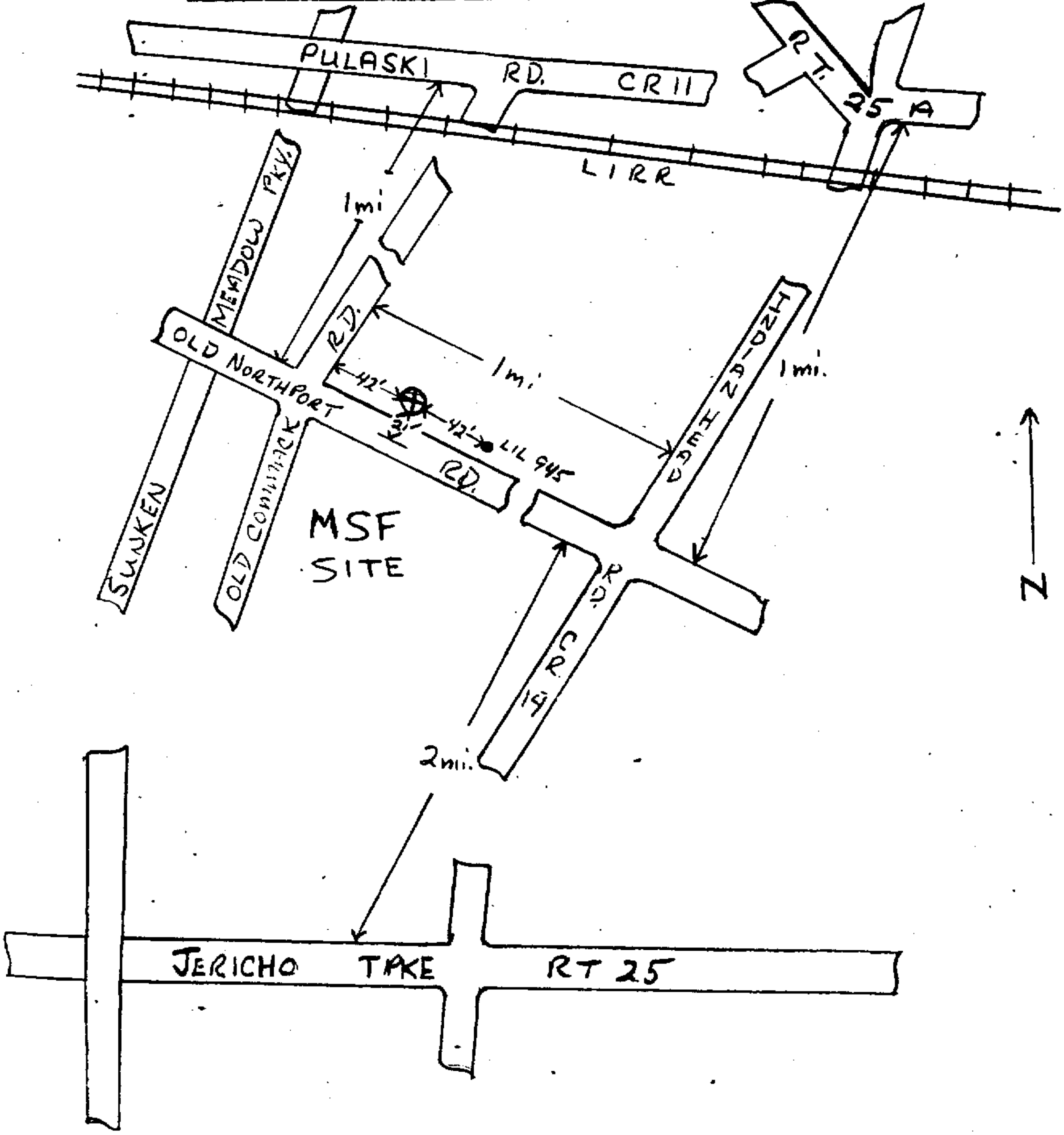
Show North Point

Site 231

5ft. Brown Clay with Gravel
10ft. Coarse to fine tan sand with grits and gravel
15ft. " " " " " " " " " "
20ft. " " " " " " " " "
25ft.X"" " " " " " " " " " "
30ft. " " " " " " " " "
35ft. " "" " " " " " " " "
40ft. " " " " " " " " "
45ft. " " " " " " " " "
50ft. " " " " " " " " " "
55ft. " " " " " " " " "
60ft. " " " " " " " " "
65ft. " " " " " " " " "
70ft. " " " " " " " " " "
75ft. " " " " " " " " "
80ft. " " " " " " " " "
85ft. " " " " " " " " "
90ft. " " " " " " " " "
95ft. " " " " " " " " "
100ft. " " " " " " " " "
105ft. " ' ' " " " " " " "
110ft. " " " " " " " " "
115ft. " " " " " " " "SOme grits and mica
120ft. Brown clay with fine sand
125ft. " " " " "
130ft. Coarse to fine tan sand with grits and gravel
135ft. " " " " " " " " "
140ft. Coarse to fine tan sand with grits and gravel
145ft. " " " " " " " " "
150ft. " " " " " " chunk of clay
155ft. Brown clay
160ft Fine red sand
165ft. Fine red snad with some clay
170ft. Hard brown gray clay

LOCATION SKETCH

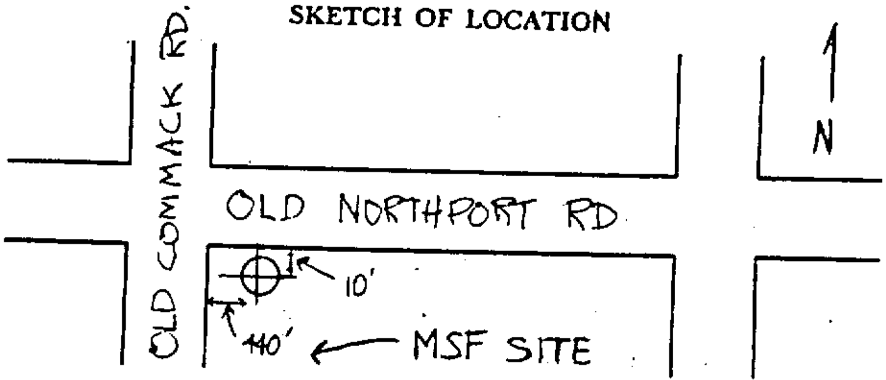
1)Community KINGS PARK 2)N.Y.S. Well # S-46965
3)Township SMITHTOWN 4)Lat,Long.&Seq.# 405230-0731644-01
5)Owner S C D E C
6)Address HAUPPAUGE
7)Completion Date of Well 2-23-73 8)Aquifer screened WATER TABLE
9)Desc. of MP TOP OF FLANGE IN MANHOLE
10)Elev. of MP 164.66 4/74 11)Elev. of Land Surface 166.36
12)MP 1.70 ~~abov~~e/below land surface 13)Diam. of casing 6"
14)Well depth 151'6" 15)Screened Interval 136'9" TO 146'9".
16)Type of well CABLE TOOL 17)Depth to water 121'7"
18)Use of well OBS 19)Quadrangle name GREENLAWN



etched By S. HANSEN Date 4-4-74 Hagstrom Map 8-9;F

TOWN OF SMITHTOWN
DRILLER'S LOG - WELL # 5

SKETCH OF LOCATION



Locate well with respect to at least two streets or roads, showing distance from corner and front of lot.

ELEVATION OF GROUND - 164 FT MSL

0-3	Loam
3-100	Fine to Coarse sand, grits, gravel
100-130	Fine to Coarse sand, grits, gravel, streaks of clay
130	Solid multi-colored clay

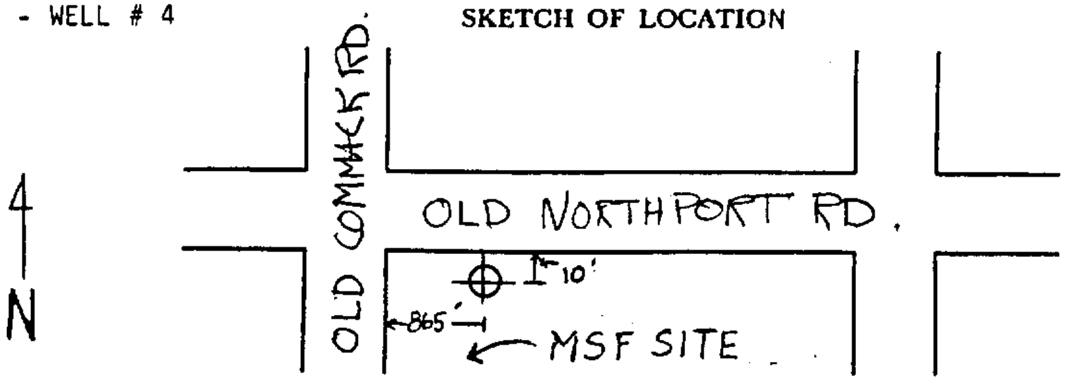
Type of Screen: 10' x 4" PVC 18 Slot

120-130 Screen PVC

Static Water Level 117'

TOWN OF SMITHTOWN
DRILLER'S LOG - WELL # 4

SKETCH OF LOCATION



Locate well with respect to at least two streets or roads, showing distance from corner and front of lot.

ELEVATION OF GROUND - 158 FT MSL

0-3 Loam
3-100 Fine to Coarse brown sand, grits, gravel
100-127 Fine to Coarse brown sand, grits, gravel, streaks of clay
127-145-Sandy white clay
Type of Screen: 10' x 4" PVC 25 Slot
113-123 Screen PVC

Static Water Level 114'

TOWN OF SMITHTOWN

INSTALLATION OF GROUNDWATER MONITORING WELLS
AT
THE MUNICIPAL SERVICES FACILITY

OCTOBER 1990

DETAILED SPECIFICATIONS

SECTION 1.0 PURPOSE OF WORK

1.1 Cell No. 6 - Municipal Services Facility Landfill

A Landfill Expansion (Cell No. 6) at the Town's Municipal Services Facility (MSF) in Kings Park, New York, has recently been undertaken. The MSF is presently used as a Landfill (Phase I) and Solid Waste Recycling Center. As part of the Engineering Report phase of the project, and as part of further supplemental investigations, numerous test borings and monitoring well clusters were installed in the Phase II-Cell No. 6 area. Previously, the Town had installed a test boring and deep well cluster down to the Raritan Clay Foundation extending to a depth of about 620 feet below grade surface.

