HELEN KRAMER LANDFILL SUPERFUND SITE

MANTUA TOWNSHIP, NEW JERSEY

REMEDIAL ACTION DESIGN

CONTRACT NO. DACW 41-86-C-0113

- PRELIMINARY DESIGN - 35% -

DESIGN ANALYSIS REPORT

APPENDIX 2

DEPARTMENT OF THE ARMY

KANSAS CITY DISTRICT, CORPS OF ENGINEERS

JANUARY 1987

COPY 2 OF 10

Prepared by

URS Company, Inc.

DR 000283

recommendations by A-E paperclipped in yellow

DESIGN ANALYSIS REPORT

APPENDIX 2

DR 000284

REPORT
GEOTECHNICAL INVESTIGATION FOR
PRELIMINARY DESIGN
SLURRY WALL AND CAP AND COVER
HELEN KRAMER LANDFILL SUPERFUND SITE
MANTUA TOWNSHIP, NEW JERSEY

JANUARY 5, 1987
JOB NO. 0836-024-10

Dames & Moore

CRANFORD, NEW JERSEY

DR 000285

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1.0 INTRODUCTION

This report presents the results and conclusions of Dames & Moore's Geotechnical Investigation and Preliminary Design for upgradient slurry wall and final cap and cover construction at the Helen Kramer Landfill Superfund Site (Helen Kramer Site), Mantua Township, New Jersey. The report and the scope of services was prepared and performed in accordance with the contract between URS Co., Inc. (URS) and Dames & Moore as amended and executed by representatives of each firm on November 7, 1986. Services in addition to those described in the contract were also provided in accordance with discussions between URS and Dames & Moore and URS's November 26, 1986 letter of authorization. Activities and services provided for this project were performed as coordinated with URS, including the URS on-site field representatives.

Results and conclusions presented herein are based upon field investigations and laboratory and office analyses completed during Phase II of the project and those completed previously by others. Field activities have been completed and the majority of laboratory analysis is finished and is continuing. Although we do not forsee that substantial revisions will be necessary as a result of additional laboratory analysis, all future laboratory testing results will be provided immediately upon completion.

This report is submitted to URS for inclusion in URS's 35% completion report to the U.S. Corps of Engineers (COE). This report represents a portion of the Phase II requirements as specified under the Prime Contract, DACW 41-86-C-0113, between URS and the Corps of Engineers. Final designs for slurry wall and cap and cover construction at the landfill will be provided subsequently under Phase III of the Prime Contract. Specifically, results and conclusions for Tasks 1A, 1B, 2A, 2B, 2C, 3A, 3B, 3C, and 3D in the November 7, 1986 contract are documented in this report. Results described in these tasks will be refined as additional data is obtained and through completion of Phase III activities.

Our report has been organized to present discrete sections of discussions in logical sequence. Initial sections of the report provide discussions of project objectives, scope of work, site background and hydrogeology. This is followed by descriptions of field and laboratory investigations and data analysis. Subsequent sections of the report provide our results and conclusions for preliminary design criteria for slurry wall and cap and cover and present our rationale for selected criteria.

2.0 OBJECTIVES AND SCOPE OF WORK

The objectives of Phase II of the project are to develop sufficient geotechnical information necessary to provide designs for the proposed remedial action elements recorded in the Record of Decision at the Helen Kramer Landfill and to allow for preparation of construction bid documents. Technical specifications for construction of the slurry wall and landfill cap are provided. These are based upon our understanding of the lateral extent of refuse, proposed wall alignment, site stratigraphy, soil properties, slurry wall and cap compatibility, cap material properties, and estimates of settlement under cap load.

To meet these objectives, the following scope of work has been completed:

Task 1A — Geophysical Survey

An electromagnetic survey was performed at selected locations along the landfill boundary and slurry wall alignment. The survey measured subsurface conductivity along the survey lines and allowed for interpretation of the presence/absence of buried wastes.

The purpose of the electromagnetic survey was to identify the extent of buried refuse to assist in selection of boring locations and slurry wall alignment along the surveyed sections of the landfill.

Task 1B — Drilling and Sampling of Slurry Wall Borings

To characterize site stratigraphy and obtain samples for laboratory testing, 18 borings were drilled along the proposed slurry wall alignment and four (4) borings along the proposed ground water collection drain alignment. Five (5) of these 22 borings penetrated the Mt. Laurel/Wenonah and Marshalltown Formations and were terminated in the Englishtown Formation. These borings were continuously sampled and the Mt. Laurel/Wenonah was cased off during deeper drilling. Remaining borings were terminated in the Marshalltown Formation. These borings were continuously sampled for the top 30 feet and at 5-foot intervals thereafter. Four of these borings were converted to ground water observation points by installing 2-inch diameter PVC piezometers. The piezometers were installed as ground water observation points and leachate sampling points for subsequent compatibility testing. Remaining borings were backfilled with a bentonite-cement grout using the tremie pipe method. All borings were continuously sampled during drilling operations in the Marshalltown Formation. Six foundation borings were drilled and five temporary well point piezometers installed. Slug tests were performed in the piezometers to estimate permeability of the Mt. Laurel-Wenonah Formation along the leachate/ground water collection drain alignment.

Task 2A — Laboratory Soil Testing for Slurry Wall

Selected soil samples from the borings were chosen for testing to evaluate their geotechnical properties. Testing included sieve analyses, hydrometer analyses, water content, Atterberg limits and permeability tests. Laboratory testing of soil samples characterized soils in the Mt. Laurel-Wenonah, Marshalltown and Englishtown formations. The Mt. Laurel-Wenonah Formation laboratory testing identified soil properties, including percent fines, moisture content and grain size distribution. This soil will be used as backfill for the slurry mix and information obtained from laboratory testing was used for selecting initial slurry wall design mix. Similarly, a portion of the backfill mix will be obtained from the Marshall Formation and these soils were also tested.

Since the slurry wall will be keyed into the Marshalltown Formation, additional characterization of this unit was necessary. Atterberg limits testing, hydrometer analysis and permeability testing were also performed on selected soil samples of the Marshalltown. In addition to field, office, and laboratory classifications, these tests were performed to evaluate the continuity of the formation and its geotechnical properties. Permeability testing was performed on relatively undisturbed samples of the Marshalltown Formation collected using Shelby tubes and Denison samplers. Soil samples were visually classified and vane stear strength tests performed in the field. Samples were re-examined in the laboratory as part of editing of the logs.

On the basis of information obtained from laboratory testing of the soils, slurry wall backfill mixes were selected. Permeability testing utilizing tap water from near the site was performed on potential slurry wall backfill mixes using typical slurry proportions and various percentages of dry bentonite. Additional testing of backfill mix include sieve and hydrometer analyses, water content, unit weight, permeability, consolidation and slump tests.

After establishing appropriate design backfill mix utilizing tap water, subsequent confirmation testing of the design mix for permeability and compatibility is to be performed on the selected mix utilizing tap water and ground water/leachate collected at the site in a flexible wall permeameter . The compatibility testing will utilize ground water/leachate obtained at the site. This permeant will be passed through the design mix and any changer in permeability with time noted. Seven pore volumes of ground water/leachate are passed through the mix sample. This method of testing is required for assessing slurry wall compatibility with ambient ground water conditions.

Task 2B — Preliminary Assessment of Slurry Wall Compatibility

Field and laboratory data and case histories of slurry wall performance were evaluated to assess the integrity of the slurry wall. The analysis includes a literature review and analysis of compatibility testing performed under Task 2A. The laboratory compatibility testing is required to assess observed changes in permeability as a result of slurry wall exposure to site contaminants.

Task 2C — Preliminary Design of Slurry Wall

Technical specifications for slurry wall design were selected based on evaluation of geotechnical, stratigraphic and laboratory data. Specifications for slurry wall design are based on previous investigations and tasks completed during this investigation. Design criteria provided include wall alignment, thickness, depth, slurry mix, backfill mix, and construction procedures.

Task 3A — Sampling and Laboratory Testing of Cap Materials

Field and laboratory analysis of proposed borrow materials were conducted to evaluate clay sources, landfill cap and construction procedures. The location of local borrow pits which can provide clay for use as capping material were identified. Clay samples were obtained from three pits and laboratory analysis performed on samples from the two most appropriate clay sources. Additional clay borrow pits were identified but are not yet operational. Laboratory testing includes sieve analyses, hydrometer analyses, Atterberg limits, water contents, Proctor density determinations and permeability testing. The laboratory testing was used to evaluate suitability of the material for use as cap material and construction considerations.

Task 3B — Construction of Field Test Section on the Landfill Surface

A representative section of the landfill was selected and a 50 ft. x 50 ft. settlement pad was constructed. The pad was constructed by installing six settlement plates and placing and compacting clean sandy fill similar in weight to the anticipated capping materials on the pad. Movement of the settlement plates due to settlement of the landfill surface under the load was monitored until settlement approached stable conditions. The data generated were assessed to assist in evaluating cap construction procedures and settlement analysis.

Task 3C — Preliminary Assessment of Cap Compatibility

Chemical composition of gas samples collected by URS will be reviewed and evaluated to assess effect of landfill gas in long-term performance of the clay cap, especially permeability and rheological characteristics of clay. Identified, time dependent changes in cap permeability and rheologic properties caused by exposure of the cap to landfill gases will be noted.

Task 3D — Differential Settlement Analysis of Landfill Surface and Cap Integrity

Field and laboratory data and/or literature search is being used to evaluate potential for differential settlement under the clay cover. Methods to minimize adverse impacts of differential settlement are identified and evaluated.

The results of the above tasks are documented in this written report. The report includes boring logs, well specifications, ground water level information, cross sections and pertinent field data, including problems encountered in the field. Laboratory results and design specifications and rationale for design criteria selection are included.

2.1 SUPPLEMENTAL SERVICES

During the course of the investigation, URS requested Dames & Moore to perform additional services. These supplemental services included:

- Supervision of drilling and sampling activities of foundation borings. We understand URS will utilize information from the borings to design foundations for the pretreatment facility. URS subsequently will select soil samples for analyses in Dames & Moore's soils laboratory to determine geotechnical properties of the soil.

- Drilling and installation of five well point piezometers along Edwards Run and performance of slug tests. We understand URS will use this information to assist in design of ground water/leachate treatment facilities.

The available results of these supplemental investigations, including edited boring logs, well point construction details and permeabilities based on slug test data are provided in this report.

3.0 SITE BACKGROUND

The majority of information presented in Section 3 was obtained form R. E. Wright's RI/FS dated September 1985.

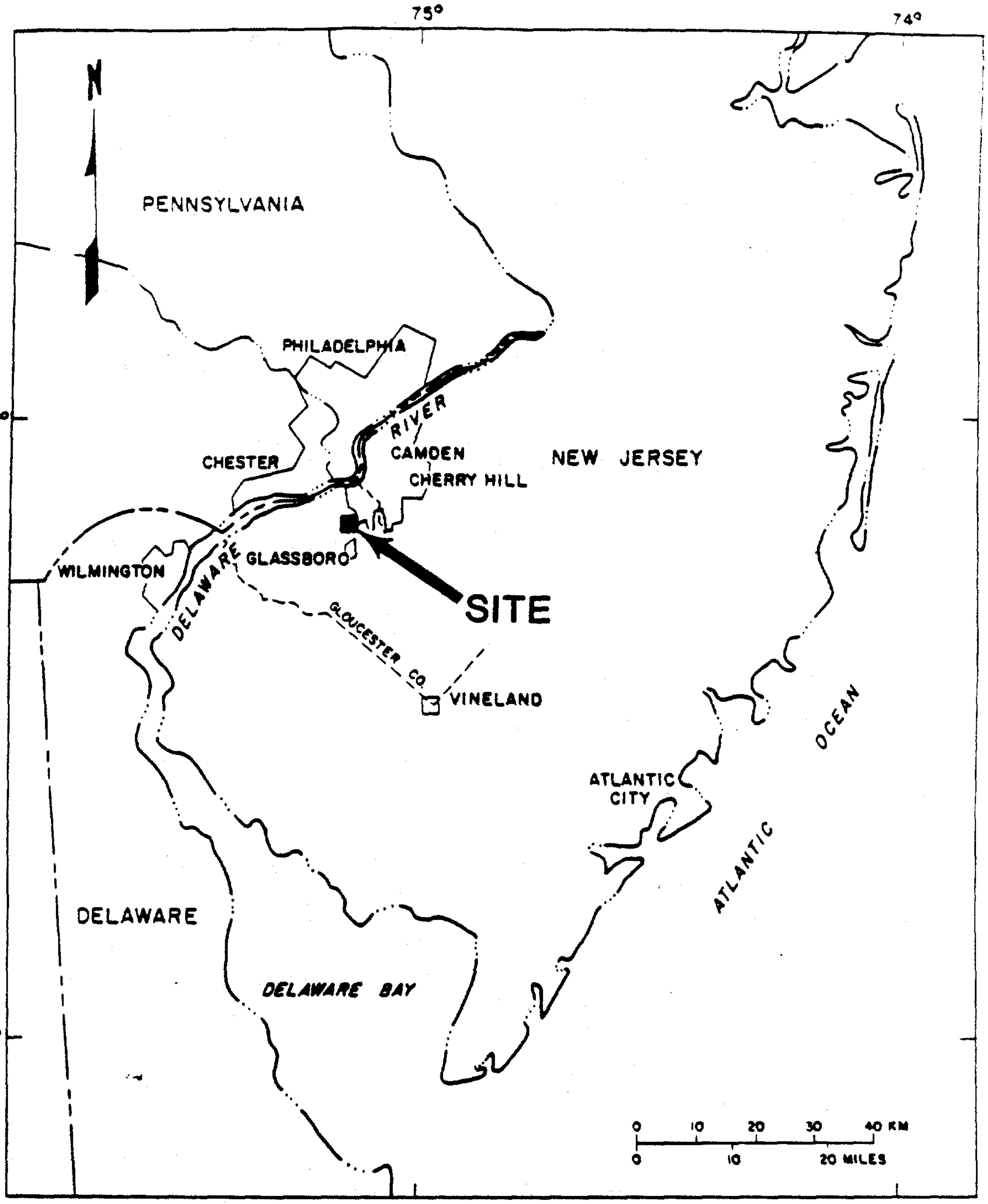
3.1 LOCATION

The Helen Kramer Landfill occupies approximately 77 acres in Mantua Township, Gloucester County, New Jersey (Figure 3-1). The 77-acre site includes 66 acres of refuse and 11 acres of stressed vegetation. The landfill is bounded on the north by Jessup Mill Road, on the east by Edwards Run Creek, on the south by Boody Mill Road, and on the west by Leave Road. These boundaries roughly define a rectangle bordering the site. A ridge formed by mounded refuse runs north-south through the center of the site. The landfill slopes steeply down to the east to Edwards Run and slopes gently down to the west toward Leave Road. The surface is generally undulating with refuse exposed at various locations.

The site lies in a semi-rural area of Gloucester County with several homes and farmers' fields in the immediate site vicinity. The suburban communities nearest to the landfill are Center City, located approximately one-half mile to the east and Mantua, located 1.4 miles to the northeast. The density of homes near the site increases as one moves east and west away from the landfill along Jessups Mill and Boody Mill Roads.

