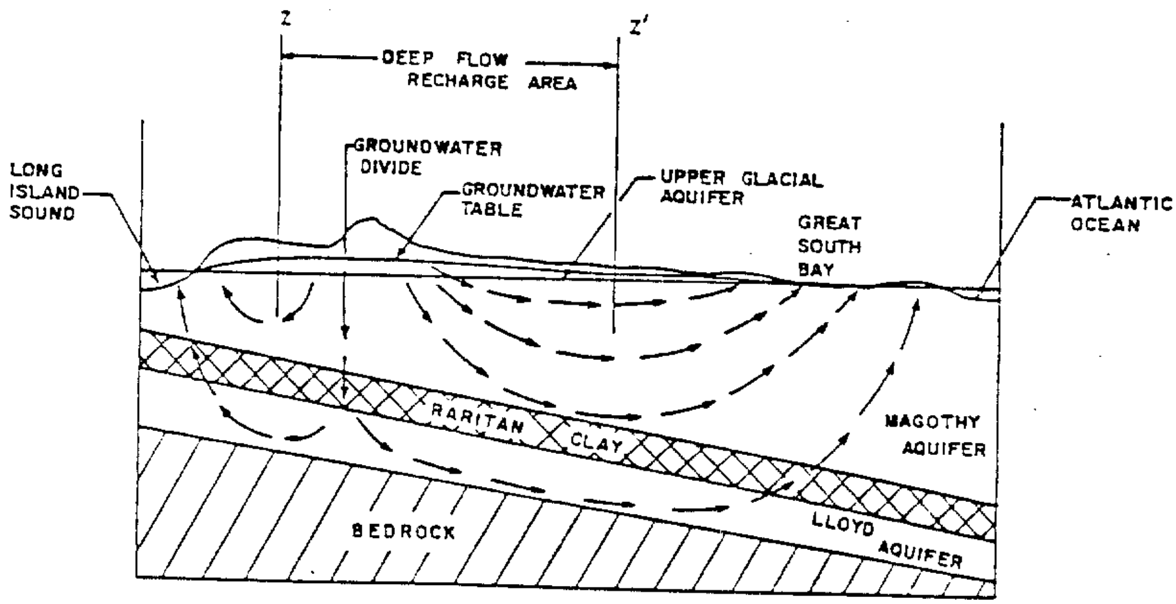
TOWN OF SMITHTOWN

SUFFOLK COUNTY, NEW YORK

HYDROGEOLOGIC INVESTIGATIONS



KINGS PARK AREA
AND
MSF LANDFILL

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HYDROGEOLOGIC INVESTIGATIONS

KINGS PARK AREA

TOWN OF SMITHTOWN

SUFFOLK COUNTY, NEW YORK

APRIL 1986

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SECTION 1

SUMMARY AND CONCLUSIONS

1.0 SUMMARY

1. The hydrogeological investigations was initiated to establish the geology and groundwater flow patterns beneath the Smithtown MSF landfill and the site's proximity to the hydrogeologic Zone I boundary as defined in the 208 Study.

   To accomplish these objectives, a deep well cluster approximately 625 feet deep was drilled to the Raritan formation. In addition, information was obtained on other wells in the area and three well fields owned and operated by the Suffolk County Water Authority (SCWA).

2. The drilling program confirmed the existence of the Smithtown Clay unit having a thickness of approximately 35 feet at the site and located just beneath the existing MSF Landfill.

   This semi-impermeable barrier in addition to the composite double liner system of the landfill provides maximum protection to the deep flow region of this portion of the Town.

3. Based upon analysis of data collected under this program and prior reports, the Smithtown Clay unit appears to be continuous between the MSF landfill site and the limits of the deep flow recharge area as defined by the 208 Study. This continuous clay unit impedes direct recharge of the deep flow system at the landfill and in the local area.

4. At the MSF landfill site the upper surface of the Magothy formation was confirmed to be at approximately elevation -90 feet relative to MSL. The depth of the clay member of the Raritan Formation was at elevation -490 feet and was identified as an apparent transition zone boundary containing both Magothy and Raritan Formation material.

5. At the MSF Landfill site there is an apparent downward vertical flow component as established through potentiometric head measurements taken at the well cluster in February 1986.

   In measurements obtained at the Suffolk County Water Authority Carlson Avenue well field, potentiometric elevations in shallow and deep wells were identical thus signifying its location at the boundary of the deep flow recharge area. This SCWA site is located approximately 1.5 miles from the MSF Landfill in the apparent direction of groundwater flow. The Lawrence and Kings Park Road well sites indicated higher potentiometric elevations in the shallow wells signifying a downward flow component thus located within the deep flow recharge area.

6. Based upon data collected under these investigations, it would appear that the limit of the Zone I boundary area, as defined in the 208 Study, is reasonably accurate.

1.1 CONCLUSIONS

1. Based upon field investigations conducted in February 1986, the MSF landfill site appears to be within the deep flow recharge area as defined under the 208 Study. However, due to the areal extent and thickness of the Smithtown Clay in the study area, the impact of the landfill site is minimal relative to recharge of the deep flow zone.

   Hydrogeology of the study area is complex due to the Smithtown Clay unit thus the accepted concepts relative to deep flow recharge not directly apply to the study area and specifically the MSF landfill site.

2. The deep flow region below the Smithtown Clay unit from the MSF landfill site to present Zone I-Hydrogeologic Boundary line appears to be a flow transition zone.

3. The potentiometric head relationship at the site involving the clay unit/water table surface is complex. A one (1) foot upward flow differential was measured between the top and bottom of the Smithtown Clay unit. Locally this would indicate a vertical flow direction from under the clay member.

SECTION II

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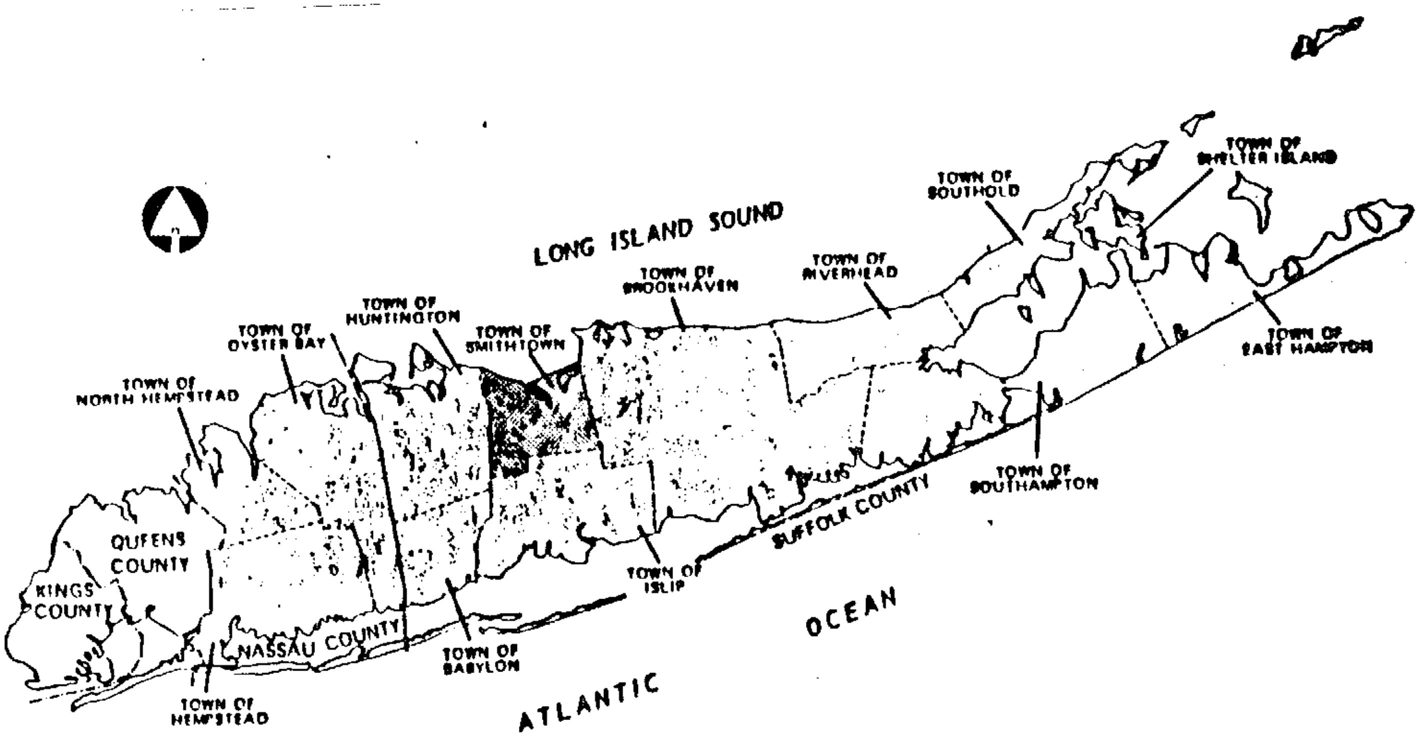
SECTION 2.0

INTRODUCTION

2.1 LOCATION AND DESCRIPTION OF STUDY AREA

The Town of Smithtown is situated in the northwesterly portion of Suffolk County and comprises an area of 53.3 square miles (34,017 acres). 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. A location plan of the regional area is included as Figure 1. The Town includes the Incorporated Villages of Head of the Harbor, Nissequogue and The Branch and unincorporated areas of Commack, Fort Salonga, Hauppauge, Kings Park, Lake Ronkonkoma, Nesconset, St. James and the Hamlet of Smithtown.

Smithtown achieved its greatest period of growth during the fifties and sixties. The population of the Town doubled in the fifties and again in the sixties but the increase during the seventies was modest at approximately two (2%) percent. The decline in growth between 1970 and until the recent economic upturn is attributed to young adults moving out, declining birth rate and very little new home construction.



TOWN OF SMITHTOWN

LOCATION PLAN

FIGURE 1

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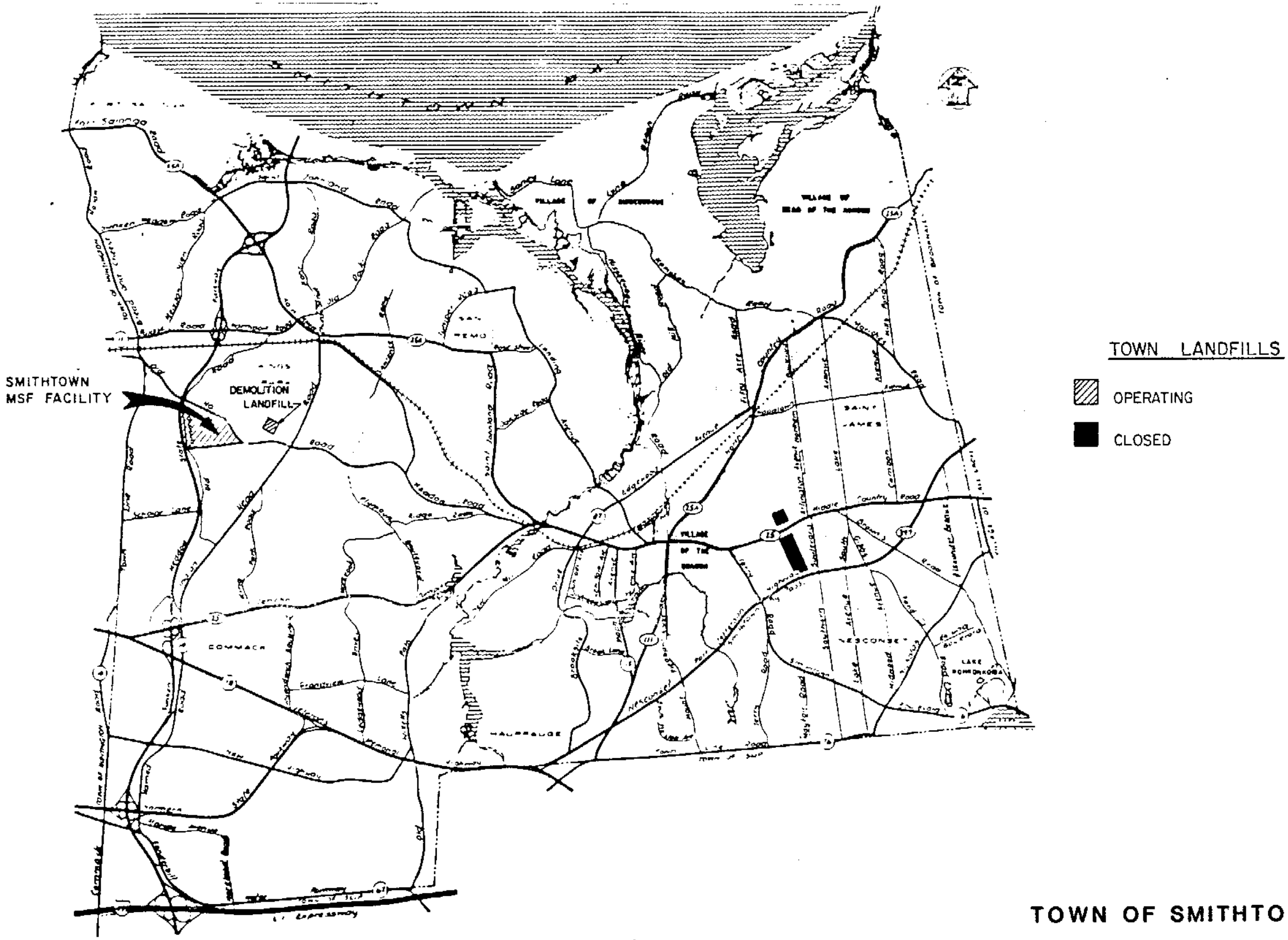
The population for the Town of Smithtown in 1980, based on U.S. Census data, was 116,663. Saturation population based on existing zoning ordinances for the Town and its Incorporated Villages for the year 2020 is projected to be about 142,900 persons.

2.2 MUNICIPAL SERVICES FACILITY AND LANDFILL

The Town's Municipal Services Facility (MSF) including landfill encompasses approximately 86 acres in the southeast corner of the intersection of Old Northport Road and Old Commack Road in Kings Park, Figure 2. Approximately 70 acres of the site is designated landfill area with the remaining 16 acres used for buffer zones, process building, administration building and parking, gate house, recharge basin and access roads. The Municipal Services Facility Site Plan is shown on Figure 3.

2.2.1 Processing Building

Construction on the solid waste management facility started in 1975 under Environmental Facility bond Act Resource Recovery Project 1-MSWRR-001Q. The processing building is approximately 200' x 300' (60,000 SF) and incorporates resource techniques to remove salvageable solid waste materials and a high density hydraulic press to bale all of



TOWN OF SMITHTOWN

LANDFILL LOCATIONS

FIGURE 2

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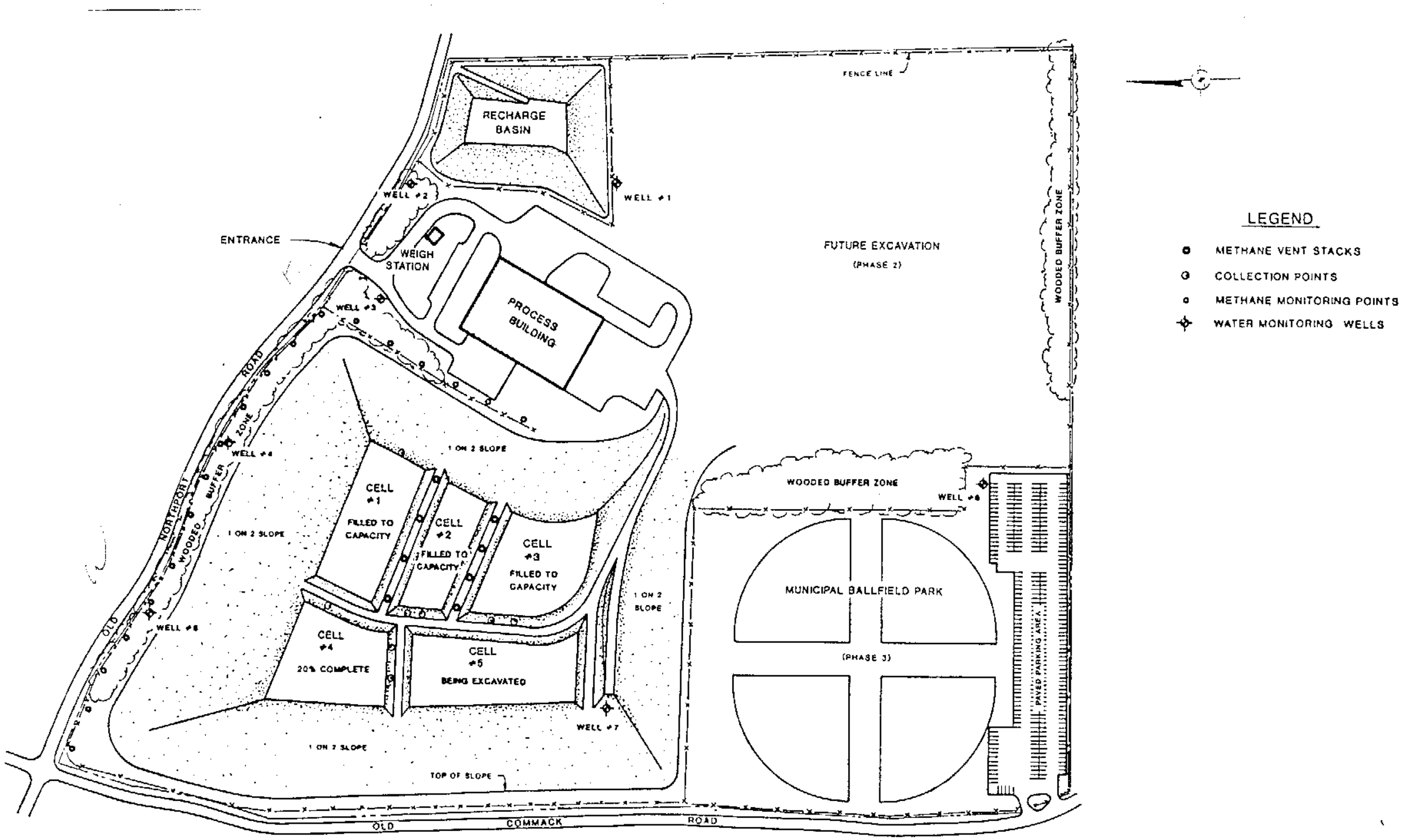

SITE PLAN

SMITHTOWN MUNICIPAL SERVICES FACILITY

FIGURE 3

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the remaining un-salvageable solid waste material. The Town ceased operation of the baler in September 1983 after four (4) years of service due to mechanical failures. The building was closed in May 1984.

2.2.2 Landfill Area

Landfilling of solid waste began in June 1979 for baleable and unbaleable material. However, since the baler operation ceased in September 1983, only conventional landfilling is being performed at this site. The 70 acres of this site designated as landfill area was developed to proceed in three (3) phases. Phase I (23.5 acres) is the current landfilling area and has been further segmented into five (5) separate operational cells, see Figure 3.

Composite Double Liner System

This Phase I area is constructed with a flexible membrane liner (FML) Composite Double Liner system. The flexible membrane liner (FML)/composite double liner system consists of a primary leachate collection and removal system, a top FML (primary) liner, a secondary leachate collection system, and a bottom composite FML (secondary) liner. This system complies with current design guidelines, is state-of-the-art technology for landfill liners and provides maximum protection to human health and the environment.

The function of the primary leachate collection and removal system is to minimize the head (depth) of leachate on top of the primary liner during the landfill operations period and to remove liquids through the post-closure period. The primary liner has been designed to prevent migration of waste liquid constituents during operations and the post-closure period to minimize infiltration of any constituent into the liner itself.

Leachate collection is by a six (6) inch perforated polyvinyl chloride (PVC) pipe system which flows to a precast concrete sump for removal from the landfill. Leachate is pumped from the collection sump into trucks by an independent contractor and disposed of at the Suffolk County Kings Park Wastewater Treatment Plant.

The secondary leachate detection system between the two FML liners is provided to rapidly detect, collect, and remove liquids entering the system for disposal through the post-closure monitoring period. The secondary (bottom) liner consists of two components that is intended to function as one system, hence, the term "composite" liner. The upper component of the secondary liner is designed to prevent the migration of any constituent of the waste liquid during the facility operation, including post-closure period.

This design methodology is effective in preventing virtually all percolation of leachate into the groundwater because the combination of the two components in the secondary liner system will provide for virtually complete removal of waste or leachate by the leachate collection system if a leak were to occur in the primary liner system.

An added barrier and protection to the groundwater system is the 35 feet of Smithtown Clay unit immediately beneath the MSF landfill site.

No hazardous, toxic, radioactive, explosive, or biologically unacceptable waste material is accepted at the MSF landfill site.

2.2.3 Useful Landfill Life

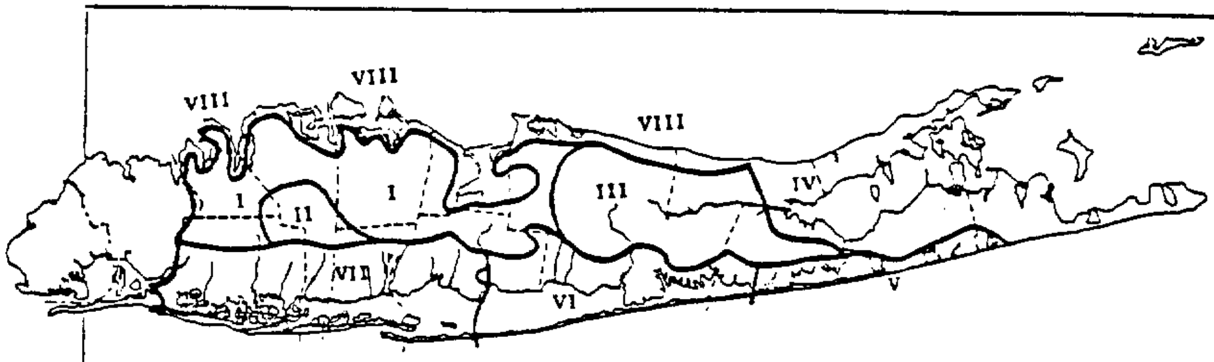
Under present operational conditions, landfilling of raw refuse, the remaining life of the Town of Smithtown MSF Landfill (Phased I, II and III) is approximately 28 years. Based upon population projections presented in the Town's Phase I Solid Waste Management Plan, the MSF landfill could serve the Town to the year 2013. The useful landfill life could increase significantly if the site were used in conjunction with a Town Resource Recovery Facility for the disposal of ash residue, unprocessible materials and system bypass.

2.3 PURPOSE AND SCOPE OF INVESTIGATIONS

The United States Environmental Protection Agency (EPA) has designated Long Island as a sole source aquifer region. This designation is a product of the Long Island Comprehensive Waste Treatment Management Plan of 1978 (i.e., the 208 Study) which study was prepared pursuant to Section 208 of the Federal Water Pollution Control Act. Sensitive deep flow recharge areas within the counties of Nassau and Suffolk have been defined by the plan as Hydrogeologic Zones I, II and III. The approximate location of these zones and typical groundwater flow patterns are shown on Figure 4.

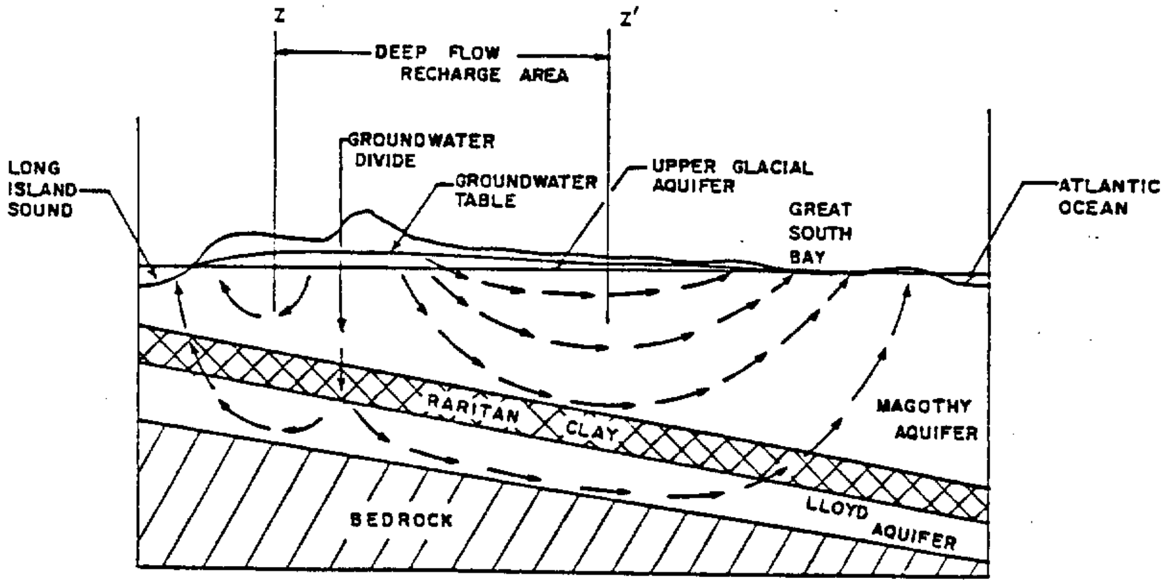
The Long Island Landfill Bill was signed into law on June 21, 1983 and has an effective date of December 18, 1983. The purpose of this legislation was to phase out the landfilling of raw municipal refuse as a primary solid waste disposal practice in Nassau and Suffolk Counties and to have resource recovery facilities replace the landfilling no later than December 18, 1990.

New York State Department of Environmental Conservation (NYSDEC) has determined that the Smithtown MSF landfill is within the sensitive deep flow recharge area, Hydrogeologic Zone I, and must be phased out of operation by December 18,



Hydrogeologic Zones in the Nassau-Suffolk 208 Study Area

FIGURE O



Typical Groundwater Flow Patterns on Long Island

FIGURE P

SOURCE - DRAFT - LONG ISLAND GROUNDWATER MANAGEMENT PROGRAM
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

HYDROGEOLOGIC ZONES IN THE SMITHTOWN (LANDFILLS) AREA.
FIGURE 4

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1990. The site is situated about 7500 feet (1.4 miles) southwesterly of the defined 208 line in the groundwater flow direction.

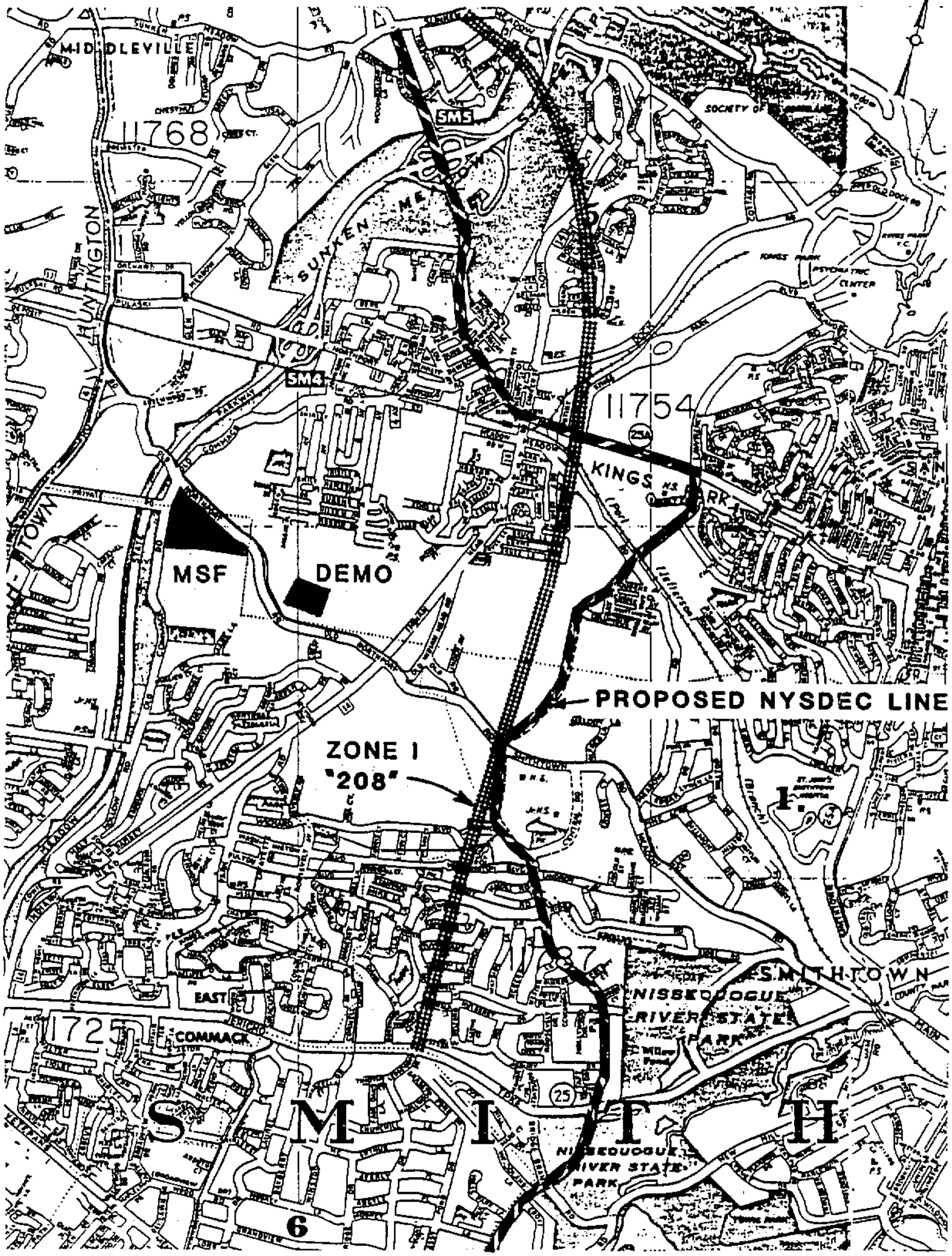
The location of the Smithtown landfill within the Zone I area has significant implications for the Town of Smithtown in its ability to include the existing site in the development of a long term solid waste management plan. The forced closure of the landfill would most probably require the Town to site and construct a new landfill, and/or be faced with the inability to dispose of its municipal solid waste without implementation of a Resource Recovery Program.