The purpose of this program will be to install a total of eight (8) groundwater monitoring wells as part of the Final Environmental Monitoring Program (FEMP) at the Phase II-Cell No. 6 area. The final monitoring well array and program for Cell 6 was previously defined in the Hydrogeological Investigations Report for the site (R.E. Pustorino, P.C., May 1990). In addition, geologic information obtained during the installation of the two (2) proposed deep monitoring wells will further add to the knowledge of the stratigraphy and hydrogeologic conditions in the Cell 6 area.

Appropriate drilling, testing, and field logging procedures will be utilized to facilitate the optimum placement of the proposed groundwater monitoring wells within the Upper Glacial Aquifer. Where available, however, geologic data obtained from previous site investigations will form the basis for installation of the proposed monitoring wells. Supplemental laboratory testing and in-situ permeability (slug) testing will characterize the properties of the materials in the proposed screened intervals, as well as verify the integrity of the monitoring well design and construction.

The groundwater monitoring wells that are installed as part of this program will be incorporated into the baseline and ongoing sampling program at the Phase II-Cell No. 6 area. Analytical results from the program will be used to detect any significant changes in groundwater quality that may be attributed to the Phase II landfilling operation.

SECTION 2.0 SITE DESCRIPTIONS

2.1 Introduction

The following description is provided for general information only, and may not represent the actual conditions to be encountered during the performance of this work. The Contractor will be held as having examined the drilling sites in order to acquaint himself with local conditions. Information on the character of geologic deposits in the vicinity of the work sites is contained in publications of the U.S. Geological Survey, Town of Smithtown, Suffolk County, and others.

TOWN OF SMITHTOWN and/or R.E. PUSTORINO, P.C., will not be responsible for any assumption, interpretations, or conclusions drawn by the Contractor as to the nature of the subsurface materials or the efforts required to perform his work, that differ from the written description or the apparent conditions as determined by an onsite visit. The risk that actual conditions may vary should be reflected in the unit prices.

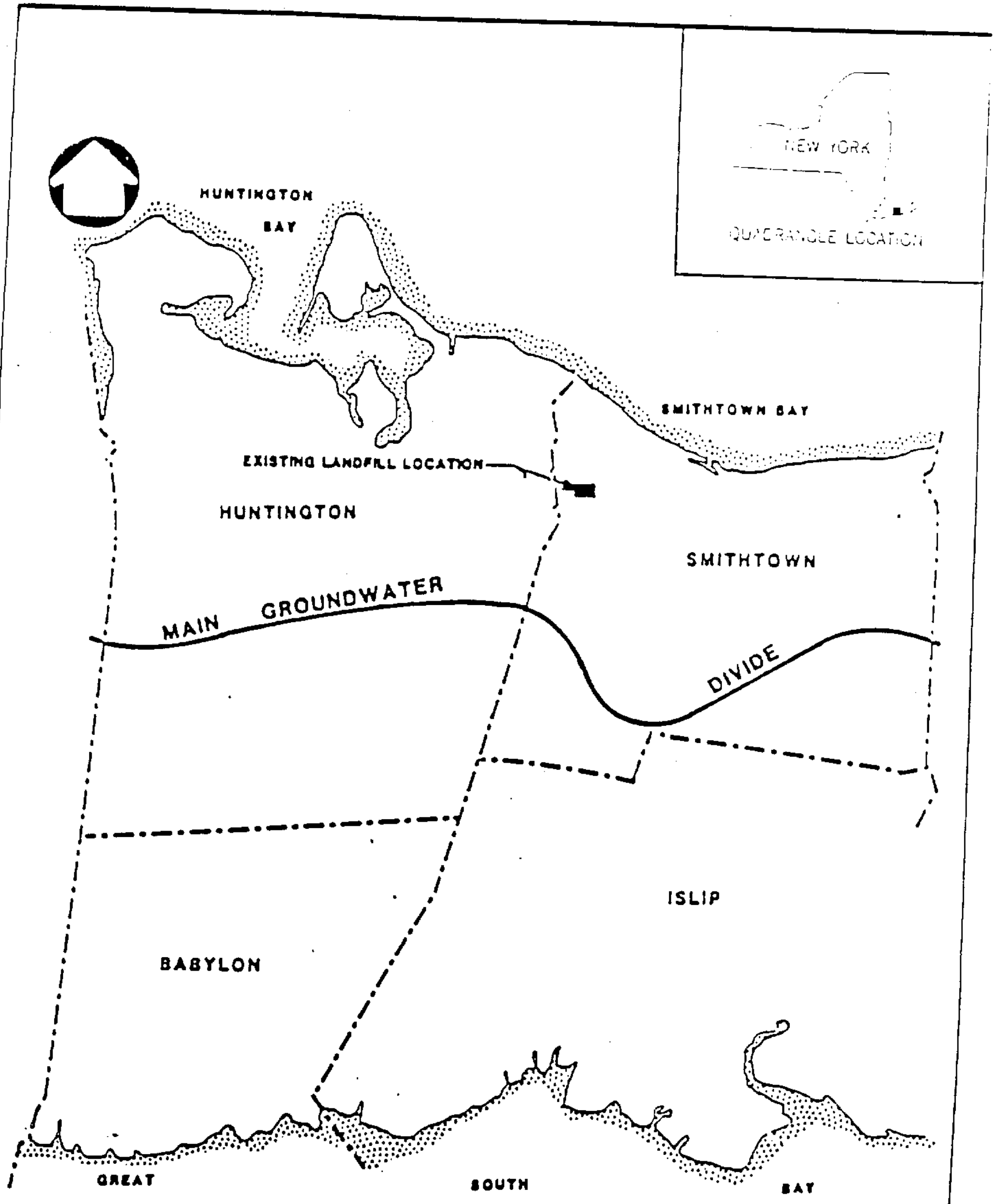
2.2 Cell No. 6 - Municipal Services Facility Landfill

2.2.1 Site Location

The Municipal Services Facility (MSF) Landfill is located in the unincorporated area of Kings Park, on an 86 acre parcel, in the northeasterly section of the Town of Smithtown. The Regional Geographic Location Plans for the MSF are presented in Figures 1 and 2. The Cell No. 6 landfill expansion covers an area of about 23.1 acres and is situated in the southeasterly portion of the MSF site. This Cell No. 6 area is shown on the Site Plan in Figure 3, along with the existing groundwater monitoring wells.

2.2.2 Area and Site Geology

Prior investigations included the drilling of a deep well cluster to establish lithologic changes at the MSF site and the construction of three (3) deep test borings in and around the Cell. Also, 10 additional monitoring wells were installed around the Cell which included a complete record of subsurface material in those boreholes. A final borehole depth of 620 feet below grade surface (Elev. 110 +/-) was recorded for the deep well cluster, and corresponded approximately to the top of the Clay member of the Raritan Formation. The test borings and monitoring wells delineated Pleistocene and Upper Cretaceous Strata including the Smithtown Unit, Gardiners or correlatable strata, and the Magothy Formation.



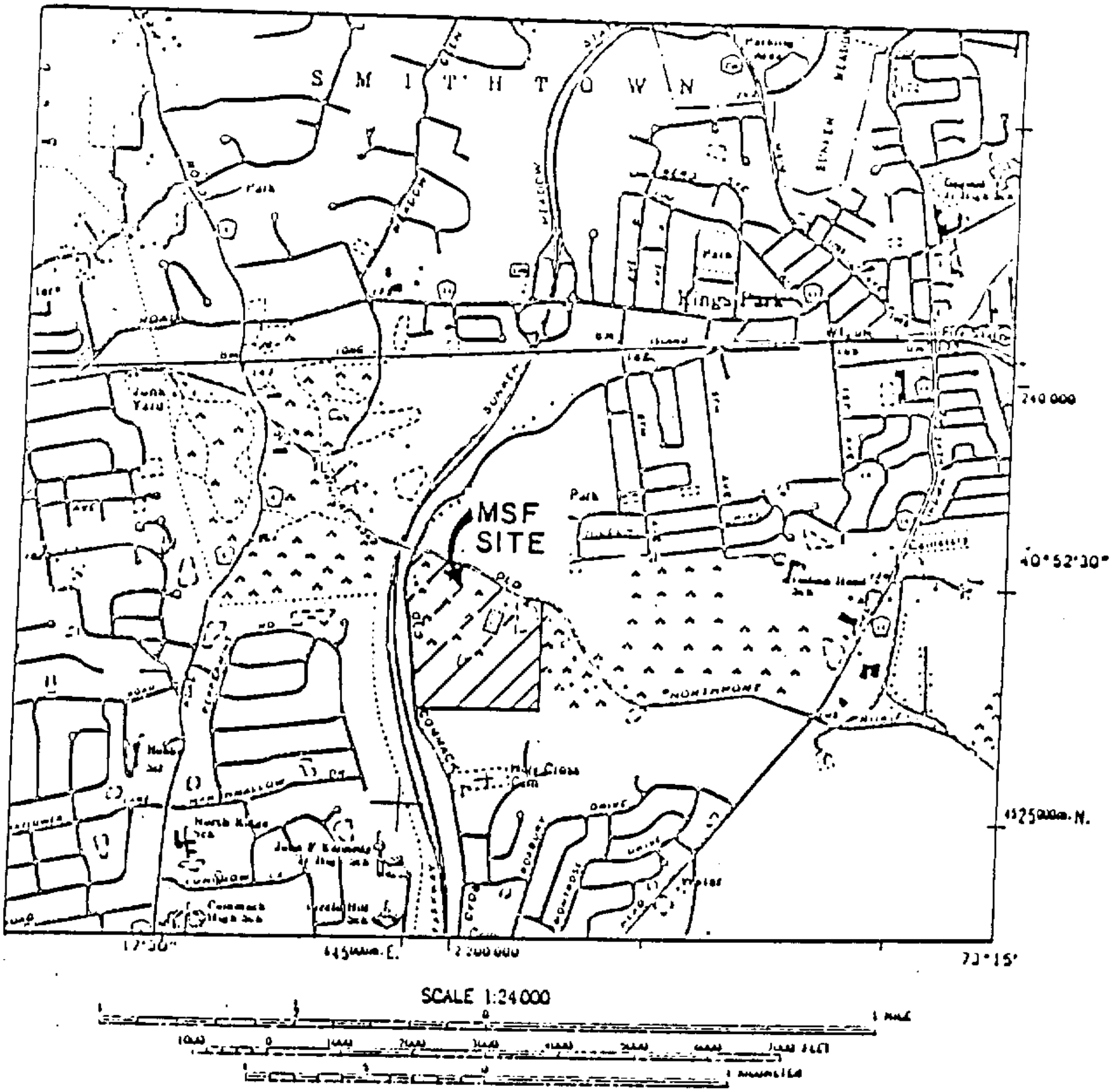
SOURCE: U.S. GEOLOGICAL SURVEY, JENSEN & SOREN, 1974

FIGURE 1
REGIONAL LOCATION PLAN

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

APPENDIX B

TYPICAL DETAILED SPECIFICATIONS FOR WELL DRILLING



Polyconic projection. 1927 North American datum.