3.2 LANDFILL HISTORY

The Helen Kramer Landfill became operational between 1963 and 1965. Prior to 1965, the site was an active sand and gravel pit. Landfilling operations began in the area north of the south ravine along Edwards Run and were subsequently extended to fill the south ravine and to cover the rest of the site. Little information is available about operations during the period of 1965 through 1970. Landfill activities continued through 1981, throughout a period during which NJDEP had issued Notice of Registration Revocation, Notices of Prosecution and several notices of



SITE LOCATION MAP
HELEN KRAMER LANDFILL
MANTUA, N.J.

DR 000299

MODIFIED FROM RIFS FINAL REPORT
R.E. WRIGHT ASSOCIATES, INC.
SEPTEMBER, 1986

Dames & Moore

FIGURE 3-1

violations. NJDEP responses were based on inadequate submittals of Landfill Engineering Designs, and NJDEP inspections which noted chemical waste disposal, leachate discharging to Edwards Run, and improper use of cover and working faces.

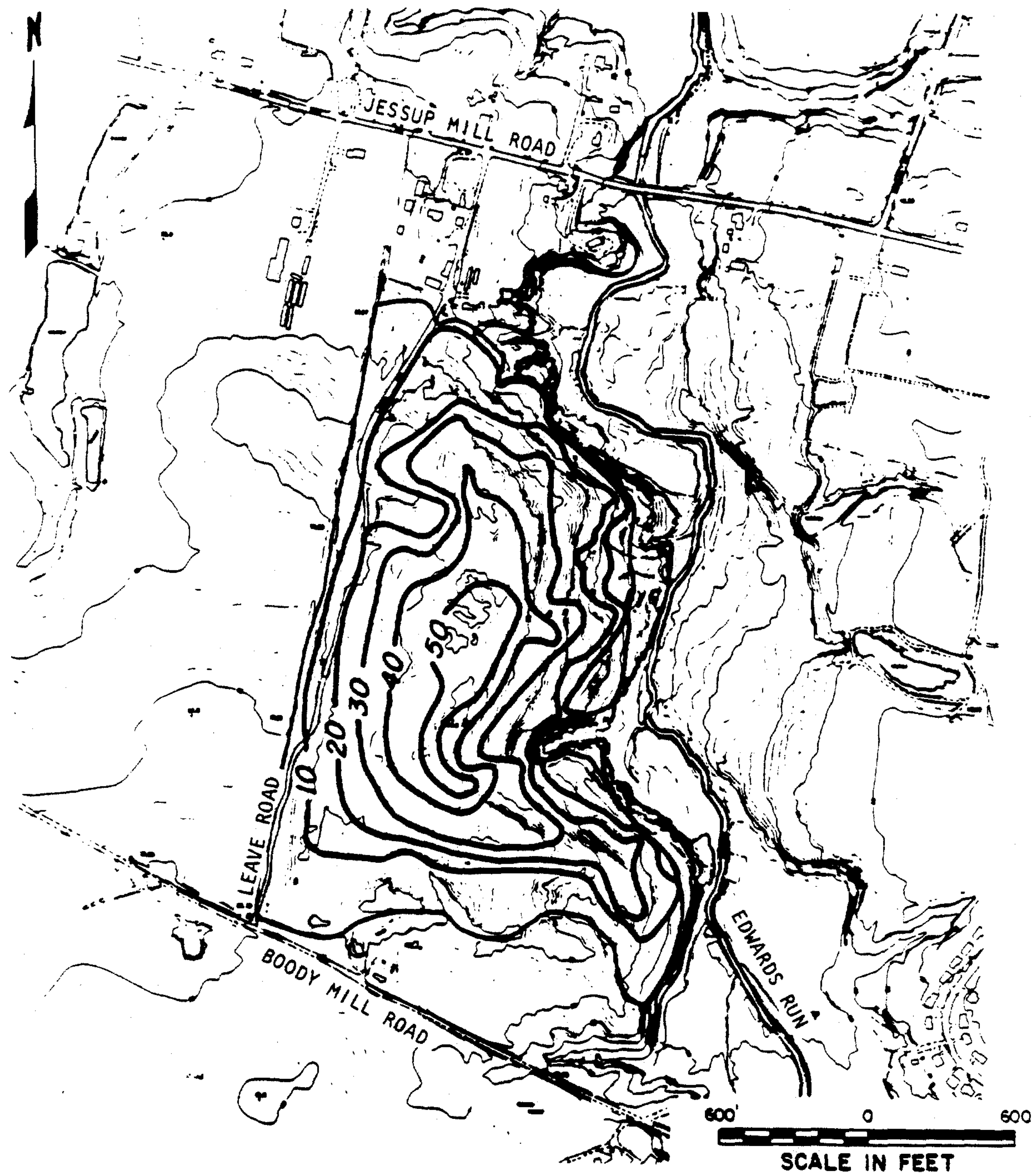
The landfill was closed by Gloucester County Court Order in March 1981 on the basis that operations had exceeded permitted elevations and capacity. Subsequently, several fires broke out at the landfill which were reportedly extinguished through owner and DEP actions.

3.3 WASTE DISPOSAL

According to R. E. Wright's RI/FS, an estimated 2,000,000 cubic yards of refuse and waste materials were landfilled at the site during active operations. Thickness of the fill is reportedly greater than 50 feet, a conservative estimate based on air photo analysis. It is likely that fill thickness may exceed 50 feet in places. Refuse thickness decreases radially from the center of the landfill toward the landfill's boundaries. An isopach map of fill thickness is presented as Figure 3-2. Daily cover and compaction of wastes was reportedly poorly conducted and resulted in significant settlements of the landfill.

Waste types disposed of at the landfill are varied and include municipal refuse, septic waste, hospital wastes, industrial waste and inorganic and organic chemical wastes. Detailed descriptions of the lateral and vertical distribution of each waste type has not been established and is believed not to have been controlled to a significant degree. Waste type records for the period of 1963 to 1973 are absent.

During the course of operations, NJDEP inspections noted chemical wastes dumped in trenches and in at least seven lagoons as well as being allowed to drain across areas of the site and pool on soils. Septic wastes were placed in open faces of the landfill. Municipal wastes are reported to be the predominant material disposed at the facility. Additional waste types include incinerator waste, syringes, vials, serum bags, sludges, oils, degreasers, solvents, chemical intermediaries, acids, caustics, metals, heavy metals and plasticizers. Both drummed liquid and contents of bulk tankers are reported to have been disposed of on site.



ISOPACH MAP SHOWING THICKNESS OF FILL

HELEN KRAMER LANDFILL
MANTUA, N.J.

KEY:

LIMIT OF FILL

10 CONTOUR OF FILL THICKNESS, CONTOUR INTERVAL 10'

OBTAINED FROM RIFS FINAL REPORT, RE WRIGHT ASSOCIATES, INC. SEPT. 1986.

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FIGURE 3-2

3.4 PREVIOUS INVESTIGATIONS

Previous studies at the Helen Kramer Landfill have been performed by USEPA, NJDEP and private consultants. These earlier investigations were designed and implemented to characterize hydrogeology, landfill history, and soil, water, sediment and air quality.

Earliest investigations performed in 1974 and 1976 involved installation of monitoring wells and ground water and surface water sampling for inorganic compounds. Subsequently, in 1980 and 1981, NJDEP sampled local domestic wells and USEPA performed sampling and analysis of ground water leachate and sediment as well as preliminary bioassay study. In addition, methane gas migration studies were performed and air monitoring performed during and after historical on-site fires.

The results of these studies documented ground water flow direction, contamination of Mt. Laurel/Wenonah aquifer, contaminants leaving site, contamination and detrimental effect of the landfill on Edwards Run aquatic life, lateral migration of methane gas, and levels of organic vapors above background levels at the landfill. At the time the investigations were performed, it was concluded that area ground water supplies had not been degraded with the exception of one well which was subsequently closed and that organic vapors did not pose immediate concern for public health.

As a result of these general studies and the various NJDEP inspections, it became apparent that a detailed investigation of the landfill was warranted. This need led to the design and implementation of a Remedial Investigation/Feasibility Study which was performed by R. E. Wright Associates, Inc. and documented in their September 1985 report. The report characterized the site and surrounding area and identified remedial alternatives for site control.

USEPA reviewed the RI/FS and remedial alternatives. On the basis of this review, Mr. Christopher Daggett, EPA Regional Administrator, prepared a Record of Decision dated September 27, 1985, in which Remedial Alternative No. 4 was the chosen option. Alternative No. 4 includes the following:

- Ground Water/Leachate Collection and Treatment System
- Clay Cap
- Upgradient Slurry Wall
- Active Gas Collection and Treatment System
- Dewatering, Excavation and Backfilling of Lagoons
- Security Fence
- Monitoring
- Operation and Maintenance

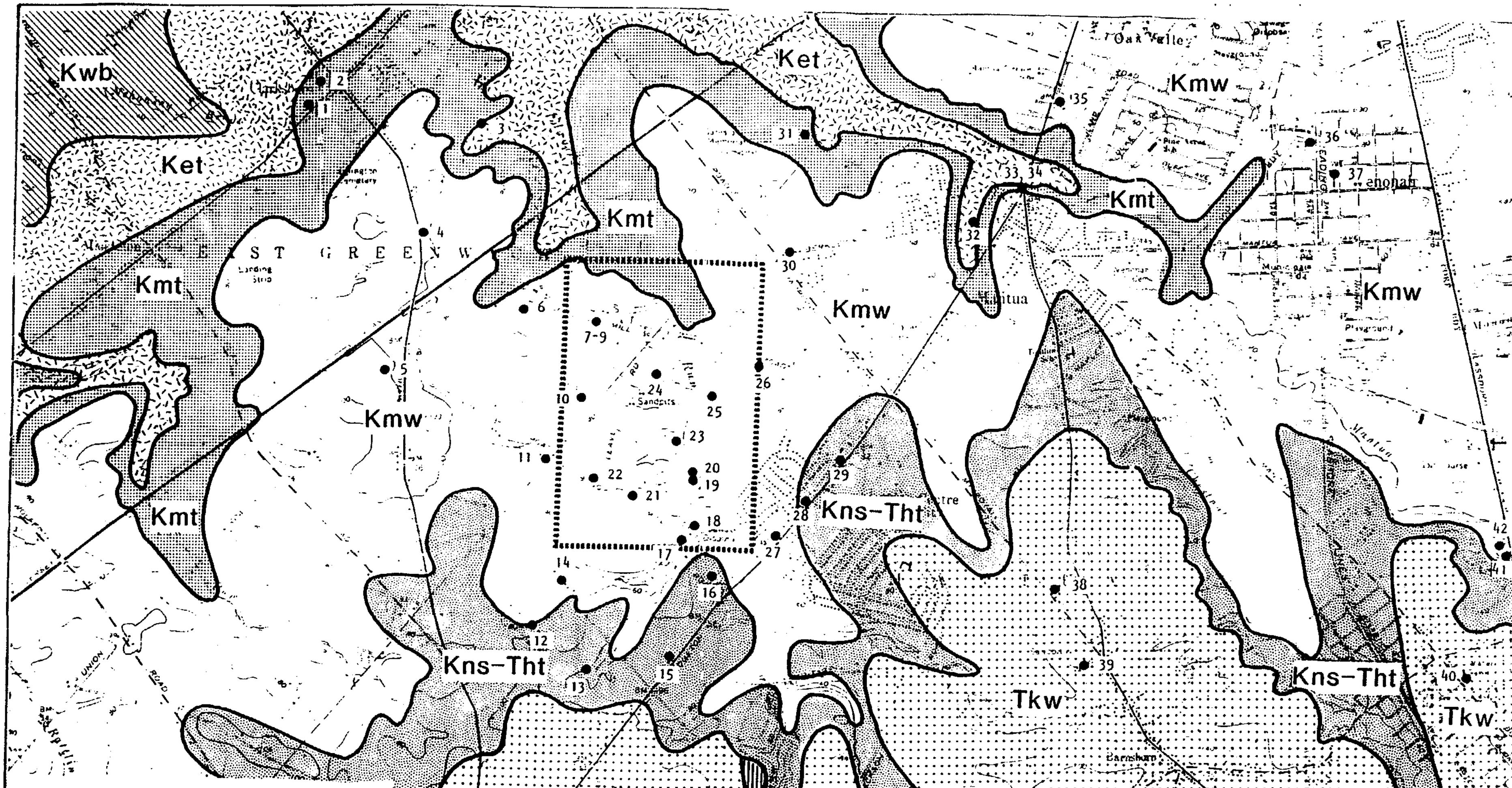
USEPA determined that this alternative is "technically feasible and reliable and effectively mitigates and minimizes damages to and provides adequate protection of public health, welfare and the environment." The State of New Jersey agreed with the selected option and it was written in the Record of Decision that the current studies are required to design the remedial action elements.

4.0 GEOLOGY AND HYDROLOGY

4.1 REGIONAL GEOLOGY

The Helen Kramer landfill is situated in the Atlantic Coastal Plain and is immediately underlain by unconsolidated formations of Cretaceous age. A geologic map of the site area is shown in Figure 4-1. A stratigraphic column for geologic formations found in Gloucester County is presented in Figure 4-2.

With the exception of the Magothy and Raritan Formations which in Gloucester County were largely of continental origin, the formations of Tertiary and



KEY:

Kwb - WOODBURY CLAY
Ket - ENGLISHTOWN FROMATION
Kmt - MARSHALLTOWN FORMATION
Kmw - Mt. LAUREL-WENONAH FORMATION
Kns-Tht - NAVESINK FORMATION AND HORNERSTOWN FORMATION
Tvt - VINCENTOWN FORMATION
TKw - KIRKWOOD FORMATION

1 ● LOCATION OF WELLS USED FOR STRATIGRAPHIC CONTROL

0 2000 FEET

AREA GEOLOGIC OUTCROP/SUBCROP MAP AND OFFSITE WELL CONTROL

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FIGURE 4-1

Era	System	Series	Formation	Lithology	Thickness (feet)
Cenozoic	Quaternary	Holocene	Alluvium	Mud, black, silt and sand	0-40
			Eolian deposits	Sand, white frosted	0-10
		Pleistocene	Cape May Formation	Sand, gravel, and clay	0-40
			Unconformity		
			Pensauken Formation	Sand and gravel	0-30
			Unconformity		
			Bridgeton Formation	Sand and gravel	0-50
			Unconformity		
	Tertiary	Pliocene (?) and Miocene (?)	Cohansey Sand	Sand, clay and gravel, light colored	0-130
			Unconformity		
		Miocene	Kirkwood Formation	Sand, clay, and some gravel	50-160
			Unconformity		
		Eocene	Manasquan Formation (subsurface)	Sand and clay, glauconitic	0-25
		Paleocene	Vincentown Formation	Limy sand and limestone	0-55
			Hornerstown Sand	Clay and sand, glauconitic	8-30
			Unconformity		
Mesozoic	Cretaceous	Upper Cretaceous	Navesink Formation	Clay and sand, glauconitic	0-40
			Mount Laurel Sand	Sand, medium to coarse, glauconitic	65-95
			Undifferentiated		
			Wenonah Formation	Sand, fine to medium, micaceous	
			Marshalltown Formation	Clay, sandy in places, glauconitic	10-40
			Englishtown Formation	Sand, white and yellow, micaceous, slightly glauconitic	0-50
			Woodbury Clay	Clay, black, micaceous	50-80
			Merchantville Formation	Clay, glauconitic, some sandy zones	45-70
			Unconformity		
			Magothy Formation	Clay, dark colored and sand, light colored (alternating)	150-500-
			Undifferentiated		
			Raritan Formation	Clay and sand, variegated (alternating)	
			Unconformity		
Precambrian		Upper Precambrian (?)	Wissahickon Formation (subsurface)	Banded micaceous schist or gneiss	5,000-8,000

STRATIGRAPHIC COLUMN FOR GEOLGIC UNITS FOUND IN GLOUCESTER COUNTY, N.J.