The Town's Phase I - Solid Waste Management Plan projected the useful life of the MSF site to be approximately 28 years when landfilling raw municipal refuse and demolition materials. If closed by December 18, 1990, 24 years of useful life at the existing site would be unavailable for disposal of municipal refuse without implementation of a resource recovery facility. Notwithstanding, the Town would still require an active landfill for the ash disposal, landfilling of bypass and for disposal of unprocessable materials.

Hydrogeologic zone boundaries established through the 208 Study used available data and information. Although several reports were published at that time which described the Huntington-Smithtown hydrogeology, they did not have sufficient hydrogeologic data to accurately describe the presently used Zone I boundary or its proposed modification by the NYSDEC, Figure 5. The relative lack of data coupled with the complexity of the Smithtown geology raises questions as to the exactness of this boundary line and its use in planning or implementation efforts.

The principle and subordinate objectives of the project include:

- Verification that the existing Smithtown Landfill site is within/without the deep flow recharge area and the significance of its location relative to the Zone 1 hydrogeologic boundary.
- To supplement geological information in the vicinity of the Smithtown Landfill and expand upon the existing data base for this complex flow regime area.
- Develop hydrogeologic information that will be of assistance to Federal, State and local agencies for water resources planning and implementation of the NYSDEC Long Island Groundwater Management Program.
- To supplement the groundwater monitoring wells in the vicinity of the Smithtown Landfill and other private landfill sites.



PROPOSED MODIFICATION TO HYDROGEOLOGIC ZONE BOUNDARIES IN THE VICINITY OF TOWN OF SMITHTOWN LANDFILL SITES

FIGURE 5

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- o To compile information on existing wells, geology and other groundwater information in the Kings Park area.

2.4 REGIONAL AND LOCAL PHYSIOGRAPHY AND GEOLOGY

The area in general is characterized by very hilly and irregular topography. Land surface elevations average about 150 feet above mean sea level (MSL) in the immediate vicinity of the Smithtown MSF complex. To the north, west, and south, as one approaches the Harbor Hill and Ronkonkoma terminal moraines, elevations average over 200 feet above MSL and exceed 300 feet above MSL southwest of the site near Dix Hills. The land surface drops off to the east and reaches sea level at the Nissequogue River.

The geology consists of a thick sequence of southeast-sloping, unconsolidated deltaic/alluvial sediments resting uncomfortably on dense, crystalline bedrock. The sediments are effectively covered by recent glacial moraine and outwash deposits. In general, the sediments are comprised of porous, water-saturated, sand and gravel beds, somewhat clayey and silty, with numerous interbedded and discontinuous clay layers (Table 1). All gradations from one type of material to another are represented in the strata. A summary of the hydrogeologic formations underlying the Smithtown area follows and is shown

—Summary of the stratigraphy and water-bearing properties of the deposits underlying the Huntington-Smithtown area, Suffolk County, N.Y.

System	Series	Stratigraphic unit	Thickness (feet)	Character of deposits	Water-bearing properties
Quaternary	Recent	Recent deposits Artificial fill, marsh deposits, beach deposits, and surficial soil.	0-20±	Sand, gravel, silt, and clay; organic mud, peat, loam, and shells. Colors are brown, yellow and gray.	Sandy and gravelly beach deposits may locally yield small supplies of fresh to brackish water to wells. Marine silt and clay in north-shore harbors retard salt-water encroachment and confine underlying aquifers.
Quaternary	Pleistocene	Upper Pleistocene deposits.	0-300±	Till composed of unassorted clay, sand, and boulders as ground moraine in area north of Harbor Hill terminal moraine and possibly as buried ground moraine of the Ronkonkoma ice. Outwash deposits of brown well-stratified sand and gravel—predominantly quartzose but containing biotite and other dark minerals and igneous and metamorphic rock fragments—including advance outwash, channel and valley-fill, and outwash-plain deposits. Ice-contact deposits of crudely stratified sand and gravel and isolated masses of till in the Ronkonkoma and Harbor Hill terminal moraines. Glaciolacustrine deposits of brown and gray silt and clay intercalated with outwash deposits in buried valleys.	Till, relatively impermeable; commonly causes perched-water bodies to form locally and impedes recharge from precipitation. Outwash and ice-contact deposits are moderately to highly permeable. Wells screened in outwash deposits generally at depths of less than 250 ft yield as much as 1,700 gpm. Specific capacities of public-supply wells range from 22 to 222 gpm per ft of drawdown. Water is generally fresh and unconfined. Chief source of water for domestic, public-supply, industrial, and irrigation wells in project area. Glaciolacustrine deposits of silt and clay are relatively impermeable and locally retard movement of water between adjacent water-bearing beds in Pleistocene and Cretaceous deposits.
		- - - -Unconformity?- - - -			
Quaternary	Pleistocene	Pleistocene deposits undifferentiated.	0-400±	Sand, gravel, clay, and silt. Lignite present in some silt or clay layers. Colors are brown and gray. These deposits are present in deep buried valleys and may include equivalents of the Gardiners clay and the Jameco gravel found elsewhere on Long Island. This unit may include some Pliocene(?) deposits, but evidence is scanty.	Coarser sand and gravel beds are permeable and would presumably yield moderate to large supplies to properly constructed wells. One well, S16,137, screened in these deposits yields 1,400 gpm, and has a specific capacity of 46 gpm per ft of drawdown. Silt and clay beds confine water in adjacent water-bearing beds.
		- - - -Unconformity?- - - -			
Tertiary(?)	Pliocene(?)	Mannetto gravel	0-300±	Stratified sand and gravel and scattered clay lenses; unit is predominantly quartzose; igneous and metamorphic rock fragments are scarce. Colors are pale to yellowish brown. Caps hills in western part of Huntington and locally present in buried valleys.	Deposits are moderately to highly permeable but generally lie above the zone of saturation. Locally, water supplies for domestic use are obtained from these deposits, such as at wells S4, S208 and S927. No large public-supply or industrial wells were screened in these deposits in 1960.
		- - - - Unconformity - - - -			
Cretaceous	Upper Cretaceous	Magothy(?) formation	0-800±	Sand, clayey, with silt, clay, and some gravel. Colors are white, gray, brown, yellow, and red. The upper part of the formation commonly includes interbedded clay, fine to medium sand, silt, and some lignite; the lower part is largely coarse sand, gravel, and some clay.	Generally ranges from moderately to highly permeable. The lower part of the formation is more permeable than the upper part. Several public-supply wells screened in the basal zone have yields ranging from 1,000 to 1,500 gpm and specific capacities from 30 to 90 gpm per ft of drawdown. Water is generally of excellent quality. Second most important source of water to wells. Unconfined conditions are common in uppermost part of formation, but confined conditions prevail in the lower part; some wells flow.
		- - - - Unconformity - - - -			
Cretaceous	Upper Cretaceous	Raritan formation: Clay member	0(?)-188±	Clay and silt, and a few layers of sand. Lignite and pyrite concretions are common. Colors are mostly gray, white, and red.	Relatively impermeable. Acts as a confining bed, which retards but does not prevent movement of water between the Magothy(?) formation and the Lloyd sand member.
Cretaceous	Upper Cretaceous	Raritan formation: Lloyd sand member	200-265±	Sand, fine to coarse, and gravel, mixed with some clay and some layers of silt and clay. Colors are white to pale yellow.	Moderately permeable. Not extensively developed. Several public-supply and industrial wells yield as much as 250 gpm in northern Huntington, but potential yields from properly constructed wells are much greater. Water is confined and some wells flow. Water is generally of excellent quality, but on Eaton Neck it is brackish.
		- - - - Unconformity - - - -			
Precambrian to lower Paleozoic		Bedrock		Crystalline metamorphic and igneous rocks.	Relatively impermeable. Forms the floor of the ground-water reservoir.

SOURCE: Lubke (1964)

TOWN OF SMITHTOWN
SMITHTOWN LANDFILL

SUMMARY OF DEPOSITS UNDERLYING THE SMITHTOWN AREA

TABLE NO. 1

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schematically in Figure 4. The reader is referred to the paper by Lubke (1964) for a more in-depth description.

The bedrock basement underlying the Smithtown area is the oldest geologic unit and consists mainly of gneiss and schist of low hydraulic conductivity. Its upper surface ranges in elevation from 650 feet below MSL in the northwest corner of the town to 1350 feet below MSL in the southeast near Lake Ronkonkoma.

The Raritan Formation lies directly on top of the bedrock and is the earliest of the upper Cretaceous deposits. It consists of a lower Lloyd Sand Member and an upper Clay member. The formation ranges from about 300 feet below MSL in the northwest to 800 feet below MSL near Lake Ronkonkoma. The Lloyd Sand Member (Lloyd Aquifer) generally consists of beds of fine to coarse sand and gravel, commonly in a clayey matrix, with some interbedded layers of solid and silty clay. The Clay member consists of solid and silty clay with few layers of sand. The hydraulic properties of the Lloyd Sand Member are generally quite good. Groundwater contained within the sediments is strongly confined under artesian conditions by the overlying, relatively impermeable Clay member.

The Magothy Formation (Magothy Aquifer) is in general the most important water supply source in the Smithtown area.

Its lower boundary generally corresponds to the upper surface of the Raritan Formation. The sediments are mostly silty, fine to medium sand with interbedded gravel and clay layers. The lower 50-200 feet of the deposit commonly contain abundant gravel. Groundwater contained within the upper portion of the formation generally exists under unconfined, water table conditions. With increasing depth, artesian conditions prevail as the numerous, interbedded clay layers become more effective in confining the water. The upper surface of the formation is highly irregular due to extensive erosion which occurred during pre-glacial times by streams draining the land surface.

Lying atop this eroded surface and comprising the remainder of the land mass are deposits of undifferentiated pre-, intra-, and post-glacial sands, gravels, and clays. Termed the Upper Pleistocene deposits (Upper Glacial Aquifer), these sediments contain mostly interbedded fine to often very coarse sand and gravel with some thick marine and glacial silt and clay layers. The sediments are generally very porous and permeable and are also an important water supply source for the Smithtown area. Groundwater generally exists under unconfined, water table conditions. Locally, however, artesian conditions prevail beneath the numerous and often quite extensive clay deposits.

2.5 PREVIOUS STUDIES

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 performed more recently by Jensen and Soren (1974), McClymonds and Franke (1972), Donaldson and Koszalka (1982), and Donaldson (1982). Krulikas, Koszalka, and Doriski (1983) presented an updated interpretation of the Matawan Group-Magothy Formation surface, and Krulikas and Koszalka (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).

In addition, the Town of Smithtown has installed a number of shallow permanent observation wells for the purposes of monitoring water table levels and groundwater quality in and around the MSF site.

Information from all previous studies was used to its maximum extent as background data and supplemental information and incorporated into these investigations.

SECTION III

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SECTION 3.0

SITE INVESTIGATIONS

3.1 GENERAL

The primary objective of the site investigations was the installation of a deep well cluster for the purposes of evaluating head differentials beneath the Smithtown MSF Landfill site. Information from the program would provide verification that the existing MSF landfill site is within/without the deep flow recharge area and the significance of the site relative to the published 208 Study - Zone I hydrogeologic boundary.

A drilling program was designed to advance a 24 inch diameter borehole to the top of the Raritan Formation Clay member, estimated to be about 600 feet below grade surface (Jensen and Soren, 1974). Three, four (4) inch wells were installed in the borehole and screened at various depths. Each well was individually developed and static water levels were recorded.

The information gained from the well cluster is three-fold:

1) Potentiometric Surface - The potentiometric surface is the elevation (referred to mean sea level) to

which water will rise in a tightly cased well from a given screened interval in an aquifer. The water table is a particular potentiometric surface. Differential potentiometric surface elevations of wells in the cluster are head losses associated with vertical flow through the aquifer(s).

2) The relative component direction of groundwater flow--whether upwards, downwards, or horizontal--can be deduced from a comparison of the differential heads as measured in the cluster wells. Groundwater flows from regions of higher energy head, or fluid potential, to regions of lower energy head. A higher potentiometric surface elevation in the shallow well of a cluster than in the deeper well is indicative of a region of groundwater recharge, thus, downwards flow component. The reverse case of potentiometric surface elevations in the well cluster would indicate a upwards flow component, or an area of groundwater discharge. Identical potentiometric surface elevations for both deep and shallow wells would be associated with horizontal flow, neither recharge nor discharge.

3) Periodic potentiometric surface measurements in cluster wells can be used to determine seasonal or long term changes in contours of groundwater levels together with flow lines and, similarly, flow lines within the confined aquifer which are orthogonal to

contours of the potentiometric surface. This information can be used to better understand the groundwater flow region of the area and characterize the hydrogeological environment.

Supplemental information in the form of geologic corelog descriptions and static water level measurements of existing wells in the vicinity was compiled and evaluated in order to more definitively determine the surrounding subsurface hydrogeologic environment.

The literature and files of the NYSDEC and U.S. Geological Survey was researched to identify deep wells or combination of wells in the study area which could be considered as representative well "clusters" for measurement purposes. Due to the lack of deep wells accessible for such measurements and, at the same time, beyond the range of influence of major public supply pumping wells, additional well clusters could not be defined in the study area.

Static head measurements were obtained, however, directly from several Suffolk County Water Authority (SCWA) public supply deep well clusters during non-pumping conditions. The SCWA had been in the process of undertaking a pumping test program at its well fields throughout the County for evaluating the characteristics of individual wells and, in general, the overall efficiency of the system. Part of this program entailed taking out of service the entire well field for several hours and allowing the system to achieve predevelopment or non-pumping conditions. It was through this cooperative effort that Velzy was able to obtain potentiometric surface measurements for the various SCWA deep wells in proximity to the Smithtown MSF site and in the vicinity of the 208 Study Zone I hydrogeologic boundary line.

3.2 DEEP WELL CLUSTER INSTALLATION

3.2.1 Drilling Phase

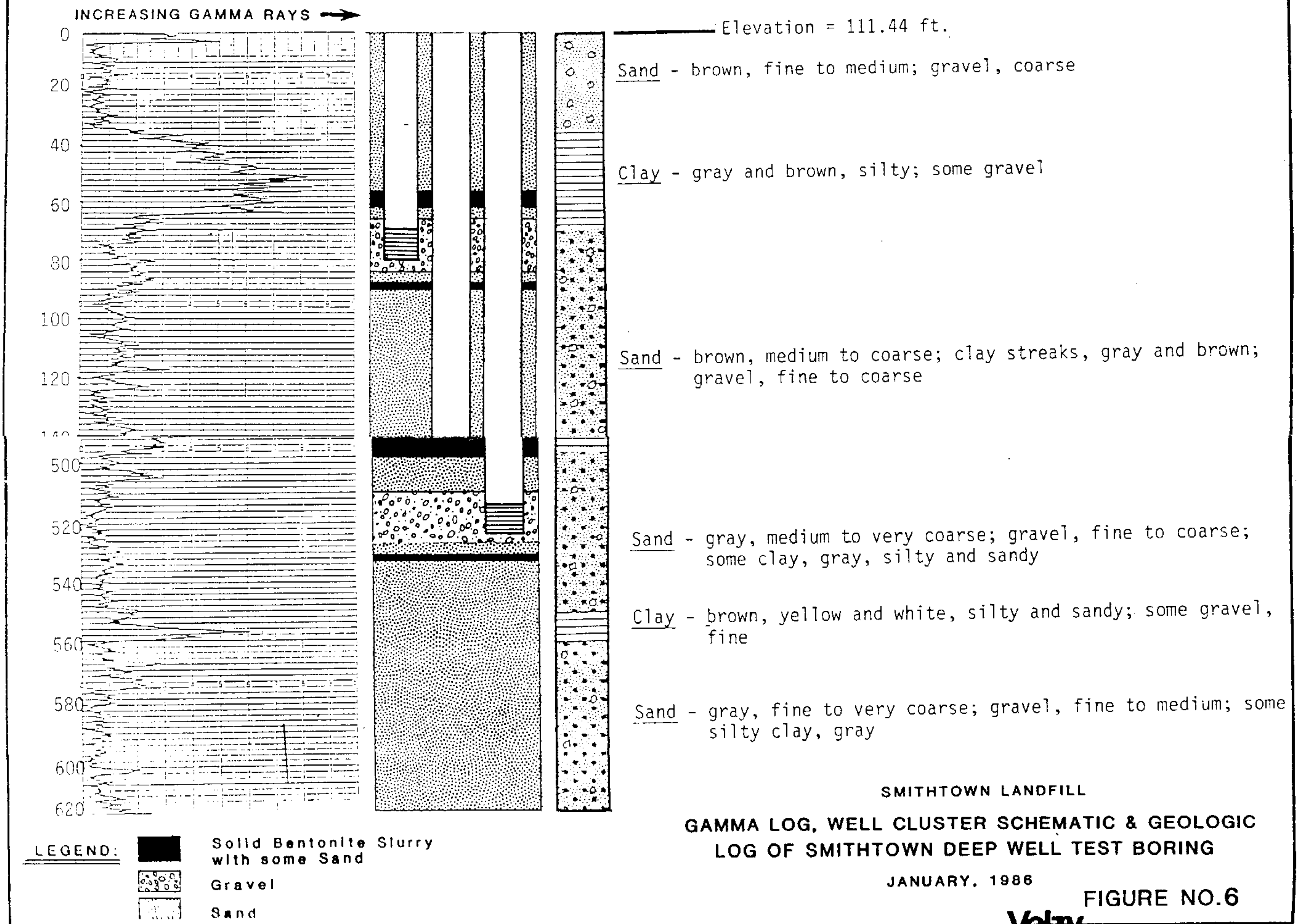
Drilling operations commenced on January 13, 1986, and were completed on January 24, 1986. The Reverse Rotary drilling method was employed. The work was performed by Delta Well, Ronkonkoma, New York. A final borehole depth of 620 feet below grade was recorded. This depth corresponds approximately to the top of the Clay member of the Raritan Formation.

Split-spoon geologic core samples, approximately twelve (12) inches long each, were taken at twenty (20) foot intervals and at depths where a distinct change in lithology of the sediments occurred. In addition, discharge pit washings were continuously monitored. Laboratory analysis of the core samples was performed in order to confirm field estimates of grain size ranges and percentages. Results are included in Appendix A. A copy of the geologic log for the borehole is shown in Figure 6.

Representatives of the U.S. Geological Survey and New York State Department of Environmental Conservation frequented the site to observe and collaborate with Velzy's geologist in identification of various strata penetrated.

Approximately 200 feet of Upper Pleistocene/Pliocene(?) deposits were penetrated as well as about 420 feet of Late Cretaceous deposits. Included in the Upper Pleistocene/ Pliocene(?) deposits was 35 feet of an extensive clay deposit identified as the Smithtown Clay, a major confining clay which was presumably deposited in an intramorainal lake.

Also observed in the Upper Pleistocene deposits about 90 feet below the Smithtown Clay and just above the Magothy Formation were significant clay lenses and intercalations which may be related to the Gardiner's Clay and/or Monmouth Greensand. These two formations have as yet to be identified definitively in the Smithtown area, but are quite extensive in southern Long Island. The lateral extent of this clayey material and its confining influence could not be fully confirmed given the existing lack of available deep well data on the area. In contrast, the



SMITHTOWN LANDFILL

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

JANUARY, 1986

FIGURE NO.6

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lateral extent of the Smithtown Clay is well known and was mapped by Krulikas and Koszalka (1983).

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 unknown given the available well data. No clay layers exceeded a thickness of ten (10) feet and one thirty (30) foot thick layer of silty clay with sandy intercalations was observed approximately centered at the 400 foot depth. The lower Magothy Formation was typically very coarse-grained and gravelly.

No strata uniquely identifiable as the clay member of the Raritan Formation was penetrated. Instead, Raritan and Magothy Formation material was identified together in the same strata beyond the 600 foot depth. This situation would indicate an apparent transition zone between the formations and not a clear-cut boundary.

3.2.2 Geophysical Logging

Geophysical logs furnish continous records of subsurface conditions that can generally be correlated from one well to another. They also serve as valuable supplements to geologic logs. Upon completion of the drilling phase of this program, natural-gamma logging of the uncased borehole was performed by representatives of the U.S. Geological Survey.

Because all subsurface materials emit natural-gamma radiation, a record of this constitutes a natural-gamma log. The radiation originates from unstable elements that occur to varying amounts in subsurface formations.

In general, the natural-gamma activity of clayey formations is significantly higher than that of quartz sands, etc. The most important application to groundwater hydrology is identification of lithology, particularly clayey sediments, which posses the highest gamma intensity. However, the emission of natural-gamma radiation and its intensity can also be used to identify differences between the types of materials associated with successive strata.

At the Smithtown site, the natural-gamma log in conjunction with geologic logs was used to establish lithology of the borehole and for establishing the most favorable placement for screen intervals of the well cluster.

Figure 6 shows the natural-gamma log of the uncased borehole sediments together with its geologic interpretation.

3.2.3 Well Screen Settings

Well screen settings were chosen on the basis of the natural-gamma log and geologic core sampling lithology results, as well as field observations of drilling rates. It was desired to place the screens in relatively permeable, sandy zones where the wells could be adequately developed and where measured potentiometric surfaces are more indicative of regional flow conditions.

Representatives of the New York State Department of Environmental Conservation and U.S. Geological Survey were also on site during the well screen setting phase of the project.

Well screens consist of ten (10) foot long, four (4) inch diameter, stainless steel, continuous slot No. 20 screens with four (4) inch diameter, Schedule 80, polyvinyl chloride (PVC) casings. Joining of casing lengths was accomplished using flush thread-type joints.

The upper screen was set below the Smithtown Clay in the Upper Pleistocene deposits. The remaining two screens were set in the Magothy Formation, the middle screen in the upper Magothy and the lower screen in the lower (basal) Magothy. Figure 6 shows a schematic of the borehole and placement of well screens.

In addition, a fourth length of PVC casing with a three (3) inch diameter, slotted, ten (10) foot long, PVC screen was set in the top of the Smithtown Clay. This was used to detect any perched water that may have been resting on top of the clay unit.

Each well screen setting consists of a gravel filter pack enveloping the well screen. A Bentonite clay pellet seal is placed above and below the filter pack to hydraulically isolate the screen settings and prevent a vertical flow of water through the annular space of the borehole to the screens. Fine sand "buffer" layers were emplaced between the filter packs and Bentonite seals to disallow migration of the Bentonite clay towards the well screen during well development. The remaining annular space was backfilled with a similar fine sand material.

3.2.4 Well Development

Each four (4) inch well was developed using the air-lift methodology. Pumping rates of about 10-15 gallons per minute (gpm) were maintained for a minimum of two (2) hours and until turbidity declined to acceptable levels and each well yielded clean, silt-free, formation water.

3.3 POTENTIOMETRIC SURFACE MEASUREMENTS

During an eight (8) day monitoring period in February, 1986, static potentiometric surface measurements were recorded for designated wells in the vicinity of the Smithtown MSF site. Background information, details of the wells and measured potentiometric surface elevation (heads) are presented in Table 2. The location of each monitoring location is shown in Figure 7.

3.3.1 Suffolk County Department of Health Services Wells

The Suffolk County Department of Health Services (S.C.D.H.S.) maintains an extensive network of observation wells throughout Suffolk County. Potentiometric surface measurements are compiled and detailed annual water table contour maps developed from this data.

Three (3) S.C.D.H.S. permanent observation wells are located in the study area. Potentiometric surfaces for these wells represent the water table at time of measurement. The wells are relatively shallow and are screened in a zone of the Upper Glacial Aquifer where groundwater exists under unconfined, water table conditions. Details of these wells are presented in Table 2 and location shown in Figure 7.

TABLE 2
RECORDED HEADS IN THE VICINITY OF THE TOWN OF SMITHTOWN MSF LANDFILL
FEBRUARY, 1986

NYSDEC WELL NUMBER	OWNER	DATE OF MEASUREMENT	SCREENED FROM/TO (mean sea level)	MEASURED HEAD (mean sea level)
S-74868	Smithtown	2/27/86	26/16	44.57
S-74869	"	"	45/35	44.68
S-74870	"	"	44/34	44.68
S-74872	"	"	25/5	46.09
S-82188 Shallow	"	2/21/86	40/30	46.63
S-82188 Middle	"	"	-190/-200	45.61
S-82188 Deep	"	"	-405/-415	45.01
S-15923	S.C.W.A.	"	?/-110	44.44
S-33006	"	"	-188/-351	42.26
S-53361	"	"	-285/-366	44.24
S-16129	"	2/25/86	-252/-382	37.64
S-64062	"	"	-351/-466	37.30
S-24545	"	"	-282/-350	36.02
S-66758	"	"	-333/-424	35.10
S-45402	S.C.D.H.S.	2/27/86	13/3	42.24
S-46964	"	"	33/23	41.14
S-46965	"	"	24/14	43.99

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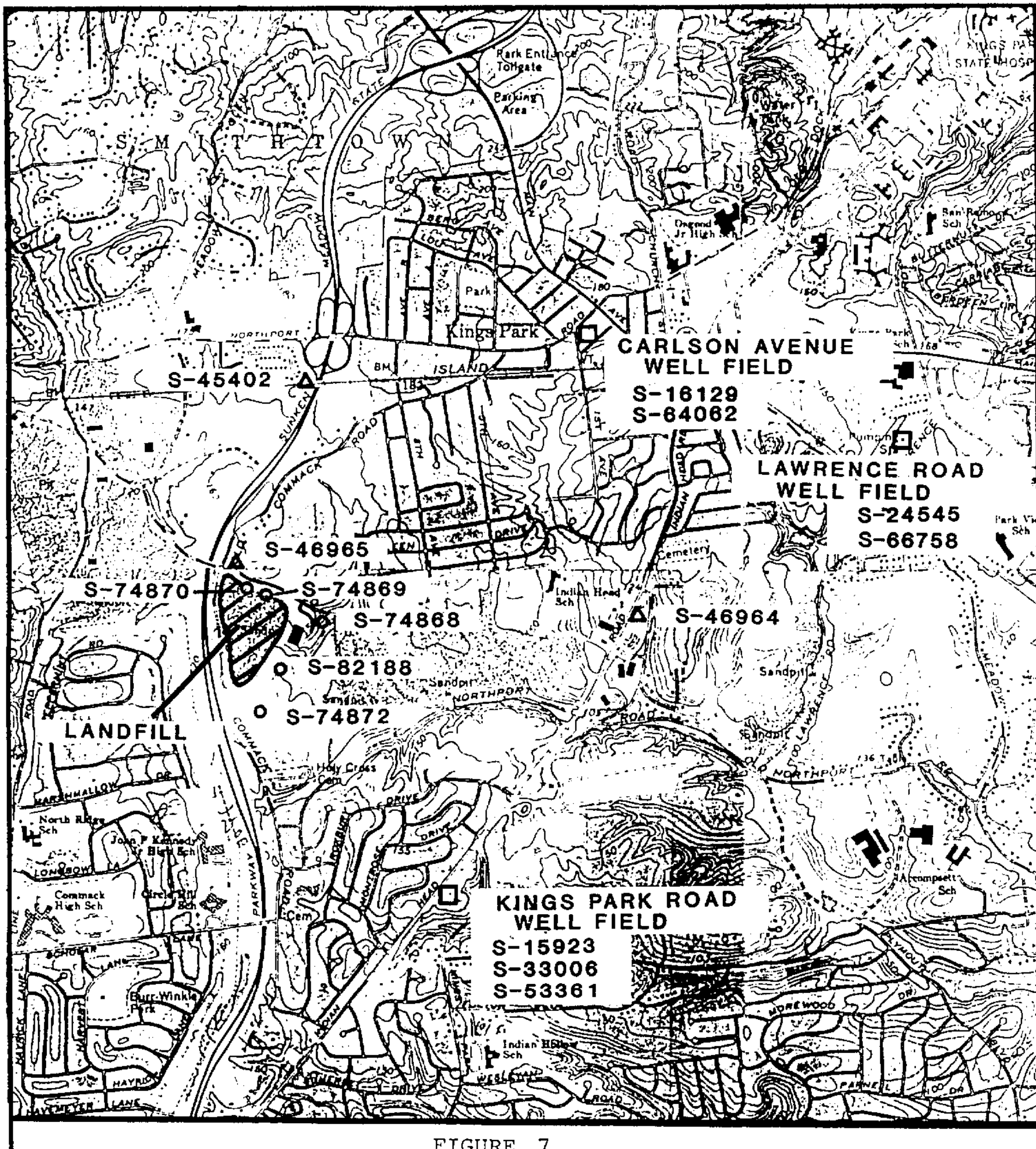

FIGURE 7
LOCATION MAP OF WELLS AND WELL CLUSTERS IN THE VICINITY OF THE TOWN OF SMITHTOWN LANDFILL

○ Town of Smithtown Observation Wells

△ Suffolk County Dept. of Health Services Shallow Observation Wells

□ Suffolk County Water Authority Public Supply Well Fields

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3.3.2 Suffolk County Water Authority Wells

The Suffolk County Water Authority (S.C.W.A.) maintains a number of operable public supply well fields within the Town of Smithtown. Three (3) S.C.W.A. well fields are located within two (2) miles of the Smithtown MSF site and include the Kings Park Road, Lawrence Road, and Carlson Avenue stations (Figure 7).