1000-meter ticks based on the New York Transverse Mercator grid. Between 72° and 78° West Longitude, this grid is identical to Zone 18 of the Universal Transverse Mercator grid. Areas east of 72° and west of 78° are direct mathematical extensions of Zone 18.

10,000-foot ticks based on the New York Plane Coordinate grid, Long Island Zone.

Magnetic declination for 1981 is approximately 13° West

FIGURE 2
GEOGRAPHIC LOCATION PLAN
TOWN OF SMITHTOWN
MUNICIPAL SERVICES FACILITY (MSF)

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

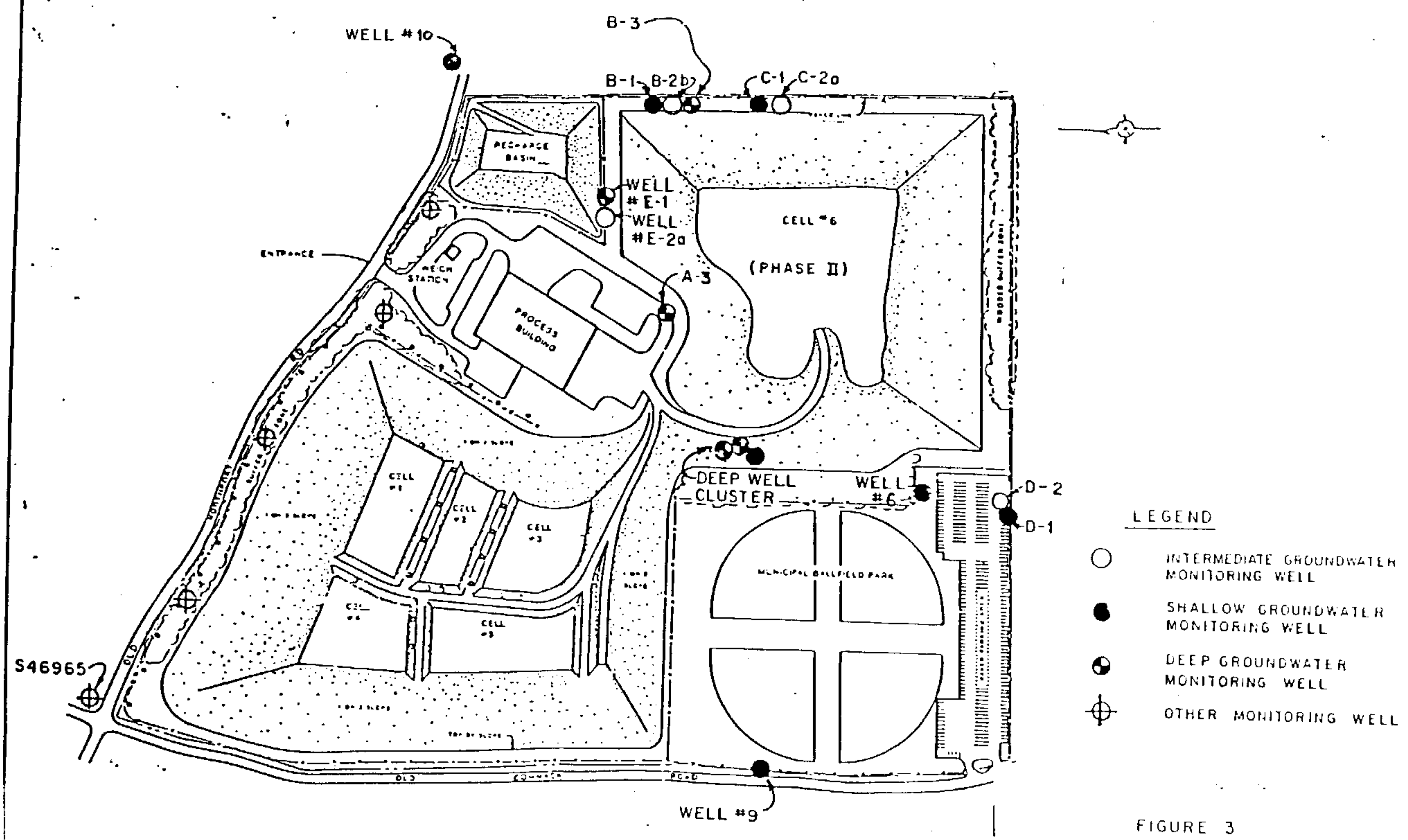


FIGURE 3

SITE PLAN

SMITHTOWN MUNICIPAL SERVICES FACILITY

EXISTING MONITORING WELLS

H. E. PUSTORINO, P. C.
CONSULTING ENGINEERS

At the deep well cluster approximately 200 feet of Upper Pleistocene/Pliocene (?) deposits were penetrated as well as about 420 feet of Late Cretaceous deposits. Included in Upper Pleistocene/Pliocene deposits was approximately 30-50 feet of silty sand, clayey sands and interbedded layers of clay identified as the Smithtown Unit, and 10-20 feet of solid organic silt and clay of the Gardiners Clay interval.

The Magothy Formation generally contained silty and clayey sand with interbedded layers of gravel. As is typical, it also contained some silty and sandy layers of clay, the lateral extent of which is not well defined given available well data for the area.

At the MSF site, the groundwater table presently ranges from 45- 50 feet above mean sea level (MSL), which is near its historic high level for the area.

2.2.3 Well Drilling Conditions

The Town has previously completed the installation of several groundwater monitoring wells at the MSF site. Based upon the recent drilling, the proposed wells will be in soil materials as described in Section 2.2.2.

Proposed wells have been sited so that no solid waste or related demolition type material will be encountered during the drilling operation.

The Town has installed methane migration control systems in areas of potential landfill gas migration. These systems are operated and routinely monitored by personnel of the Town Engineering Department. In addition, a private vendor has installed a landfill gas recovery/utilization system at the MSF Phase I landfill site. Results of methane monitoring at the site and configuration of the site are such that gas migration from the existing landfill should not be a factor in the proposed drilling program.

The Contractor shall monitor the site of the work for combustible gases to ensure the health and safety of his employees.

The Contractor is hereby advised that the Phase II-Cell No. 6 landfilling area is an active landfilling area. The Contractor shall conduct his operations in such fashion as to not interfere with the ongoing landfill operations and/or access and travel on the site.

SECTION 3.0 DEFINITIONS

Within the context of the work to be performed, the following definitions will apply:

3.1 Owner: defines TOWN OF SMITHTOWN and its representatives.

3.2 Engineer: defines R.E. PUSTORINO, P.C., and its representatives, as consultant to the Owner.

3.3 Contractor: defines (to be selected at a later date) and its representatives, including subcontractors, who will perform the work hereinafter specified.

3.4 State: defines the New York State Department of Environmental Conservation (NYSDEC) and its representatives.

3.5 Others: defines any other firms, individuals or agencies who may be appointed to perform certain aspects of the work by the Owner or the Engineer.

SECTION 4.0 SCOPE OF WORK AND RESPONSIBILITIES OF THE PARTIES

4.1 The work to be performed under this specifiction shall consist of: making soil borings; performing in-situ geotechnical and hydrologic tests; collecting and preserving soil samples; installing single groundwater monitoring wells; development of those wells; and preparing field reports and drilling logs on the results obtained.

4.2 The Contractor shall furnish the qualified technical personnel, and all labor, equipment, tools, materials, supplies, transportation and incidentals required to complete the work.

4.3 The Contractor, may not change the location of borings and wells, the type of sampling required or the amount of services to be performed in any category as the work progresses. Changes will be based on the needs of the job as they may vary with the information disclosed by the completed borings and/or by parallel studies which may be performed at the site. Work will be subject to inspection by the Engineer.

4.4 Responsibilities of the Contractor

4.4.1

Any and all arrangements required to gain access to the site(s) and perform the specified services, including all drilling permits and clearances shall be the responsibility of the Contractor.

4.4.2

The Contractor shall be responsible for supplying all services (including labor), water from an approved potable supply, water truck, equipment and material required to perform the drilling and testing program, as well as maintenance and quality control of such required equipment, together with the necessary supervision required to perform and complete the work as stipulated in the Specifications and/or shown on Drawings. Therefore, omission of specific mention of the fact from any part of the Specifications shall not be deemed a waiver of the Contractor's obligation to furnish all supervision, materials, labor, plant, equipment, tools, and any other item of expense required to perform and complete the work.

4.4.3

The Contractor will be responsible for the correctness of the procedures to be used, as well as for the accurate reporting of the results thereof, as described in this specification and as required by the Engineer.

4.4.4

The Contractor is hereby advised that, in some instances, the proposed drilling operation will occur in and around existing gravel lined drainage swales. The Contractor shall furnish and install material and equipment as required to facilitate his operation.

The Contractor shall be responsible for restoring all areas used, modified or disturbed by him in his work to the satisfaction of the Engineer.

4.4.5

The Contractor shall report any problem encountered in the field, which might preclude the successful performance of any items of this specification, to the Engineer within 24 hours.

4.4.6

The Contractor shall provide the Engineer advance written notification for any changes in field procedures, describing and justifying such changes. No changes shall be made to the procedures, unless requested or authorized in writing by the Engineer. In certain cases, prior written authorization may be waived by the Engineer, at his discretion, and the changes may be requested and/or authorized verbally. This waiver, however, will not release the Contractor of his obligation to follow up with a written explanation for the aforesaid changes.

4.4.7

The Contractor shall be responsible for familiarizing himself with the conditions of the site prior to the preparation of the bidding package.

4.4.8

The Contractor shall be solely responsible for contacting all private and public utilities which serve the area for utility field markout prior to drilling.