HELEN KRAMER LANDFILL
MANTUA, N.J.

NOTE: ADAPTED FROM TABLE 1 OF WATER RESOURCE AND GEOLOGY OF GLOUCESTER COUNTY, NEW JERSEY, SPECIAL REPORT 30, 1969.

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FIGURE 4-2

Cretaceous age identified in Figure 4-2 are of marine origin — the deposits being laid down in inner-shelf, near-shore and beach areas (Zapacza, 1984). These unconsolidated formations dip to the southeast and thicken oceanward. Each succeeding younger formation has a lower dip than the unit upon which it rests (Hardt and Hilton, 1969). The basal part of the deepest, and oldest, formation, the Raritan, dips to the southeast at more than 60 ft/mile, while the upper beds of the Kirkwood Formation have a dip of only about 10 ft/mile. The dip of the Mt. Laurel-Wenonah unit and the underlying Marshalltown Formation, the two units closest to the surface at the landfill, is reported to range from 35 to 40 ft/mile (Hardt and Hilton, 1969).

The following description of the lithology of the Coastal Plain formations in Gloucester County will be limited to those formations which underlie the site and which are within 150 to 200 feet of the surface. This includes, with increasing depth: the Mt. Laurel-Wenonah Formation, the Marshalltown Formation, the Englishtown Formation, the Woodbury Clay and the Merchantville Formation.

The Mt. Laurel Sand portion of the Mt. Laurel-Wenonah Formation is characterized by light gray to dark green medium - to coarse-grained quartzose sands, with generally 5 to 40 percent glauconite (Hardt and Hilton, 1969). The underlying Wenonah unit is commonly a fine-to coarse-grained quartz sand with colors ranging from yellow, through red to black or brown. Ferruginous layers, representing ironstone, are common within the Wenonah. The Mt. Laurel-Wenonah Formation is often associated with a "salt-and-pepper" appearance, due primarily to the ample presence of glauconite. The unit is underlain conformably by the Marshalltown Formation (Hardt and Hilton, 1969).

The Marshalltown Formation in Gloucester County is described as a dark-green to black clay, sandy clay or silt, and is locally micaceous and glauconitic. However, from Mullica Hill northeast toward Camden County, well logs indicate that the formation consists of clauconitic silty, clayey sand (Hardt and Hilton, 1969). There is some indication that the clay content of the unit increases downdip of the outcrop areas. The Marshalltown Formation is conformably underlain by the Englishtown Formation.

The Englishtown is not everywhere present in the county, as in certain local areas it has been removed by erosion. In its outcrop area, the Englishtown Formation commonly consists of yellow and brown fine-to coarse-grained quartzose sand with local lenses of clay (Hardt and Hilton, 1969). Downdip of the outcrop area, the color changes to white and gray, and the sand tends to grade into clay. South of Mullica Hill and Sewell (south of the landfill) the Englishtown is barely distinguishable from the silty or clayey units immediately overlying and underlying it — the Marshalltown Formation and the Woodbury Clay, respectively. The Englishtown conformably overlies the Woodbury Clay.

The Woodbury Clay is described as a dark-blue or black, blocky clay (Hardt and Hilton, 1969). However, over a portion of its outcrop area, the unit consists of a micaceous silty clay, or a fine sand. Thin white sand streaks have been found within the unit in some localities. The Woodbury Clay conformably overlies the Merchantville Formation.

The Merchantville Formation in Gloucester County is commonly a green to black glauconitic and micaceous silt and clay, or a quartzose/glauconitic sandy clay (Hardt and Hilton, 1969). At Mantua, the upper part of the formation is dark-green to brown fine- to coarse-grained sand, and is fossiliferous, glauconitic and micaceous. Near Wenonah, the upper two-thirds of the formation is fine- to medium-grained sand, and the lower one-third contains clay. Zones comprising fine- to coarse-grained sand as well as zones of indurated clay occur within the county in the Merchantville Formation. The Merchantville Formation unconformably overlies the Magothy and Raritan Formations.

4.2 GEOLOGY OF THE SITE AND VICINITY

Figure 4-1 shows the geologic outcrop or subcrops of the coastal plain formations in the vicinity of the landfill. This outcrop-subcrop map was obtained from the geologic overlays to New Jersey Atlas Sheets 30 and 31. To transfer the boundaries from the geologic overlays to the larger-scale 7-1/2-minute quadrangle, we enlarged the overlays appropriately and then traced the boundaries onto the

7-1/2-minute topographic sheet. The resulting boundary lines were then adjusted at that larger scale to correspond to details of the local topography. In addition to showing the outcrop-subcrop areas, Figure 4-1 and Table 4-1 also shows the location of wells for which well-log data were obtained in order to evaluate the stratigraphy of the vicinity area.

As shown on Figure 4-1, the landfill is situated on the outcrop of the Mr. Laurel-Wenonah Formation. The underlying Marshalltown Formation crops out closest to the site in the Edwards Run depression north of Jessups Mill Road and about 1,500 feet north and northwest of the site. The figure shows that in general the Marshalltown outcrop occurs as a narrow (1,000 to 3,000 feet wide) band located north and west of the landfill. The Englishtown Formation, which in turn underlies the Marshalltown, crops out as a somewhat broader band adjoining the Marshalltown outcrop on the north and west. Exposures of the Englishtown closest to the site are found in the topographic depressions associated with the lower reaches of Mantua Creek and Edwards Run.

Southeast of the landfill, the Mt. Laurel-Wenonah Formation is immediately overlain by the Navesink Formation and the Hornerstown Sand, which are mapped as a single unit in Figure 4-1. This undifferentiated unit crops out as a relatively narrow band; its closest exposure is about 1,200 feet southeast of the site. Southeast of this unit, the younger Vincentown and Kirkwood Formations occur either as outcrops or as subcrops beneath surficial Pleistocene sand and gravel deposits.

4.2.1 Lithologic Description of Units Underlying the Site

The following description of the lithology of geologic units at the site includes a discussion of the Mt. Laurel-Wenonah Formation and the underlying Marshalltown and Englishtown Formations.

TABLE 4-1

LOCAL WELLS USED FOR STRATIGRAPHIC ANALYSIS

Well no. on Fig 4-1	Owner	Well Depth (ft)	Unit Tapped	Reference
1	East Greenwich Twp Water Dept No. 2	216	Raritan-Magothy	Hardt, 1963
2	East Greenwich Twp Water Dept No. 1	205	Raritan-Magothy	Hardt, 1963
3	East Greenwich Twp Water Dept, EGWD Test 3	234	Raritan-Magothy	USGS, 1986
4	Dianne Rebok	66	Mt. Laurel-Wenonah	NJDEP, 1986
5	Joseph Workman	127	Englishtown	NJDEP, 1986
6	William Rule	24	Mt. Laurel-Wenonah	NJDEP, 1986
7	J. Roscoe	227	Raritan-Magothy	NJDEP, 1986
8	East Greenwich Twp, off Jessup's Mill Rd	69	Englishtown	NJDEP, 1986
9	Angelo Musomeci	71	Englishtown	NJDEP, 1986
10	State of New Jersey, just west of landfill	347	Raritan-Magothy	USGS, 1986
11	Russell Nolte	25	Mt. Laurel-Wenonah	NJDEP, 1986
12	Mike Maybrook	87	Englishtown	NJDEP, 1986
13	William Hazelton	325	Raritan-Magothy	NJDEP, 1986

TABLE 4-1 (cont)

LOCAL WELLS USED FOR STRATIGRAPHIC ANALYSIS

Well no. on Fig 4-1	Owner	Well Depth (ft)	Unit Tapped	Reference
14	Joseph DeCarlo	128	Englishtown	NJDEP, 1986
15	Ernest Cramer	140	Englishtown	NJDEP, 1986
16	Carl Danielson	?	?	NJDEP, 1986
17	Toby Reid	191	Merchant-ville (?)	NJDEP, 1986
18	State of New Jersey Well X-6D	82	Englishtown	R.E.Wright, 1986
19	State of New Jersey Well WE-7	22	?	NJDEP, 1986
20	State of New Jersey Well WE-6	22	?	NJDEP, 1986
21	Jacklyn Parks	70	Mt. Laurel-Wenonah	NJDEP, 1986
22	State of New Jersey Well X-1D	146	Englishtown	R. E. Wright, 1986
23	State of New Jersey Well X-4D	81	Englishtown	R. E. Wright, 1986
24	State of New Jersey Well X-2D	91	Englishtown (?)	R. E. Wright, 1986
25	State of New Jersey Well X-7D	81	Englishtown	R. E. Wright, 1986
26	George Ogren	75	Englishtown	NJDEP, 1986

TABLE 4-1 (cont)

LOCAL WELLS USED FOR STRATIGRAPHIC ANALYSIS

Well no. on Fig 4-1	Owner	Well Depth (ft)	Unit Tapped	Reference
27	B. R. Lodge	28	Mt. Laurel-Wenonah	NJDEP, 1986
28	William Donovan, Jr	263	Raritan-Magothy	NJDEP, 1986
29	Edward E. Burrows	64	Mt. Laurel-Wenonah	NJDEP, 1986
30	Raymond J. Moore	84	Englishtown	NJDEP, 1986
31	George Frenoy, Jr	182	Raritan-Magothy	NJDEP, 1986
32	Mantua Water Company Well No. 4	337	Raritan-Magothy	USGS, 1986
33	Mantua Water Company Well No. 1	235	Raritan-Magothy	Hardt, 1963
34	Emma Hunter	145	Raritan-Magothy(?)	NJDEP, 1986
35	Joseph Biddle	200	Merchant-ville	NJDEP, 1986
36	Wenonah Water Dept Well No. 2	310	Raritan-Magothy	Hardt, 1963
37	Wenonah Water Dept Well No. 1	320	Raritan-Magothy	Hardt, 1963
38	George F. Haas	270	?	NJDEP, 1986
39	Mantua Twp MUA Well No. 6	418	Raritan-Magothy	USGS, 1986

TABLE 4-1 (cont)

LOCAL WELLS USED FOR STRATIGRAPHIC ANALYSIS

Well no. on Fig 4-1	Owner	Well Depth (ft)	Unit Tapped	Reference
40	Sewell Water Company Well No. 4	377	Raritan-Magothy	Hardt, 1963
41	City of Woodbury Water Dept., Well No. 1	314	Raritan-Magothy	Hardt, 1963
42	City of Woodbury Water Dept., Sewell * 1A	345	Raritan-Magothy	USGS, 1986

4.2.1.1 Mt. Laurel-Wenonah Formation

The Mt. Laurel-Wenonah Formation beneath the site ranges in thickness from 10 feet or less beneath the eastern boundary of the landfill to 40 to 60 feet along the western margin. In the upper portion, the unit generally consists of fine to medium sand with a trace to little silt or clay. The color of formation materials is generally reddish-brown, orange-brown, yellowish-brown or reddish-yellow. In places, the color is predominantly grayish-brown, olive-brown or greenish-gray, occasionally with red and yellow mottling. Ferruginous partially-cemented zones are common.

There is a trend for fine materials to increase with depth, although this is not evident in all of the borings. But at many locations, the lower part of the formation tends to consist of finer-grained sand and to have a higher silt-clay content. Commonly, the lowest 5 to 10 feet of the formation consists of a silty fine sand, or in some cases, a clayey fine sand. In rare cases, a layer of silt or clay occurs at the bottom of the formation, such as an old boring X-3, where a greenish-gray sandy clayey silt comprises the lower eight feet of the unit.

In the following paragraphs, we provide detailed descriptions of the lithology of the Mt. Laurel-Wenonah Formation for each side of the landfill, based on the boring logs from the present investigation (Appendix 5-2).

<u>Western Boundary of Landfill</u>

Eight borings were drilled for the present investigation along this boundary (SB-1 through SB-6 and SMW-2 and SMW-3). The boring logs show that with the exception of Boring SB-6, which is at the far southern end, the Mt. Laurel-Wenonah Formation is characterized by a layer of fine to medium sand with a trace of silt (SP or SP-SM in the Unified Soil Classification System, USCS) underlain by a layer of fine to medium sand with little silt, 10 to 20 percent (SM, in the USCS). The SP, or SP-SM, layer ranges in thickness from 11 to 46 feet, and the underlying SM layer is 5 to 33 feet thick. At Boring SB-6, there is no underlying SM layer; the SP layer (59 feet thick) directly overlies the Marshalltown Formation.

Southern Boundary of the Landfill

The boring logs for the six borings bordering the southern side of the site indicate a lithology and stratigraphy for the formation similar to that along the western boundary. However, in three of the six borings (SB-7, SB-8 and SB-15) no bottom SM layer was recorded. In these cases, the SP, or SP-SM, layer (53 to 60 feet thick) directly overlies the Marshalltown. Grain-size analysis of samples, such as from SB-8, indicates that some of the lower part of the formation borders on being an SM material. In the remaining three borings (SB-9, SMW-4 and SMW-5) the bottom SM layer exists and ranges in thickness from 14 to 40 feet; it is the thickest at the western end and the thinnest at the eastern end.

Eastern Boundary of the Landfill

Eight borings are used to characterize the Mt. Laurel-Wenonah Formation underlying the eastern edge of the landfill. With the exception of two borings, SB-11 and PW-4, the formation generally consists of a layer of surficial fine to medium sand with trace of silt (SP or SP-SM) underlain by a layer of silty fine to medium sand (SM) or clayey fine to medium sand (SC). The SP, or SP-SM, layer ranges in thickness from 2 to 11 feet, while the SM or SC layer is 4 to 20 feet thick. No bottom SM or SC layer was encountered at Borings SB-11 and PW-4. At those locations, an SP layer 3 to 10 feet thick directly overlies the Marshalltown Formation.

Northern Boundary of the Landfill

The five borings used to characterize the formation along the northern boundary are SB-14, SMW-1, PW-1, PW-2 and FB-1. In all cases, except Boring SB-14, an SM layer of silty fine sand, with generally 10 to 20 percent fines, lies at the bottom of the Mt. Laurel-Wenonah Formation. At these four borings, this layer ranges in thickness from 11 to 20 feet. With the exception of a six-foot thick surficial layer of SP material at Boring FB-1, none of these four borings showed evidence of an SP layer in the formation. (The SP-SM layer shown in the depth interval 25 to 35 feet in the SMW-1 boring log, appears to be borderline SM material, based on the grain-size analysis.) At Boring SB-14, a five-foot thick layer of clayey fine sand is underlain by four feet of SP material, which in turn directly overlies the Marshalltown Formation.

4.2.1.2 Marshalltown Formation

Based on the boring investigation program performed for this project, the Marshalltown Formation beneath the site has been found to consist of a dark-gray, greenish-black or black silty very fine sand. The clay content is variable, but rarely exceeds 10 percent. In only a few of the borings, we found one or more layers of silt or clay interlayered with the dominant silty sand.

Table 4-2 provides the results of grain-size analyses and Atterberg limits tests on 10 samples of the Marshalltown taken from borings drilled on site. Based on these data, we conclude that the Marshalltown Formation beneath the site is in general made up of silty fine sands having a clay content less than 10 percent.