Through the cooperative effort with the S.C.W.A., static potentiometric surface measurements were recorded at each well field during non-pumping conditions.

The Kings Park Road wells were shut down for twenty-five (25) hours prior to the taking of measurements. The two (2) deeper wells recorded different potentiometric levels, yet, they are screened at about the same elevations thus should theoretically yield the same, or very similar, results. A number of factors could be responsible for this discrepancy. Averaging of the two potentiometric surface elevations was considered sufficient for the purposes of this report. This average value for the potentiometric surface elevation was 43.3 feet above MSL. The differential between the upper and lower screened zones is about 14.4 inches (1.2 feet) with the shallower well yielding the higher water surface elevation. This would suggest that the Kings Park Road station is in a region of groundwater recharge, e.g. Zone I hydrogeologic area.

The Carlson Avenue and Lawrence Road well fields were both shut down for over two (2) hours. The differential potentiometric levels between the two well screens recorded at the Lawrence Road well field and between those at the Carlson Avenue well field were 9.6 inches (0.8 feet) and 2.4 inches (0.2 feet) respectively. The higher water surface elevation for both sites were recorded in the shallower wells. These results would indicate that these well fields should be at the limit of a deep flow recharge area, e.g. boundary of the Zone I hydrogeologic area. For the period of these measurements, this would tend to confirm the general location of the Zone I boundary as established by the 208 Study.

3.3.3 Town of Smithtown Observation Wells

Shallow Water Table Wells

In compliance with New York State Part 360 Solid Waste Management Facilities Guidelines, the Town of Smithtown has installed a series of shallow permanent observation wells in the vicinity of the MSF landfill. The purposes of these wells is to monitor water table elevations and groundwater quality. Measurements obtained from these observation wells were used to supplement those recorded for the S.C.D.H.S. shallow wells.

Deep Well Cluster

This well (NYSDEC No. S-82188) was described fully in Section 3.2. At the time of measurements, the shallow (upper) well had a 12.2 inch (1.02 feet) differential in potentiometric surfaces than the intermediate or upper Magothy well. Similarly, the differential in potentiometric surface elevations between the intermediate and deep or lower (basal) Magothy well was 7.2 inches (0.6 feet) with the upper Magothy having the higher elevation.

Results of the potentiometric surface measurements indicate a total 19.4 inch (1.62 feet) downward differential between the Upper Pleistocene, just below the Smithtown Clay unit and the lower (basal) Magothy formations.

SECTION IV

SECTION 4.0

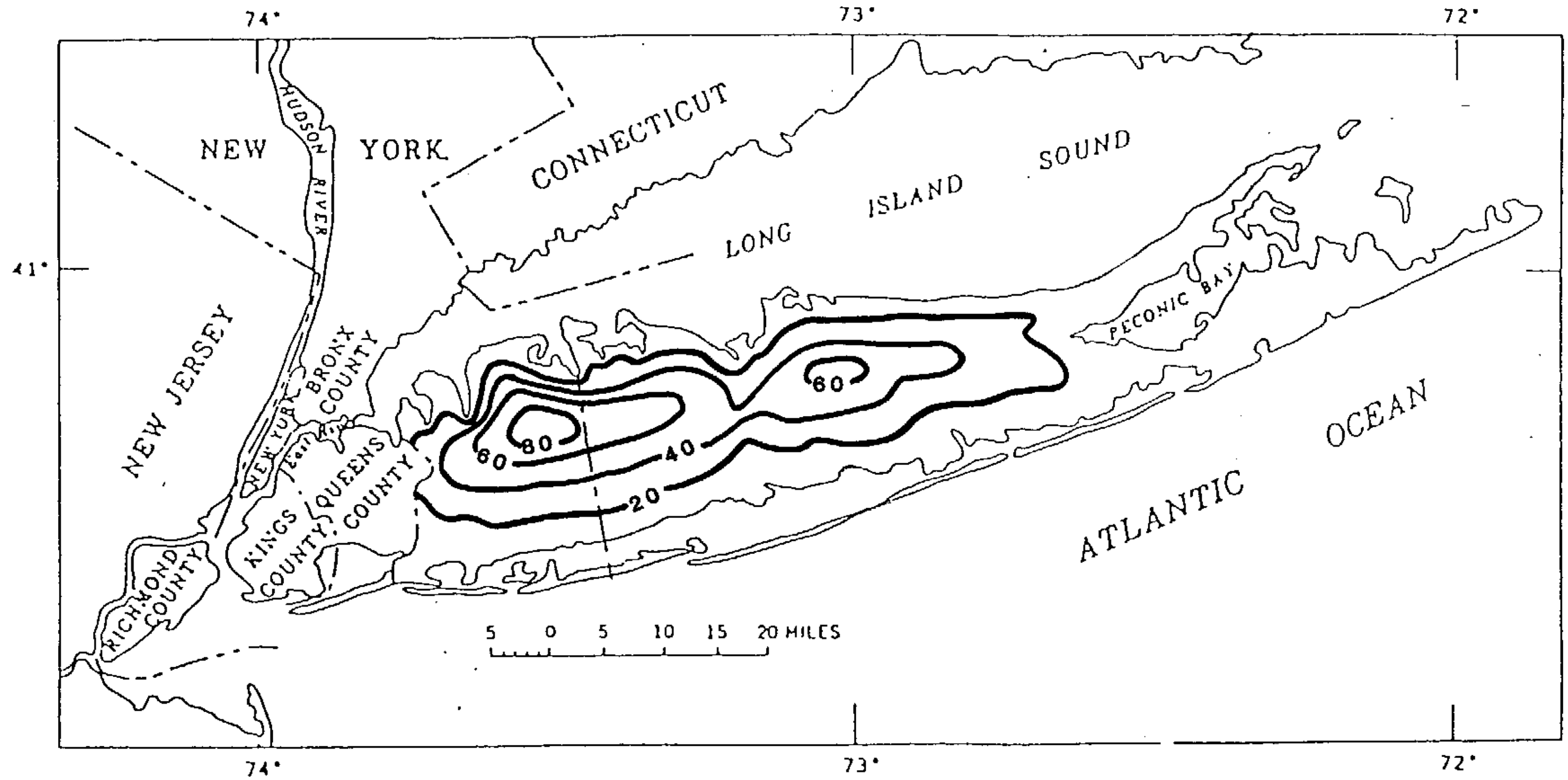
REGIONAL AND LOCAL HYDROGEOLOGY

4.1 CONTOURS ON THE WATER TABLE

4.1.1 General

Water table contour maps are prepared from potentiometric surface measurements of wells screened in the shallow, saturated zones of aquifers. The water table represents the boundary between saturated and unsaturated conditions and can be viewed as a subdued replica of the topography. Below the water table, the intergranular voids of the sediments are filled with water. The voids above the water table are only partially filled and act as the conduits for downward percolating precipitation which feeds the groundwater reservoir.

On Long Island, under natural conditions, the water table can be expected to fluctuate within a range of as much as ten (10) feet, according to long-term variations in precipitation and groundwater pumpage. This maximum fluctuation occurs at the groundwater divide. A generalized water table contour map for Long Island is included in Figure 8.



GENERALIZED WATER TABLE CONTOURS ON LONG ISLAND

FIGURE NO. 8

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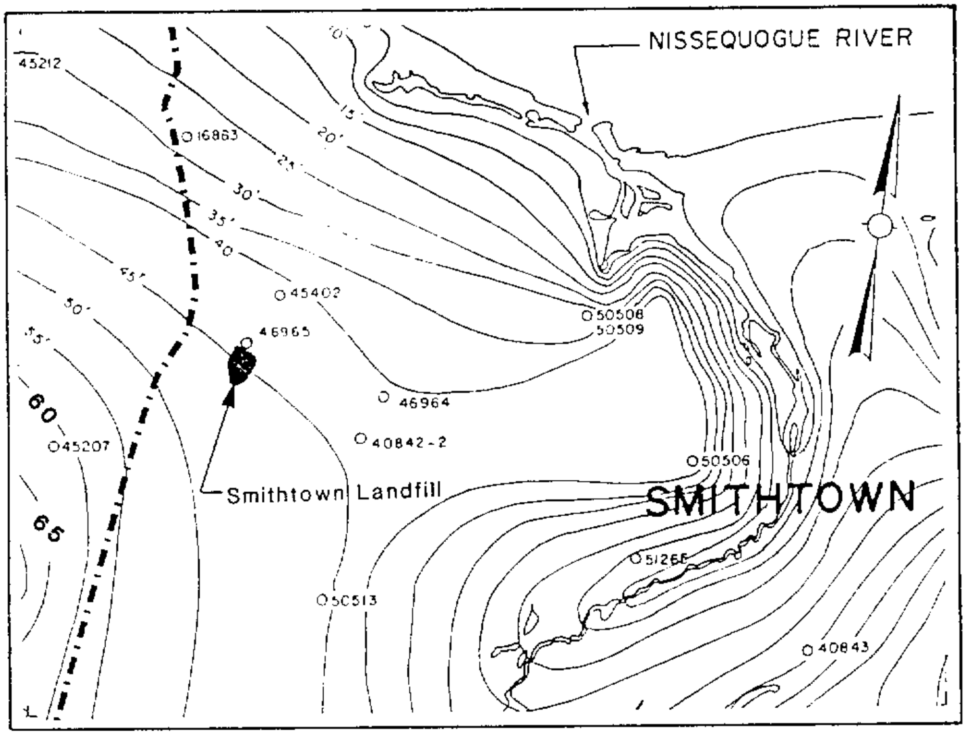
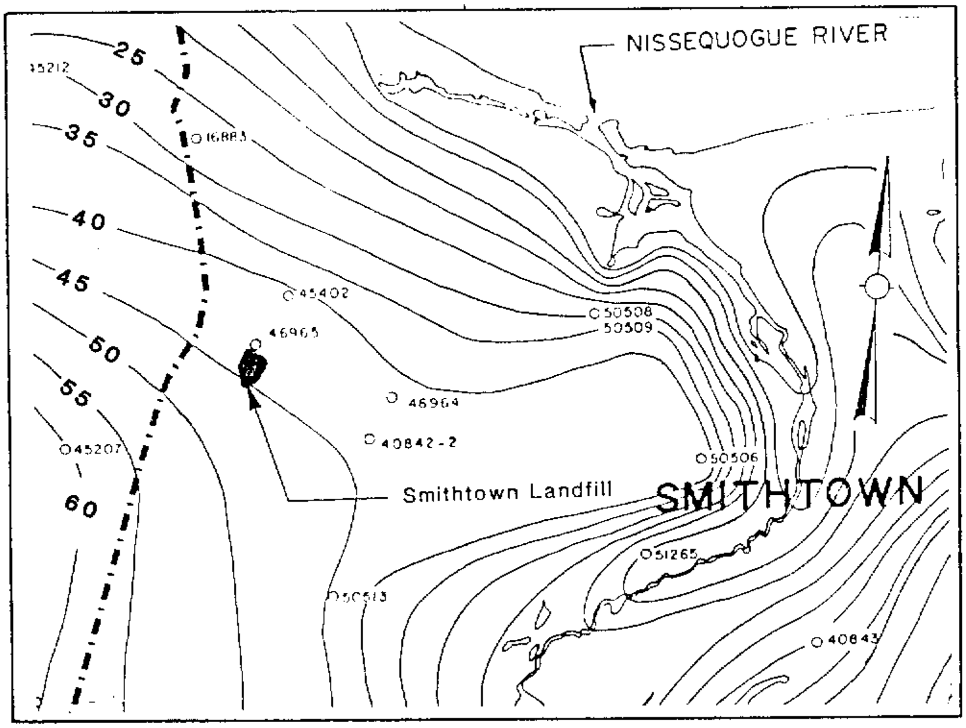
4.1.2 Regional Contours on the Water Table

Water table contour maps, for the years 1982 to 1985, prepared by the Suffolk County Department of Health Services are included in Figures 9 and 10. Characteristic features of the water table in the study area include a water table mound to the southwest (off the map) and a water table trough to the east and southeast. A water table mound, or local high point on the water table, exists to the southwest, corresponding to a topographic high on the Ronkonkoma terminal moraine in central Huntington. The edge is evidenced by the 60 and 65 foot contours in the lower left corner of the maps. The water table is relatively flat due east of the MSF site, and abruptly drops off towards the Nissoguogue River. A major trough, or low point, exists on the water table surface corresponding to the Nissoquogue River Valley.

Water Table maps of 1979 through 1985 indicate that the maximum annual elevation of the water table has fluctuated within a range of about seven (7) feet at the MSF site, from elevation 44 feet to 51 feet above MSL, during the seven (7) year period. Unlike other locations in the study area, there appears to be an adequate number of shallow observation wells (supplemented by the Town of Smithtown



CONTOURS OF THE WATER TABLE - 1982



CONTOURS OF THE WATER TABLE - 1983

TOWN OF SMITHTOWN
SMITHTOWN LANDFILL

GROUNDWATER CONTOURS
SMITHTOWN LANDFILL VICINITY

FIGURE NO. 9

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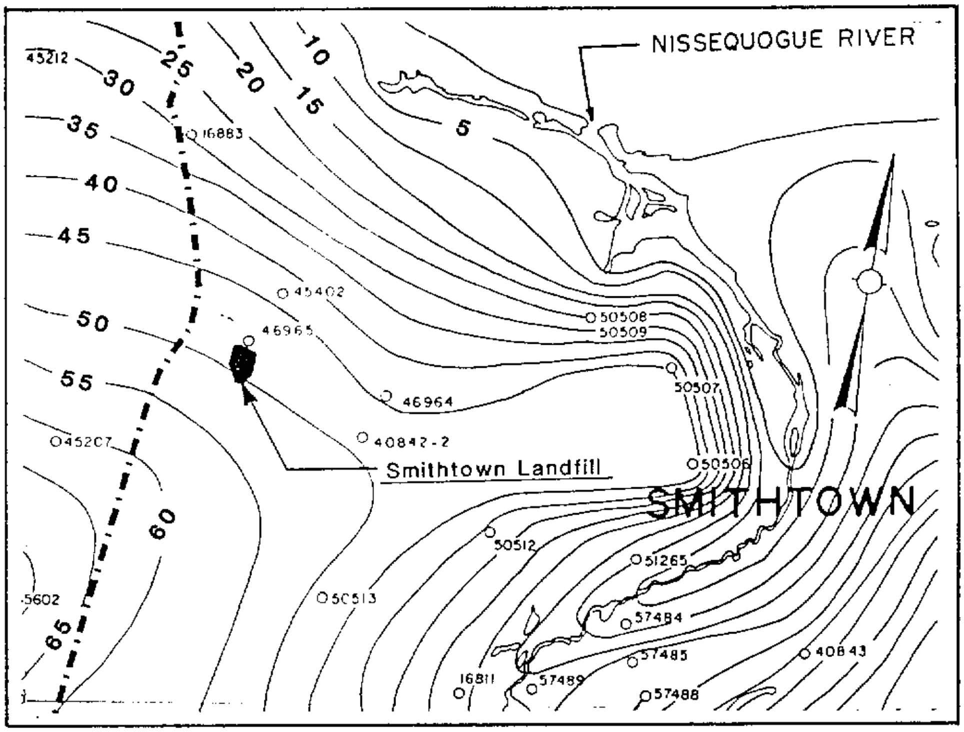
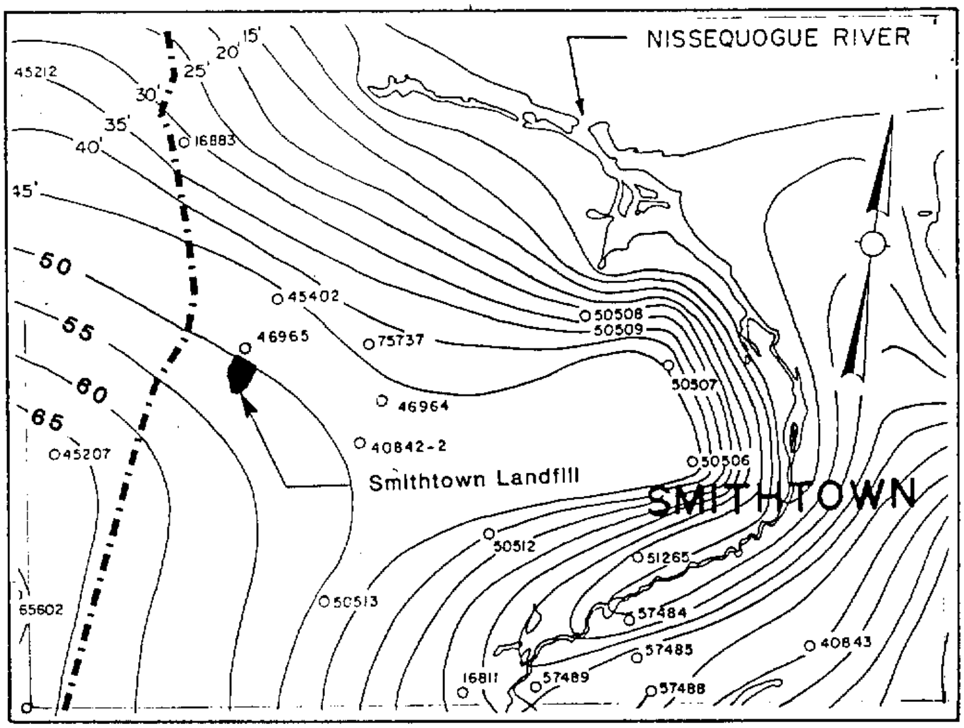


CONTOURS OF THE WATER TABLE - 1984



CONTOURS OF THE WATER TABLE - 1985

TOWN OF SMITHTOWN
SMITHTOWN LANDFILL

GROUNDWATER CONTOURS
SMITHTOWN LANDFILL VICINITY

FIGURE NO. 10

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shallow wells) for accurate water table contouring purposes near the MSF site.

During the February 1986 monitoring period, water levels in Well Nos. 46964, 46965, and 45402 were recorded. Well No. 40842-2 was damaged and unavailable for measurements. Well No. 75737 is a wastewater treatment plant well and is not considered suitable for regional contouring purposes.

4.1.3 Flow in Relation to Groundwater Contours

Generalized horizontal components of shallow groundwater flow can be deduced from water table contour maps. Because no flow crosses an impermeable boundary, flow lines must parallel it. Simlarly, if no flow crosses the water table of an unconfined aquifer, it becomes a boundary flow surface. Therefore, under steady-state conditions, the elevation of any point on the water table equals the energy head and, as a consequence, flow levels lie perpendicular to the water table contours. Therefore, groundwater flows from regions of higher energy head (contour elevation) to lower energy head and in the direction of greatest differential head.

Contour maps of the water table indicate a north-northeast flow direction reaching Smithtown Bay somewhere west of the

Nissequogue River outlet. This groundwater flow appears to have remained fairly constant over the past several years.

Contours of the water table for the immediate vicinity around the MSF site are shown in Figure 11. This water table map is based on potentiometric surface measurements recorded in late February, 1986. A water table elevation of about 46 feet above MSL is somewhat low for the MSF site average, corresponding to a deficit of precipitation during the previous fall and winter, as recorded at Nissequogue River State Park.

These updated contours are similar, if not identical, to S.C.D.H.S. contours for the years 1979 to 1985. They suggest a similar north-northeast flow path for shallow groundwater flow between the MSF site and Smithtown Bay.

4.2 EXTENT OF SMITHTOWN CLAY UNIT

4.2.1 Regional Correlations

The areal extent of the Smithtown Clay, a major confining clay unit, throughout the Smithtown area is well-documented (Krulikas and Koszalka, 1983). Figure 12 illustrates its general location, thickness, and inferred limit, as correlated from well records by the U.S. Geological Survey. Additional correlations were identified based on geologic

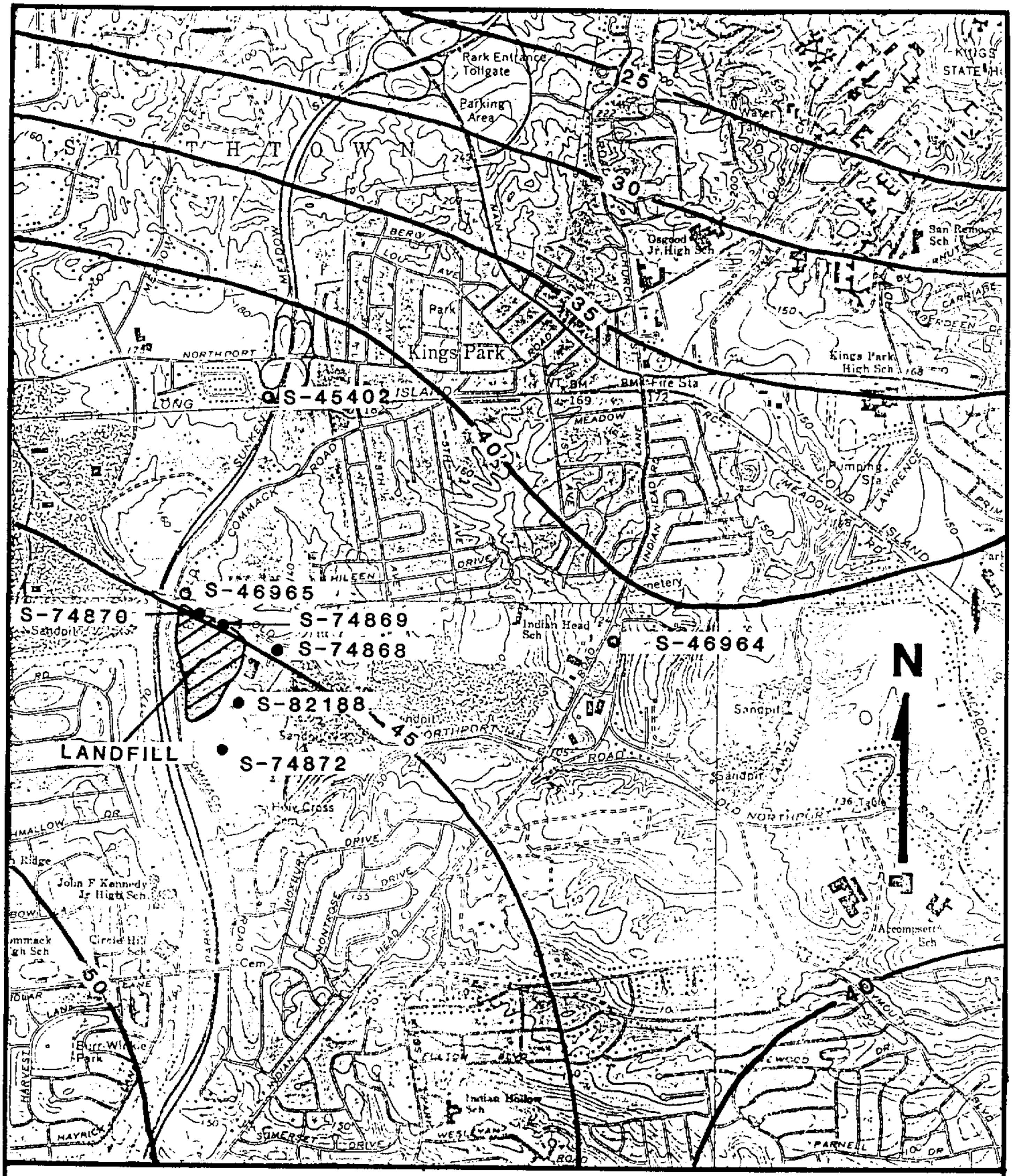

FIGURE 11
GROUNDWATER CONTOURS - SMITHTOWN LANDFILL VICINITY
FEBRUARY, 1986

—35— Approximate location of Water Table Contours. Datum is above mean sea level.

○ Suffolk County D.H.S. Water Table Observation Wells.

● Town of Smithtown Observation Wells

Scale: 1" = 2000'

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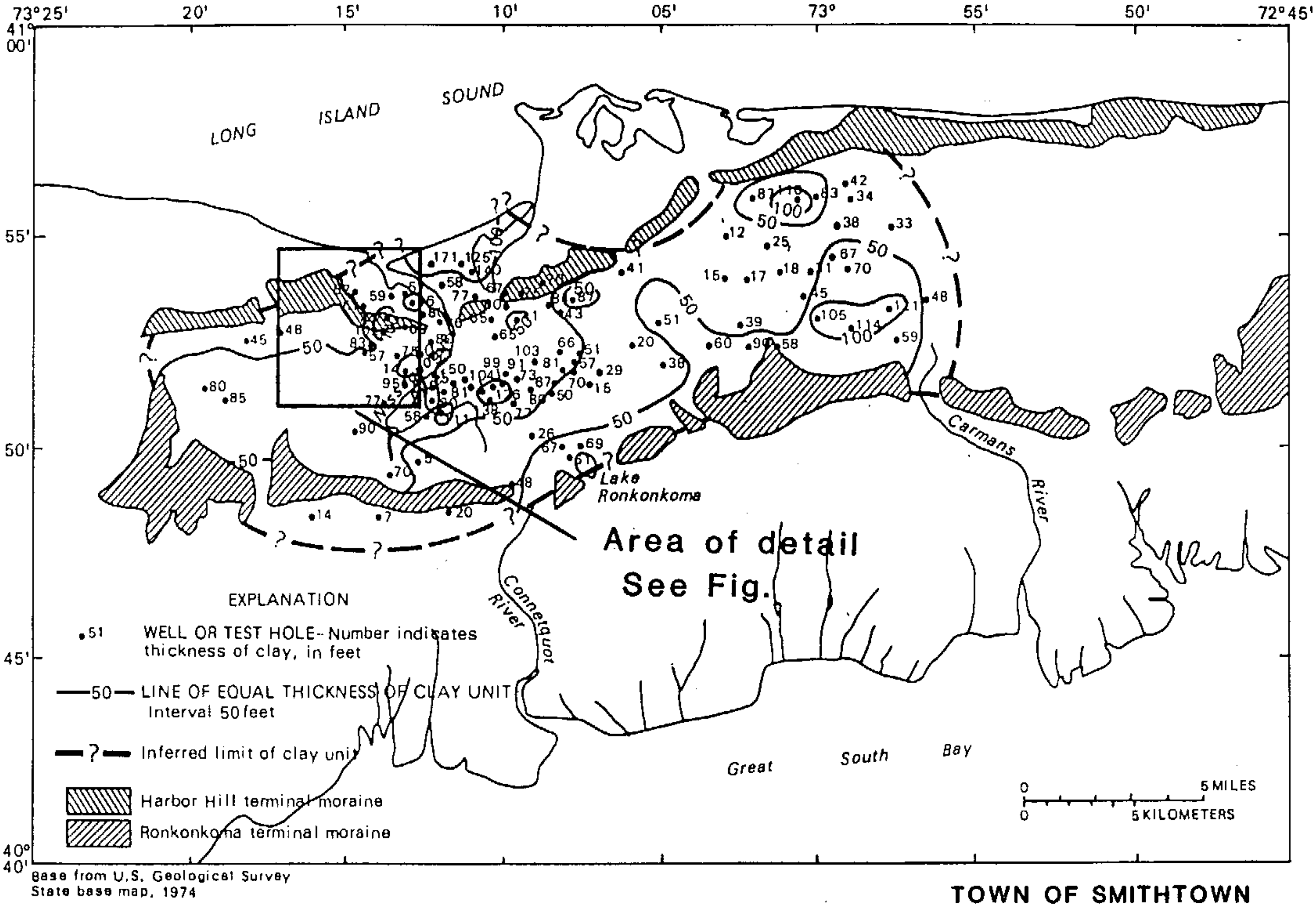

TOWN OF SMITHTOWN
SMITHTOWN LANDFILL

THICKNESS OF SMITHTOWN CLAY UNIT

FIGURE NO.12

Source: Krulikas and Koszalka (1983)

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core log descriptions included in well records on file at the NYSDEC. Figure 13 presents the locations of the wells used for mapping the Smithtown clay and the estimated thickness of the clay unit in relation to the MSF landfill site.