4.5 Responsibilities of the Engineer and Owner

4.5.1

A representative of the Owner and/or Engineer will generally be present during the field operations for consultation. However, their physical presence is not to be construed as an obligation of either the Owner or Engineer, nor shall it relieve the Contractor in any way whatsoever of his obligations under this Contract.

4.5.2

The Owner and/or Engineer shall not be responsible for any loss or damage to equipment sustained by the Contractor, prior to, during, and after the performance of this contract.

4.5.3

The Owner and/or Engineer will be responsible for all soils analyses and water quality determinations, if required.

4.5.4

The Owner and/or Engineer will be responsible for field surveys and establishing elevations and other topographic features after installation of the monitoring wells.

4.6 Site Monitoring

Environmental monitoring will not be performed at the drilling sites.

4.7 Communication

4.7.1

All correspondence shall contain subject headings to be established by the Engineer.

4.7.2

All correspondence shall be addressed to:

R.E. Pustorino, P.C.
2171 Jericho Turnpike
Commack, New York 11725
Att: Edward J. Reilly
Project Leader

4.7.3

A cover letter shall accompany all shop drawings, technical reports, etc., and shall include a summarized description of their content.

4.7.4

Boring logs and other drilling and testing information will be submitted as described in Section 9.0 and other parts of this Specification.

4.8 Water Supply

4.8.1

The Contractor shall utilize the on-site potable water system as the source of supply for the filling of all water tanks, water trucks, steam generators, etc., which require potable water in the prosecution of the work.

4.8.2

The Contractor shall obtain the potable water only from the on-site hydrant designated by the Engineer. The hydrant is readily accessible to vehicles.

4.8.3

Prior to commencing the work, all water tanks, water trucks, steam generators, etc., shall be thoroughly drained of its contents and rinsed (two full volumes) with the designated water supply. This operation shall be conducted in the presence of the Engineer.

4.8.4

The Contractor shall certify in writing prior to commencing the work that all vessels intended to be used for the storage, transport, etc., of potable water have only been used for potable water in the past. The addition of additives, anti-freezes, etc., is strictly prohibited.

SECTION 5.0 SERVICES AND PRICES

5.1 General Criteria

5.1.1

The Contractor shall supply all personnel, vehicles, equipment, instruments, services, facilities, approved potable supply of water, power and support necessary for the successful completion of the proposed work. Deliverables, supervision, travel, subsistence and reports shall be included in the prices.

5.1.2

The Contractor understands that the compensation paid shall be based on the unit prices. With the approval of the Engineer, or if so ordered by him, modifications to the estimated quantities shall be made by the Contractor and payment shall be adjusted for the actual work done and accepted.

5.1.3

The Contractor should further note that the item quantities tabulated in the Proposal Form may not represent true anticipated items or quantities, but are only used for the purpose of estimating the cost of work. The tabulated items include, but may not be limited to those that can be reasonably expected to be used efficiently and successfully, as alternatives or combinations thereof, in light of the Engineer's present state of knowledge and understanding of the site hydrogeologic conditions. The tabulated quantities have been selected with the same criteria.

5.1.4

The Contractor is encouraged to present and document, together with his contract bid, any ideas he might have on methods and procedures that, in his opinion, would be more effective both technically and cost-wise. The Engineer will review and consider, but not be bound to accept such alternative methods and procedures.

5.2 Price Schedule

The cost proposal tabulation to be used by the Contractor in preparing his bid is provided in the contract section of this document. The stipulated estimated quantities and the unit and lump sum prices written in words will be the basis for computing the total estimated bid.

SECTION 6.0 PROGRESS AND TIME OF COMPLETION

6.1 The work under this Contract shall be commenced within ten (10) consecutive calendar days from the date of written notice to proceed, and shall be performed continuously to completion.

6.2 The Contractor shall immediately state in written notice, following issuance of Notice to Proceed, the date on which work at the project sites will commence. The work will commence at this date or sooner.

6.3 The rate of work shall not be less than that shown on the "Schedule of Progress", which is to be submitted by the Contractor for review and acceptance by the Engineer, prior to commencing the work.

6.4 If the quantities stated in the proposal are changed, the number of calendar days allowed for completion will be similarly changed.

6.5 The Contractor shall maintain upon the site sufficient independent drilling rigs and crews to complete the work within the time allowed.

6.6 The time of completion for the Contract shall be 45 calendar days after the date set to commence work.

6.7 The hours of operation shall be Monday thru Friday, 7:00 A.M. to 5:00 P.M. No deviation in the operating hours will be permitted without the written approval of the Engineer.

SECTION 7.0 MEASUREMENT AND PAYMENT

7.1 Payment for the items included in this Contract shall be for the work actually done and accepted, according to the unit prices, or lump sums, listed in Cost Proposal, except as described below.

7.2 No payment will be made for lost tools, drill rods, bits, or any other equipment normally involved in the operations. No payment will be made for casing left in place unless it has been left at the specific request of the Engineer. The Contractor shall not elect to leave casing in place.

7.3 No payment will be made for the Soils Engineer/Geologist's boring logs, the cost shall be included in the unit prices for Soil Drilling.

No payment will be made for the holding and disposal of pumping test water, development water or drilling fluids. The cost shall be included in all the other items of work.

7.4 The Owner reserves the right to direct the Contractor to utilize the "Alternate Well Completion Detail" on any of the wells installed under this Contract. Payment for the furnishing and installation of the "Alternate Well Completion Detail" shall be the bid unit price stated in the Proposal.

7.5 During the progress of the work, the Contractor, with approval by the Engineer, will within the first ten days of each month, estimate the amount of work done and materials and equipment built into the work during the previous calendar month. The quantities so determined will be used as the basis for a periodical estimate whenever the value of said monthly work exceeds One Thousand ($1,000.00) Dollars. The certified periodical estimate will be presented to the Owner by the Engineer and shall indicate the value of the work performed and materials and equipment built into the work in accordance with the Contract. As soon as practicable thereafter, the Owner will pay the Contractor an amount equal to ninety five (95%) percent of the value of such work, materials and equipment indicated on the periodical estimate, less the amount of all previous payments. The five (5%) percent shall be deducted from each and every estimate made under the entire Contract as a guarantee that the Contractor will faithfully and completely fulfill all obligations and requirements herein contained.

7.6 The monthly estimate, as approved by the Engineer, will be considered approximate and no claim shall be made by the Contractor for additional payment based on any error in a periodical estimate.

7.7 Payment may at any time be withheld if the work is not proceeding in accordance with the Contract, or, if in the judgment of the Engineer, the Contractor is not complying with the requirements of the Contract Documents.

7.8 No partial payment will be made for any materials before they are incorporated in the work.

7.9 Before any payments will be made under this Contract, the Contractor and all Subcontractors performing any part of the work called for by this Contract must file in the office of the Town of Smithtown verified statements provided for in Section 220e of the Labor Law, as amended, certifying to the amounts then due and owing from the Contractor and Subcontractor filing such statement, to any and all laborers for daily or weekly wages on account of labor performed upon the work under this contract, setting forth therein the names of the persons whose wages are unpaid and the amount due each respectively. The Contractor must set forth in his statement the names of his Subcontractors. If the Contractor or Subcontractor has no Subcontractor, he shall so state in his statement. If there is nothing due and accruing to any laborer for daily or weekly wages on account of labor performed upon the work under this Contract, verified statements to the effect must be filed by the Contractor and all Subcontractors before any payments are made under this Contract.

7.10 For the Contractor's complete performance of the work, the Town will pay, and the Contractor agrees to accept, subject to the terms and conditions hereof, the lump sum price or unit prices at which this Contract was awarded, plus the amount required to be paid for any extra work ordered by the Town.

7.11 The sum total for these items shall constitute full payment for the work complete, tested and ready for use, including all work required, but not specifically mentioned in the bid items, and also for all losses or damages arising out of the nature of the work or from the action of the elements, or from any unforeseen difficulty encountered in the prosecution of the work, and for all risks of every description connected with the work, and for all expenses incurred by or in consequence of the suspension or discontinuance of the work herein specified, and for any actual or alleged infringement of patent, trademark or copyright, and for well and faithfully completing the work as herein provided.

SECTION 8.0 TECHNICAL REQUIREMENTS FOR DRILLING AND TESTING

8.1 8.1.1 General

Bore holes shall be made with heavy duty drilling equipment of a size and type designed to drill holes of the required sizes and depth specified herein. Drilling units shall be equipped with a hydraulic feed.

8.1.2

Monitoring wells shall be installed by use of proper equipment, having adequate capacity and quantity and all required accessories. The installation equipment shall include, but not be limited to, drilling rigs, jacks, casing, pipes and screens of the required types, diameters and schedules, granular filter material, sealing material, and other miscellaneous equipment required for installation.

8.1.3

Where it is determined by the Engineer that contaminated drilling or pumping test water might be encountered, the Contractor shall provide the necessary equipment and containment systems until testing results determine proper disposal actions. Random disposal at the boring locations or surrounding property is <u>not</u> acceptable.