As shown in the boring logs (Appendix 5-2), in 25 of the 28 borings recently drilled at the site (SB-series, SMW-series and FB-series), the Marshalltown Formation, to the extent it was penetrated, consists only of a silty fine sand with a trace to little clay. Only in the remaining three borings (SB-5, SB-7, and SB-12) were any silt or clay layers encountered within the Marshalltown. These layers range in thickness from 3 to 12 feet thick and have the following characteristics:

Boring No.	Description of Layer	Elevation of Top (ft)	Elevation of Bottom (ft)
SB-5	Black sandy silt, trace to little clay	27	15
SB-7	Black sandy silt, trace to little clay	-12	-24
SB-12	Black silt, little fine sand, trace to little clay	-17	-20

Based on elevation similarities, it is possible that the silt layer encountered

TABLE 4-2

GRAIN-SIZE AND TEXTURAL PROPERTIES OF MARSHALLTOWN FORMATION SAMPLES

Boring	Depth (ft)	% Fines*	% Clay+	Plastic Limit	Liquid Limit
SB-1	51.5-53.5	37	8	NP	NP
SB-1	54.0-56.0	49	9	NP	NP
SB-1	72.0-74.0	25	6	NP	NP
SB-3	58.5-60.5	29	7	NP	NP
SB-3	60.5-62.5	32	8	NP	NP
SB-4	69.5-71.5	43	5	NP	NP
SB-4	81.5-83.5	27	5	NP	NP
SB-6	68.0-70.0	24	5	NP	NP
SB-8	70.0-72.0	22	3	NP	NP
SMW-1	44.0-46.0	30	6	NP	NP

* Percent by weight smaller than No. 200 sieve
+ Percent by weight smaller than 0.002 mm
'NP' = Non-plastic

in Borings SB-7 and SB-12 is continuous south to north between the two borings; the intervening Borings SB-11 and SB-16 were not quite deep enough to reach such a layer should it exist there.

Our conclusions regarding the lithology of the Marshalltown agree with the descriptions by the R. E. Wright geologist given in the Remedial Investigation report (R.E. Wright, 1986). According to the logs of the X-series borings, the Marshalltown beneath the site most commonly consists of a very fine to fine silty sand with varying amounts of clay. In certain zones, the material was described as grading from a silty sand to a fine sandy silt.

4.2.1.3 Englishtown Formation

The Englishtown Formation was encountered and sampled in only six borings in the present investigation (SB-1, SB-4, SB-7, SB-12, SB-14 and FB-5), and in only five borings in the remedial investigation (X-1D, X-2D, X-4D, X-6D and X-7D). In four of the six borings drilled for this investigation (SB-1, SB-4, SB-14 and FB-5), the unit consisted of a light-gray, greenish-gray or gray fine sand with a trace to little silt. Pockets of clayey silt or sandy clay were encountered in places within the sand, and in Boring SB-1 a gray micaceous clayey silt layer was sandwiched between two layers of the light gray sand.

No sandy zones were found in the Englishtown in Borings SB-7 and SB-12 to the extent penetrated; instead, the upper 14 feet of the formation in both cases consisted of gray to dark-gray clayey silt containing thin interbeds to fine to very fine sand. Such alternating thin layers of sand and clay, or clayey silt, were also found in the Englishtown in Boring X-6D.

4.2.2 Local Stratigraphy and Structure

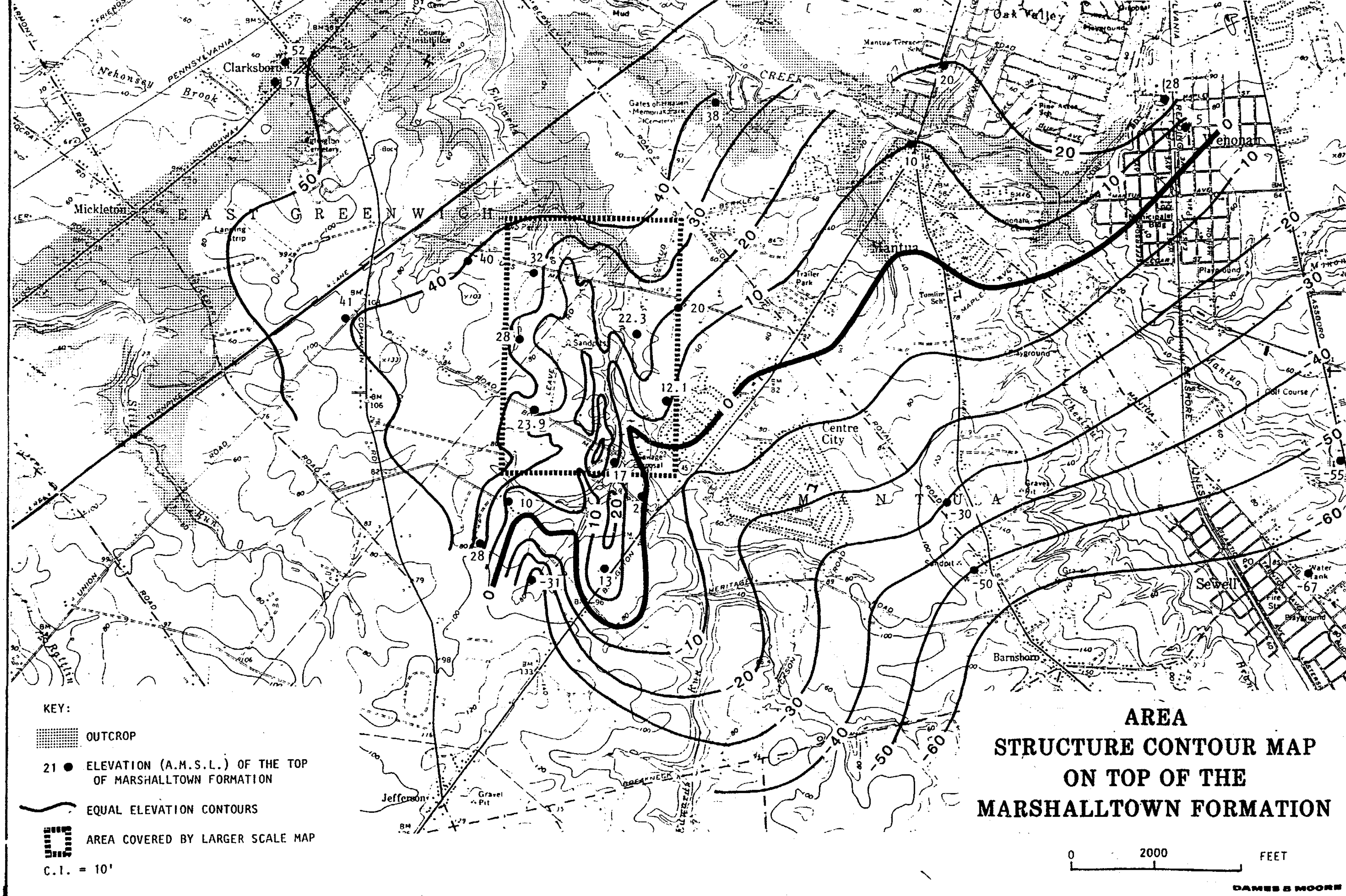
Isopach and structure-contour maps have been prepared relative to the Marshalltown and Englishtown Formations, both for the vicinity and for the site itself. These are shown in Figures 4-3 through 4-8. The site maps are based on the edited logs of borings and wells drilled at the site under this study as well as those drilled for the remedial investigation. The area, or vicinity, contour maps are based on these well data, and also on logs of local wells (shown in Figure 4-1) obtained from available reports and from the files of the U.S. Geological Survey (USGS) and the New Jersey Department of Environmental Protection (NJDEP), including Hardt, 1963; Zapecza, 1984; USGS, 1986; and NJDEP, 1986. Table 4-1 provides information on the lcoal wells used for geologic control.

Figures 4-3 and 4-4 show the structure contours on the top of the Marshalltown for the area and for the site, respectively. Figures 4-5 and 4-6 show isopach contours of the thickness of the Marshalltown for the area and for the site, respectively. The combination of these four figures indicate clearly that the Marshalltown is a continuous unit in the region and beneath the site.

The structure contours shown in Figure 4-3 indicate that the top of the Marshalltown Formation is dipping toward the southeast with an average dip of 40 to 45 ft/mile. The comparable site map, Figure 4-4, shows that the top of the Marshalltown beneath the landfill ranges from about Elevation +20 to +25 feet (m.s.l. datum) along the western boundary, to approximately Elevation 0 ft, beneath Edwards Run.

Figure 4-4 also shows pronounced relief on the unit's surface in contrast to the more generalized contours for the vicinity shown in Figure 4-3. This relief is largely due to two depressions in the surface of the Marshalltown on the east side of the site area. One of the depressions, the deeper of the two, corresponds with the present course of the creek and may be the result of the prior erosive removal of the upper part of the formation by the waters of Edwards Run. The other depression, oriented north-south, is located 400 to 800 feet west of the Edwards Run. It is not presently known what was the origin of this depression and the associated high immediately to its east. It is conceivable that this structure reflects minor faulting of at least the pre-Marshalltown Cretaceous formations underlying the site.

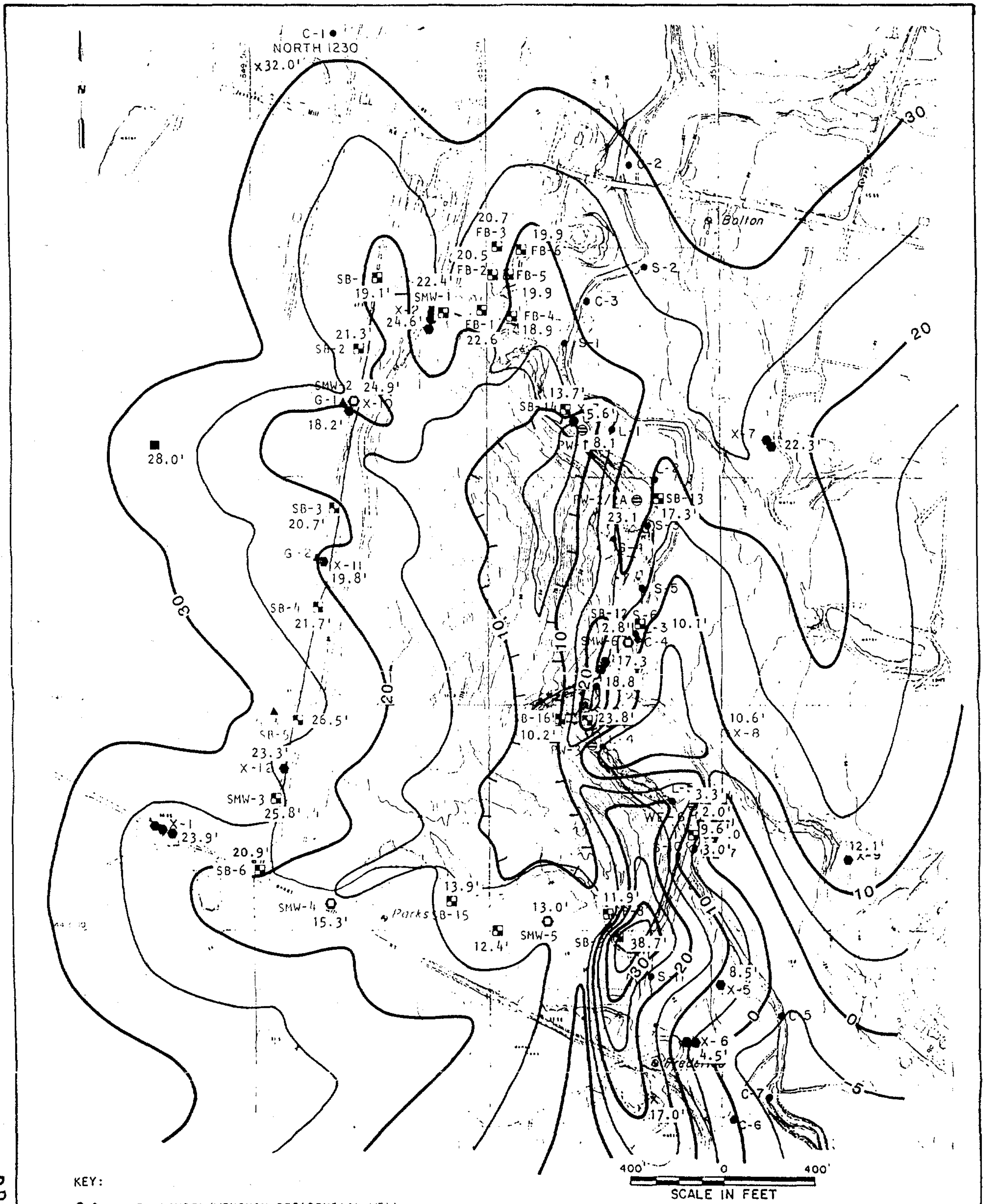
Local faulting of this kind would have potential importance in terms of ground-water and leachate flow in the Mt. Laurel-Wenonah Formation beneath and



AREA STRUCTURE CONTOUR MAP ON TOP OF THE MARSHALLTOWN FORMATION

DR 000319

FIGURE 4-3



KEY:

- Parks MT. LAUREL/WENONAH RESIDENTIAL WELL
- S-1 GROUNDWATER DISCHARGE SEEP
- C-1, L-1 SURACE SAMPLING LOCATIONS
- G-1 DEEP GAS BORING
- DAMES & MOORE PIEZOMETER
- EXISTING MONITORING WELL
- DAMES & MOORE SOIL BORING
- EXISTING SOIL BORING
- PW TEMPORARY WELL POINT (PIEZOMETER)
- SB SOIL BORING
- FB FOUNDATION BORING
- 30 TOP OF MARSHALLTOWN FORMATION THICKNESS