4.2.2 Site Correlation

The upper surface of the Smithtown Clay beneath the MSF landfill was identified from core log descriptions of Town observation wells. During installation of the shallow water table wells at the site in 1983, drilling proceeded to or into the top of the clay unit. The depth at which clay was reached was recorded in the drilling report. This information, along with that supplied by the more recent deep well cluster, was used to contour the upper surface of the Smithtown clay beneath the MSF site in Figure 14.

The upper surface of the clay lies about 100 to 150 feet below land surface at the site and slopes off to the east-northeast, in the direction of shallow groundwater flow. The clay unit is approximately 35 feet thick at the deep well cluster.

Top of the Smithtown Clay unit lies at about the same elevation as the water table in the study area. The upper surface of the clay unit is generally quite irregular and

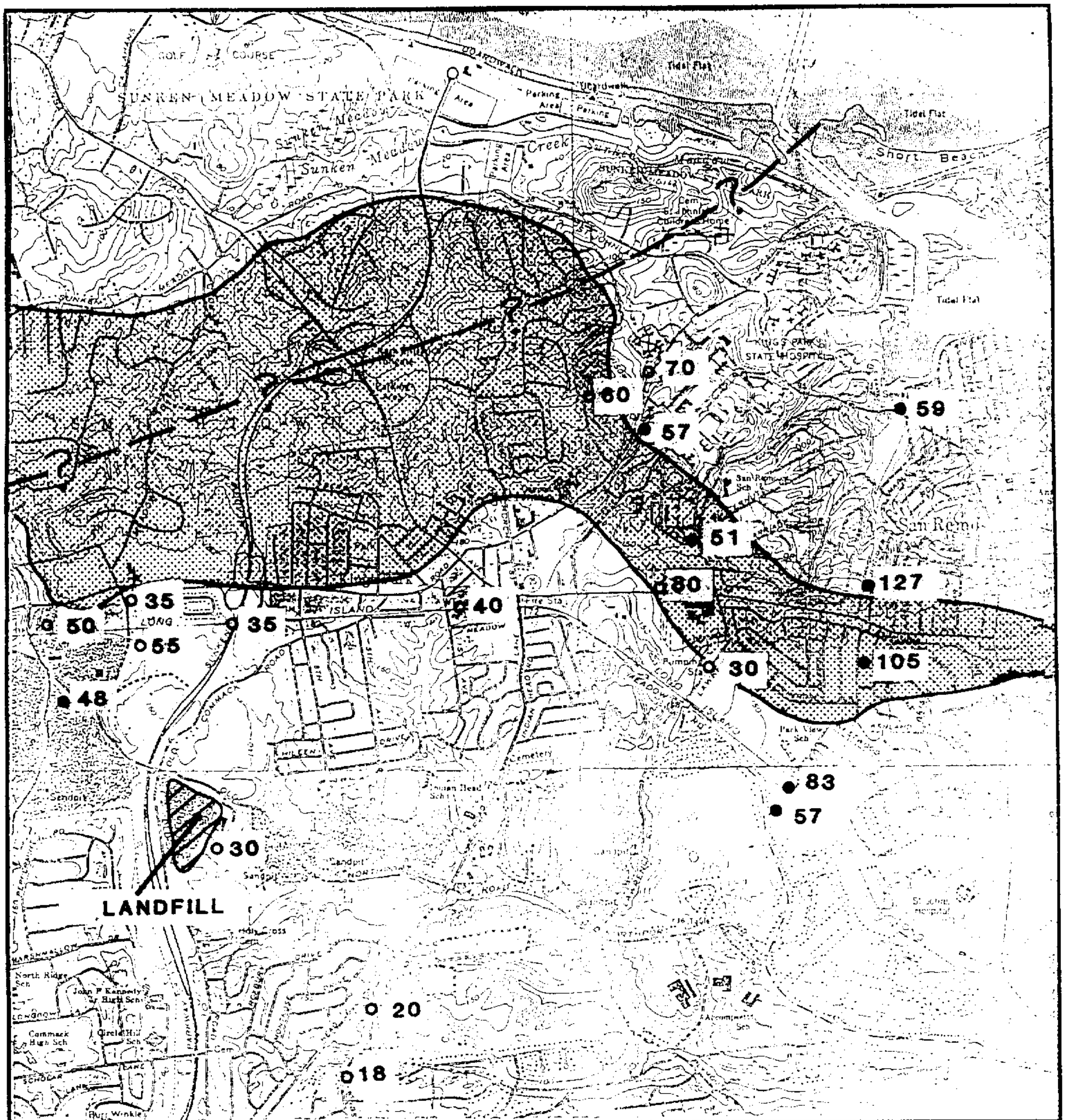

FIG. 13

LOCATION OF WELLS AND ESTIMATED THICKNESS OF SMITHTOWN CLAY - SMITHTOWN LANDFILL

(in feet)

o 50 Smithtown Clay Unit Thickness Data From Available Well Reports

• 50 Smithtown Clay Unit Thickness From U.S.G.S. Report (Fig.)

-?- Inferred Limit of Smithtown Clay

Harbor Hill Terminal Moraine (Jensen Soren, 1974)

Scale: 1" = 2500'

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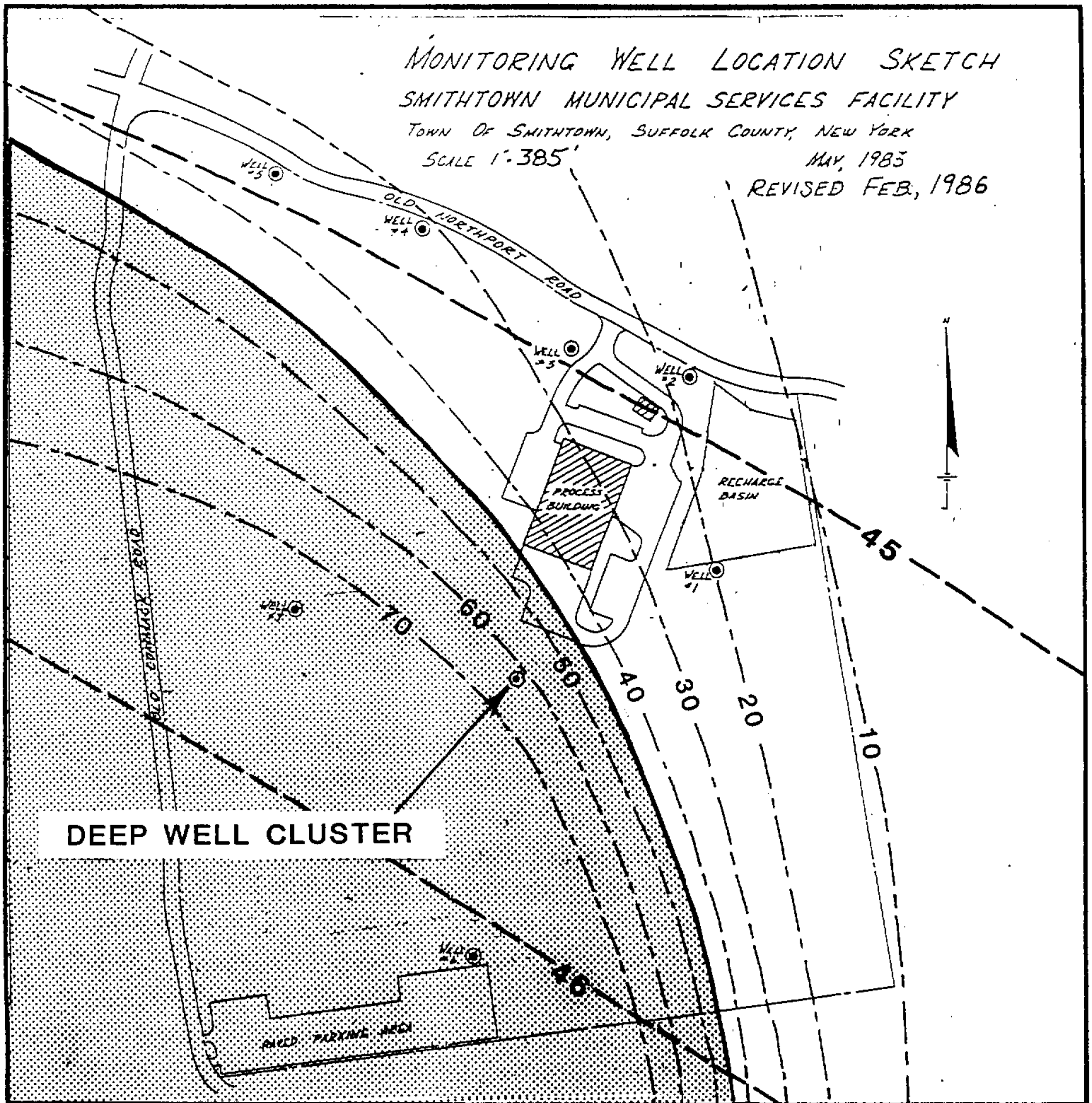


FIGURE 14
CONTOURS OF THE WATER TABLE AND UPPER SURFACE OF SMITHTOWN CLAY UNIT - SMITHTOWN LANDFILL VICINITY
FEBRUARY, 1986

—45— Approximate location of local water table contours

—30— Approximate location of contours on the upper surface of the Smithtown clay

[stippled box] Areas where the water table is located within the Smithtown clay. Otherwise, the water table is above the Smithtown clay.

Note: All datum is above mean sea level.

hilly due to erosional forces which acted prior to deposition of the overlying sand and gravel layers. In contrast, the water table surface is fairly regular. As a result, in some areas the clay unit often includes the water table surface within its thickness; in other areas, the water table is located above the upper surface of the clay and appears to be the condition at the MSF site.

Drilling records during installation of the Town wells indicate that Well No. 6 (S-74872), an upgradient well, is screened within the clay unit and that the remaining wells are all screened above the clay unit. At the deep well cluster location drilled in February, the water table was within the clay at about 25 feet below the top of the clay unit.

Figure 14 presents the upper surface of the clay unit; water table contours; and, areas where the water table is located within and above the clay unit. The line separating the shaded from non-shaded area approximates the intersection of the water table with the upper surface of the clay unit.

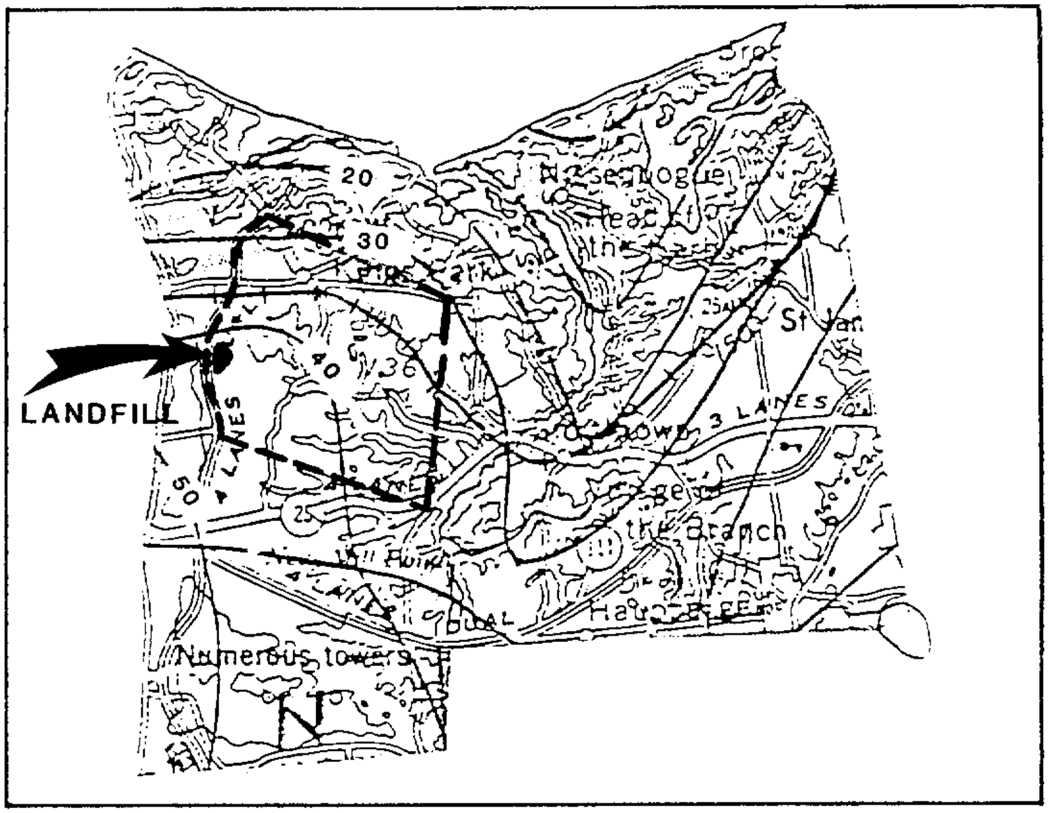
4.3 POTENTIOMETRIC CONTOURS

Potentiometric contour maps for Long Island have been published by the U.S. Geological Survey based on measurements of wells screened in the Magothy Formation. Potentiometric contours on a map represent equipotential lines (equal head, or potential, of the formation water).

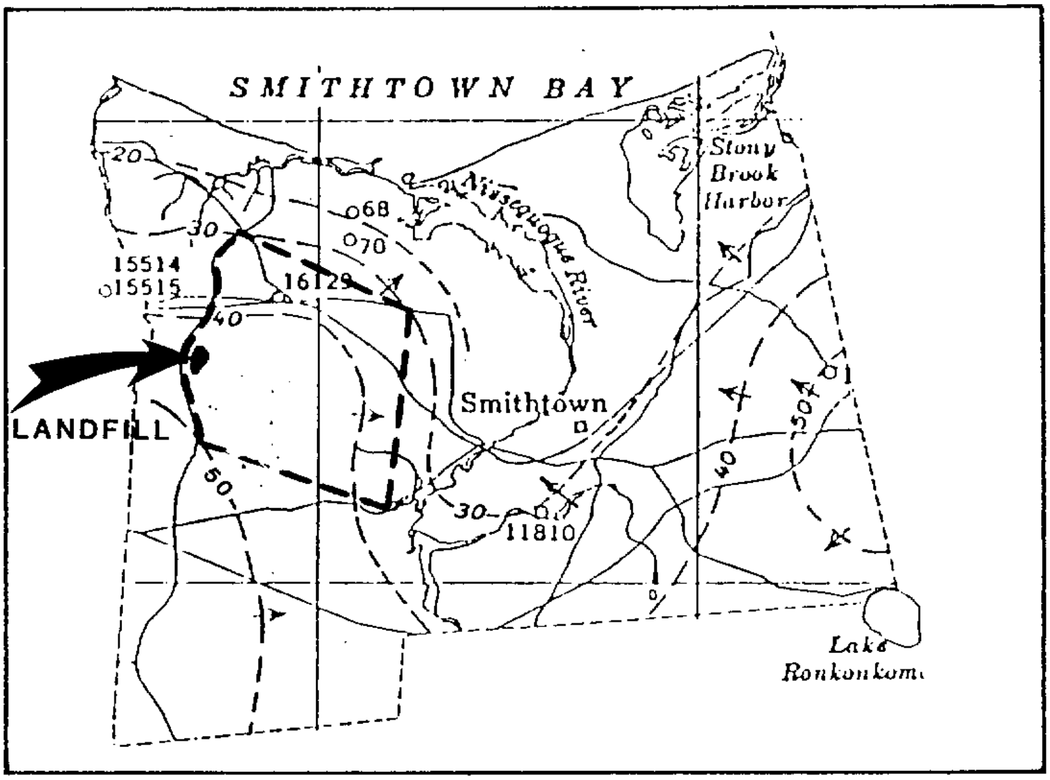
Potentiometric contour maps are analogous to water table contour maps. However, unlike water table contour maps, potentiometric contour maps are prepared for deep aquifer zones where the formation water exists under confined conditions. Similarly, flow lines within the confined aquifer are orthogonal to contours of the potentiometric surface.

Potentiometric contour maps for the Magothy Formation for the years 1959, 1971, and 1979 are shown on Figures 15 and 16. High and low points on the potentiometric surface can be seen southwest and east-southeast of the MSF site, respectively, corresponding to the same high and low points on the water table contour maps. A north-northeast horizontal direction of groundwater flow is suggested by these maps.

A modified potentiometric contour map for the immediate vicinity around the MSF site is presented Figure 17. These contours are developed from measurements taken in the Town of Smithtown and S.C.W.A. deep well clusters in February, 1986. Results are similar to those of previous years, as represented by the U.S.G.S. maps.



POTENTIOMETRIC CONTOURS OF THE MAGOTHY-1971
Source: Jensen and Soren (1974)



POTENTIOMETRIC CONTOURS OF THE MAGOTHY -1959
Source: Lubke (1964)

TOWN OF SMITHTOWN
SMITHTOWN LANDFILL

POTENTIOMETRIC CONTOURS

FIGURE NO. 15

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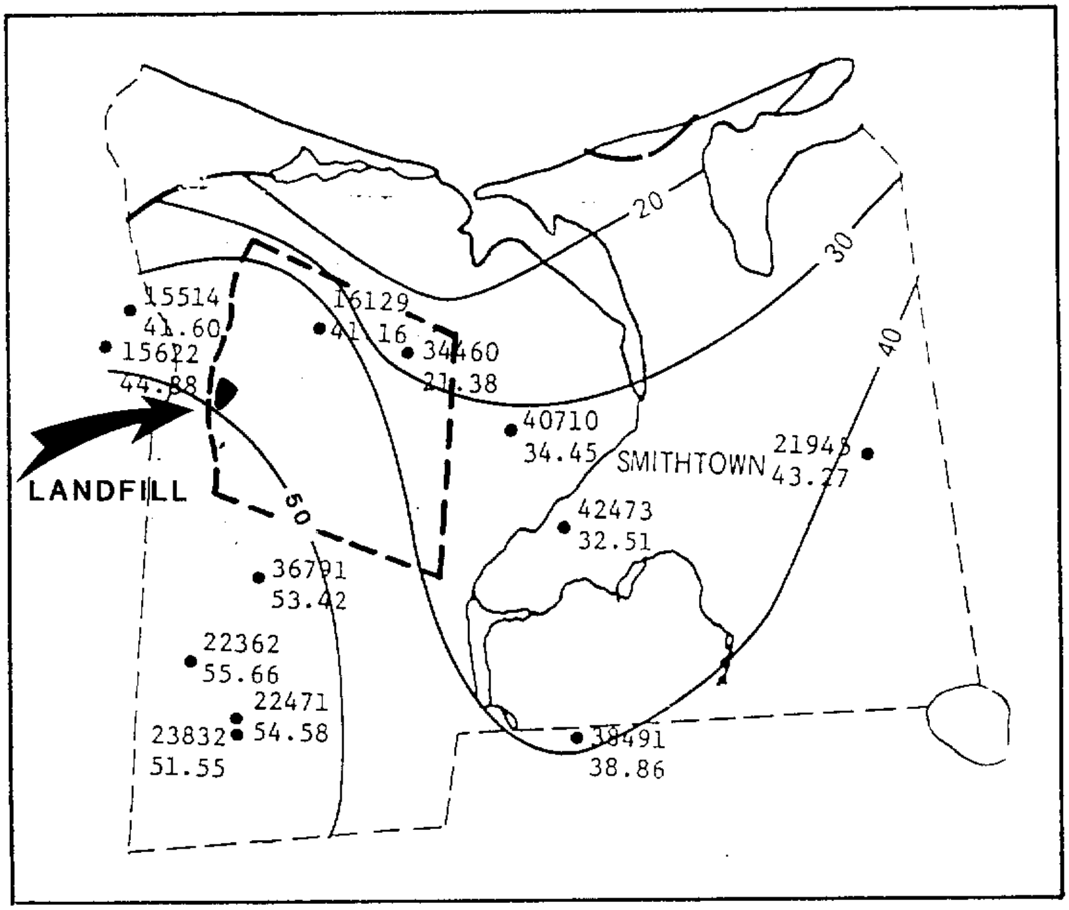

POTENTIOMETRIC CONTOURS OF THE MAGOTHY - 1979

Source: Donaldson and Koszalka (1982)

TOWN OF SMITHTOWN
SMITHTOWN LANDFILL

POTENTIOMETRIC CONTOURS

FIGURE NO. 16

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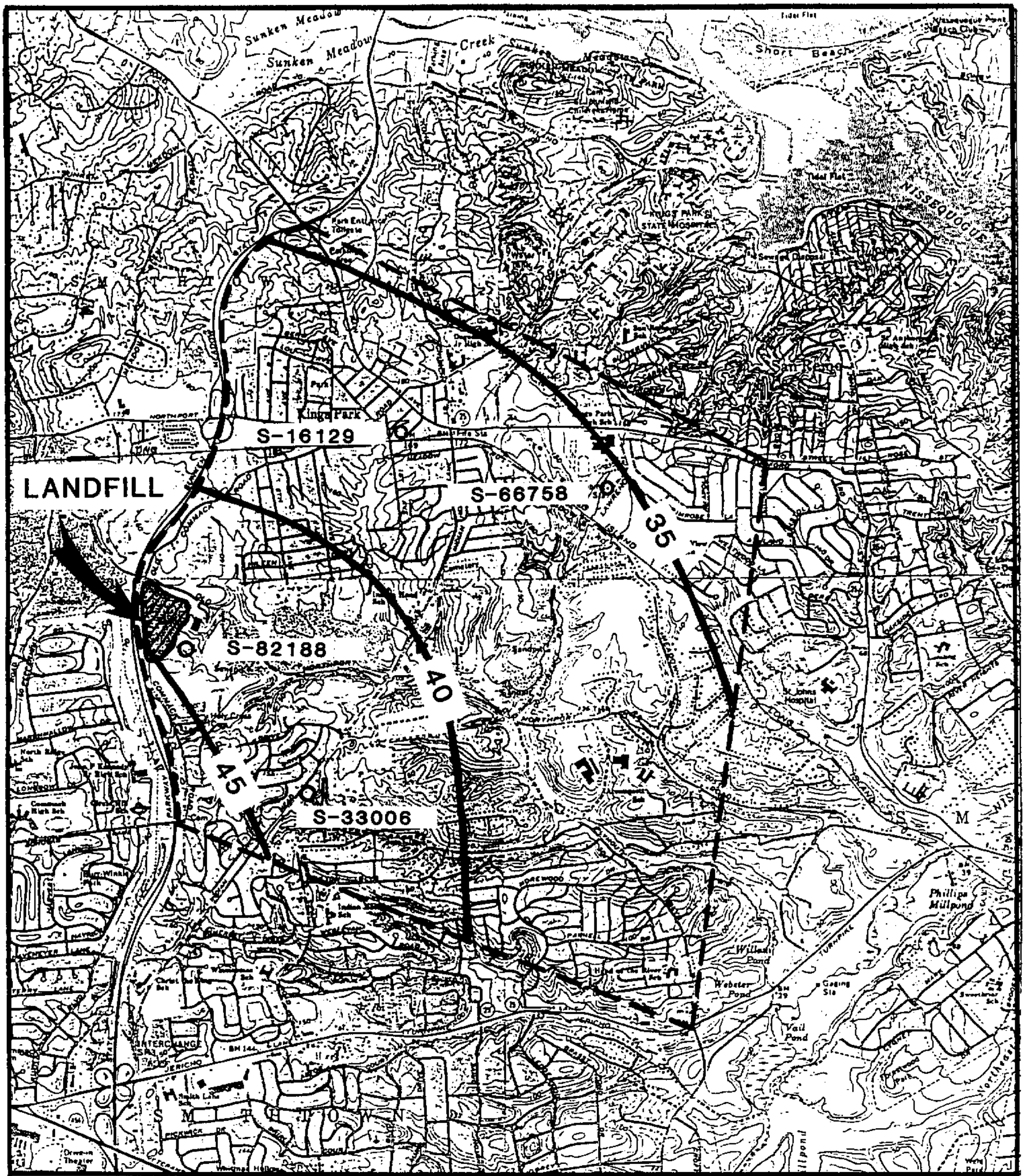

FIGURE 17

POTENTIOMETRIC CONTOURS OF THE MAGOTHY FORMATION
SMITHTOWN LANDFILL VICINITY

(SEE FIGURES 15 AND 16)
DATUM: MEAN SEA LEVEL

FIGURE NO. 17

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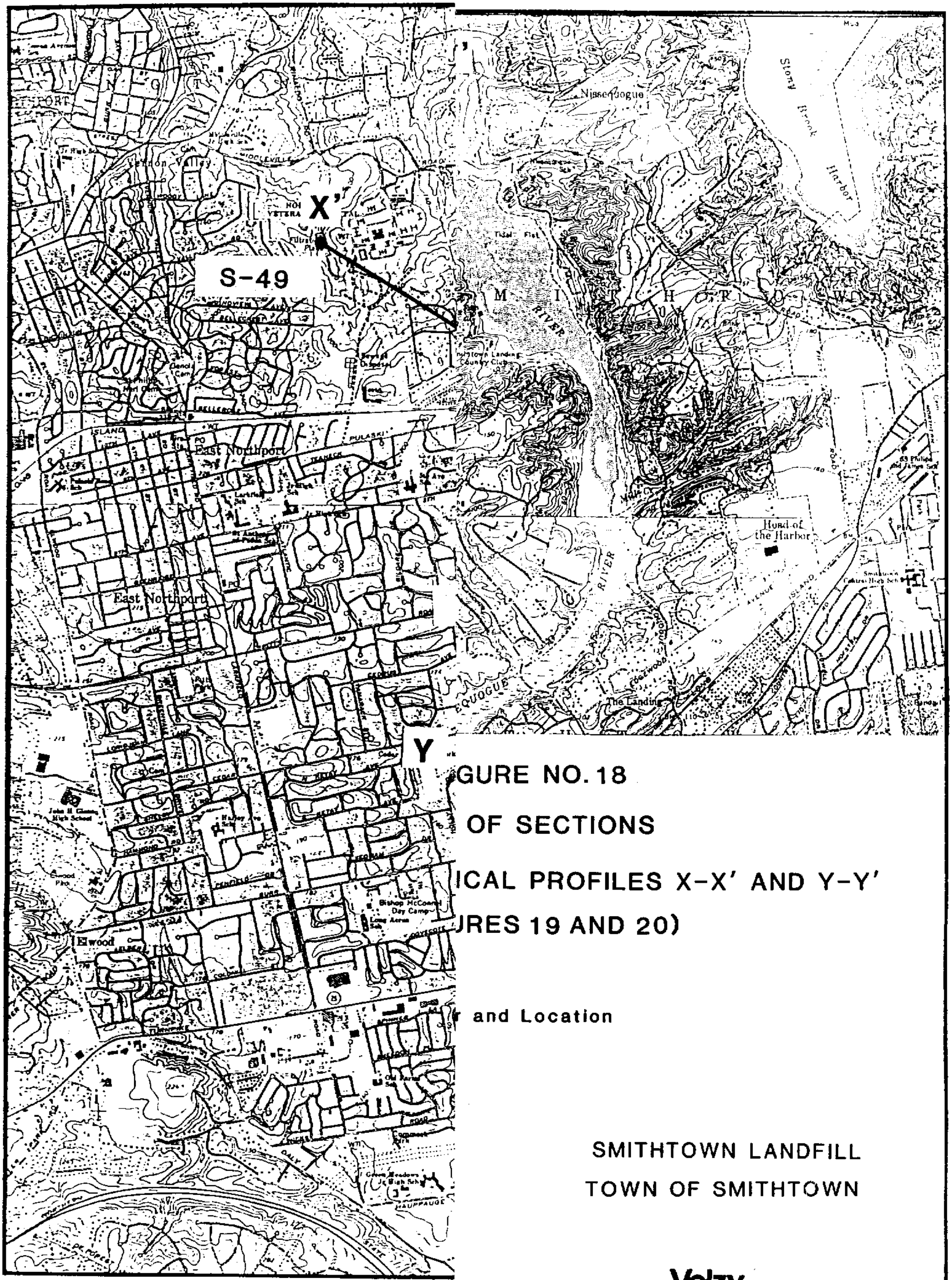
4.4 HYDROLOGIC CROSS SECTIONS

To assess the significance of vertical flow gradients, potentiometric surface elevations were plotted on hydrologic cross sections (at the midpoint of the well screens) to determine lines of equal potentiometric head. The direction of vertical flow was determined by drawing a line perpendicular to the equal potential contour lines. Convex contours indicate regions of groundwater recharge, while concave contours are associated with groundwater discharge.

The location of hydrologic cross sections and wells used for its development are shown on Figure 18.

Hydrologic profile Y-Y' is in the direction of groundwater flow, Figure 19, while profile X-X' is perpendicular to the flow direction, Figure 20. Inferred direction of groundwater flow in the confined formation are shown by arrows plotted on the equal potential contour lines. The orthogonal flow net formed by flow and equipotential lines was not developed. Additional deep well clusters and potentiometric surface measurements within the study area would be required for development of flow nets.