8.1.4

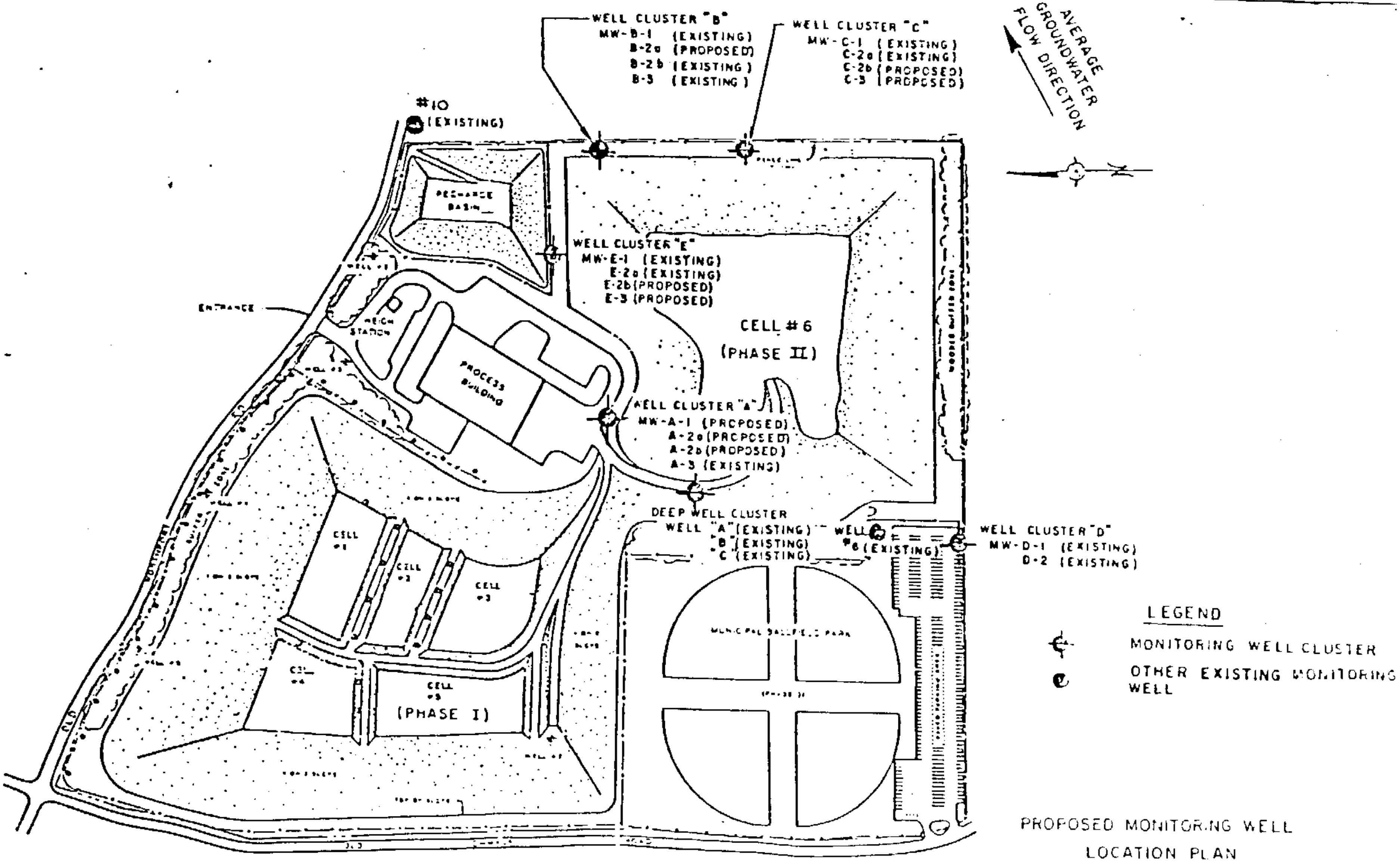
The general areas in which the borings and monitoring wells are to be located are shown on the Proposed Monitoring Well Location Plan (Figure 4). Table 1 lists the proposed wells, their estimated depths, elevations, and other pertinent details. Additional drawings may be furnished or approved hereafter by the Engineer to explain the work in greater detail.

8.1.5

The borings and monitoring well locations shown or implied on the Plans are approximate. The exact location shall be determined in the field by the Engineer. In case of relocations or adjustments, the Engineer shall be consulted and his decisions shall be final.

8.2 Access and Setup

The Contractor shall be responsible for providing access to all drilling and testing locations and for setting up all drilling, pumping, and associated equipment at each location. The manner of access shall be subject to the Engineer's approval.



PROPOSED MONITORING WELL
LOCATION PLAN
AND FINAL MONITORING WELL ARRAY
PHASE II - CELL 6
SMITHTOWN MUNICIPAL SERVICES FACILITY

FIGURE 4

R. E. PUSTORINO, P.C.
CONSULTING ENGINEERS

TABLE I

PROPOSED GROUNDWATER MONITORING WELL SPECIFICATIONS
FINAL ENVIRONMENTAL MONITORING WELL PLAN (FEMP)
SMITHTOWN MSF - PHASE II - CELL 6

Well I.D. #	Well Location	Total Depth*	Depth of Screen	Screen Length	Surface Elevation	Elevation Mid-Screen	Type of Screen	Formation Screened	Top of Screen Relative to Water Table**
		(feet)	(feet)	(feet)	(ft. MSL)	(ft. MSL)			
		(estimated)	(estimated)	(estimated)	(estimated)	(estimated)	(estimated)		
MW-A1	Downgradient NW	100	75-95	20	123	43	4in. 20slot	Smithtown Unit	+3
MW-A2a	Downgradient NW	127	105-125	20	123	13	4in. 20slot	Upper Glacial	-27
MW-A2b	Downgradient NW	152	135-150	15	128	-15	4in. 20slot	Upper Glacial	-60
MW-E2b	Downgradient N	175	155-170	15	140	-22	4in. 20slot	Upper Glacial	-65
MW-E3	Downgradient N	200	180-195	15	140	-47	4in. 20slot	Upper Glacial	-90
MW-B2a	Downgradient NE	142	120-140	20	140	13	4in. 20slot	Upper Glacial	-30
MW-C2b	Downgradient E	175	150-170	20	140	-20	4in. 20slot	Upper Glacial	-60
MW-C3	Downgradient E	200	182-197	15	140	-50	4in. 20slot	Upper Glacial	-93

All well screens and riser pipes shall be flush-joint Schedule 80 PVC.

* All depths and elevations are approximate.

** Water Table Elevation as of 1/90 is about 50ft. above MSL which is near its historic high-level mark

9.0 METHOD OF CONSTRUCTION

9.1 General

The purpose of the test boring construction is to determine the type, thickness and physical properties of the soil strata in the critical part of the section, and to identify the lower boundary of the aquifer (where applicable), so that the monitoring wells can be properly designed and installed. The physical properties of the materials are to be determined by field (in-situ) testing and geophysical logging. Soil samples are to be collected for both visual identification and laboratory (grain-size) analysis.

9.2 Drilling in Soils

This subsection applies to all drilling in soil materials including, but not being limited to, sand, gravel, clay, silt, cobbles, boulders, hardpan.

9.2.1 Drilling by Cased Hole Method

9.2.1.1

This method shall be applicable wherever the formation and the ground water conditions warrants its use. With the cased hole method, soil samples shall be recovered only by means of a sampling tube attached to the end of the hollow drill rod which shall be lowered at the bottom of the previously cleaned hole and driven into the undisturbed soil below the bottom of the hole.

9.2.1.2

Casing for soil boring shall be extra heavy pipe; the minimum nominal diameter shall be 8 inches. Overburden and observation well installation requirements may require the use of larger size casing than specified or of telescoping techniques. The contractor may use such casing and/or techniques without increase of cost. Flush joint casing equipped with a cutting bit may be required to drill through boulders, etc. The Contractor may use such casing when conditions warrant without increase of cost.

9.2.1.3

The casing shall be driven down in stages of not more than five (5) feet, after which the material shall be cleaned out by rotary drilling, by washpipe and chopping bit, or by some other method. Water shall generally be used for removing the loosened soil. When gravelly or other coarse materials are encountered, drilling mud may be used, subject to approval by the Engineer, to remove the cuttings. A continuous record shall be kept of the blows per foot in driving the casing.

9.2.1.4

Simultaneous washing and driving of the casing will not be permitted except when approved by the Engineer. The elevations between which water is used in driving the casing shall be recorded when this procedure is used.

9.2.1.5

The casing shall be driven all the way down to the final depth of the hole. When stiff cohesive soils such as clays are encountered such that the borehole will not cave, the Contractor may drill through such soils without using casing, subject to approval by the Engineer.

9.2.1.6

The casing when driven shall be advanced by a three hundred (300) pound hammer falling freely through a height of thirty (30) inches, or as otherwise approved by the Engineer.

9.2.1.7

It shall be the Contractor's responsibility when boulders or other obstacles are encountered to carry the drilling through or past such obstacles to enable normal spoon samples to be taken as required.

9.2.1.8

The casing shall be completely removed from the borehole as the installation of the monitoring well progresses.

9.2.2 Drilling by Mud Rotary Method

9.2.2.1

This method shall be applicable wherever the formation and the ground water conditions permit.

9.2.2.2

The method of drilling shall be direct rotary, or other method as submitted by the Contractor and approved by the Engineer.

9.2.2.3

The borehole shall be at least four (4) inches greater in diameter than the largest outside dimension of the outer casing.

9.2.2.4

The Contractor shall provide all equipment and experienced personnel necessary to conduct efficient drilling operations. The drilling equipment shall be in good condition and capable of drilling holes and installing casings and screens to 300 feet without difficulty. The Contractor shall provide all materials, tools, drilling equipment, accessories, water, fuel, power, and all other materials and services necessary for the satisfactory completion of any and all work.

9.2.2.5

A temporary steel casing at least ten (10) feet long shall be installed in the top part of the test well to prevent unnecessary caving of the rotated hole.

9.2.2.6

During drilling, hydrostatic pressure of the drilling fluid shall exceed the earth pressures and any artesian pressures.

9.2.2.7

If during mud thickening, the drilling fluid becomes too viscous to pump down the hole, only potable water may be added to the drilling fluid with approval from the Engineer. During drilling of the monitoring wells, mud thickness shall be reduced in the screened intervals, when possible, to facilitate development of the well.

9.2.2.8

The driller shall use only pure bentonite mud such as "Premium Gel", manufactured by the American Colloid Company, or approved equivalent. The use of modified bentonite, additives, polymers, organic or man made muds is strictly prohibited. Only potable water shall be used in the preparation of drilling fluids.

9.2.2.9

The Contractor shall supply and utilize portable mud pits of fabricated steel. Mud pits constructed in and/or on native soils are not acceptable. The portable mud pits shall satisfy the needs for settling cuttings, mixing of drilling fluids, and supplying the mud pumps.

9.2.2.10

A) Mud density shall be measured as pounds per gallon in the field with the use of a mud balance. A weight of approximately 9.0 pounds per gallon is regarded desirable. However, local geology may result in a different pound per gallon number. It will be the responsibility of the driller to determine the appropriate mud weight on a per gallon basis. The Contractor shall supply and maintain an acceptable mud balance at the site at all times.

B) Fluid viscosity shall be measured in the field by use of a Marsh funnel or equivalent device. The test is performed by filling the funnel to a volume of 1,500 cm(3), then noting the drainage time (in seconds) of the drilling fluid. Generally, a 9.0 lb per gallon fluid requires 35 to 45 seconds to drain. The Contractor shall supply and maintain the Marsh Funnel at the site at all times.