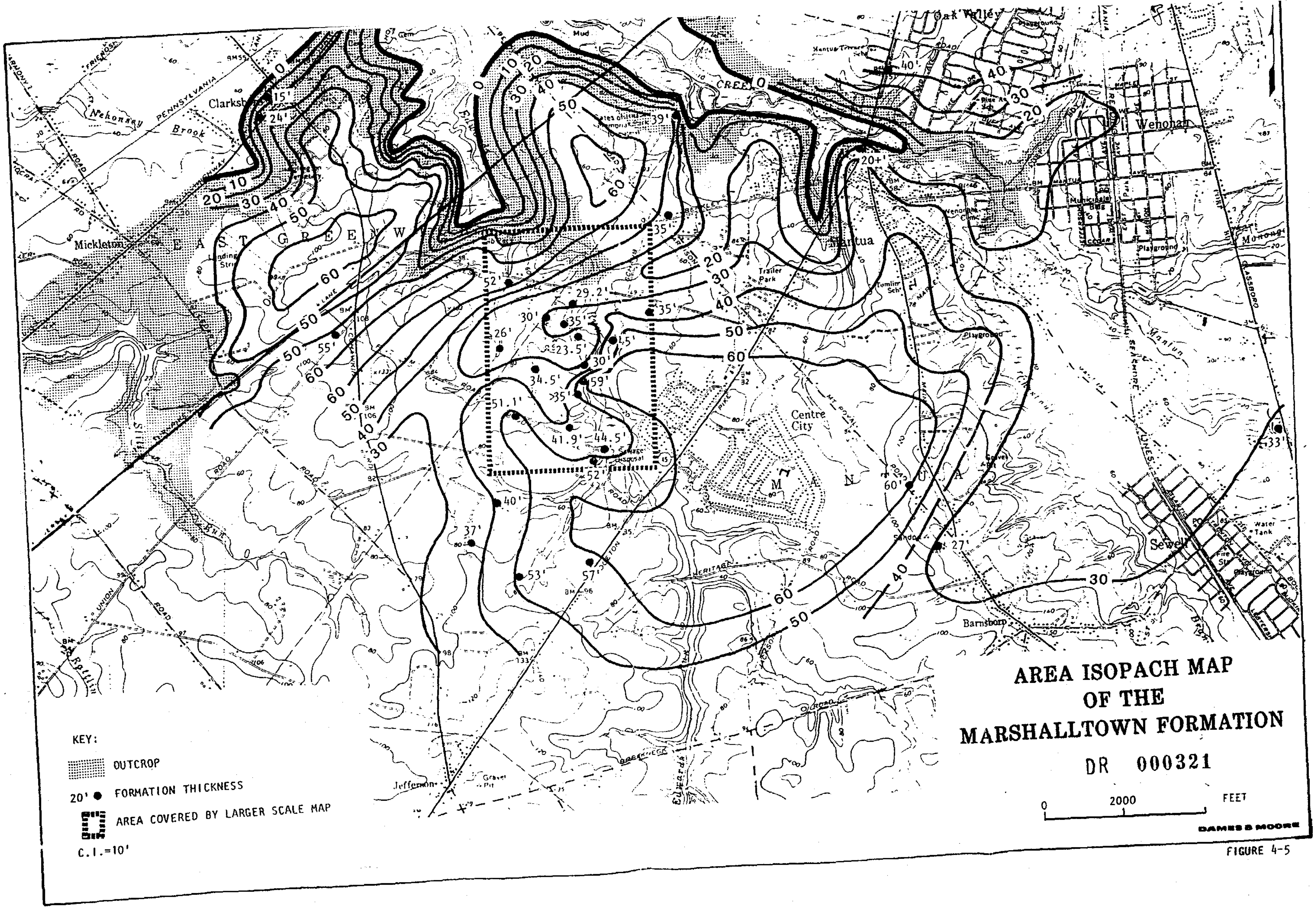
C.I. = 5'

STRUCTURE CONTOUR MAP ON TOP OF THE MARSHALLTOWN FORMATION

DAMES & MOORE

FIGURE 4-4

DR 000320

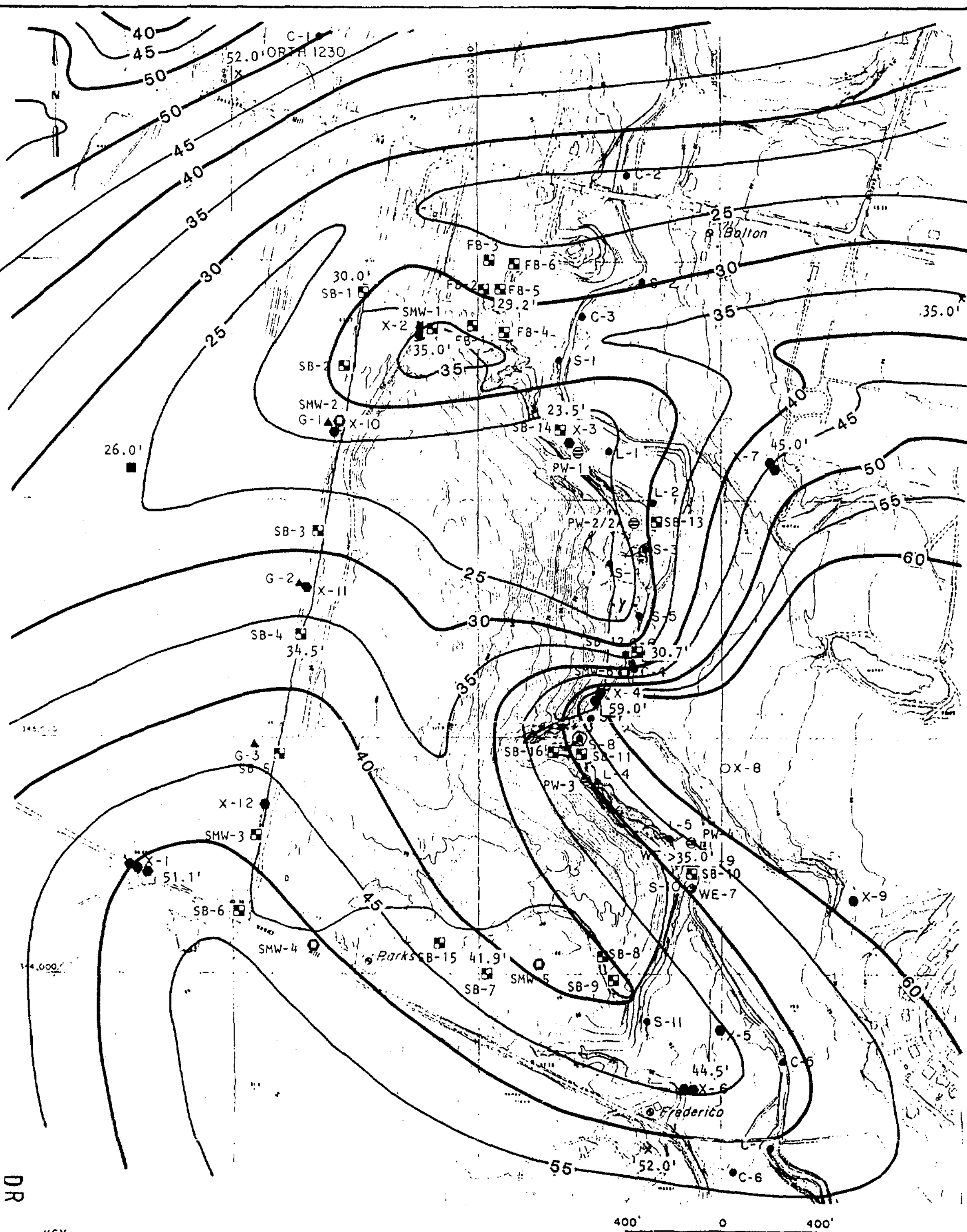


AREA ISOPACH MAP OF THE MARSHALLTOWN FORMATION

DR 000321

DAMES & MOORE

FIGURE 4-5



KEY:

- ⊗ Parks MT. LAUREL/WENONAH RESIDENTIAL WELL
- ●~ S-1 GROUNDWATER DISCHARGE SEEP
- ● C-1, L- SURACE SAMPLING LOCATIONS
- ▲ G-1 DEEP GAS BORING
- ○ DAMES & MOORE PIEZOMETER
- ● EXISTING MONITORING WELL
- ◪ DAMES & MOORE SOIL BORING
- ■ EXISTING SOIL BORING
- PW TEMPORARY WELL POINT (PIEZOMETER)
- SB SOIL BORING
- FB FOUNDATION BORING
- —40— CONTOURS OF EQUAL FORMATION THICKNESS C.I. = 5'

ISOPACH MAP OF THE MARSHALLTOWN FORMATION

DR 000322

DAMES & MOORE

FIGURE 4-6

downgradient of the landfill. Because of this, we recommend that further study be undertaken to better delineate the surface of the Marshalltown Formation along this western depression and the associated high immediately to the east.

The vicinity isopach map for the Marshalltown, Figure 4-5, indicates that downdip of its outcrop area the unit ranges in thickness from 20 to 60 feet. Figure 4-6 shows the isopachs for the unit immediately beneath the site. As seen in this figure, the thickness of the Marshalltown ranges from 25 to 30 feet at the northern end of the landfill, to 45 to 50 feet at the southern end.

Figure 4-7 shows elevation contours on the top of the Englishtown Formation in the vicinity of the site. The top of the formation within this area ranges from nearly Elevation +40 ft. (m.s.l. datum) slightly downdip of the outcrop area to the west, to Elevation -90 ft. east and south of the site. East of the site, the top of the unit dips toward the south, at approximately 45 to 50 ft/mile, as computed from Figure 4-7. The figure shows that south of the site, the dip is toward the east at 55 to 60 ft/mile.

The approximate contours on top of the Englishtown Formation beneath the site are shown in Figure 4-8. The top of the formation ranges from Elevation -5 ft (m.s.l. datum) to -40 ft, immediately beneath the landfill. The formation is seen to dip generally toward the south and southeast, with local deviations from this trend. A significant dip in the surface of the formation exists beneath the east side of the landfill near the mid-point from south to north. There, the surface drops toward the east and south by 40 feet over horizontal distances ranging from 300 to 800 feet. In addition to this, a north-south aligned depression is seen to occur 200 to 600 feet west of the creek. This depression is located in approximately the same horizontal position as that which we noted occurs in the surface of the overlying Marshalltown Formation. This provides additional evidence of the possibility of a fault-induced structure at that location.

Five geologic cross sections have been prepared based on the available boring and well log data. Their locations are shown on Figure 4-9. Figure 4-10 (Cross

MEMORANDUM OF CALL

Title II

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TO: OA - Memorandums

☐ YOU WERE CALLED BY— ☐ YOU WERE VISITED BY—

SSOMP

OF (Organization)

☐ PLEASE PHONE ▶ ☐ FTS ☐ AUTOVON

☐ WILL CALL AGAIN ☐ IS WAITING TO SEE YOU

☐ RETURNED YOUR CALL ☐ WISHES AN APPOINTMENT

MESSAGE

W/ Jeff - HSS

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Timing ?

→ Site Coo [illegible]

RECEIVED BY	DATE	TIME

63-110 NSN 7540-00-634-4018 STANDARD FORM 63 (Rev. 8-81)
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GPO : 1987 O - 170-635

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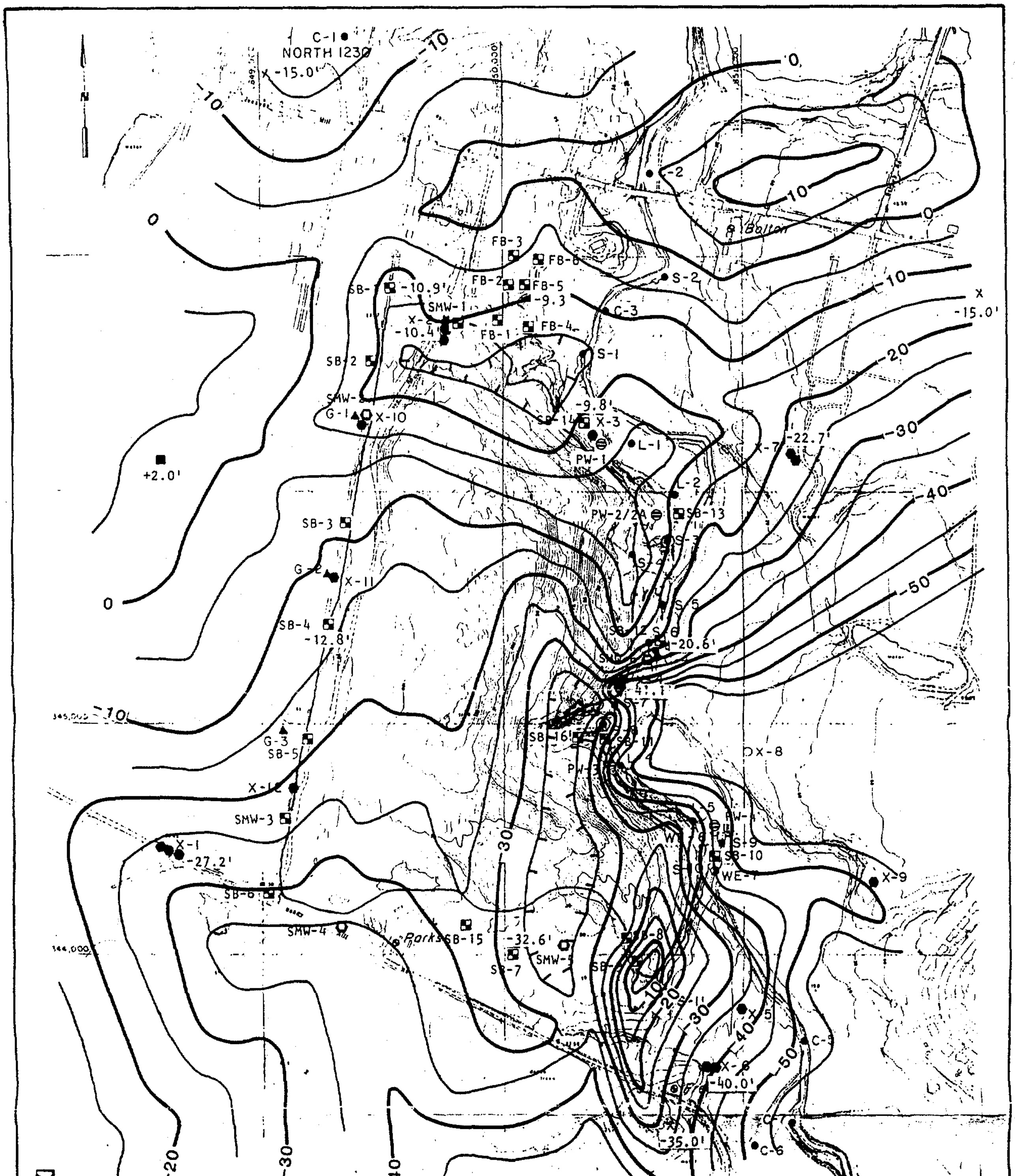


KEY:

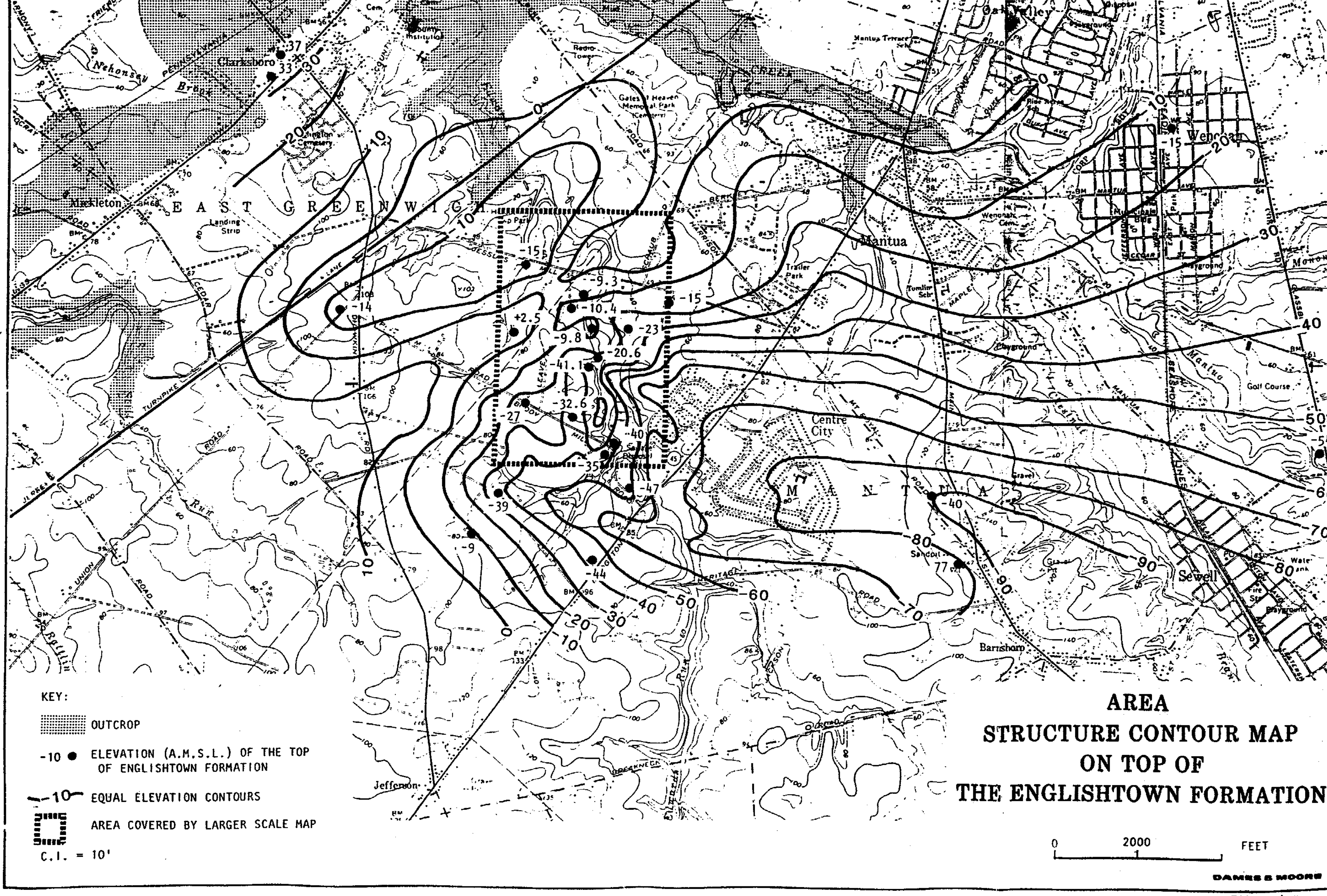
- MT. LAUREL/WENONAH RESIDENTIAL WELL (Parks)
- GROUNDWATER DISCHARGE SEEP (S-1)
- SURACE SAMPLING LOCATIONS (C-1, L)
- DEEP GAS BORING (G-1)
- DAMES & MOORE PIEZOMETER
- EXISTING MONITORING WELL
- DAMES & MOORE SOIL BORING
- EXISTING SOIL BORING
- PW TEMPORARY WELL POINT (PIEZOMETER)
- SB SOIL BORING
- FB FOUNDATION BORING
- -10 TOP OF ENGLISHTOWN FORMATION ELEVATION C.I. = 5'