GURE NO. 18

OF SECTIONS

ICAL PROFILES X-X' AND Y-Y'

JRES 19 AND 20)

r and Location

SMITHTOWN LANDFILL
TOWN OF SMITHTOWN

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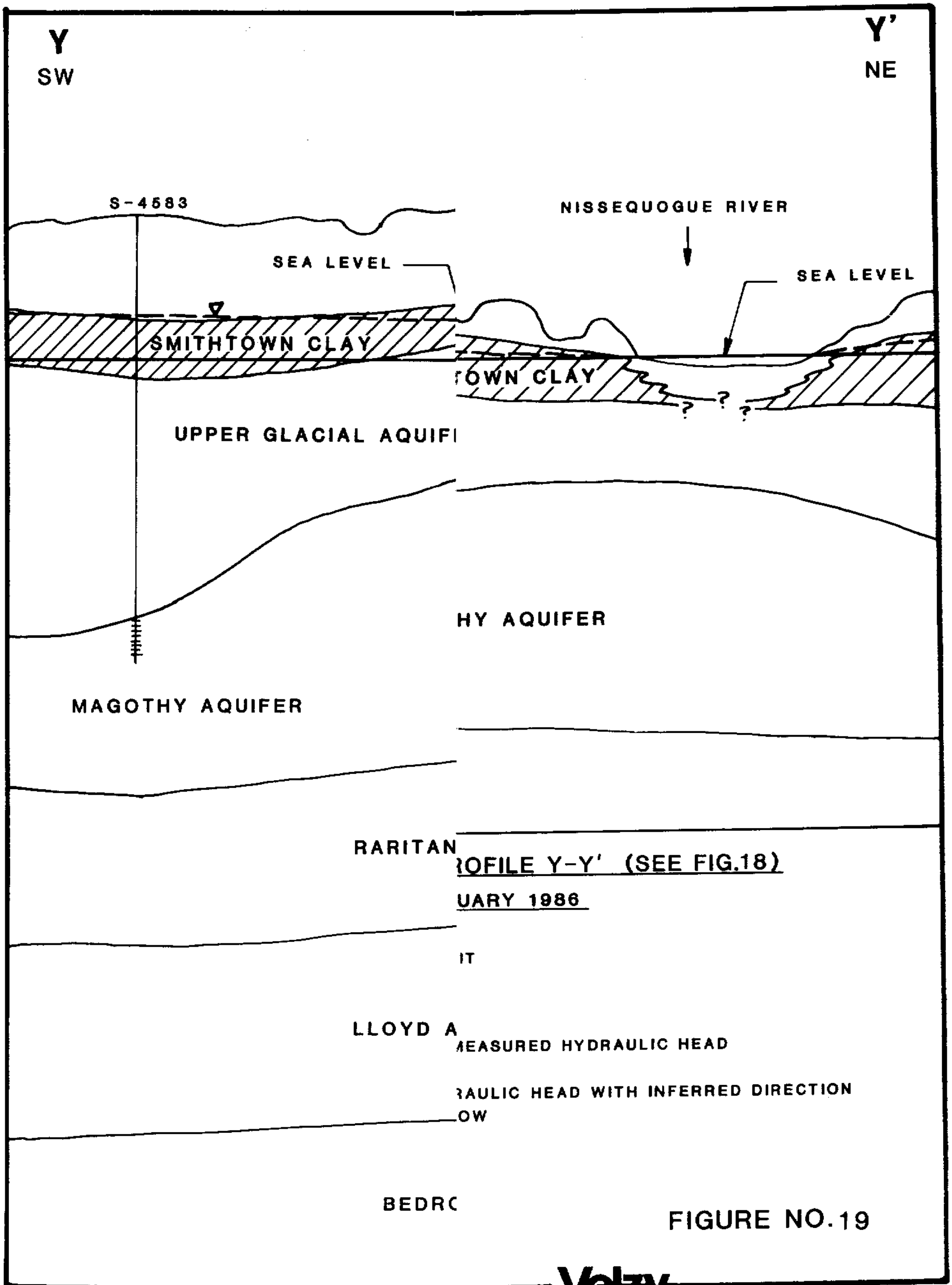

ROFILE Y-Y' (SEE FIG.18)

UARY 1986

IT

MEASURED HYDRAULIC HEAD

RAULIC HEAD WITH INFERRED DIRECTION
OW

FIGURE NO. 19

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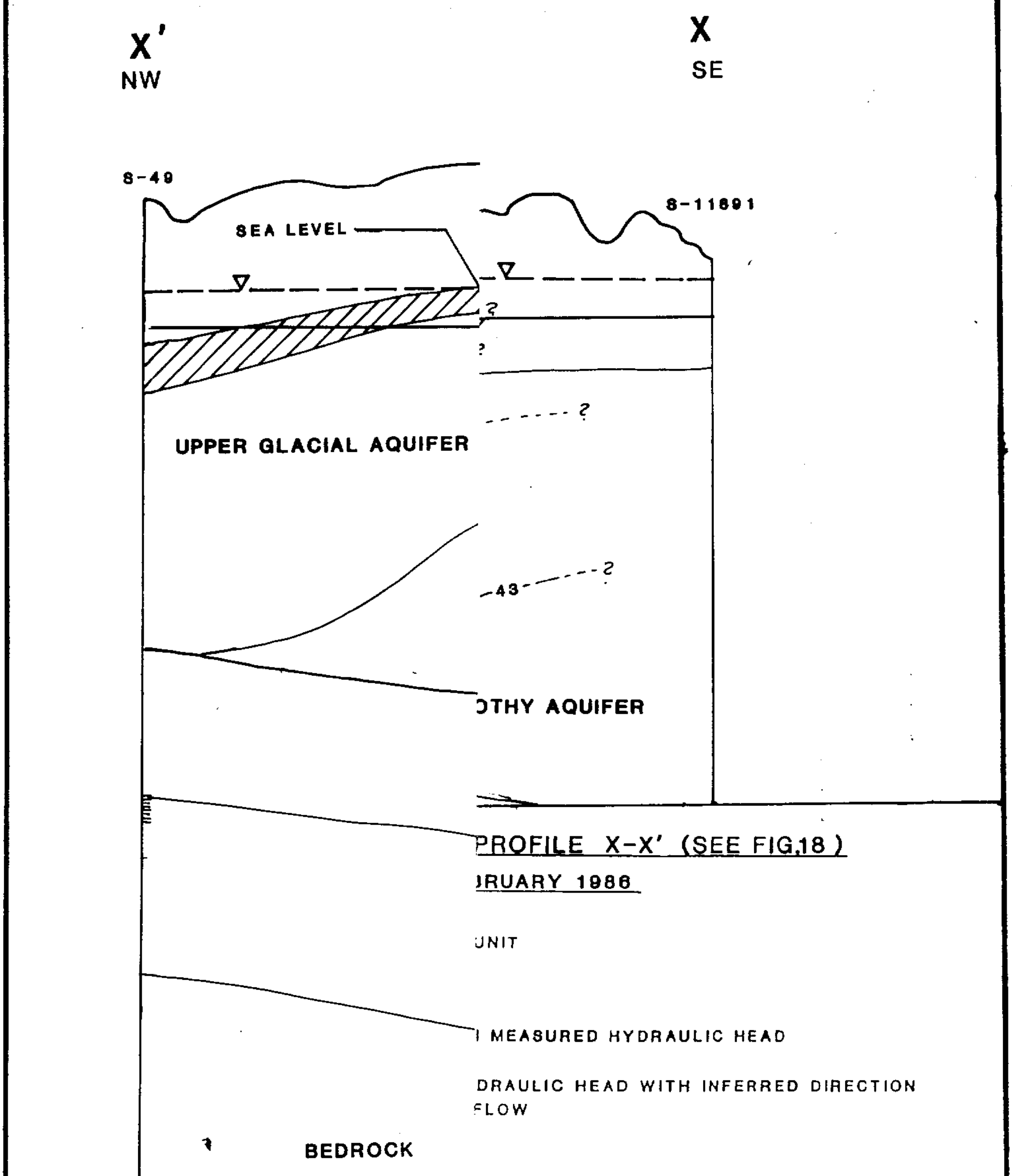

FIGURE NO.20

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Based on the potentiometric surface measurements recorded in February, 1986, and the hydrologic profiles, Figures 19 and 20, indicate groundwater recharge at the MSF site and at the Lawrence Road and Kings Park Road well fields. Data for the Carlson Avenue well field, located about 1.5 miles from the MSF site in the direction of groundwater flow, indicates horizontal flow and thus the limit of the recharge area, Zone I - hydrogeologic boundary. The Carlson Avenue field is located directly on the proposed NYSDEC modified 208 line. Groundwater flow beneath the MSF site appears to be in a transition zone approaching horizontal flow at the Carlson Avenue station of the SCWA.

It must be emphasized that the referenced groundwater flow regime occurs beneath the Smithtown Clay unit which separates the MSF landfill from the confined aquifer system. As such, the deeper Magothy formation is not directly affected by recharge at the MSF landfill site.

Based on results of this study, the Smithtown MSF landfill is located within the deep flow recharge area as defined in the 208 Study and Draft-Long Island Groundwater Management Program of the NYSDEC.

The deep groundwater flow regime in the vicinity of the MSF landfill is protected due to the geology of the area, e.g. presence of the Smithtown Clay unit. Furthermore, the area between the landfill site and the Zone I - Hydrogeologic Boundary line in the direction of flow appears to be a transition zone thus recharge at the site has little or no impact on the flow system.

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APPENDIX A

APPENDIX A

SIEVE ANALYSES OF SMITHTOWN DEEP WELL TEST BORING GEOLOGIC CORE SAMPLES

DELTA WELL CO., INC.

97 UNION AVE. P.O.BOX# 1309
RONKONKOMA, NEW YORK, 11779
TEL.# 516 - 981 - 2255

SIEVE ANALYSIS FORMULA

JOB NAME: SMITHTOWN LANDFILL

COMP. FILE NAME -B:SIEV1

WORK ORDER #

SIZE SIEVE	DEPTH BACKFILL WT.	CUM.%	DEPTH 65 WT.	CUM.%	DEPTH 85 WT.	CUM.%	DEPTH 104 WT.	CUM.%	DEPTH 124 WT.	CUM.%	DEPTH 143 WT.	CUM.%	DEPTH 163 WT.	CUM.%	DEPTH 185 WT.	CUM.%	DEPTH 204 WT.	CUM.%
.065	7	.045455	C	ERROR	0	0	14	.067	10	.055	8	.051	14	.119	8	.039	C	ERROR
.046	20	.129870		ERROR	1	.007	15	.072	11	.061	10	.064	19	.161	9	.044		ERROR
.033	36	.233766	L	ERROR	4	.027	18	.087	12	.066	18	.115	25	.212	10	.049	L	ERROR
.023	60	.389610		ERROR	8	.053	39	.188	24	.133	52	.333	34	.288	21	.102		ERROR
.016	97	.629870	A	ERROR	46	.307	135	.649	86	.475	96	.615	44	.373	86	.420	A	ERROR
.012	130	.844156		ERROR	100	.667	180	.865	146	.807	128	.821	53	.449	149	.727		ERROR
.008	147	.954545	Y	ERROR	120	.8	189	.909	154	.851	141	.904	60	.508	170	.829	Y	ERROR
PAN	154	1		ERROR	150	1	208	1	181	1	156	1	118	1	205	1		ERROR

SIZE	DEPTH 224 WT.	CUM.%	DEPTH 243 WT.	CUM.%	DEPTH 264 WT.	CUM.%	DEPTH 284 WT.	CUM.%	DEPTH 304 WT.	CUM.%	DEPTH 325 WT.	CUM.%	DEPTH 345 WT.	CUM.%	DEPTH 365 WT.	CUM.%	DEPTH 385 WT.	CUM.%
.065	8	.041237	5	.029	12	.064	0	0	10	.070	8	.043	14	.092	8	.033	C	ERROR
.046	9	.046392	6	.035	14	.074	4	.022	11	.077	9	.049	15	.099	9	.038		ERROR
.033	10	.051546	7	.041	16	.085	6	.033	12	.085	10	.054	21	.138	10	.042	L	ERROR
.023	20	.103093	20	.118	34	.181	10	.056	22	.155	30	.163	32	.211	22	.092		ERROR
.016	66	.340206	110	.647	98	.521	21	.117	84	.592	90	.489	62	.408	72	.3	A	ERROR
.012	130	.670103	145	.853	150	.798	41	.228	118	.831	142	.772	110	.724	152	.633		ERROR
.008	164	.845361	150	.882	162	.862	98	.544	126	.887	152	.826	134	.882	198	.825	Y	ERROR
PAN	194	1	170	1	188	1	180	1	142	1	184	1	152	1	240	1		ERROR

SIZE	DEPTH 405 WT.	CUM.%	DEPTH 425 WT.	CUM.%	DEPTH 443 WT.	CUM.%	DEPTH 463 WT.	CUM.%	DEPTH 483 WT.	CUM.%	DEPTH 487 WT.	CUM.%	DEPTH 503 WT.	CUM.%	DEPTH 523 WT.	CUM.%	DEPTH 543 WT.	CUM.%
.065	11	.077465	0	0	0	0	0	0	43	.141	C	ERROR	32	.198	133	.554	96	.64
.046	12	.084507	1	.006	1	.006	4	.028	83	.273		ERROR	50	.309	156	.65	102	.68
.033	14	.098592	3	.017	4	.022	9	.063	193	.635	L	ERROR	74	.457	184	.767	108	.72
.023	15	.105634	9	.052	26	.144	37	.257	261	.859		ERROR	102	.630	210	.875	118	.787
.016	22	.154930	28	.161	110	.611	107	.743	281	.924	A	ERROR	125	.772	228	.95	124	.827
.012	48	.338028	76	.437	158	.878	124	.861	290	.954		ERROR	140	.864	231	.963	132	.88
.008	101	.711268	125	.718	165	.917	130	.903	292	.961	Y	ERROR	144	.889	234	.975	135	.9
PAN	142	1	174	1	180	1	144	1	304	1		ERROR	162	1	240	1	150	1

SIZE	DEPTH 553 WT.	CUM.%	DEPTH 573 WT.	CUM.%	DEPTH 593 WT.	CUM.%	DEPTH 613 WT.	CUM.%
.065	3	.016304	155	.596	14	.126	88	.468
.046	4	.021739	176	.677	19	.171	100	.532
.033	5	.027174	193	.742	25	.225	114	.606
.023	10	.054348	208	.8	37	.333	134	.713
.016	48	.260870	220	.846	62	.559	150	.798
.012	134	.728261	234	.9	85	.766	160	.851
.008	154	.836957	240	.923	94	.847	168	.894
PAN	184	1	260	1	111	1	188	1

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

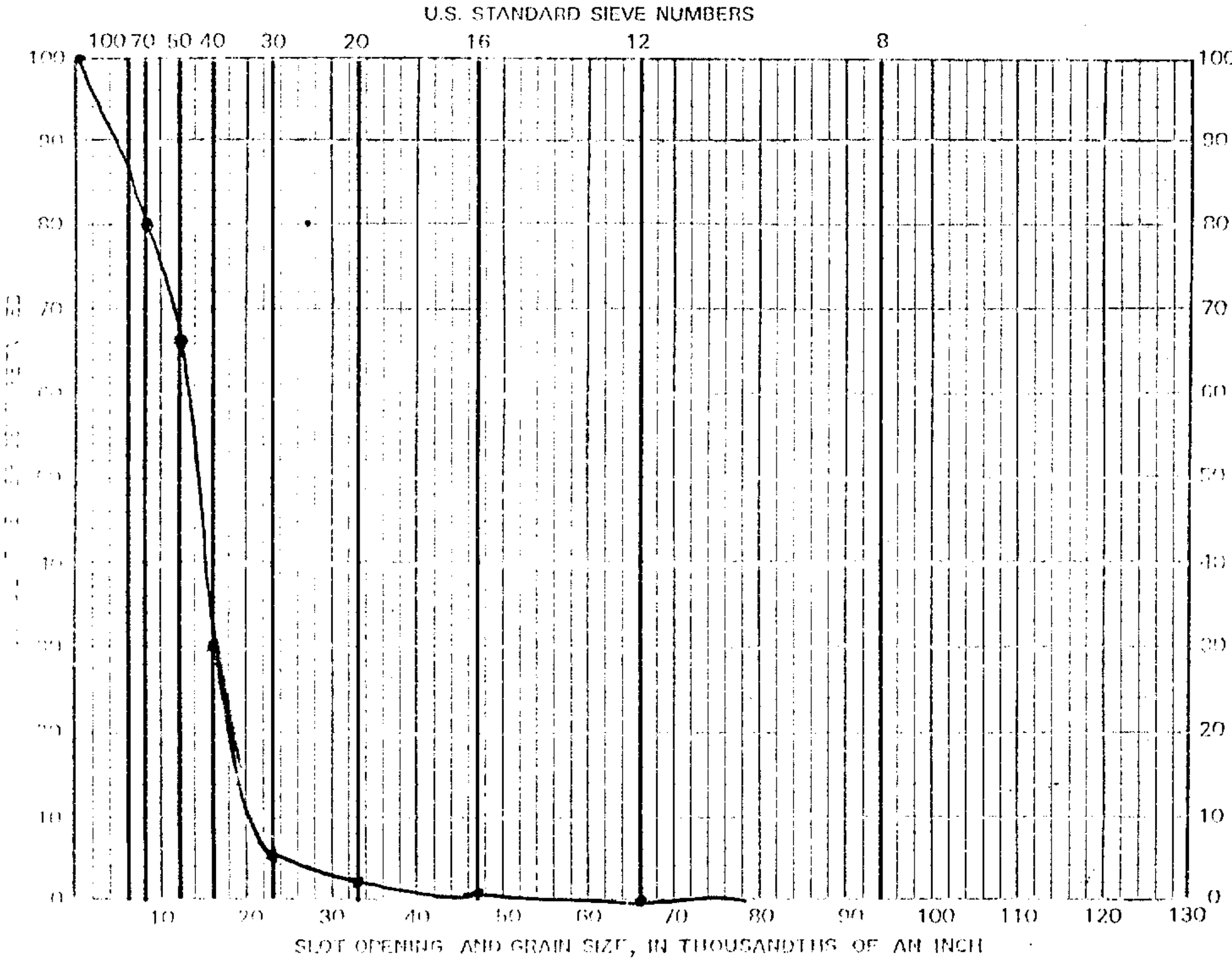
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 85'



[illegible]	[illegible]		[illegible]		
	[illegible]	[illegible]			
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14-2135

Johnson Division
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UOP Inc.

SAND ANALYSIS
(FINE)

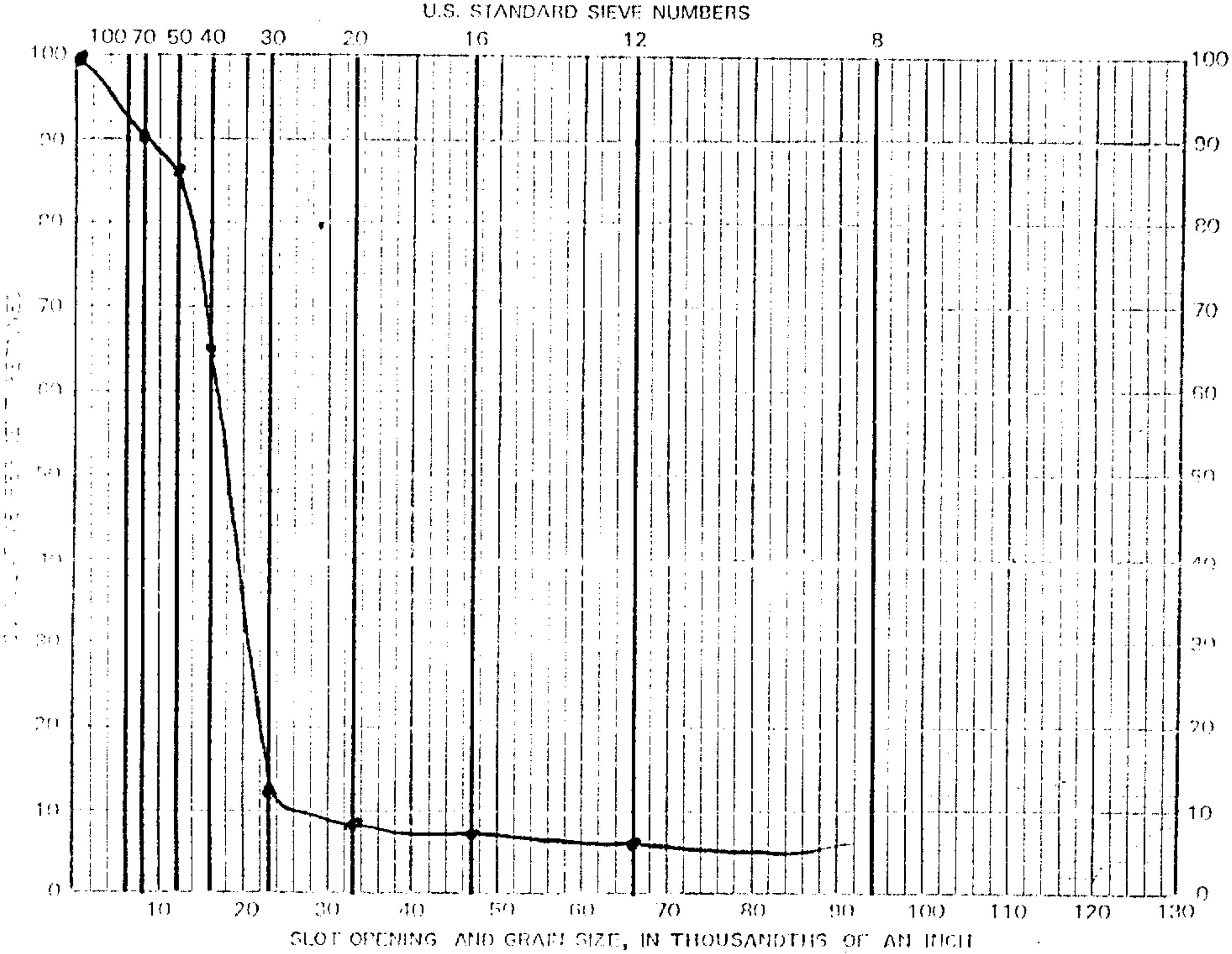
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 104'



SIEVE NO.	SIEVE OPENINGS INCHES	SIEVE OPENINGS MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

Johnson Division
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UOP Inc.

SAND ANALYSIS
(FINE)

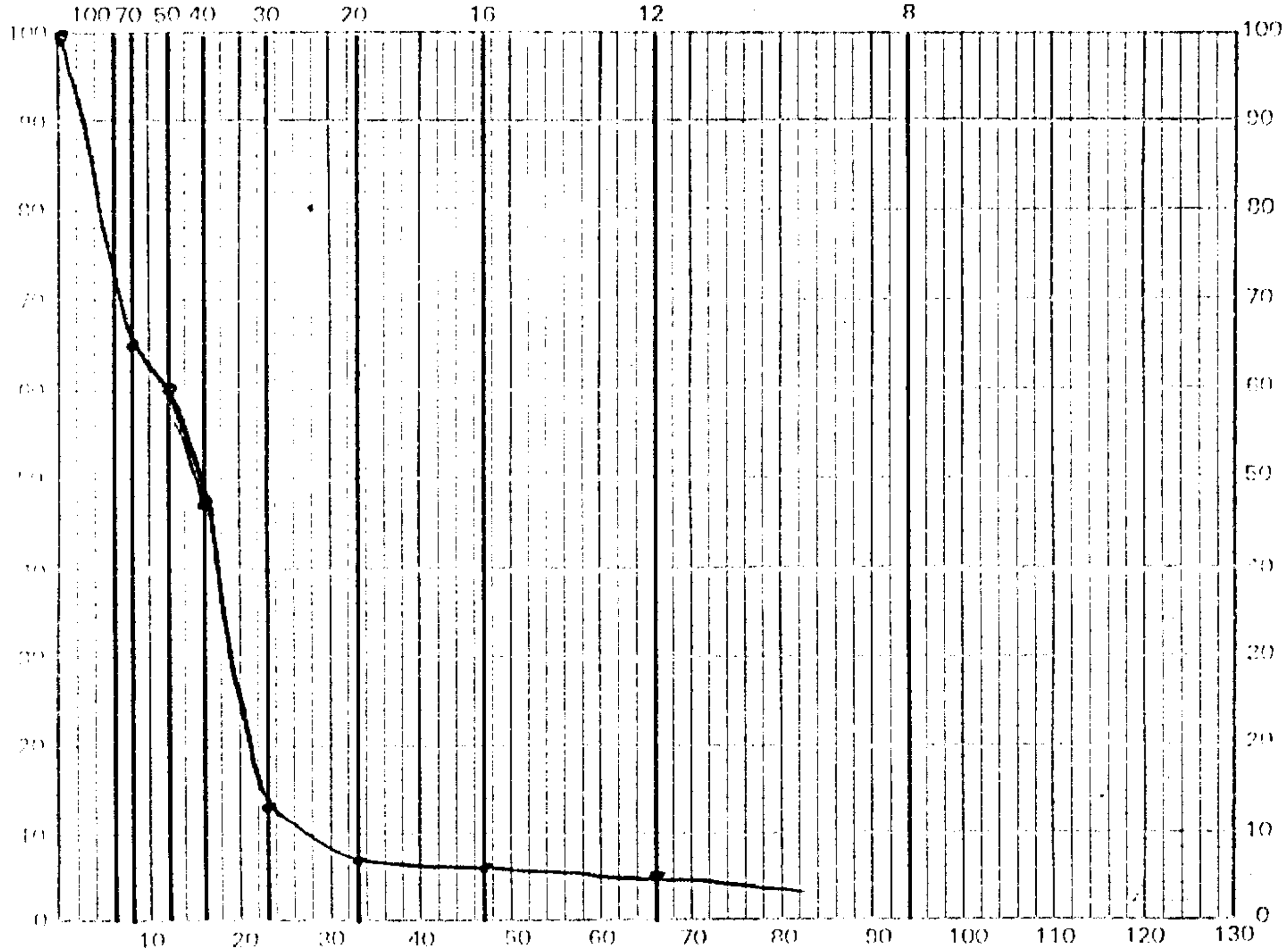
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 124'



U.S. SIEVE NO.	SLOT OPENING INCHES	SLOT OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

FORM 2155

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612-636-[illegible] • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

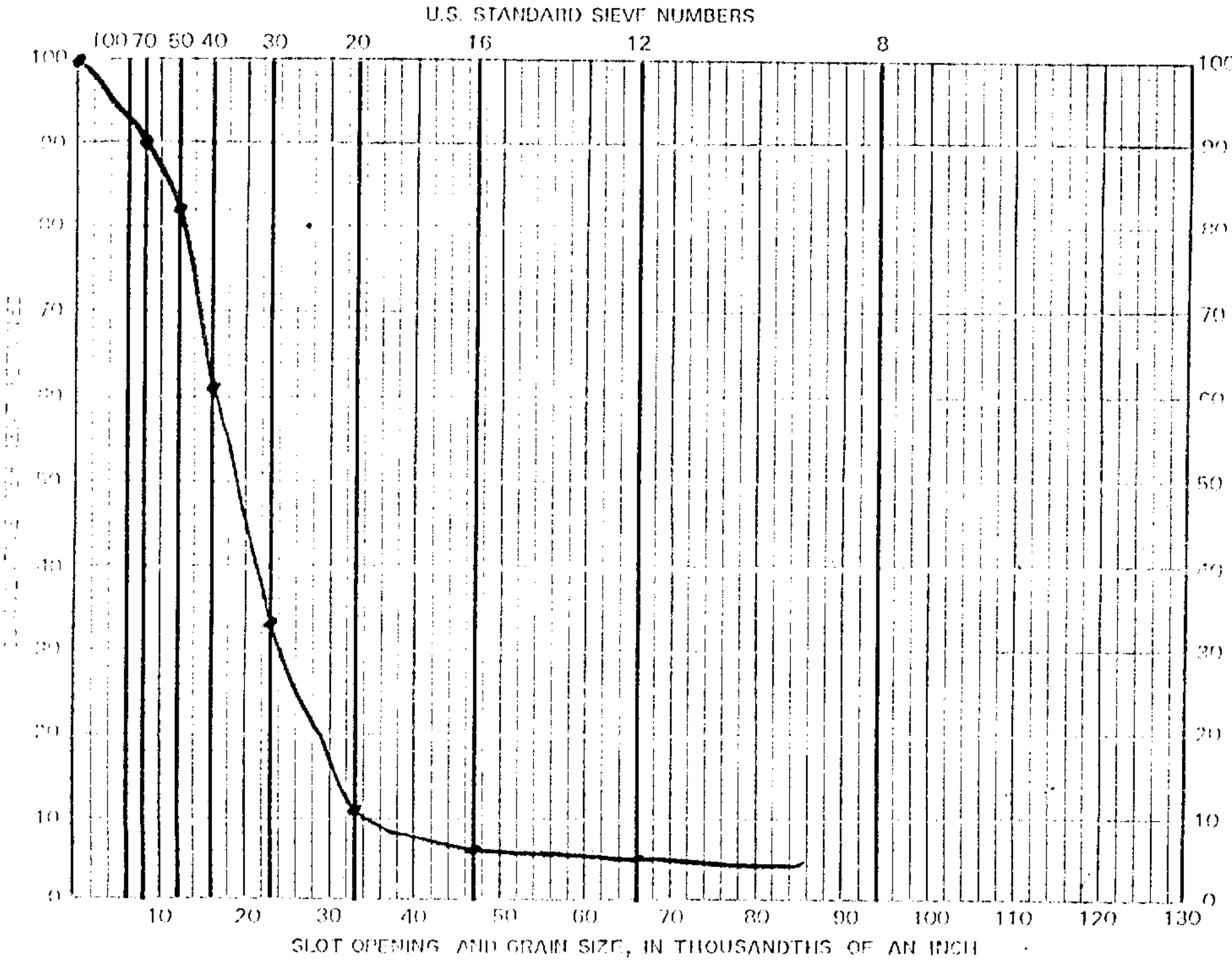
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 143'