C) The Contractor shall supply and maintain at the site at all times an acceptable apparatus for determining the sand content of the drilling fluid. The sand content apparatus shall utilize a 200 mesh screen.

D) The Contractor shall supply and maintain at the site at all times an adequate supply of litmus paper for the purpose of accurately determining the pH of the drilling fluid.

E) The Contractor shall utilize the above referenced testing equipment to monitor the characteristics of the drilling fluid. The Contractor shall perform the tests on the drilling fluid prior to commencing the boring of each well, at the completion of boring each well, and, in addition, a minimum of twice per day for each day that the boring operation is in progress.

F) The Contractor shall permit the on site use of this equipment by the Engineer.

9.2.2.11

Mud rotary drilling shall proceed by penetration of the strata down to the top of the sample interval, at which time the bit will be lifted off the bottom of the bore, and the cuttings circulated out. The drill rods can then be lifted from the bore and the appropriate sample apparatus prepared.

9.2.2.12

The Contractor shall provide the apparatus necessary to collect cuttings samples from the mud stream, as required by the Engineer. The geologist/soils engineer for the Contractor will be required to monitor the mud for lithology changes when the split spoon samples are collected at intervals exceeding 5 feet.

9.3 Soil Sampling

9.3.1 General

As for the drilling methods, the sampling methods herein described will be used in accordance with the types of material encountered, and as approved or requested by the Engineer.

As distinguished from qualified drilling personnel, the Contractor will be required to supply a geologist or soils engineer with the rig who is acceptable to the Engineer and who is experienced in analysis and description of soils, logging, and sample preparation. The qualifications and experience of this person shall be submitted to the Engineer and approved prior to his presence on-site.

9.3.2 Sample Locations

Geologic soil samples will be obtained during the critical (well-screen) intervals at each test boring location, and in all other stratigraphic intervals that have not been previously explored. Split spoon samples will be obtained at five foot intervals, and as dictated by changes in lithology or as determined by the Engineer based upon the geologic conditions.

Table II summarizes the split spoon and shelby tube sampling intervals at the individual proposed well locations. Shelby tube (undisturbed) sampling or other core-barrel sampling techniques shall be undertaken in the two deeper wells at the lower aquifer boundary (top of Gardiners Clay Interval), in order to verify the vertical permeabilities of those strata.

9.3.3 Split Spoon Sampling

The split spoon sampler will be used to obtain representative samples of soil for identification purposes and other laboratory tests, and to obtain a measure of the resistance of the soil to penetration of the samples.

Split spoon samples will be collected according to the ASTM Designation D1586-67 (reapproved 1974) and as modified below.

9.3.3.1

During the drilling process, split barrel spoon samples shall be taken in the intervals that were defined in Table II.

9.3.3.2

The sample spoons shall be of the standard split tube type, shall have a two (2) inch O.D. and 1-3/8 inch I.D. with or without 6-inch long brass or plastic liners, as requested or approved by the Engineer, and shall be equipped at the top with a reliable ball check valve. If difficulty is experienced in recovering samples, the split tube sampler shall be equipped with a basket-type retainer. The bottom edge of the drive shoe shall be sharpened to form a cutting edge at its inside circumference. The beveled edge of the drive shoe shall be maintained in good condition and, when excessively worn, shall be satisfactorily reshaped. The drive shoe of the sampler shall be replaced if damaged in such a manner as to cause projections within the interior surface of the shoe.

TABLE II

SUMMARY OF SOIL SAMPLING INTERVALS

PROPOSED WELL	DEPTHS OF SPLIT SPOONS*	DEPTHS OF SHELBY TUBES**
MW-A1	-	-
MW-A2a	100 - 125	-
MW-A2b	130 - 150	-
MW-E2b	-	-
MW-E3**	150 - 195	195 - 200 (Estimate)
MW-B2a	115 - 140	-
MW-C2b	-	-
MW-C3**	145 - 195	195 - 200 (Estimate)

* One split spoon to be taken every five (5) feet during these intervals or every ten (10) feet below the 150 foot depth at the discretion of the Engineer.

** Two (2) shelby tubes are to be taken in the top of the Gardiners Clay Interval at the test boring locations of MW-E3 and MW-C3; gamma logs will also be run in these borings.

9.3.3.3

The sample shall be taken by mechanically driving the split barrel sampler twenty-four (24) inches into the undisturbed material below the bottom of the auger with a 140 pound hammer.

The drill rods will be marked in 6-inch increments above a fixed datum. A record shall be kept of the number of blows for each six (6) inches of penetration. In hard materials requiring more than 50 blows per six inches of penetration, the blows for a smaller amount of penetration may be observed and recorded with a special note of the amount of penetration actually obtained.

9.3.3.4

To obtain a consistent determination of the relative resistance of the various strata, the split spoon sampler shall be driven by a 140 pound hammer having a free falling drop of thirty (30) inches. In no case will any deviation from maintaining a constant impact energy be permitted in obtaining the penetrating resistance.

9.3.3.5

Immediately upon extraction of the split spoon sampler by the driller, the sample will be opened by the driller and given to the Contractor's geologist (in the spoon) for analysis, logging, and sample preparation.

9.3.3.6

The surface of the core will be scraped to remove erratic material from the sample to be logged. The top 2" of the samples should be discarded where it can be identified as fall-in material from the upper bore.

9.3.3.7

The geologist or soils engineer for the Contractor will then describe the samples, including all stratified zones, following the Unified Soil Classification System (see Section 10).

9.3.3.8

Representative soil samples will then be collected from the spoon using a stainless steel or teflon-coated spatular and transferred to a wide mouth glass sample jar fitted with a teflon-lined screw cap. The jar will be filled to capacity, if possible, and capped immediately.

9.3.3.9

From each spoon at least two (2) separate samples will be placed into jars; one (1) additional container may be required for geotechnical analysis where the sample contains two distinct lithology types. Sample 1 will be stored for later verification, and sample 2 (or 2 and 3) will be for geotechnical analysis by the Engineer.

9.3.3.10

The Contractor shall provide a sufficient quantity of one pint wide mouth glass sample containers fitted with a teflon-lined screw cap.

The Contractor shall provide a separate insulated ice chest for the storage of soil sample containers.

9.3.4 Shelby tube Sampling

The shelby (thin-wall) tube will be used to collect relatively undisturbed samples of the top beds in the Gardiners Clay interval, for laboratory analysis (grain-size distribution) and permeability testing. The exact depth of shelby tube penetrations will be determined on-site by the Engineer, and are estimated in Table II.

Shelby tubes will be collected according to the ASTM Designation D1587-74 and as modified below. Although it is not anticipated, if the soils are found to be too dense for shelby tube sampling, core drilling for site investigation will be required. ASTM D 2113-70 (reapproved 1976) describes the standard method for core drilling which would be used. If required, core drilling for the taking of undisturbed samples shall be performed at the bid unit price for Shelby Tubes.

9.3.4.1

Shelby tubes with 3-5" outside diameter and made of any materials having adequate strength and resistance to corrosion are satisfactory. Tubes shall be of such length that between 5-10 times the diameter is available for penetration into sands and between 10-15 times for clays (min. 30" length).

9.3.4.2

Tubes shall be round and smooth, be clean and free of rust or dirt. The cutting edge shall be machined and free of nicks. The coupling head shall contain a suitable check-valve and venting area to the outside.

9.3.4.3

With the sampling tube resting on a clean bottom of the hole and water level at the static level or above, push the tube into the soil by continuous rapid motion, without impact or twisting. In no case shall the tube be pushed further than the length provided for the sample.

9.3.4.4

If the soils are so hard that a pushing motion will not penetrate the sampler sufficiently, a hammer may be used to drive the sample, if approved by the Engineer. In such a case, the Contractor's geologist will record the weight, height and number of blows. Before pulling the tube, turn it at least two revolutions to shear the sample off at the bottom.

9.3.4.5

Upon removal of the tube, the geologist will measure the length of penetration. After pulling the tube from the bore, he will remove any disturbed materials and measure the sample in the tube. Wax or other impermeable materials will then be used to seal both ends before storage and shipping.

9.3.4.6

Affix labels to the tubes for identification including all pertinent data. The Contractor's geologist will make a description of the soil (USCS Classification) by using soil removed from the ends of the tube.

9.3.4.7

Do not allow the tubes to freeze during the field operations and shipping.

9.3.4.8

The prepared tubes shall be delivered to the Engineer for analysis. The Contractor is advised that the used tubes will not be returned after extrusion and analysis at the laboratory.

9.4 Decontamination

A) The Contractor shall steam clean equipment such as casing, augers, drill bits, drill rods, PVC well screens and risers, and sampling devices. Steam cleaning shall be performed on all augers, drill rods, and bits prior to drilling each borehole. Sampling devices shall be steam cleaned after each sample. The cleaning operation shall include both interior and exterior surfaces.

B) The steam generator shall be capable of supplying a steady stream of steam, at a minimum temperature of 200 degrees F., as measured at the tip.

C) The Contractor shall maintain a specially designated staging area at each monitoring well site. The staging area shall consist of clean pallets suitable for ensuring that all down-hole equipment is kept off the ground.

D) When required by the Engineer, split spoon samplers and spatchlers will be aire-brushed cleaned and sanitized with a steam cleaner or in accordance with the following protocol:

1. Surface material from the sampling equipment will be removed via a wire brush.
2. Non-phosphate detergent wash.
3. Rinse with potable water.
4. Washed with acetone.
5. Final wash with hexane.

10.0 CLASSIFICATION OF SOIL SAMPLES

10.1 Classification of Soil Strata

10.1.1

Soils shall be described and recorded in accordance with the Unified Soil Classification System. The soil description shall include at least the items described below.

10.1.2

In general, soil shall be considered either as granular or cohesive. A granular soil shall be considered basically either a gravel or a sand. Soil in either category shall be described as fine, medium or coarse. A cohesive soil shall be considered basically either a silt or a clay. The textural description of either granular or cohesive soils may include the presence of organic materials or other, using measures as "trace", "little" or "some" to indicate the amounts. For soil with equal amounts of constituents, use "and", such as "sand and gravel".

10.1.3

Granular soils shall be defined in terms of compactness, as "loose", "medium dense", "dense" or "very dense". Cohesive soils shall be defined in terms of consistency, as "very soft", "soft", "medium", "stiff", "very stiff" or "hard", and in terms of plasticity.

10.1.4

The amount of moisture present in a soil sample shall be defined in terms of "wet", "moist" or "dry".