STRUCTURE CONTOUR MAP ON TOP OF THE ENGLISHTOWN FORMATION

FIGURE 4-8

DAMES & MOORE

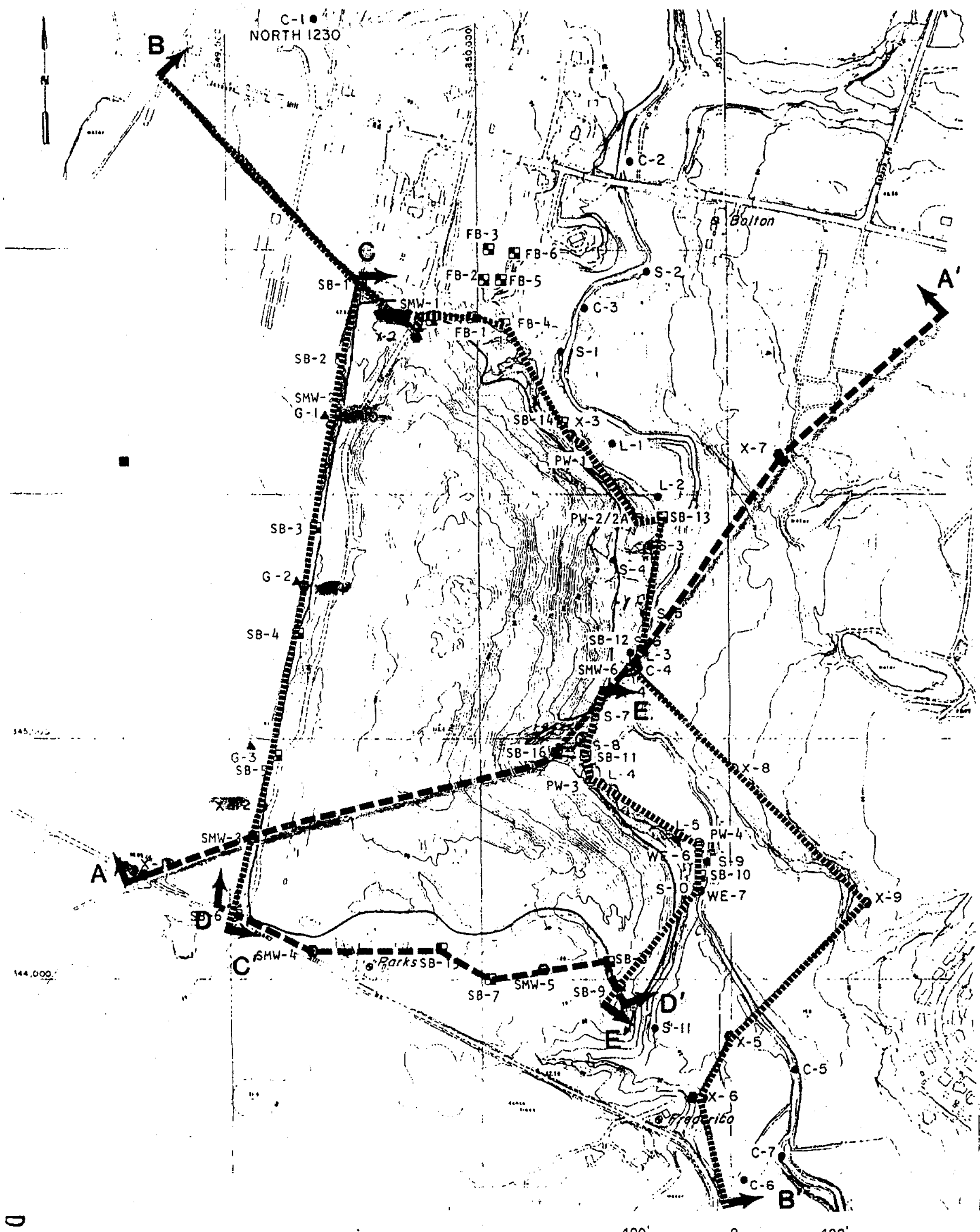
DR 000326



AREA
STRUCTURE CONTOUR MAP
ON TOP OF
THE ENGLISHTOWN FORMATION

FIGURE 4-7

DR 000327



KEY:

- Parks — MT. LAUREL/WENONAH RESIDENTIAL WELL
- S-1 — GROUNDWATER DISCHARGE SEEP
- C-1, L-1 — SURACE SAMPLING LOCATIONS
- G-1 — DEEP GAS BORING
- DAMES & MOORE PIEZOMETER
- EXISTING MONITORING WELL
- DAMES & MOORE SOIL BORING
- EXISTING SOIL BORING
- PW — TEMPORARY WELL POINT (PIEZOMETER)
- SB — SOIL BORING
- FB — FOUNDATION BORING

LOCATION OF GEOLOGIC CROSS SECTIONS

DAMES & MOORE

FIGURE 4-9

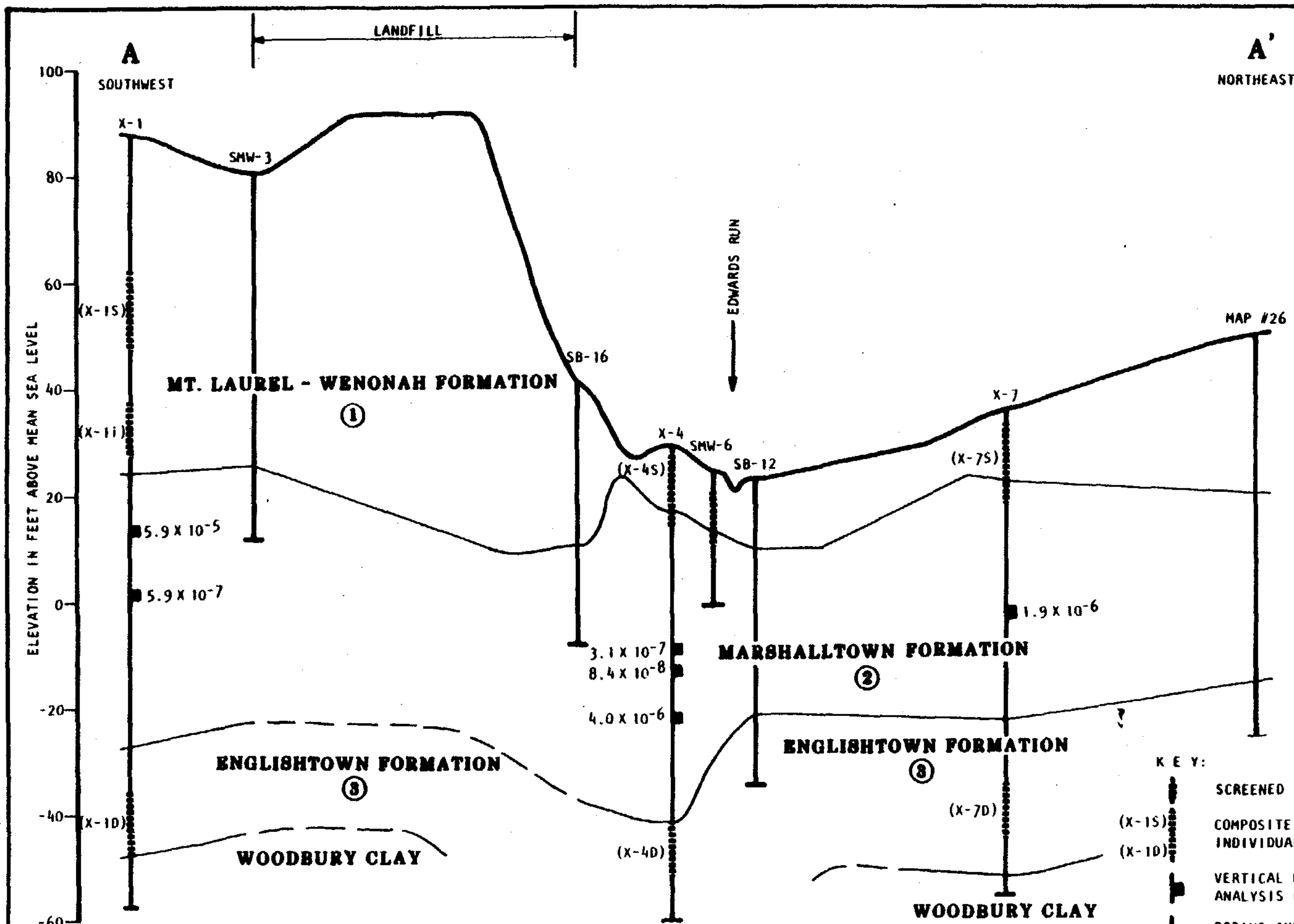
DR 000328

Section A-A') and Figure 4-11 (Cross Section B-B') show subsurface conditions beneath both the landfill and the adjacent vicinity. Section A-A' extends from southwest to northeast and is generally parallel with the strike of the formations, and Section B-B' is oriented from northwest to southeast, parallel with the direction of dip. Cross sections C-C' through E-E', shown in Figures 4-12 through 4-14, respectively, are restricted to the landfill. Sections C-C' and D-D' follow the direction of the proposed slurry wall, and Section E-E' is aligned with the southern end of the leachate trench. Section C-C' is aligned north-south along the western boundary of the landfill. Section D-D' extends from the west to east along the southern margin of the landfill, while Section E-E' extends from the south to the north over the southern one-third of the eastern boundary of the landfill.

All the cross sections indicate the areal variation in the thickness of the Mt. Laurel-Wenonah Formation, the Marshalltown Formation, and where available, the Englishtown Formation across the site area. In addition, we indicate on the sections, at the appropriate depth, the results of laboratory permeability tests on undisturbed samples of the Marshalltown. A wide range in the vertical permeability of the unit is indicated on the cross sections, from 8×10^{-8} to 2×10^{-4} cm/sec. These values represent the results from the last of three or four test runs on each sample tested by the remedial-investigation laboratory (for samples from the X-series borings) and by Dames & Moore's laboratory (for samples from the SMW- and SB- series borings). The results of the permeability testing are discussed in Section 4.3.2.

4.3 PERMEABILITY OF MT. LAUREL-WENONAH AND MARSHALLTOWN FORMATIONS

During the field investigation, in situ slug tests were performed in monitoring wells and temporary test wells at the site to estimate the horizontal hydraulic conductivity (permeability) of the saturated portion of the Mt. Laurel-Wenonah Formation. In addition, Shelby tube samples of the underlying Marshalltown Formation, which were obtained in the course of the exploratory drilling on-site, were subjected to laboratory permeability tests in Dames & Moore's Cranford, New Jersey soils laboratory. In the following sections, we present and discuss the permeability data obtained from these tests.



GENERALIZED CROSS SECTION A-A'

HELEN KRAMER LANDFILL
MANTUA, N.J.

0 400 800 FEET
HORIZONTAL SCALE
VERTICAL EXAGGERATION = 20X

KEY:

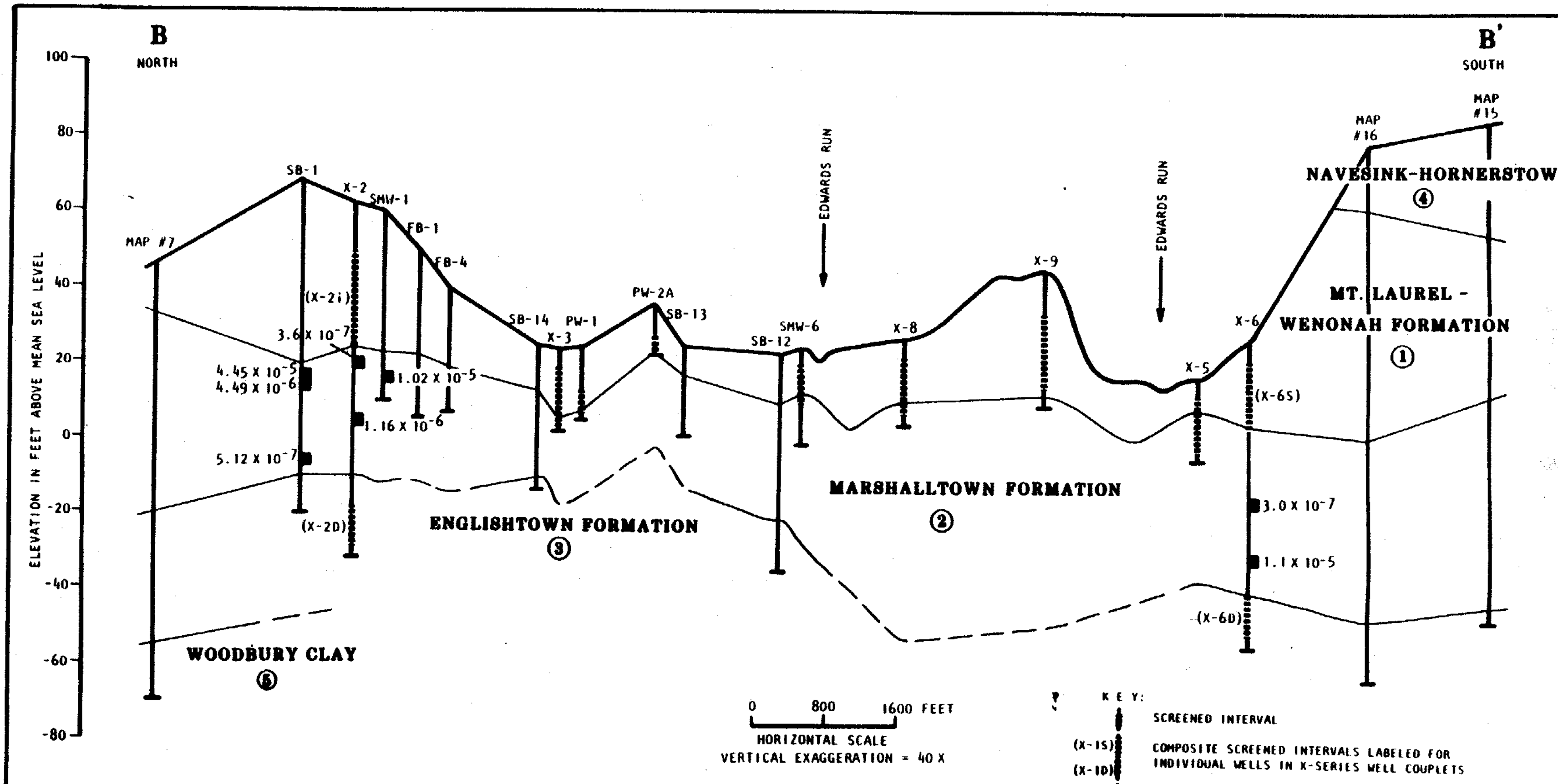
- SCREENED INTERVAL
- (X-1S) (X-1D) COMPOSITE SCREENED INTERVALS LABELED FOR INDIVIDUAL WELLS IN X-SERIES WELL COUPLETS
- VERTICAL PERMEABILITY (IN CM/SEC) FROM LAB ANALYSIS OF UNDISTURBED CORE SAMPLES
- BORING AND MONITORING WELL LOCATION
- ① YELLOW BROWN, RED BROWN & GRAY BROWN FINE TO MEDIUM SAND WITH FERRUGINOUS ZONES, & SILTY SAND & CLAYEY SAND ZONES. SILT CONTENT INCREASES WITH DEPTH.
- ② DARK GRAY & GREEN & BLACK SILTY FINE SANDS WITH GLAUCONITE & CLAYEY ZONES
- ③ LIGHT GRAY FINE TO MEDIUM SILTY SANDS