U.S. SIEVE NO.	SLOT OPENING INCHES	SLOT OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14 2105

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS

(FINE)

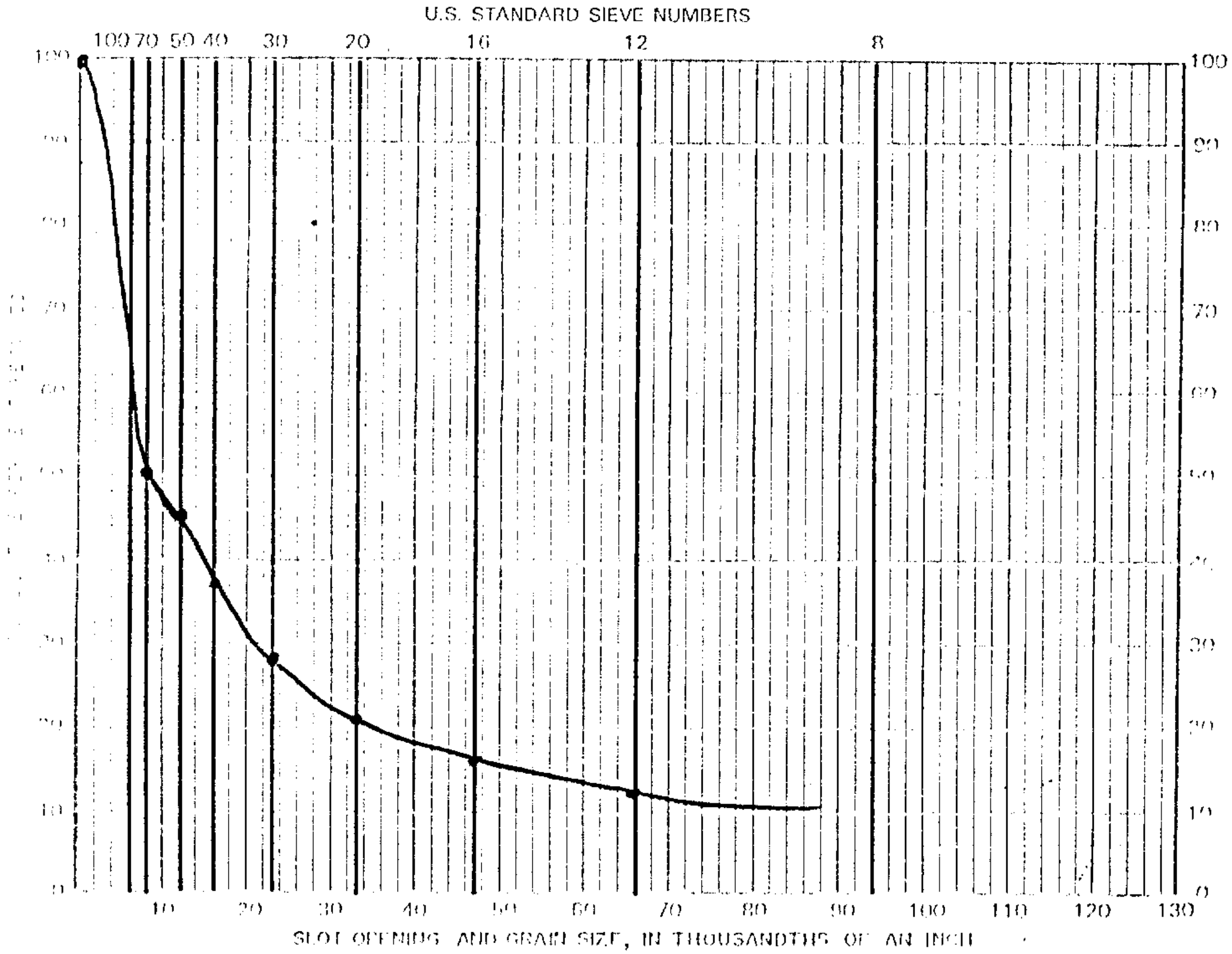
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 163'.



Sieve No.	Sieve Opening Inches	MM	Cumulative % Retained		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. ______ in. Length ______ Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

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UOP Inc.

SAND ANALYSIS
(FINE)

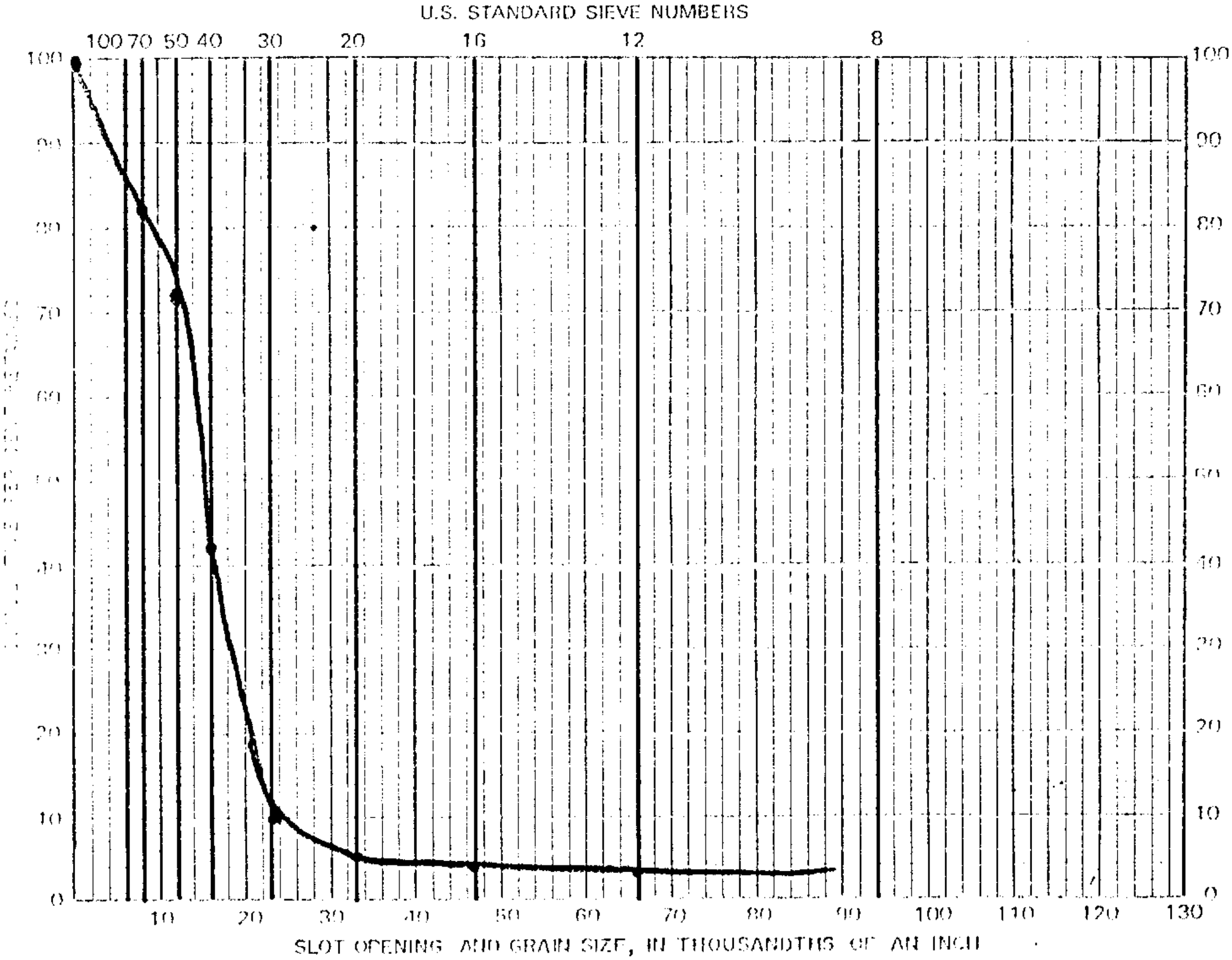
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 185'



[illegible]	SLOT OPENING INCHES	MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

Johnson Division
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UOP Inc.

SAND ANALYSIS
(FINE)

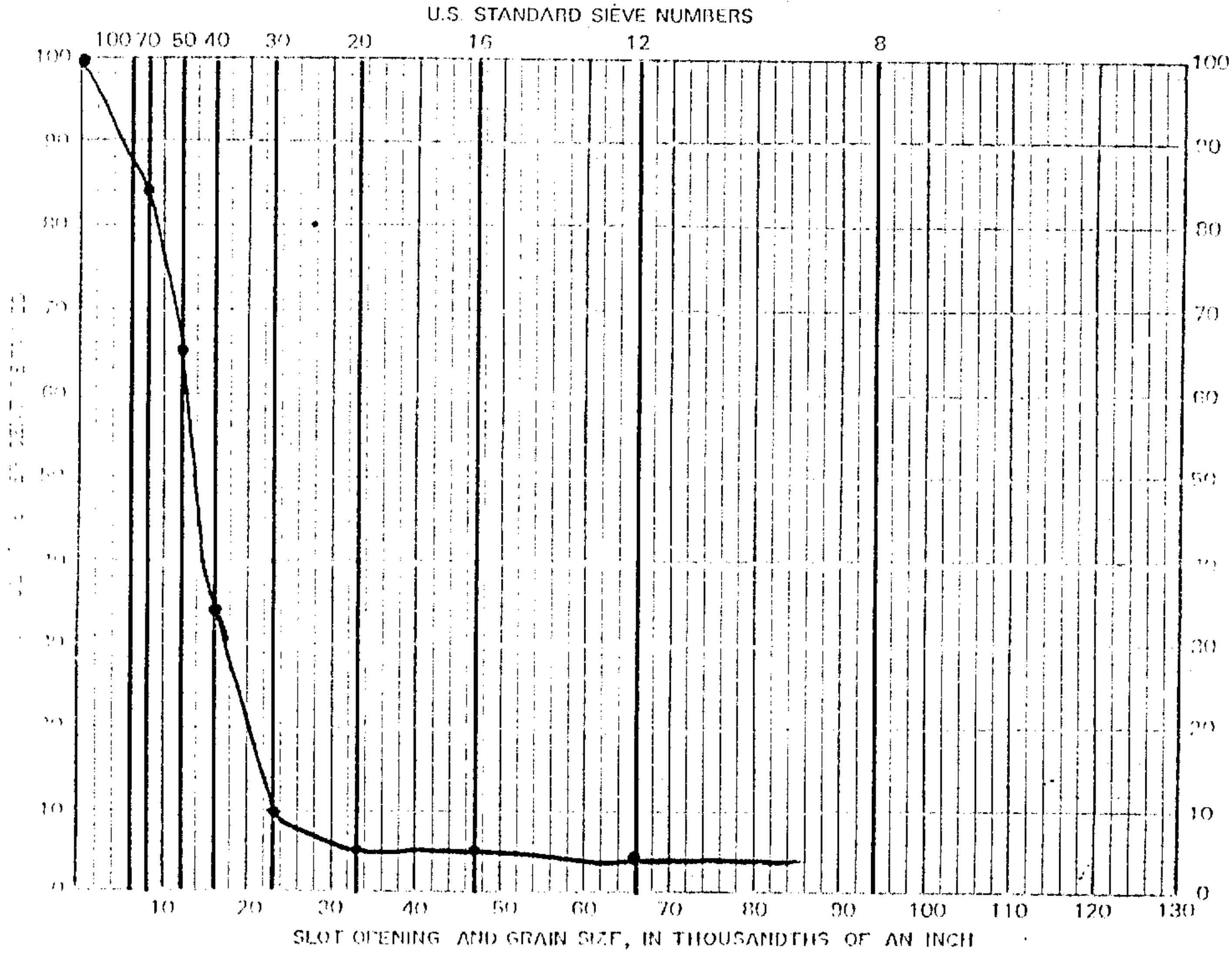
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks. Depth = 224'.



U.S. SIEVE NO.	SIEVE OPENING INCHES	MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

Johnson Division
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UOP Inc.

SAND ANALYSIS
(FINE)

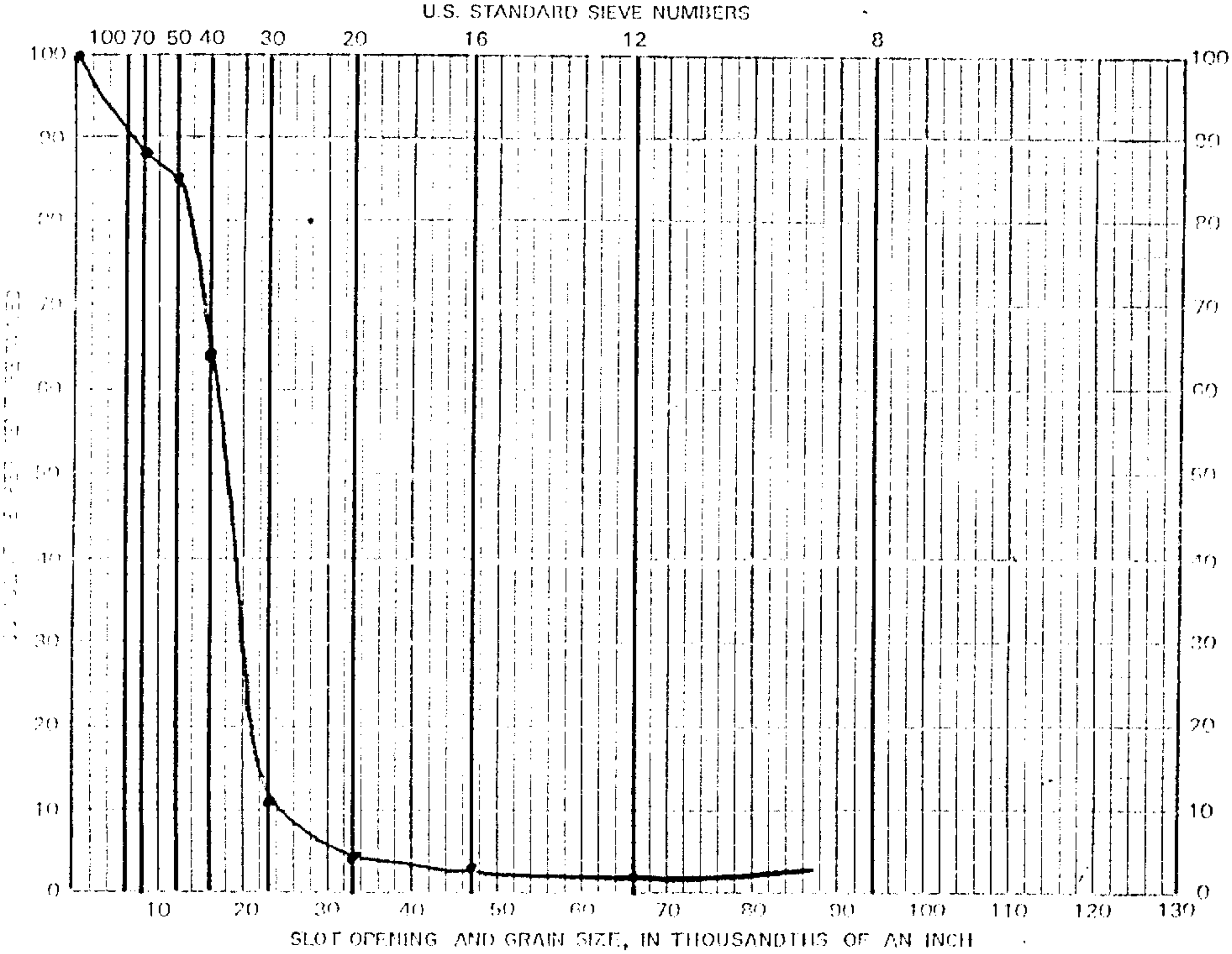
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 243'.



U.S. SIEVE NO.	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
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UOP Inc.

SAND ANALYSIS
(FINE)

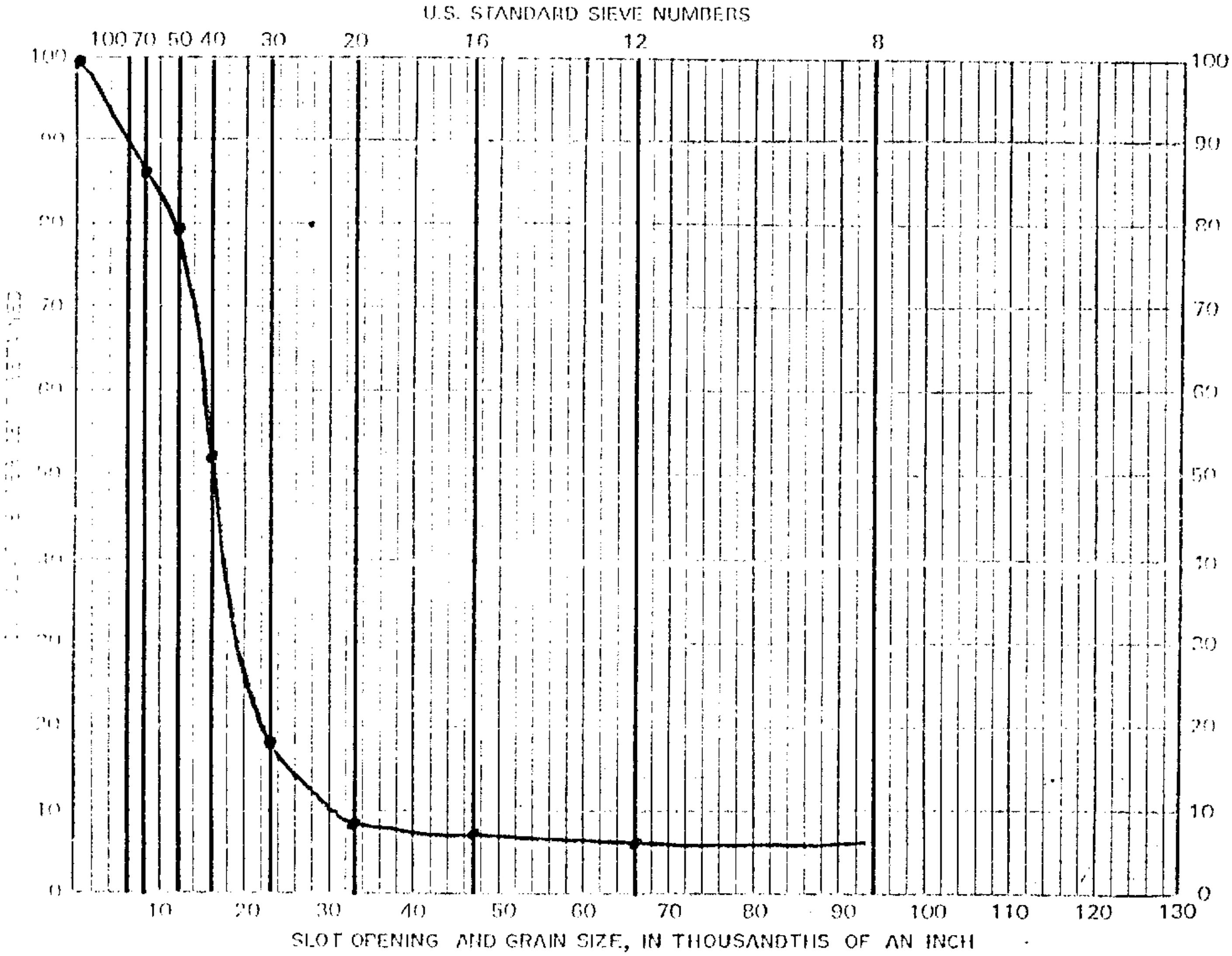
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 264'



Sieve No.	Sieve Opening Inches	Sieve Opening mm	Cumulative % Retained		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

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UOP Inc.

SAND ANALYSIS

(FINE)

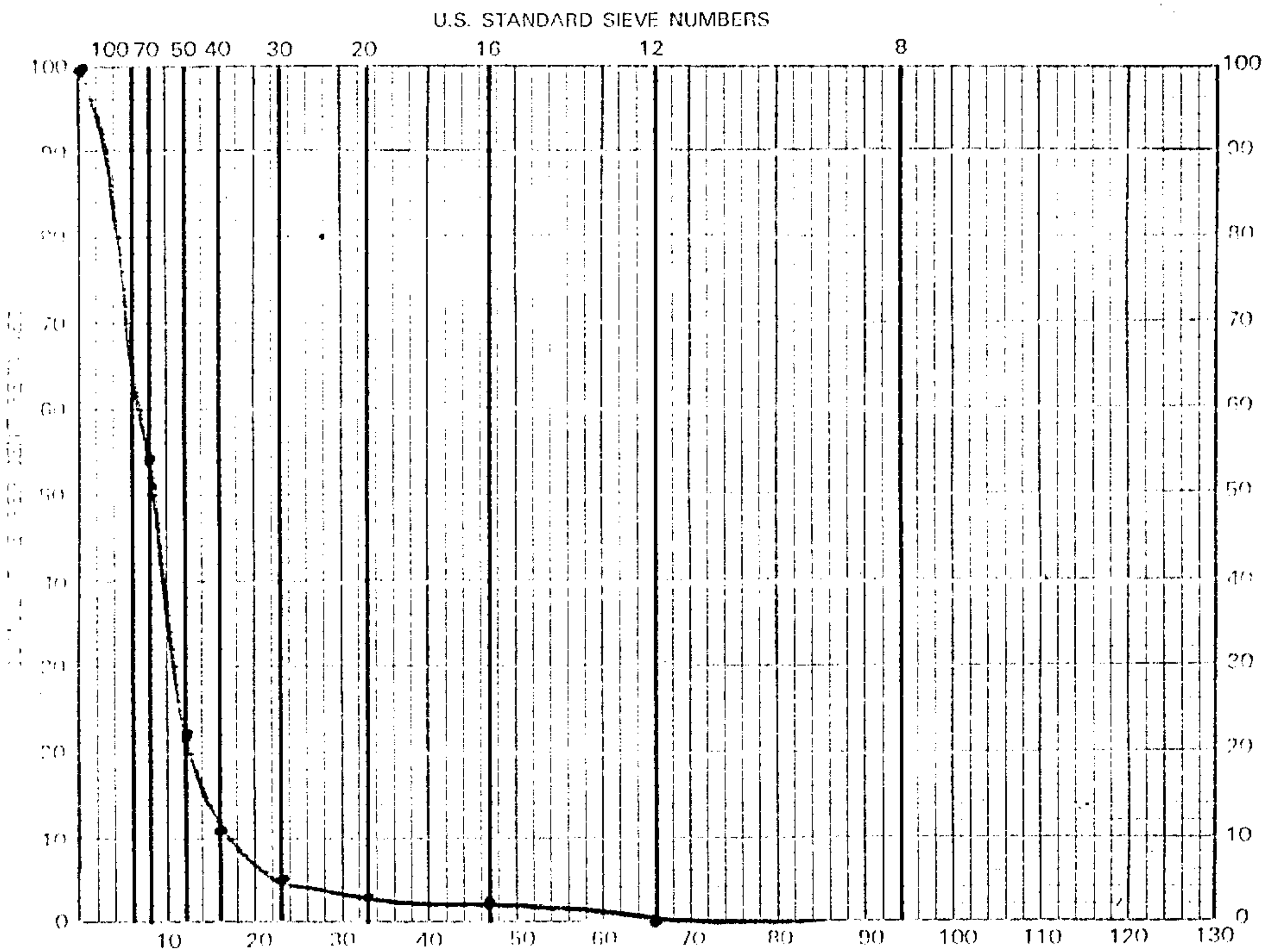
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 284'



U.S. SIEVE NO.	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14 2155

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
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UOP Inc.

SAND ANALYSIS
(FINE)

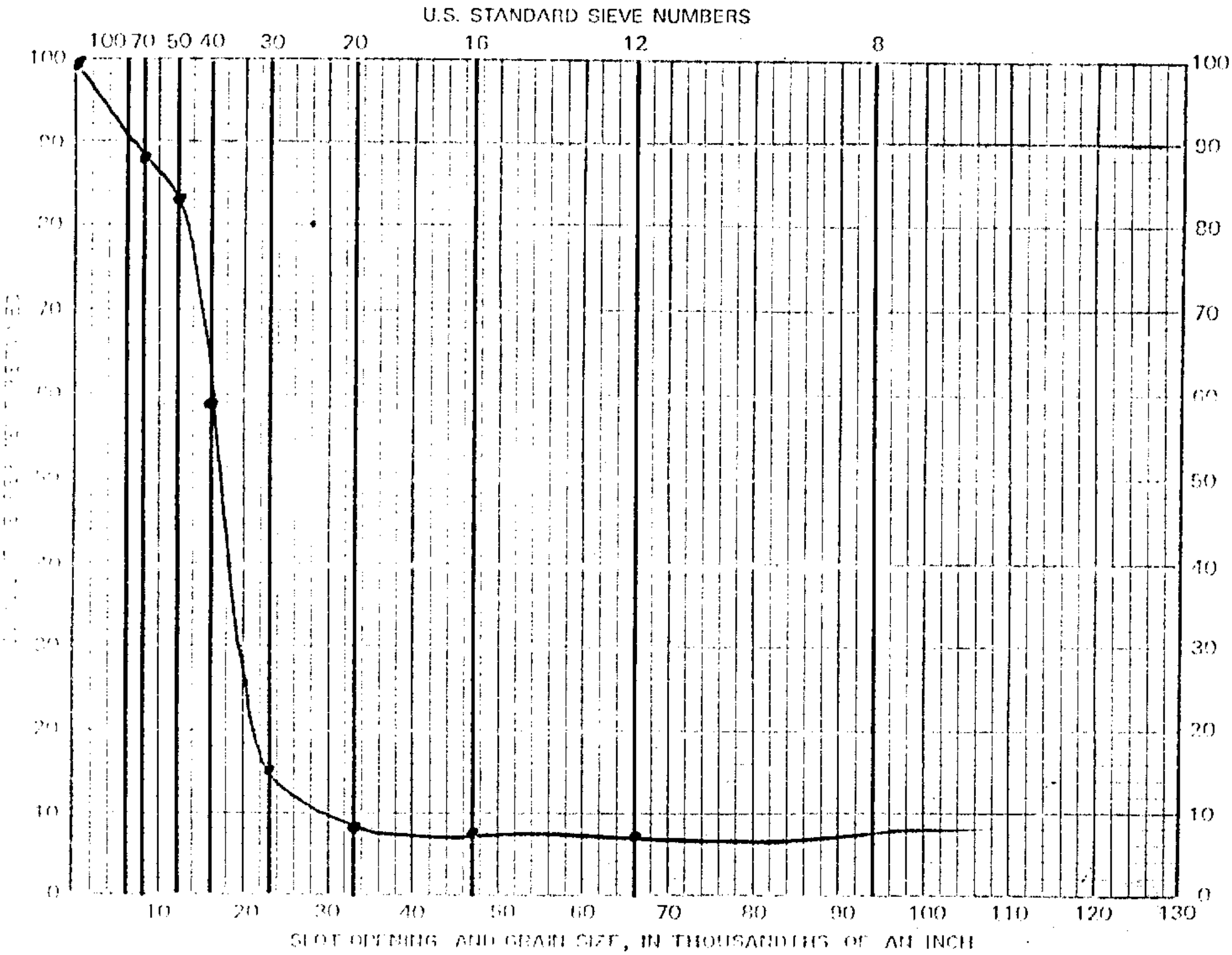
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA ▪ 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 304'



U.S. SIEVE NO.	SLOT OPENING INCHES	MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

[illegible]
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612 636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