10.1.5

The basic color of a soil, as blue, brown, gray, red or yellow, shall be given and shall be modified if necessary by adjectives such as "light", "dark", "'mottled" or "mixed".

10.1.6

In the description of the soil, its color shall be described first, followed by texture, composition, consistency and moisture. Example: Light gray silty clay with trace of fine sand, medium plastic, soft, wet (CL).

11.0 BORING LOGS

During the progress of each boring, the geologist or soils engineer for the Contractor shall keep a continuous and accurate log of the materials encountered. At the Engineer's request, copies of the field logs will be made available on a daily basis.

The Contractor shall provide to the Engineer for approval a copy of the "Boring Log" form to be used. Finalized borehole logs shall he typed and submitted to the Engineer upon completion of the job. Boring logs shall include at least the data described below in Section 11. In addition, the Contractor shall maintain a complete record of the field operations in a bound Field Record Book.

11.1 General

11.1.1 Dates and times of start and completion

11.1.2 Names of Contractor, driller and inspector

11.1.3 Identifying number of location of test boring

11.1.4 Location on form for ground elevation at the boring

11.2 Borings

11.2.1

Results of boring details of each hole arranged in tabular form giving full information on the vertical sequence, thickness and classification including degree of compactness of the materials penetrated.

11.2.2

Height of drop and weight of hammer for taking drive samples and driving casing, if any.

11.2.3

Number of blows required for each six (6) inch penetration of split spoon sampler.

11.2.4

Depth limits, type and number of each sample taken. All samples shall be numbered consecutively.

11.2.5

Depth to groundwater table at each hole, and time of observation. Water level observations shall be made and recorded at first detection and 24 hours after completion of the boring.

11.3 Completion Reports

11.3.1

The Contractor's geologist shall record in his Field Record Book all pertinent details related to installation of the monitoring wells (See Section 12), for example, types and quantities of materials used, installation depths, and any problems encountered during the operations. The Contractor should submit details of the well completion, in the form of a diagram, to the Engineer, along with the Field Record Book and the Final Log of the wells.

11.4 Geophysical Logging

The Contractor shall provide all necessary equipment and instrumentation necessary to perform Gamma Ray Logging in each of the two (2) deepest test borings/monitoring wells. The Engineer shall be immediately provided a copy of the field copy of the Gamma Log for stratigraphic analysis.

11.4.1

A total of 2 Finalized Logs shall be submitted to the Engineer which show, at a minimum, the Gamma Ray curves correlated to depths below the land surface.

12.0 MONITORING WELL INSTALLATION

The Contractor shall furnish, maintain, and operate all drilling rigs and miscellaneous equipment required to install the monitoring wells, including all slotted and unslotted plastic pipe, steel guard pipe with cap, grout, sand backfill, and miscellaneous materials.

Details of the proposed monitoring wells are shown in Figures 5 and 6.

The Contractor is advised that Figure 6 represents an alternate well completion detail utilizing precast concrete manhole section and manhole frame and cover in lieu of the protective steel surface casing depicted in Figure 5. The Owner reserves the right to direct the Contractor to utilize the alternate well completion detail on any of the wells installed under this contract. Payment for the furnishing and installation of the "Alternate Well Completion Detail" shall be the bid unit price stated in the Proposal.

12.1 Materials

12.1.1 Piping

PVC pipe and screens to be used shall be Type 1, Grade 1, PVC pipe as described in ASTM 1785, NSF-WC approved.

All casing pipe shall be four-inch diameter PVC, Schedule 80, and shall utilize threaded flush joints.

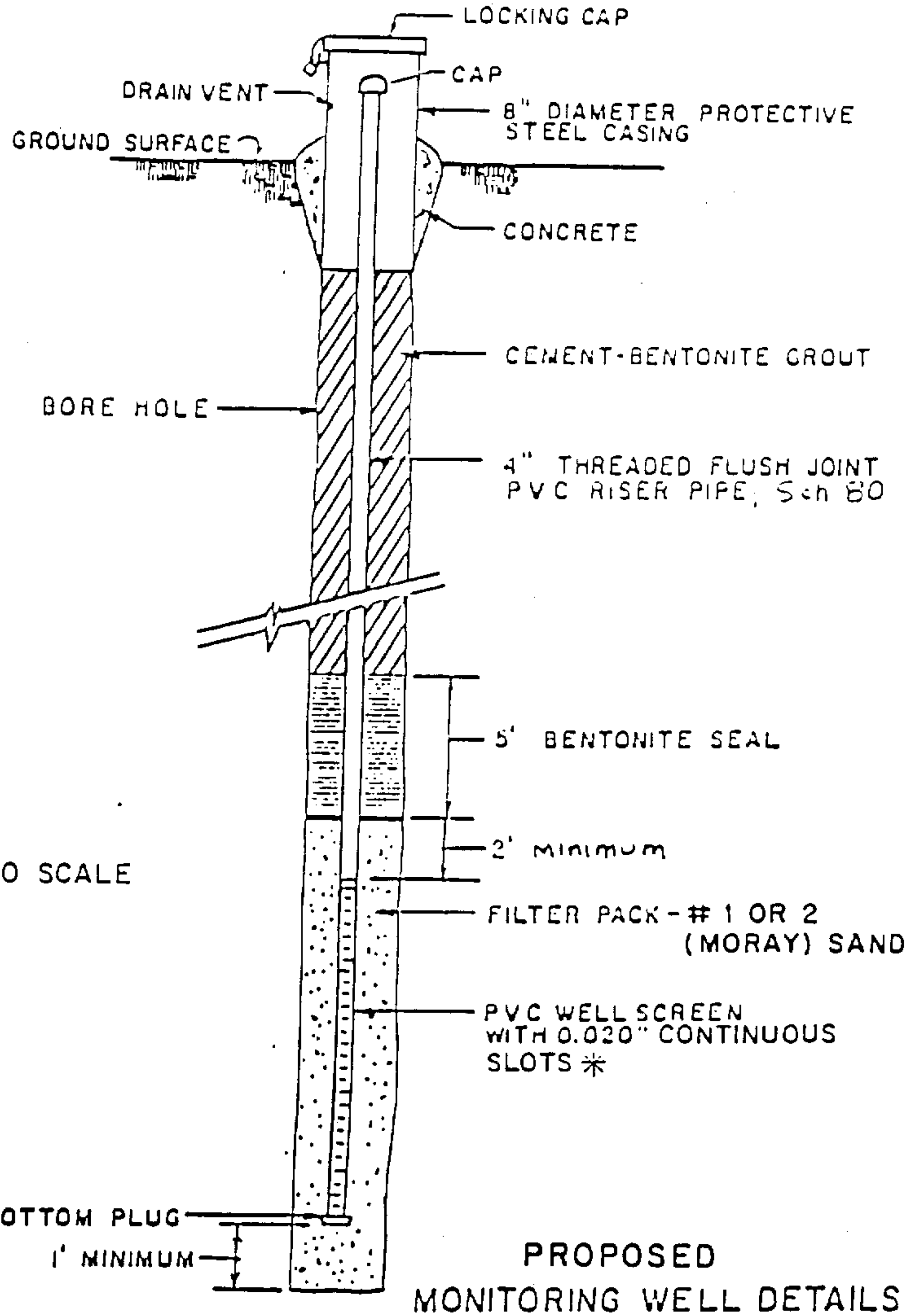
The use of solvent weld connections is strictly prohibited.

12.1.2 Screen

Screen shall be four-inch diameter PVC, Schedule 80 slotted well screen and rows of 0.02 inch or other suitable nominal width. The well screen shall be installed with stainless steel centralizers to ensure that the screen is properly centered in the well bore.

Screen slot size shall be determined by the Contractor upon field analysis of the grain size distribution of the formation. Screen selection shall meet with the approval of the Engineer. Screen slot size shall be chosen to provide sand-free water, while at the same time minimizing entrance velocity into the well.

The well screen shall be of lengths as described in Table 1, or as otherwise determined by the Engineer.