NOTES:
1. THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.
2. SEE FIGURE 4-9 FOR LOCATION OF CROSS SECTION.

DAMES & MOORE

FIGURE 4-10

DR 000330



GENERALIZED CROSS SECTION B-B'

HELEN KRAMER LANDFILL
MANTUA, N.J.

KEY:

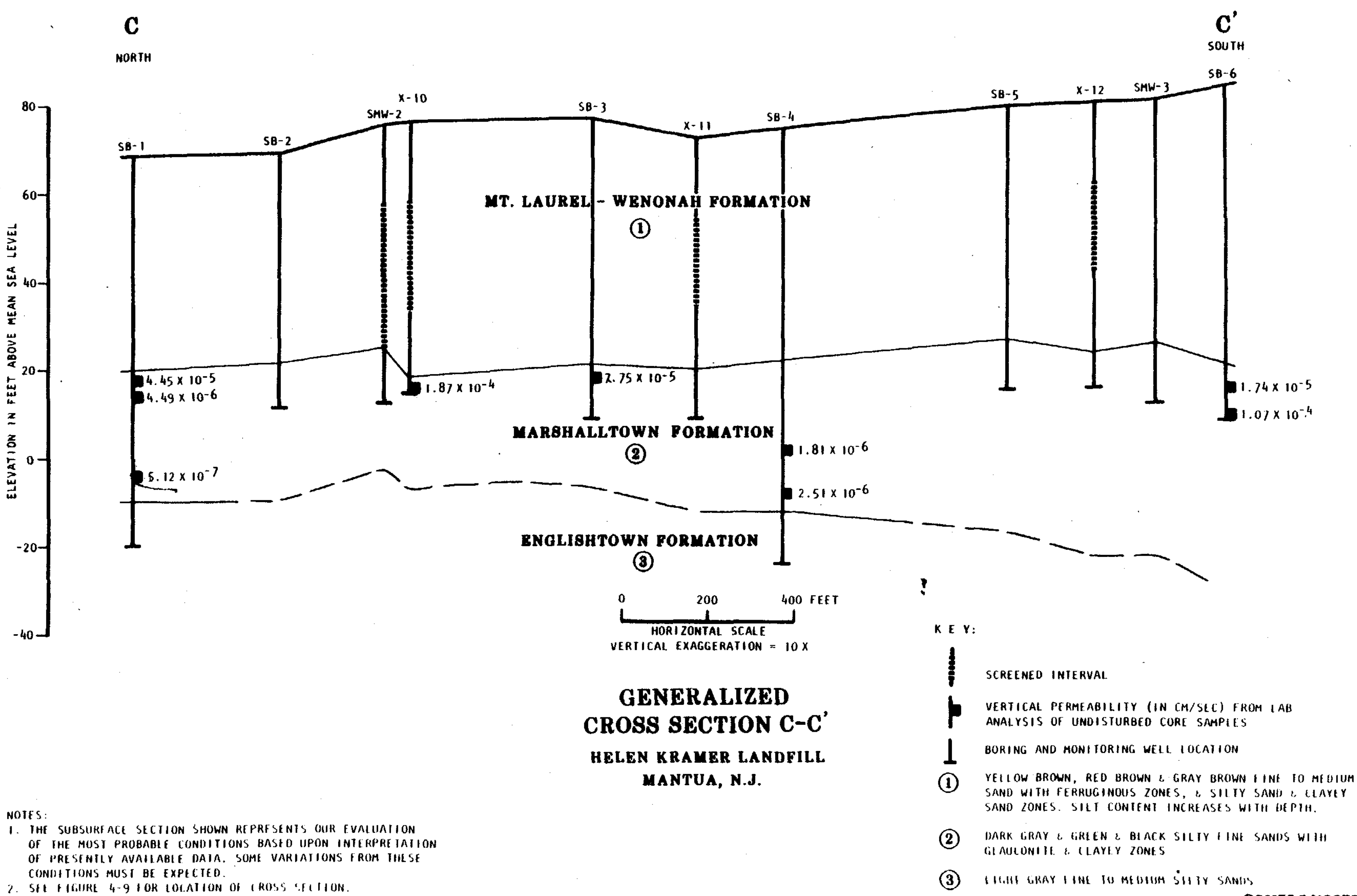
- SCREENED INTERVAL
- (X-1S) (X-1D) COMPOSITE SCREENED INTERVALS LABELED FOR INDIVIDUAL WELLS IN X-SERIES WELL COUPLETS
- LABORATORY PERMEABILITY OF UNDISTURBED CORE SAMPLE PERMEABILITY (IN CM/SEC) BASED ON LAST OF THREE RUNS
- BORING AND MONITORING WELL LOCATION
- ① YELLOW BROWN, RED BROWN & GRAY BROWN FINE TO MEDIUM SAND WITH FERRUGINOUS ZONES, & SILTY SAND & CLAYEY SAND ZONES. SILT CONTENT INCREASES WITH DEPTH.
- ② DARK GRAY & GREEN & BLACK SILTY FINE SANDS WITH GLAUCONITE & CLAYEY ZONES
- ③ LIGHT GRAY FINE TO MEDIUM SILTY SANDS
- ④ YELLOW SANDS, GRAY CLAY AND BLACK MARL
- ⑤ BLACK GRAPHITIC MUD AND CLAY

NOTES:
1. THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.
2. SEE FIGURE 4-9 FOR LOCATION OF CROSS SECTION.

FIGURE 4-11

DAMES & MOORE

DR 000331



GENERALIZED CROSS SECTION C-C'

HELEN KRAMER LANDFILL
MANTUA, N.J.

NOTES:
1. THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.
2. SEE FIGURE 4-9 FOR LOCATION OF CROSS SECTION.

FIGURE 4-12

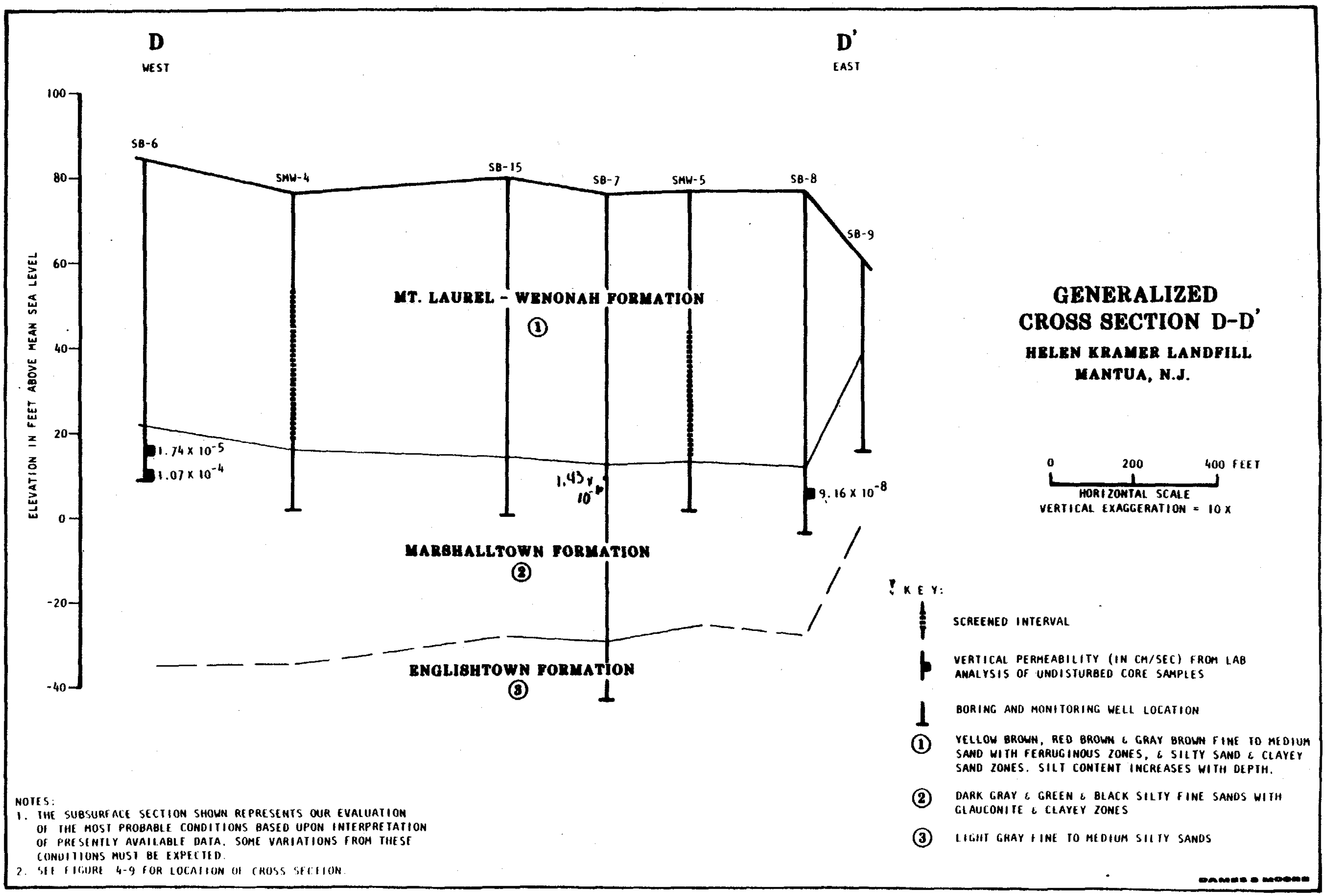


FIGURE 4-13

DR 000333

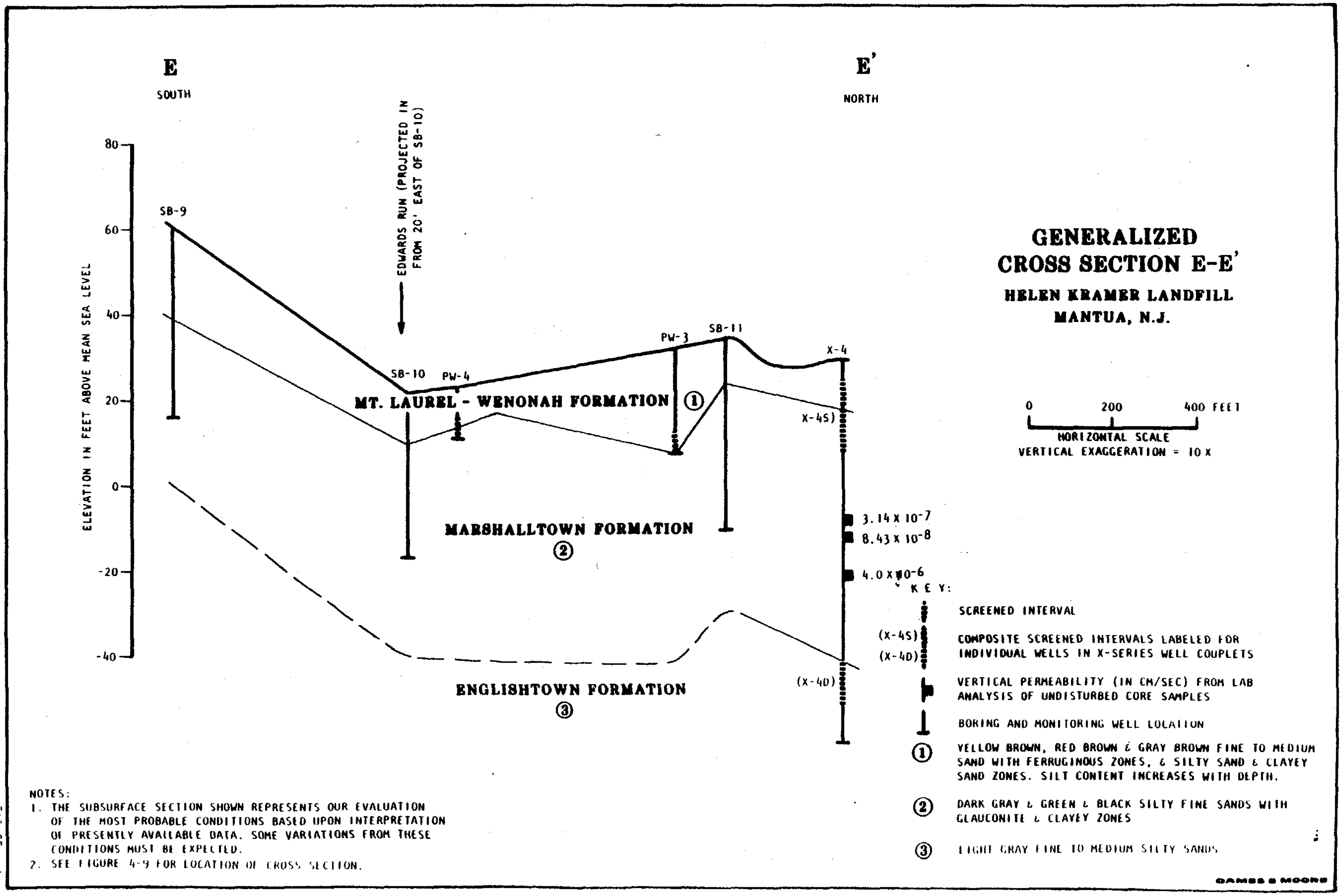


FIGURE 4-14

DR 000334

4.3.1 Permeability of Mt. Laurel-Wenonah Materials

Slug tests were performed in the four temporary test wells located close to Edwards Run (PW-1, PW-2A, PW-3 and PW-4) as well as in the four monitoring wells constructed farther west (SMW-2, SMW-4, SMW-5 and SMW-6). In all these wells, both falling-head tests and rising-head tests were performed.