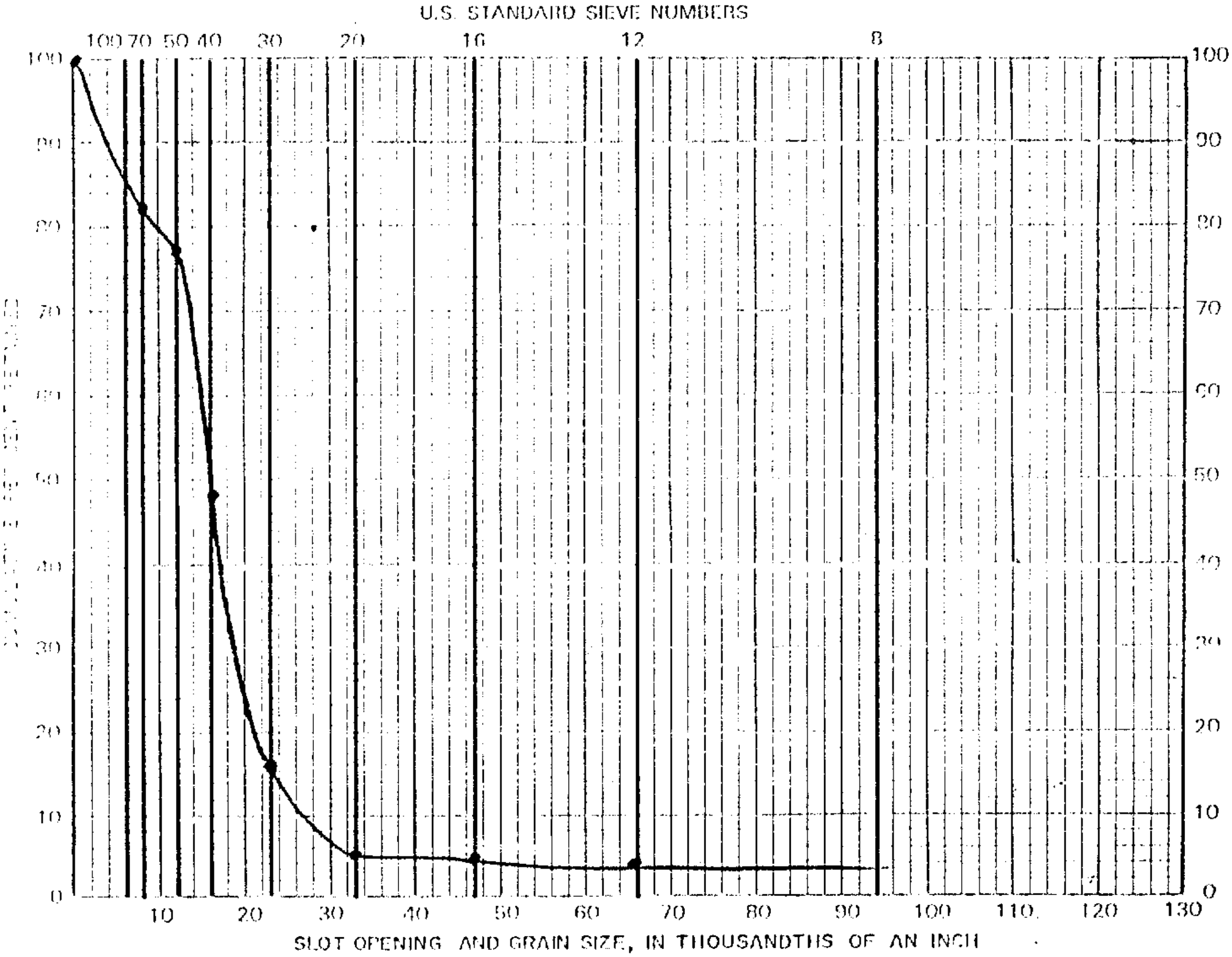
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 325'



U.S. SIEVE NO.	SIEVE OPENINGS INCHES	MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

UOP 14-2165

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

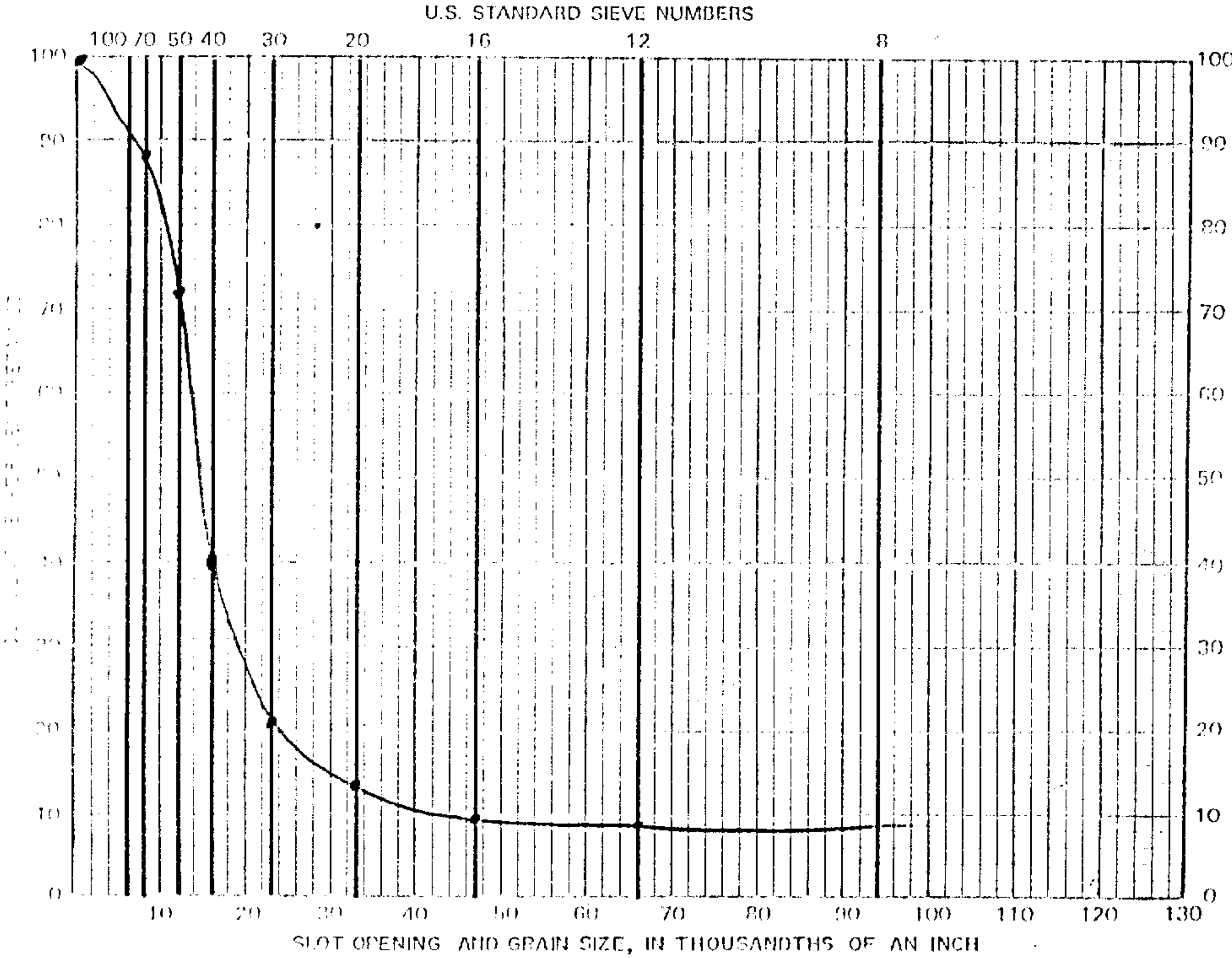
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks Depth = 345'



[illegible]	[illegible]		CUMULATIVE % RETAINED		
	[illegible]	MM			
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14 2??

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612 636 3900 • Telex 29 7451
UOP Inc.

SAND ANALYSIS
(FINE)

MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

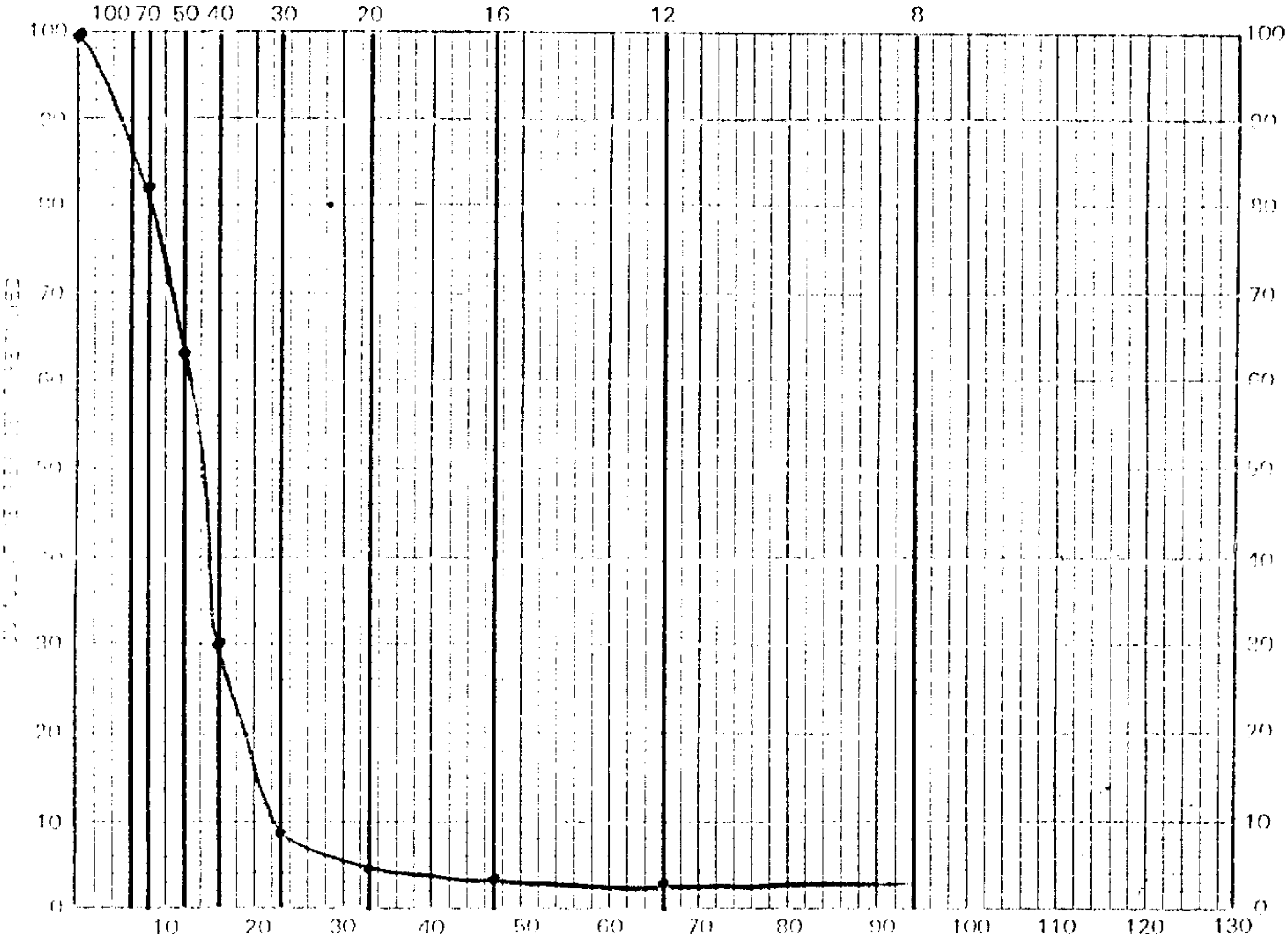
Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 365'.

U.S. STANDARD SIEVE NUMBERS



SLOT OPENING AND GRAIN SIZE, IN THOUSANDTHS OF AN INCH

[illegible]	[illegible]		[illegible]		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 11 2...

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Telephone 612 636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

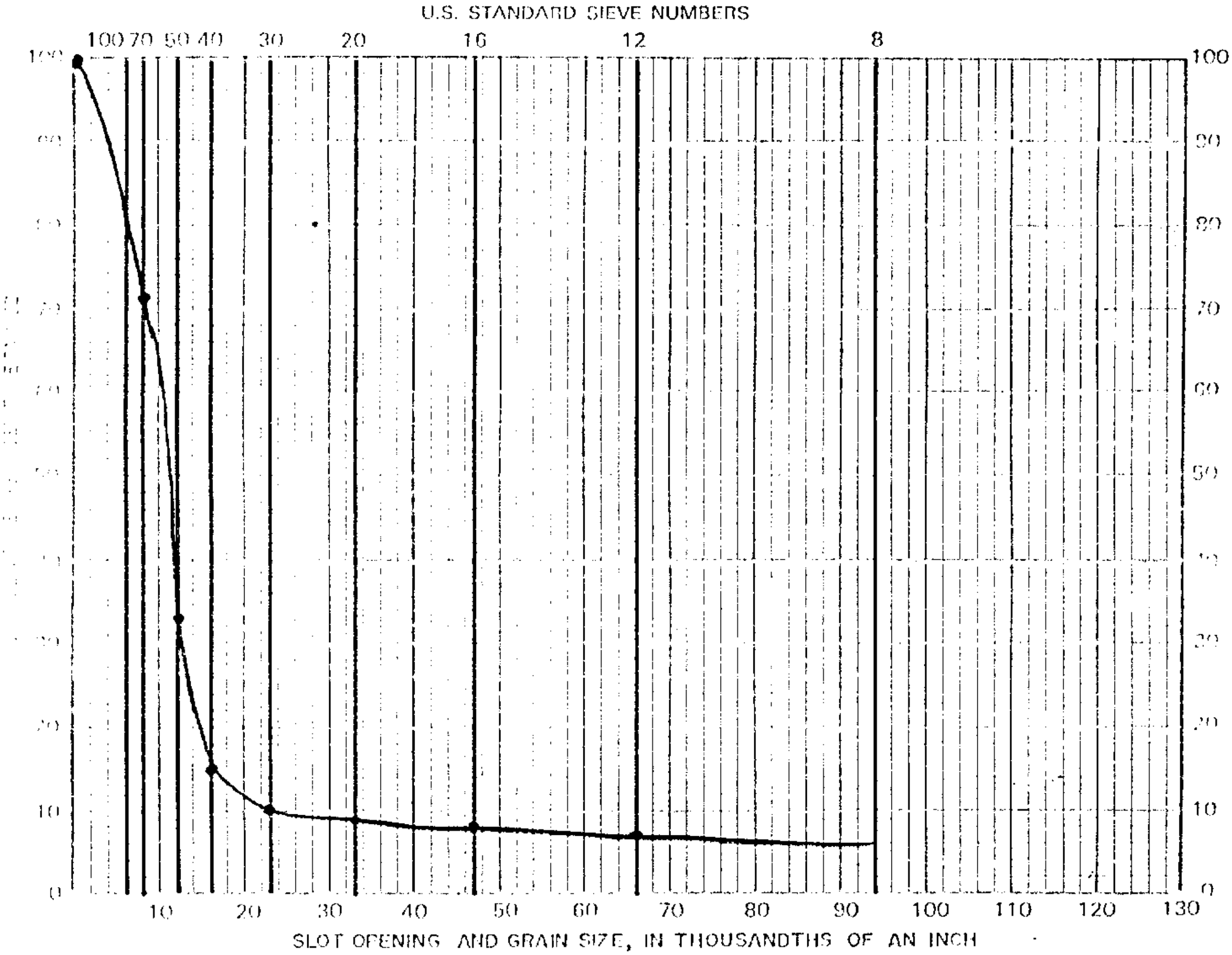
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 405'



[illegible]	Slot Openings		Cumulative % Retained		
[illegible]	Inches	MM			
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14-7155

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612 636 3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

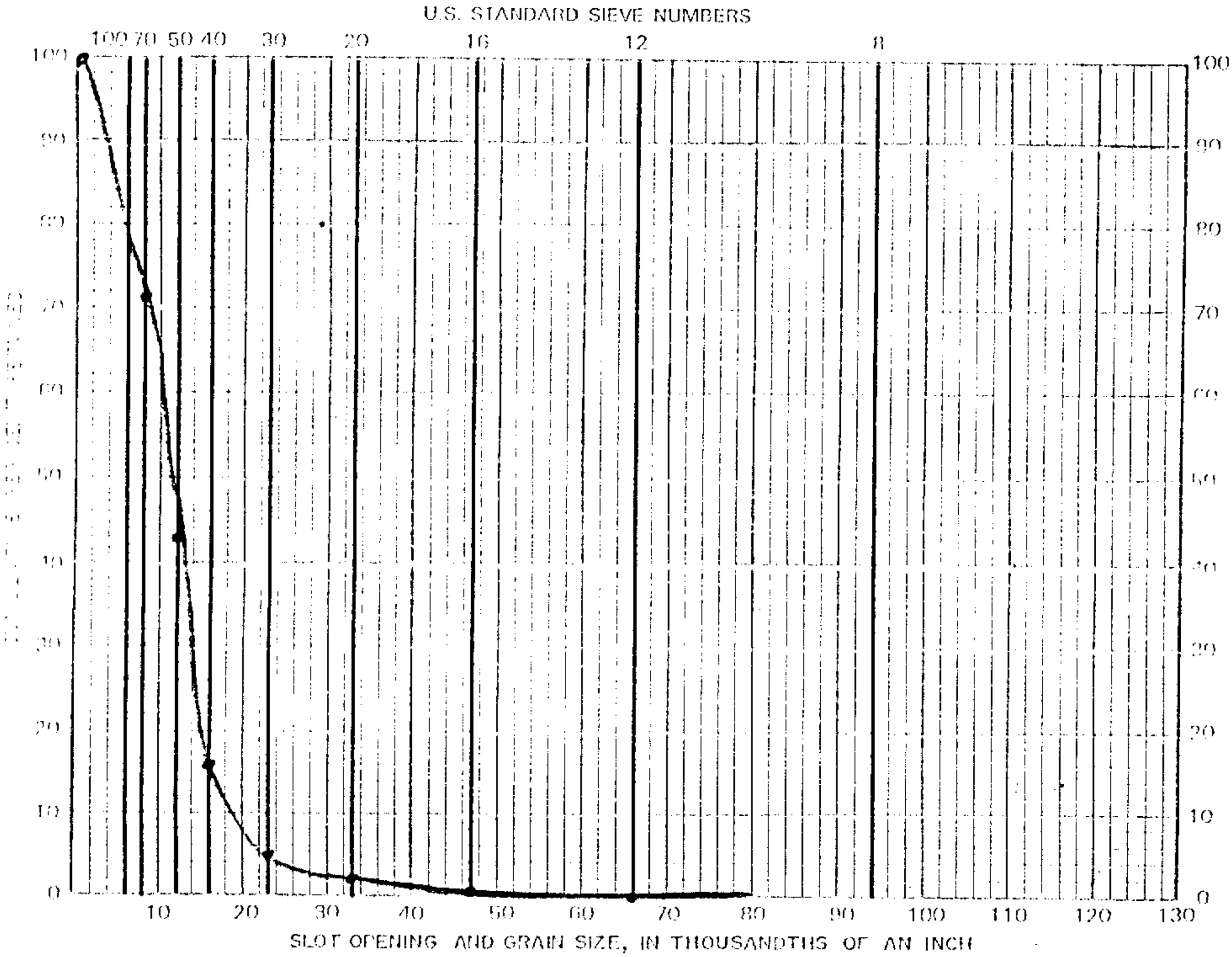
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 425'



U.S. SIEVE NO.	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

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UOP Inc.

SAND ANALYSIS
(FINE)

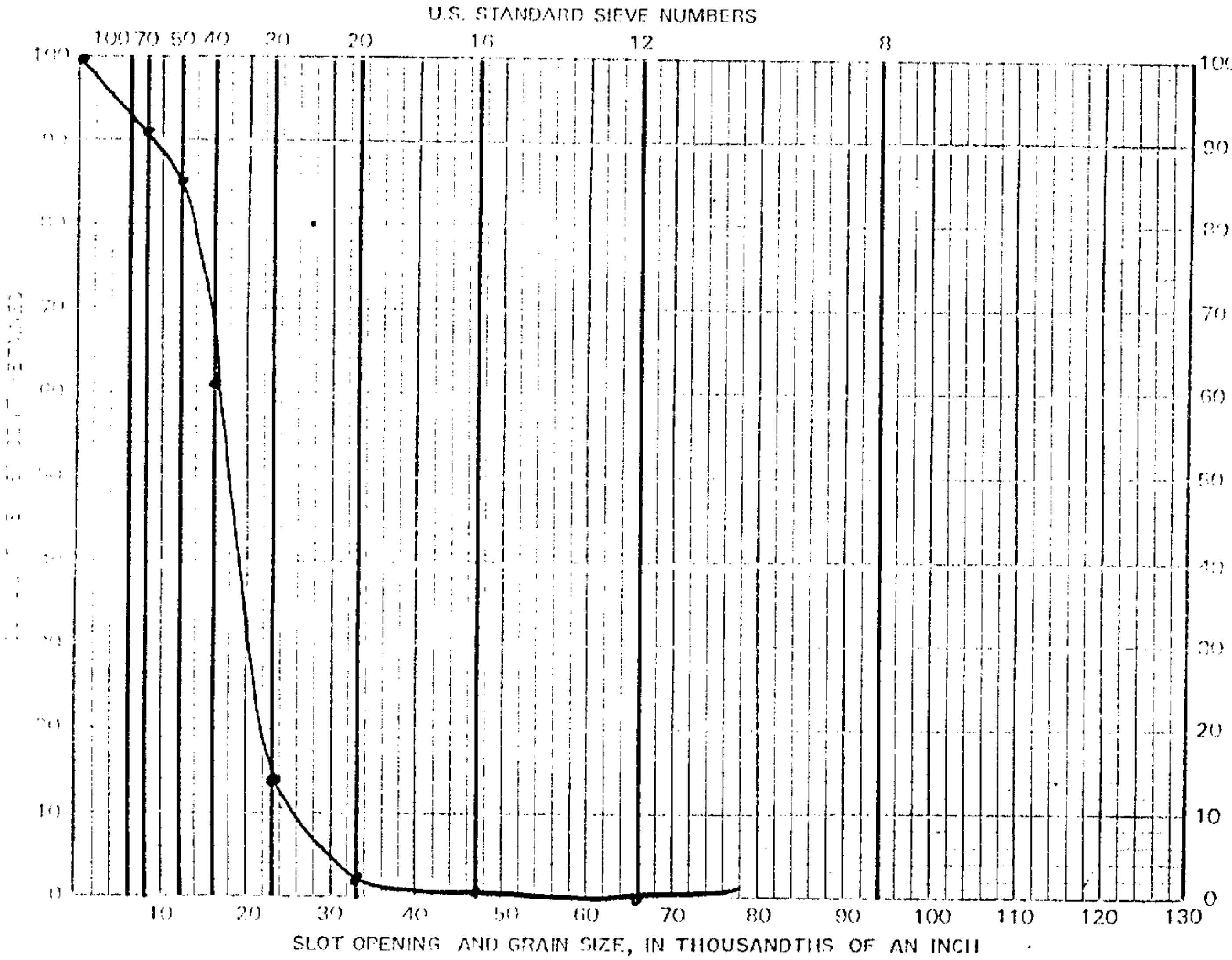
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 443′



U.S. SIEVE No.	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

DSP-14 2/85

Johnson Division
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Telephone 612 636 3900 · Telex 29 7451
UOP Inc.

SAND ANALYSIS
(FINE)

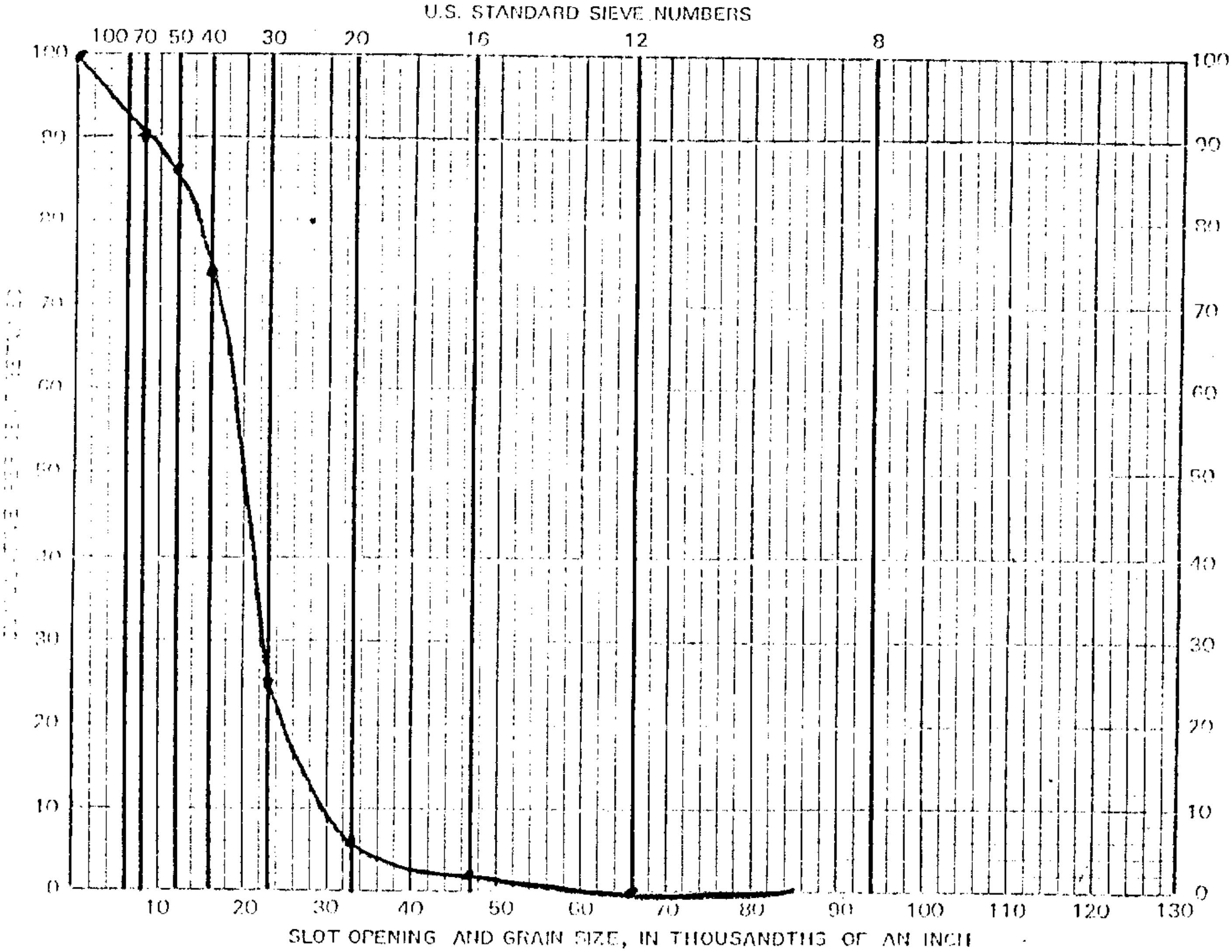
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 463'



U.S. SIEVE NO.	SIEVE OPENING INCHES	MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen. Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14-21-5

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612 636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS

(FINE)

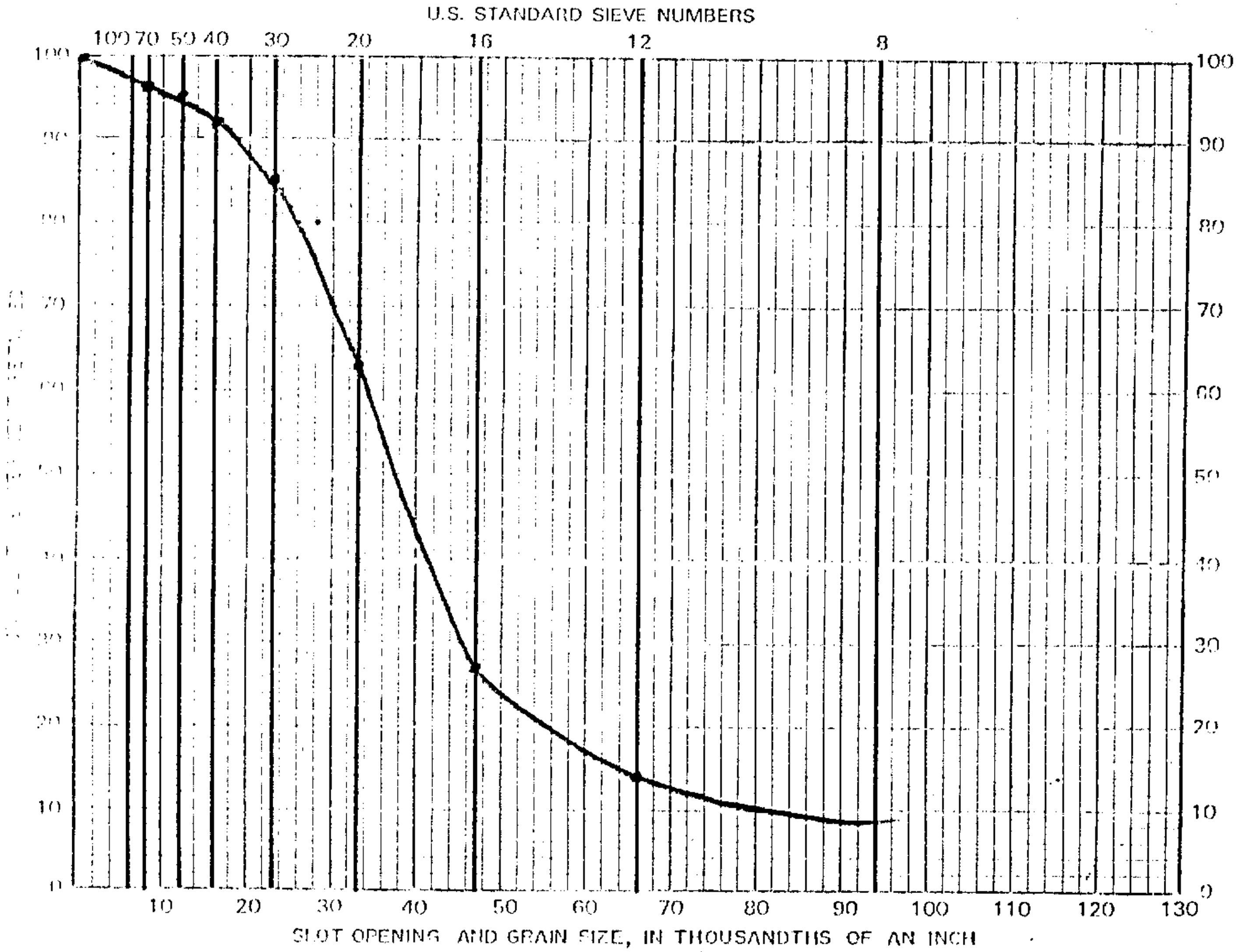
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 483'