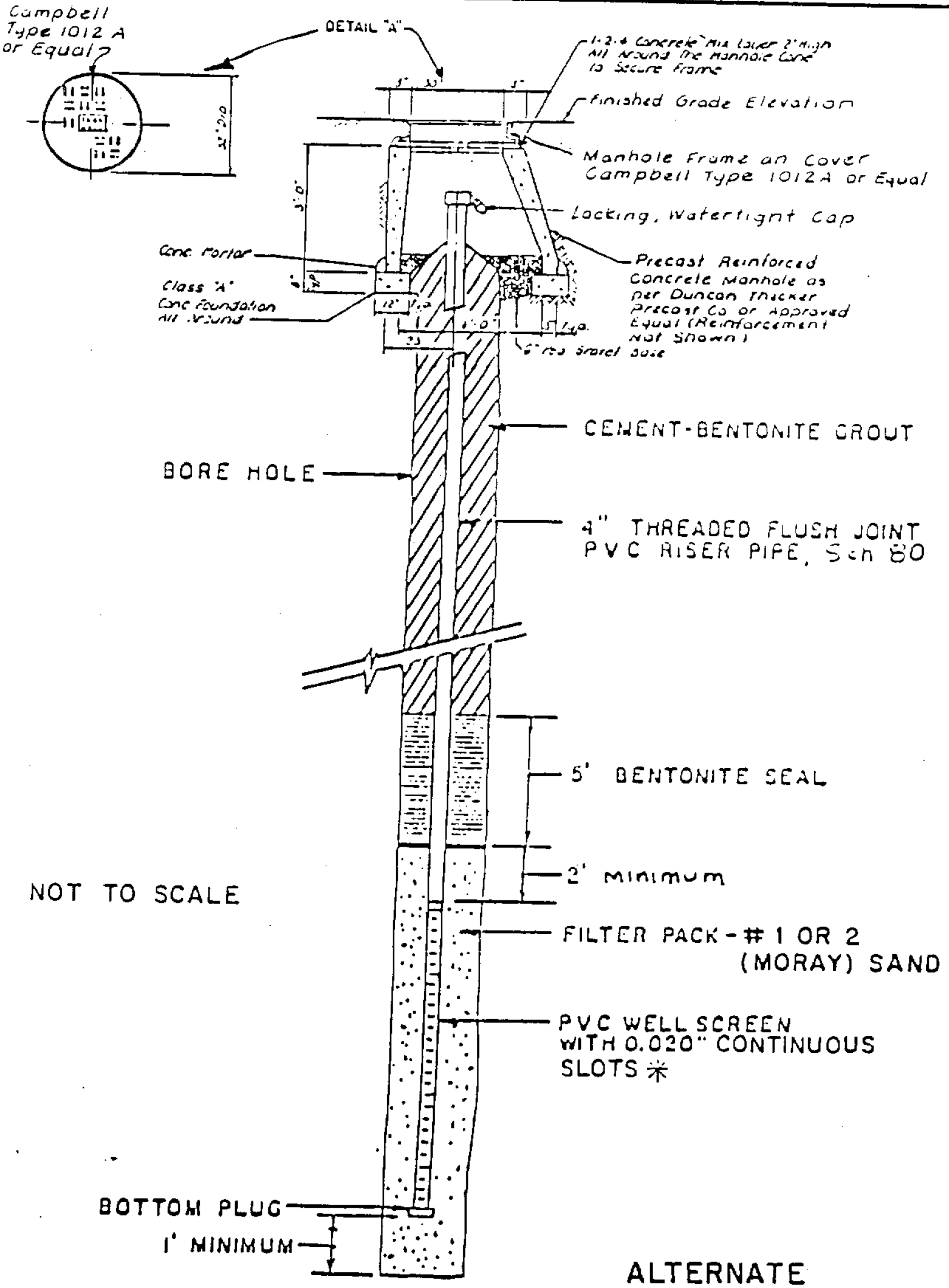
NOT TO SCALE

PROPOSED
MONITORING WELL DETAILS

* SEE TABLE I FOR PROPOSED WELL SCREEN LENGTHS AND DEPTHS

FIGURE 5

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS



* SEE TABLE I FOR PROPOSED WELL SCREEN LENGTHS AND DEPTHS

ALTERNATE
WELL COMPLETION DETAILS

FIGURE 6

R.E. PUSTORINO, P.C.
CONSULTING ENGINEERS

12.1.3 Filter Pack

The filter pack shall be a clean siliceous material of size compatible with both natural formation material and screen slot size to be used. It shall be delivered to the job site in sealed bags, and shall remain in the bags until placed in the well.

Based upon subsurface materials that have been found at the site, it is expected that a coarse Moray Sand (#1 of #2 Well Gravel) will be most appropriate for use. The Contractor's final recommendation of a filter pack size and grade must be approved by the Engineer.

12.1.4 Bentonite Pellets (if applicable)

Bentonite pellets shall be 1/2-inch diameter with a dry bulk density of 82 pounds per cubic foot, containing a minimum of 90% montmorillonite and having a pH of 8.5 to 10.5. The pellets shall swell to 10 to 15 times their dry volume when hydrated with fresh water. Bentonite pellets shall be VOLCLAY tablets, as manufactured by the American Colloid Company, or approved equal.

12.1.5 Cement Grout

The Contractor shall provide a mixture of Portland cement (ASTM C150), not more than seven (7) gallons of clean water per bag (one cubic foot or 94 pounds) of cement, plus 5% bentonite by weight (approx. 1 coffee can per bag of cement) to be used. The use of special cements, or other admixtures to increase fluidity, and/or control time of set and the composition of the resultant slurry must be approved by the Engineer prior to the grouting operation.

12.2 Installation Procedure

All well installations shall be done in accordance with the general procedure outlined below.

12.2.1

Prior to construction of the well, the Contractor shall complete the borehole, as required by the Engineer. All test borings which penetrate a clay (aquifer) boundary below the well screen depths, determined by the Engineer, require the placement of a bentonite seal below the bottom of the screen.

12.2.2.

The bottom of the screen shall be sealed with a threaded plug made of the same material as the casing. Solvent welded plugs will not be allowed.

The slotted and unslotted PVC plastic pipe shall be connected in lengths as approved by the Engineer. Pipe shall be joined watertight by threaded joints in accordance with manufacturer's directions and recommendations. Care shall be taken to ensure that, when two pipes are joined, they butt tightly together and that no gaps or restrictions exist which may prevent free passage of pumping equipment.

12.2.3

The casing and screen may be lowered into the bore hole with the drilling machine or by hand using clamps or other devices approved by the Engineer.

12.2.4

The space surrounding the well pipe in the borehole (the "annulus") shall be filled with a clean siliceous material, as described above, to a level at least two (2) feet above the screened interval. The Contractor shall exercise caution in the extraction of the casing (cable tool method) to maintain sand within the casing at all times. Both the extractions of the casing and the placement of the siliceous material shall be done in small increments not to exceed five (5) feet, or as approved by the Engineer.

The placement of the filter material shall be by TREMIE.

12.2.5

It will be required to seal off the screened well from the upper portion of the hole by placing a seal on top of the sand in the annulus at a specified depth. The seal will consist of material such as "Peltonite", "Volclay", "Pi-Pellets", or equal.

The placement of the seal material shall be by TREMIE. In order to facilitate tremie of the seal material, a slurry composed of 50% bentonite and potable water may be used. Following placement of the seal material, the well shall be permitted to "set" for a period of no less than two hours before beginning the grouting operation.

12.2.6

The Contractor shall seal off the upper portion of the hole, to within four (4) feet of grade surface, with TREMIED cement-bentonite slurry. The cement grout shall be forced up the annular space from the bottom of the hole. The tremie pipe shall be kept full continuously from the start to the finish of the grouting procedure. Details of the seal placement will be subject to the Engineer's approval.

12.2.7

The top 3 feet of boreholes shall be backfilled with cement grout. The 8 in. diameter steel surface casing pipe shall be left around the well pipe, and the borehole around the surface casing pipe shall be dug out approximately on a 2 ft. square and to a depth of 2 ft., and filled with concrete which will be sloped away from the well to prevent ponding of water adjacent to the pipe.

The top of the well casing shall be about 1.5 feet above the existing ground surface. It shall be externally threaded to accept four-inch internally threaded well caps.

An eight-inch diameter protective steel surface casing pipe (minimum wall thickness of 1/4-inch) shall be installed to protect the well casing as indicated on the plans. The protective steel surface casing shall have a minimum length of 5'-0". A hasp and padlock, welded chain with padlock, or other suitable locking device, shall be attached to the cap and casing to secure the well against vandalism.

A 1/4-inch diameter breather hole shall be drilled through the side of the casing about three inches below the bottom of the cap.

12.2.8 Alternate Well Completion Detail

A 4 ft. diameter Class A concrete foundation should be fit around the PVC pipe at the four (4) foot depth, and overlain by a precast reinforced concrete manhole (3 ft. high), as shown on the surface details in Figure 6. Concrete mortar should be placed between the foundation and the manhole cover to form a watertight seal.

After allowing at least 24 hours for possible settlement of the grout-mix into the well, additional grout should be placed around the PVC pipe, (above the bottom of the foundation) and formed to slope downward and outward from the pipe; six (6) inches of pea gravel should then be placed over the grout in the manhole to allow for drainage (See Figure 5).

The top of the PVC well casing shall be cut to approximately one (1) foot below the existing grade for easy access to the monitoring well during sampling. The PVC shall be capped and secured with a suitable locking device to protect against vandalism.

A thirty (30) inch manhole frame and cover, as detailed in Figure 5, should be placed over the manhole, and a concrete mix layer 2" high formed around the manhole cover. The top of the manhole cover shall be at the finish grade.

12.3 Monitoring Well Alignment

The entire length of the finished well to the bottom of the screen shall permit, without difficulty, the passage of a 3-3/8" (nominal) submersible pump. To ensure the easy lowering and removal of the pump, the contractor shall lower a ten-foot long section of the appropriate sized diameter API line pipe to the bottom of the well. Free passage of this pipe through the well shall indicate acceptable alignment.

12.4 Monitoring Well Development

12.4.1

All monitoring wells shall be developed by means of pumping, surging, jetting, etc., until the discharge water has been cleared of sand, silt and other assorted sediment. The process shall be continuous until a clear flow of water is produced by the well, or as directed by the Engineer so as to assure:

- o a good hydraulic connection between the well and the aquifer; and
- o collection of representative groundwater samples

12.4.2

The Contractor shall utilize a submersible pump or other techniques as approved by the Engineer. The Contractor shall provide all power, equipment, labor and appurtenances required for the development of each monitoring well.

Initially, it is desirable to utilize a development method that minimizes disturbance of the formation, for example, pumping or surging. If those methods prove unsuccessful and jetting is required, the Contractor should make sure that the volume of water extracted from the well during the jetting process exceeds that introduced into the formation.

12.4.3

The pumped formation water will be discharged onto the site, as designated by the Engineer, in an appropriate containment system; the final discharge mode shall be in compliance with all applicable Federal and State Regulations.

The Contractor is cautioned that he will be required to furnish suitable lengths of hose to direct the drilling water, development water and pumped formation water to the existing recharge basin or such other disposal point as directed by the Engineer. All costs associated with these activities shall be included in the overall cost of the project.

12.4.4

All equipment used for well development will be disassembled, as necessary, and thoroughly steam-cleaned before being introduced into each well.

Each well shall be developed to provide a minimum flow rate of 10 gpm, sand free, and a turbidity less than 50 NTU, as determined by a field nephelometer.

12.5 Aquifer Testing

Aquifer or "slug" testing will be performed in all monitoring wells that are installed for determination of the hydraulic conductivity of the materials in the screened interval. The aquifer test method and procedures that are used shall be approved by the Engineer. Analysis of the test data shall also be undertaken by the Contractor, and all calculations and results should be submitted to the Engineer in the final Field Report.

12.6 Abandonment of Wells

Should it be necessary for the Contractor to abandon a borehole before installation of the well, a cement-bentonite, or other approved mix shall be used to fill in that boring up to surface grade.

12.7 Restoration

The contractor shall minimize disruption to the site and is responsible for cleanup and complete restoration, such that the site is restored to its original state, subject to the approval of the Engineer. Restoration shall be the contractor's responsibility and no separate payment will be made to the contractor for restoration.

12.6 Abandonment of Wells

Should it be necessary for the Contractor to abandon a borehole before installation of the well, a cement-bentonite, or other approved mix shall be used to fill in that boring up to surface grade.

12.7 Restoration

The contractor shall minimize disruption to the site and is responsible for cleanup and complete restoration, such that the site is restored to its original state, subject to the approval of the Engineer. Restoration shall be the contractor's responsibility and no separate payment will be made to the contractor for restoration.