U.S. Sieve No.	Slot Opening Inches	Slot Opening MM	Cumulative % Retained		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. ______ in. Length ______ Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14-2115

P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

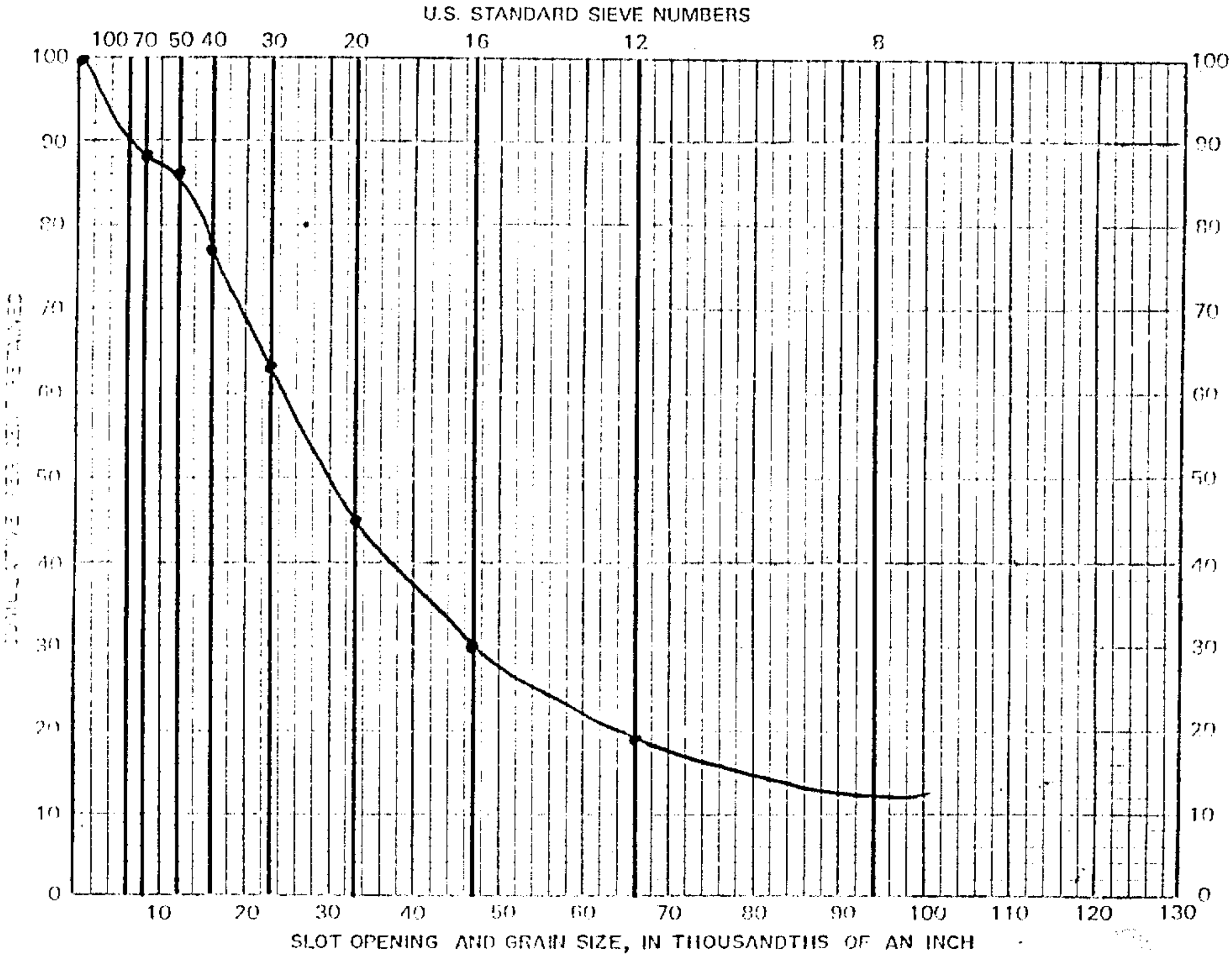
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 503'



U.S. SIEVE NO.	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14-2165

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS
(FINE)

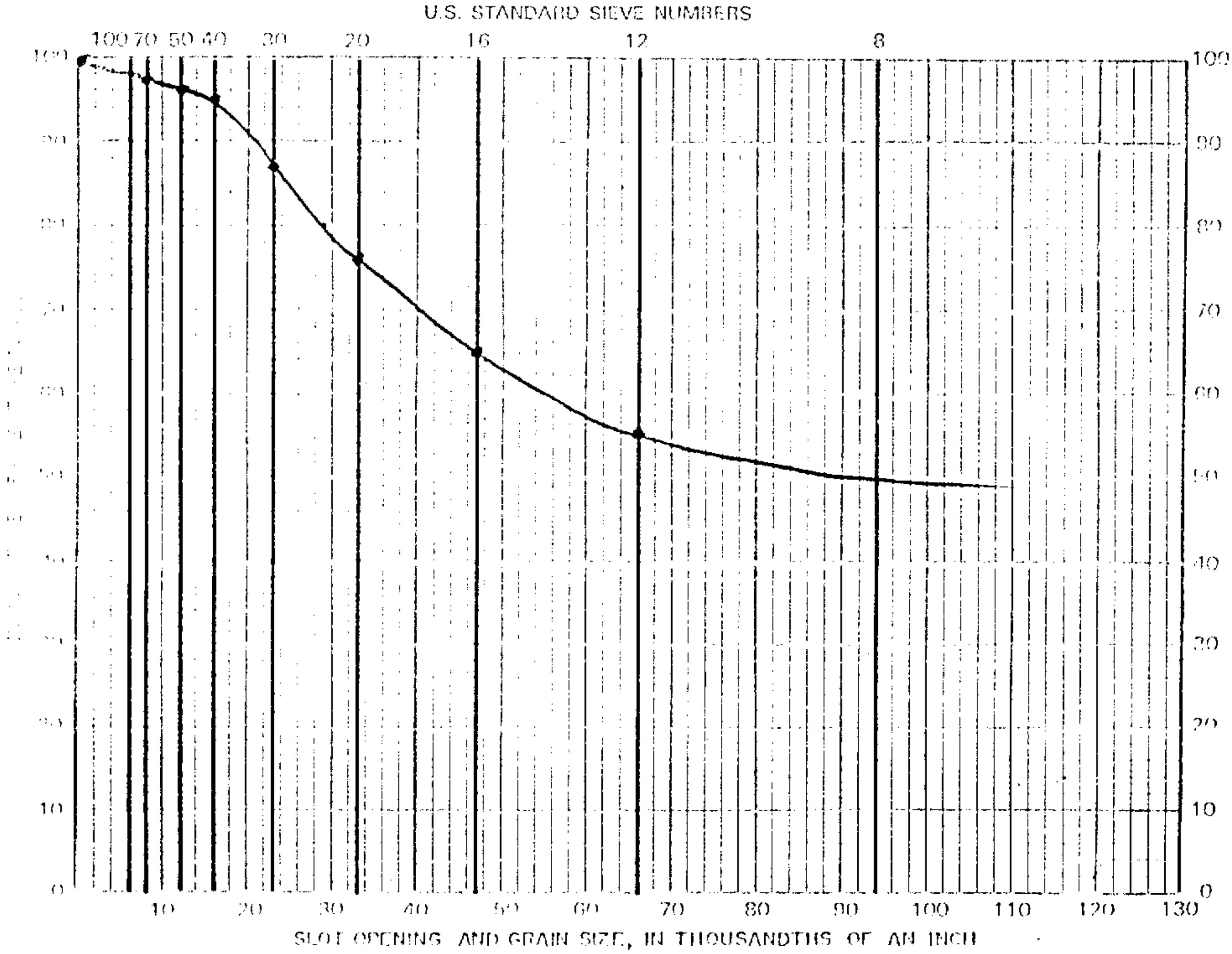
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 523′



U.S. SIEVE NO.	SLOT OPENING INCHES	MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

UOP 14-2155

Johnson Division
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UOP Inc.

SAND ANALYSIS
(FINE)

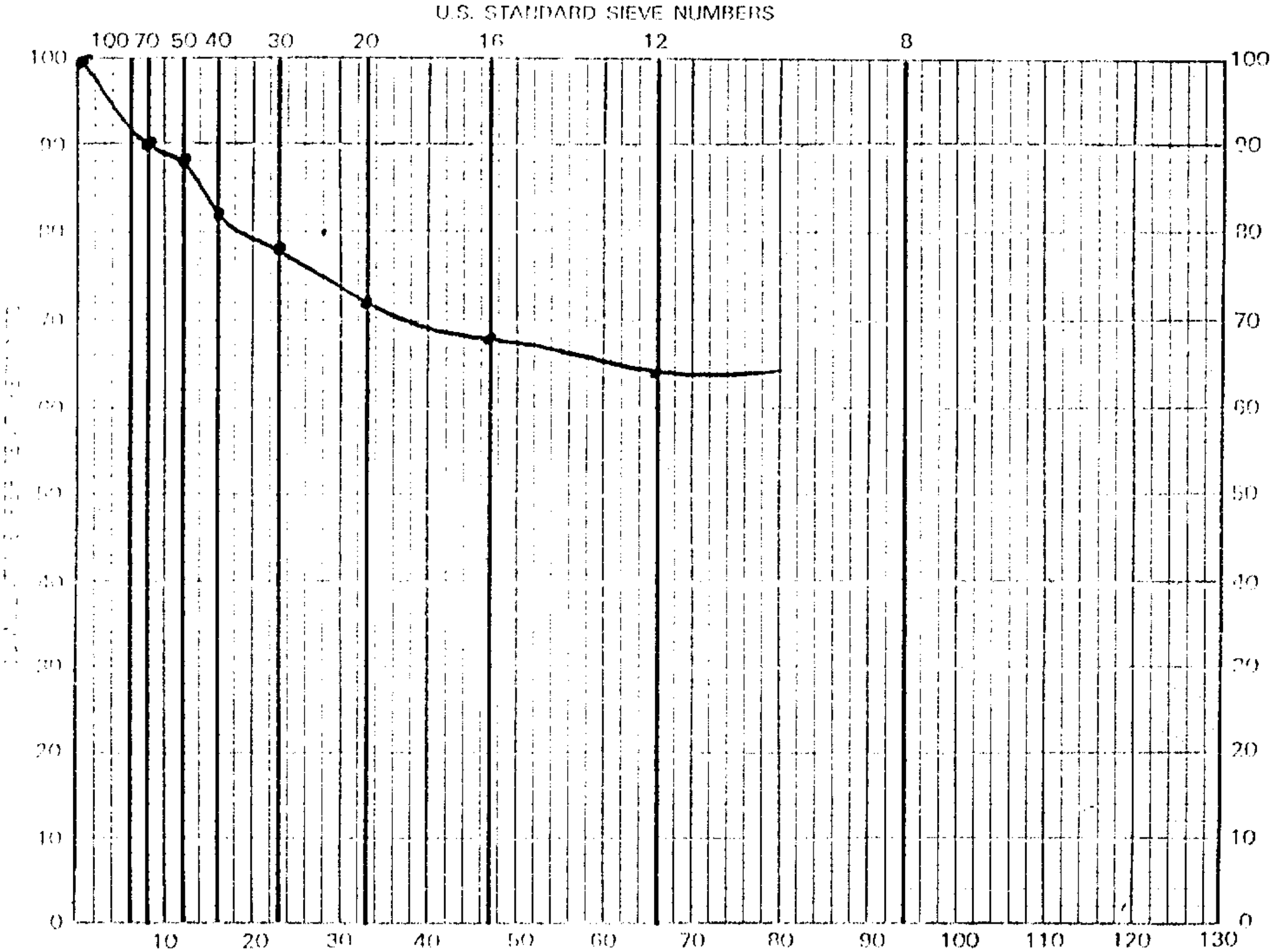
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 543'



U.S. SIEVE NO.	SIEVE OPENINGS INCHES	MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

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SAND ANALYSIS
(FINE)

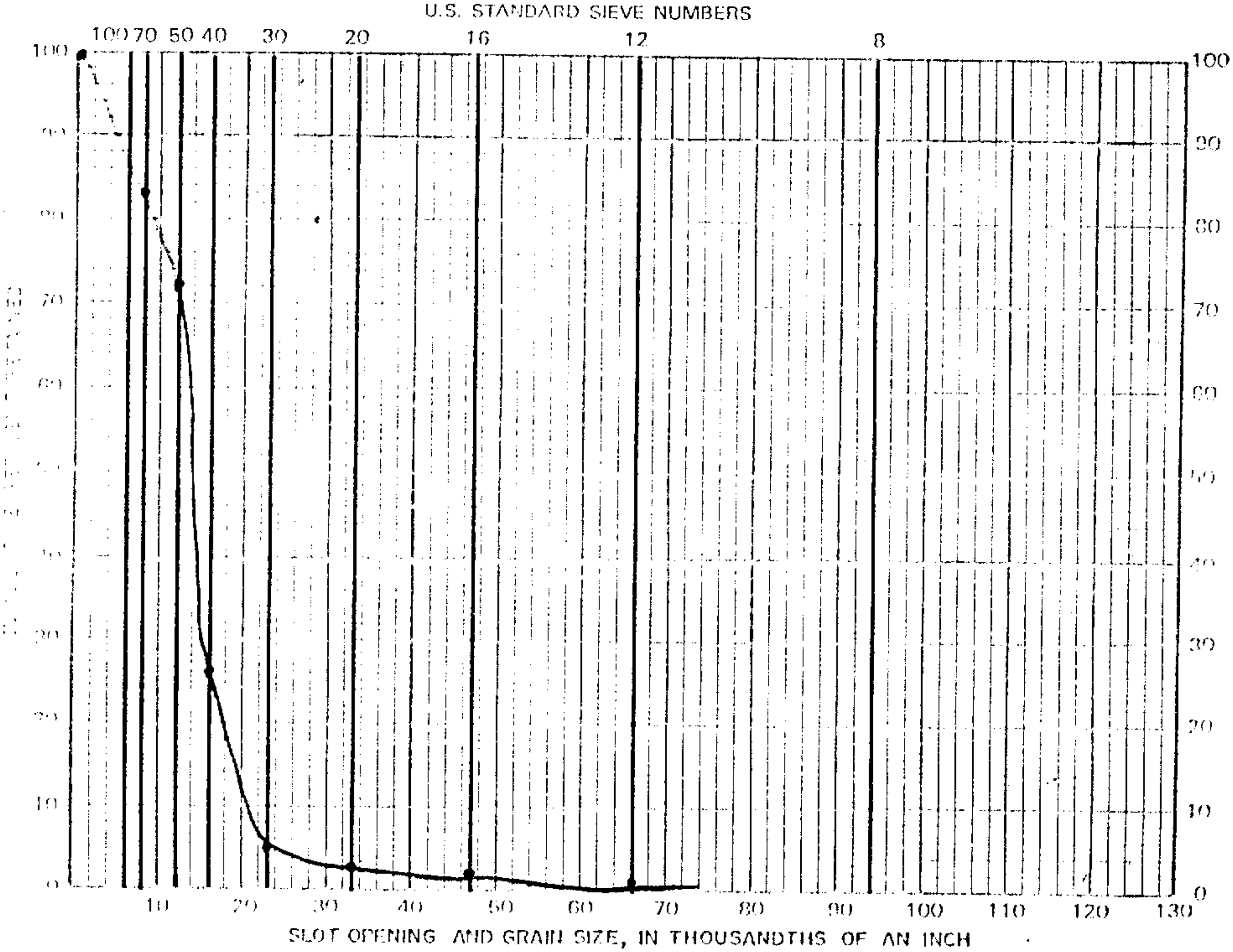
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 553'



[illegible]	[illegible] INCHES	MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

Johnson Division
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UOP Inc.

SAND ANALYSIS

(FINE)

MAILING ADDRESS: P.O. BOX 43118
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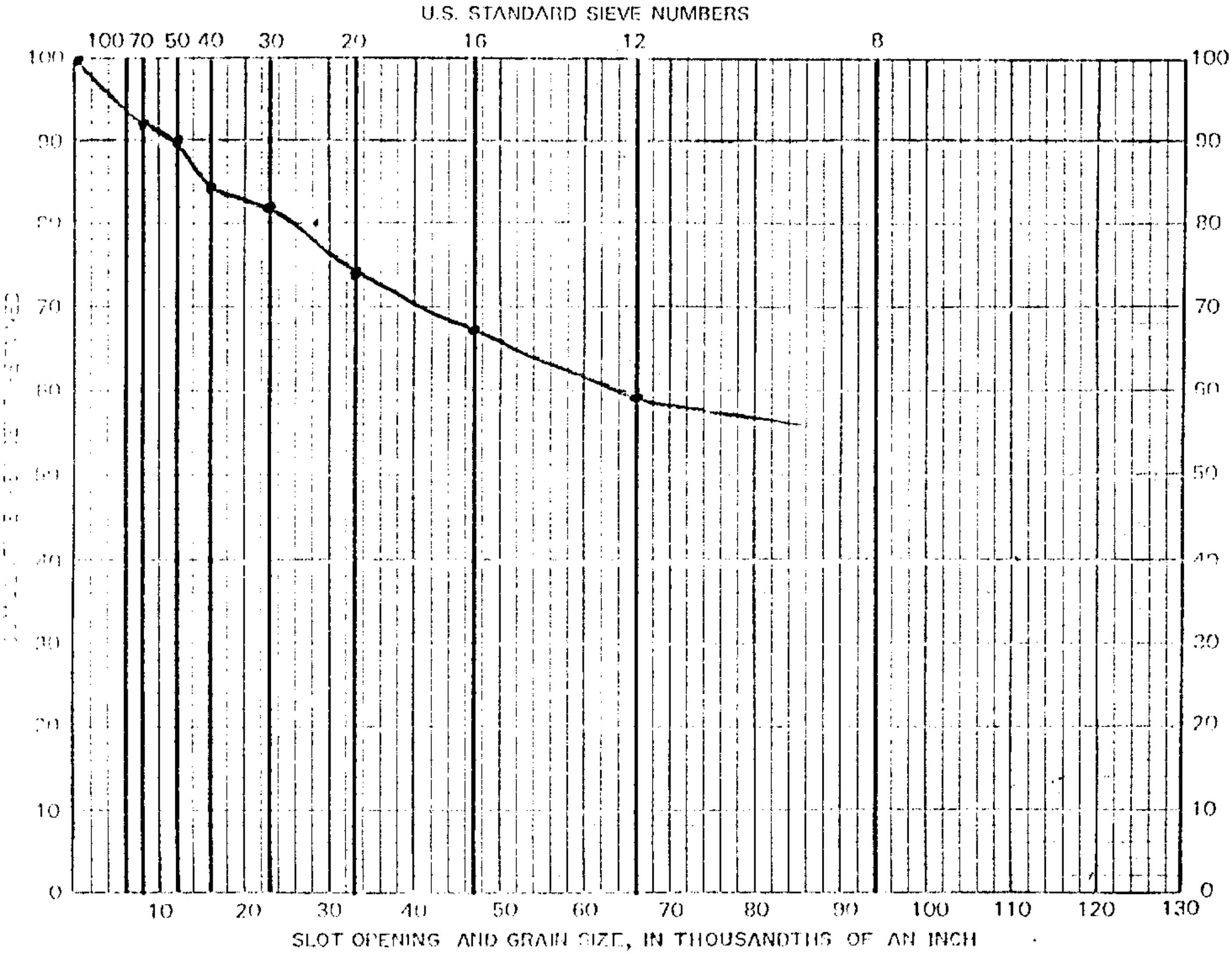
Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 573'



U.S. SIEVE NO.	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

UOP 14

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
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UOP Inc.

SAND ANALYSIS
(FINE)

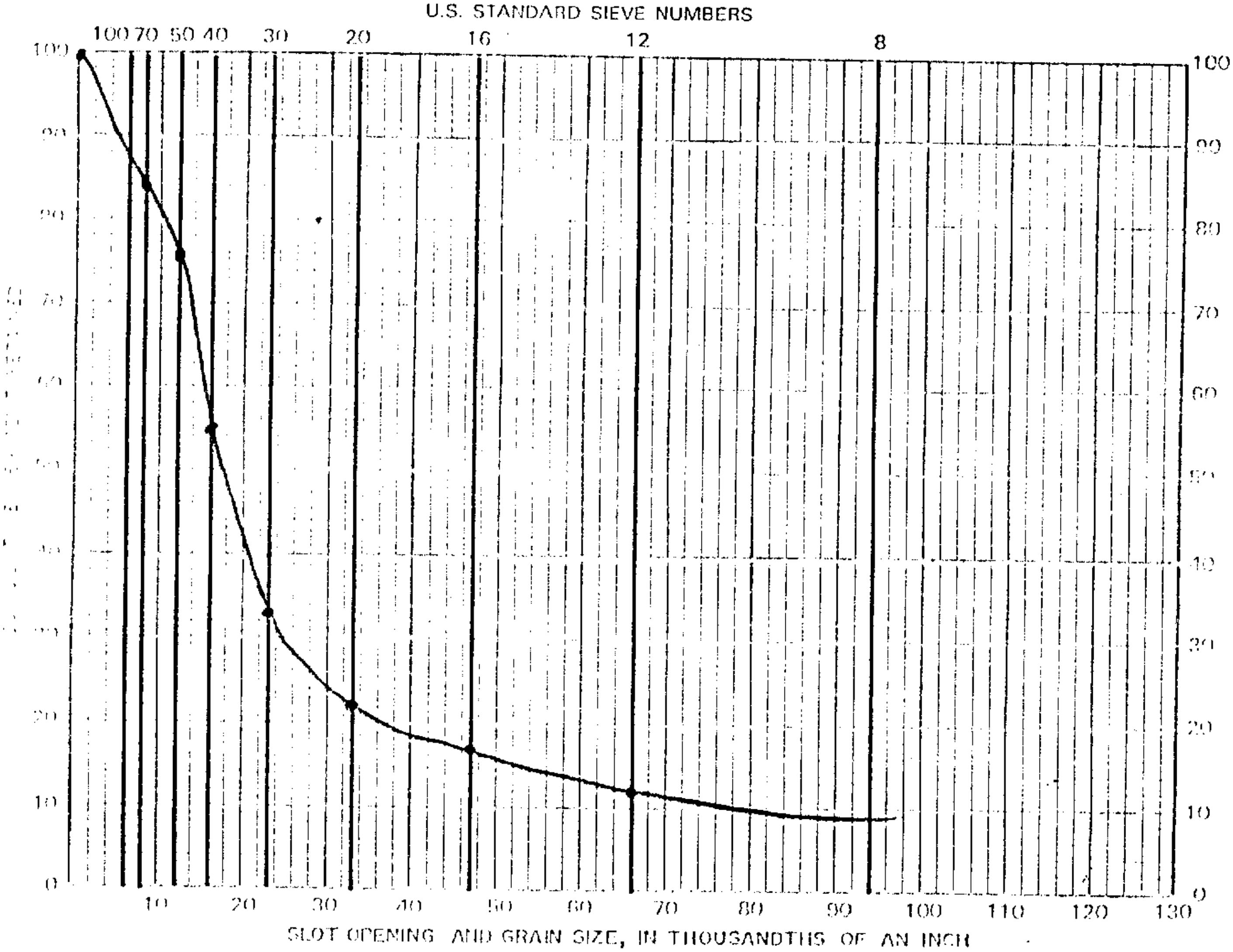
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 593'



SIEVE SIZE NO.	SLOT OPENING INCHES	SLOT OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

Johnson Division
P.O. Box 43118 • St. Paul, Minnesota 55164
Telephone 612-636-3900 • Telex 29-7451
UOP Inc.

SAND ANALYSIS

(FINE)

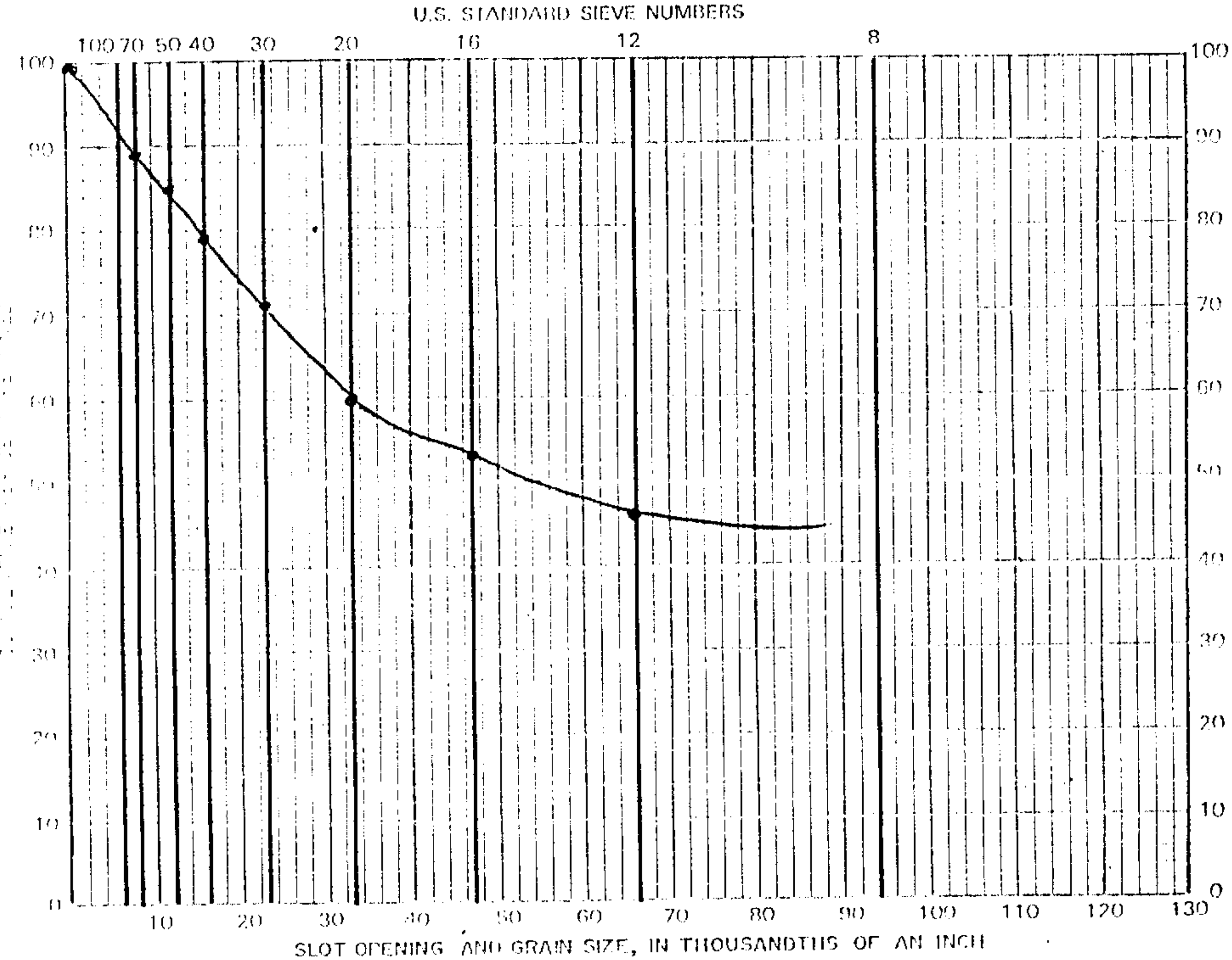
MAILING ADDRESS: P.O. BOX 43118
ST. PAUL, MINNESOTA • 55164

Sample sent in by

Town State Zip Date

From well of

Remarks: Depth = 613'.



U.S. SIEVE NO.	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes:

Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

UOP 14-2155