In the falling-head case, the slug is lowered rapidly but smoothly into the water in the well, and the water level rises instantaneously to a maximum from which it declines gradually back to the original statis level. In the rising-head case, the slug is pulled rapidly out of the water and the water level in the well drops suddenly, to rise gradually back to the static level. The detailed procedure which was employed in conducting the slug tests is provided in Appendix 4-1.

The data obtained from the slug tests were analyzed to obtain estimates of horizontal hydraulic conductivity (permeability). Dames & Moore's computer programs SLUGT and INSITU were utilized for this. The SLUGT program computes hydraulic conductivity by two methods: the method of Cooper, Bredehoeft and Papadopulos (1967) which applies to confined conditions; and the method of Bouwer and Rice (1976), which applies to water-table conditions. Program INSITU computes hydraulic conductivity by equations presented in Lambe and Whitman (1969) and the Department of the Navy (1971), as derived by Hvorslev (1951). The equations from Lambe and Whitman (1969) for computing horizontal permeability from slug-test data in water-table and confined aquifers are given in Appendix 4-2.

The results of the analysis using Programs SLUGT and INSITU are summarized in Table 4-3, which provides the estimated values for horizontal hydraulic conductivity (K_h), computed for both the falling-head and the rising-head cases by the three methods:

Cooper, Bredehoeft and Papadopulos;
Bouwer and Rice; and
Hvorslev.

TABLE 4-3

SUMMARY OF RESULTS OF SLUG-TEST ANALYSIS

Monitoring Well or Test Well	Material Screened	Falling Head (F) or Rising Head (R)	K_h (cm/sec) from Complete Data Set: C	B	H	K_h (cm/sec) from Early-Time Data Only: C	B	H
PW-1	Mt. Laurel-Wenonah Fm (Grayish-brown fine SAND, little silt; loose)	F	1.4×10^{-4}	3.8×10^{-4}	2.6×10^{-4}	2.3×10^{-4}	5.9×10^{-4}	5.6×10^{-4}
		R	2.0×10^{-4}	4.4×10^{-4}	3.4×10^{-4}	3.5×10^{-4}	7.1×10^{-4}	6.4×10^{-4}
PW-2A	Mt. Laurel-Wenonah Fm (Grayish-brown fine SAND, little silt; medium dense)	F	3.2×10^{-6}	8.3×10^{-6}	1.2×10^{-5}	--	--	--
		R	2.4×10^{-5}	1.5×10^{-5}	2.2×10^{-5}	--	--	--
PW-3	Mt. Laurel-Wenonah Fm (Grayish-brown fine to medium SAND, little silt; loose to med. dense)	F	4.7×10^{-5}	7.9×10^{-5}	1.1×10^{-4}	--	--	--
		R	8.7×10^{-5}	1.1×10^{-4}	1.6×10^{-4}	--	--	--
PW-4	Mt. Laurel-Wenonah Fm - 2 ft (Grayish-brown to brown fine to medium SAND, trace silt; loose)	F	6.4×10^{-3}	2.2×10^{-3}	3.0×10^{-3}	6.8×10^{-3}	2.4×10^{-3}	3.8×10^{-3}
	Marshalltown Fm - 3 ft (Black silty fine SAND, trace clay)	R	2.0×10^{-3}	2.4×10^{-3}	9.5×10^{-4}	5.9×10^{-3}	2.4×10^{-3}	3.2×10^{-3}
SMW-2	Mt. Laurel-Wenonah Fm (Grayish to Rd. Brown fine to med. SAND, trace to little silt) - 9 ft	F	2.3×10^{-3}	6.2×10^{-3}	6.1×10^{-4}	--	--	--
	(Grayish-brown fine to medium SAND, little silt) - 21 ft	R	1.1×10^{-3}	1.7×10^{-3}	4.3×10^{-4}	--	--	--
SMW-4	Mt. Laurel-Wenonah Fm (Fine to med. SAND, tr.-little silt) - 10 ft	F	2.1×10^{-4}	4.0×10^{-4}	1.3×10^{-4}	2.5×10^{-4}	4.7×10^{-4}	1.4×10^{-4}
	(Fine to med. SAND, little-some silt) - 5 ft (Fine to med SAND, litle silt) - 20 ft	R	4.9×10^{-4}	5.9×10^{-4}	2.0×10^{-4}	--	--	--
SMW-5	Mt. Laurel-Wenonah Fm (Fine to med SAND, little silt; very dense) - 9 ft	F	9.8×10^{-4}	1.4×10^{-3}	4.0×10^{-4}	--	--	--
	(Fine to med SAND, little silt, medium dense) - 21 ft	R	7.6×10^{-4}	1.2×10^{-3}	2.2×10^{-4}	9.4×10^{-4}	1.2×10^{-3}	3.3×10^{-4}

TABLE 4-3 (Cont)

SUMMARY OF RESULTS OF SLUG-TEST ANALYSIS

Monitoring Well or Test Well	Material Screened	Falling Head (F) or Rising Head (R)	K_h (cm/sec) from Complete Data Set			K_h (cm/sec) from Early-Time Data Only		
			C	B	H	C	B	H
SMW-6	Mt. Laurel-Wenonah Fm	F	8.7×10^{-4}	2.4×10^{-4}	2.7×10^{-4}	--	--	--
	(Fine to med. SAND, little clay) - 3.5 ft							
	(Fine to med. SAND, little silt) - 3.0 ft							
	(Rd. Brown & Grey fine SAND) - 1.5 ft	R	6.1×10^{-4}	1.8×10^{-4}	2.1×10^{-4}	--	--	--
	Marshalltown Fm							
	(Black silty fine SAND, trace to little clay) - 2.0 ft							

NOTE 'B' = Bouwer & Rice Method, 'C' = Cooper, Bredehoeft and Papadopulos Method, 'H' = Hvorslev Method, 'K_h' = Computed Horizontal Hydraulic Conductivity

As shown in the table, the K_h values obtained for the falling-head case and the rising-head case at each well compare quite closely in most cases. The largest difference shown between the falling and rising head cases was for Well PW-2A, where the permeability computed from the rising-head test by the Cooper, Bredehoeft and Papadopulos method was 7.5 times higher than that computed from the falling-head test.

Table 4-3 also shows that in most cases the permeability values computed by the three methods agree quite closely. However, in three cases (at Wells SMW-2, SMW-4 and SMW-5) the permeability values computed by the Hvorslev method are smaller, by a factor of 3 to 10, than the values computed by the Bouwer and Rice method. This may be related to the fact that of the eight wells tested, the static water level was within the well screen only at Wells SMW-2, SMW-4 and SMW-5. In this case, the Bouwer and Rice method provides for a correction to account for the change in water stored in the gravel pack outside the screen, while the Hvorslev method does not.

Plots of the logarithm of H (drawdown or drawup) vs time for Wells PW-1, PW-2A, PW-3, PW-4, SMW-2, SMW-4, SMW-5 and SMW-6 are shown, respectively, in Figures 4-1 through 4-8 in Appendix 4-3. 'H' refers to the head difference between the static water level and the water level at time t since the introduction (or removal) of the slug. In addition, the computer output from the SLUGT and INSITU programs is provided in Appendix 4-4. The output includes the recorded field data as well as the computed permeability values in each case.

How do [illegible] from 4-3 to [illegible] 4

In Table 4-4, we provide estimated values for horizontal hydraulic conductivity of the Mt. Laurel-Wenonah Formation materials at each of the eight wells, based on the values given in Table 4-3. As shown in Table 4-4, the portions of the Mt. Laurel-Wenonah Formation tested evidenced a wide range in computed horizontal hydraulic conductivity — ranging from 1×10^{-5} cm/sec (0.03 ft/day) to 6×10^{-3} cm/sec (17 ft/day).

The highest permeability values were obtained at Wells PW-4 and SMW-2 — 17 and 5.7 ft/day, respectively. As shown in Table 4-3, the upper two feet screened in

TABLE 4-4

ESTIMATED VALUES OF HORIZONTAL HYDRAULIC CONDUCTIVITY
OF MT. LAUREL-WENONAH MATERIALS
BASED ON RESULTS OF SLUG TESTS

Monitoring Well or Test Well	Interval Screened (ft below ground)	Horizontal Hydraulic Conductivity (K_h) (cm/sec)	(ft/day)
PW-1	11.5-16.5	$6. \times 10^{-4}$	1.7
PW-2A	8-13	$1. \times 10^{-5}$	0.03
PW-3	20-25	$1. \times 10^{-4}$	0.28
PW-4	7-12	$6. \times 10^{-3}$	17.0
SMW-2	18-48	$2. \times 10^{-3}$	5.7
SMW-4	23-58	$4. \times 10^{-4}$	1.1
SMW-5	33-63	$4. \times 10^{-4}$	1.1
SMW-6	4-14	$2. \times 10^{-4}$	0.57

Well PW-4 consists of relatively clean and loose sand, which is undoubtedly very permeable. While at Well SMW-2, the upper nine feet of material screened consists of fairly clean sand, which is moderately permeable. This layer is probably responsible for the overall moderately high permeability, as the underlying 21 feet of material, also screened, contains a greater proportion of silt. In the remaining wells, the Mt. Laurel-Wenonah material screened consists of fine to medium sand containing little (10 to 20 percent) silt. The test values for hydraulic conductivity at these wells, ranging from 0.03 to 1.7 ft/day, are consistent with this lithology. The differences within this range are possibly attributable to spatial differences in the density of the materials.

The slug-test results given in Table 4-4 are comparable to, although they are in general lower than, the values computed from earlier slug-test data obtained on-site and reported in Table 4-1 of R.E. Wright (1986). The following comparisons can be made from the two sets of data for wells that are in relatively close proximity:

	Present Investigation		R.E. Wright (1986)	
	Well	K_h (ft/day	Well	K_h (ft/day)
Location 1	PW-1	1.7	X-3S	2.8
Location 2	SMW-2	5.7	X-21	2.7
Location 3	SMW-4	1.1	X-12S	17.8
Location 4	SMW-6	0.57	X-4S	3.6

The high value obtained at Well X-12S (17.8 ft/day) relative to that found at nearby Well SMW-4 (1.1 ft/day) may be due to the fact that Well X-12S screened only the upper portion of the formation, while Well SMW-4 screened the entire saturated portion of the formation. As discussed in Section 4.2.1.1, the upper part of the formation at the site has been found to consist generally of cleaner, and hence, more permeable sands than the lower portion.

Of the eight wells tested in the present investigation, Wells PW-1, PW-2A, PW-3, PW-4 and SMW-6 are located on the far eastern side of the landfill, in close proximity to Edwards Run. These wells screen the lower five feet of the Mt. Laurel-Wenonah Formation, just above the Marshalltown Formation, although Well PW-4's screen extends three feet into the Marshalltown. Leaving aside the value obtained at PW-4, the computed horizontal hydraulic conductivities of the lowermost Mt. Laurel-Wenonah close to the creek range from 0.03 to 1.7 ft/day. This is a relatively wide range in permeability; it reflects the spatial variation in lithology and density of this portion of the formation.

4.3.2 Vertical Permeability of the Marshalltown Formation

Table 4-5 presents a summary of the results of laboratory permeability tests conducted in Dames & Moore's Cranford, New Jersey laboratory on 10 Shelby tube samples obtained from borings drilled during the present investigation. Table 4-6 presents all the available laboratory data on Marshalltown vertical permeability from both the current investigation and R.E. Wright (1986) in order of decreasing elevation at which the sample was obtained.

A statistical analysis was performed of the data. Arithmetic means and geometric means were computed for the permeabilities obtained in the present investigation and for those obtained in the remedial investigation. The results are:

Investigation	No. of Tests	Arithmetic Mean (cm/sec)	Geometric Mean (cm/sec)
Present	10	2.7×10^{-5}	6.0×10^{-6}
R.E. Wright (1986)	12	2.2×10^{-5}	1.8×10^{-6}

The arithmetic mean is essentially the same for the two sets of data (about 2.5×10^{-5} cm/sec), while the geometric mean for the R.E. Wright data is approximately one-third of that found in the present investigation. Assuming that the vertical permeability of the Marshalltown Formation has a log-normal distribution, the geometric mean may be the more appropriate way to compare the two sets of data. Table 4-6 shows that laboratory permeabilities for the formation range from 8×10^{-8} to 2×10^{-4} cm/sec.

TABLE 4-5

SUMMARY OF RESULTS OF LABORATORY PERMEABILITY TESTS ON UNDISTURBED SAMPLES OF THE MARSHALLTOWN FORMATION

Boring No.	Sample Depth (ft)	Vertical Permeability (cm/sec)
SB-1	51.5-53.5	4.4×10^{-5}
SB-1	54.0-56.0	4.5×10^{-6}
SB-1	72.0-74.0	5.1×10^{-7}
SB-3	58.5-60.5	7.8×10^{-5}
SB-4	71.5-73.5	1.8×10^{-6}
SB-4	81.5-83.5	2.5×10^{-6}
SB-6	68.0-70.0	1.7×10^{-5}
SB-6	74.0-76.0	1.1×10^{-4}
SB-8	70.0-72.0	9.2×10^{-8}
SMW-1	44.0-46.0	1.0×10^{-5}

TABLE 4-6

COMPARISON OF VERTICAL PERMEABILITIES FOR THE MARSHALLTOWN ON THE BASIS OF ELEVATION AT WHICH THE SAMPLES WERE OBTAINED

Location	Well or Boring	Elevation Interval of Sample Tested (ft)	Vertical Permeability* (cm/sec)	Source+
Western Side	X-2D	20.6- 18.6	3.6×10^{-7}	RI
	SB-3	18.3- 16.3	7.8×10^{-5}	P
	SMW-1	16.8- 14.8	1.0×10^{-5}	P
	SB-1	16.6- 14.6	4.4×10^{-5}	P
	X-1O	16.2- 14.2	1.9×10^{-4}	RI
	SB-6	16.1- 14.1	1.7×10^{-5}	P
	X-1D	14.6- 12.6	5.9×10^{-5}	RI
	SB-1	14.1- 12.1	4.5×10^{-6}	P
	X-11	10.3- 8.3	4.9×10^{-7}	RI
	SB-6	10.1- 8.1	1.1×10^{-4}	P
	X-2D	5.6- 3.6	1.2×10^{-6}	RI
	SB-4	2.7- 0.7	1.8×10^{-6}	P
	X-1D	2.6- 0.6	5.9×10^{-7}	RI
	SB-1	-3.9 to -5.9	5.1×10^{-7}	P
	SB-4	-7.3 to -9.3	2.5×10^{-6}	P
Eastern Side	SB-8	7.6- 5.6	9.2×10^{-8}	P
	X-7D	-0.7 to -2.7	1.9×10^{-6}	RI
	X-4D	-7.7 to -9.7**	3.1×10^{-7}	RI
	X-4D	-11.7 to -13.7**	8.4×10^{-8}	RI
	X-6D	-14.5 to -16.5	1.1×10^{-5}	RI
	X-4D	-20.7 to -22.7**	4.0×10^{-6}	RI
	X-6D	-29.5 to -31.5	3.0×10^{-7}	RI

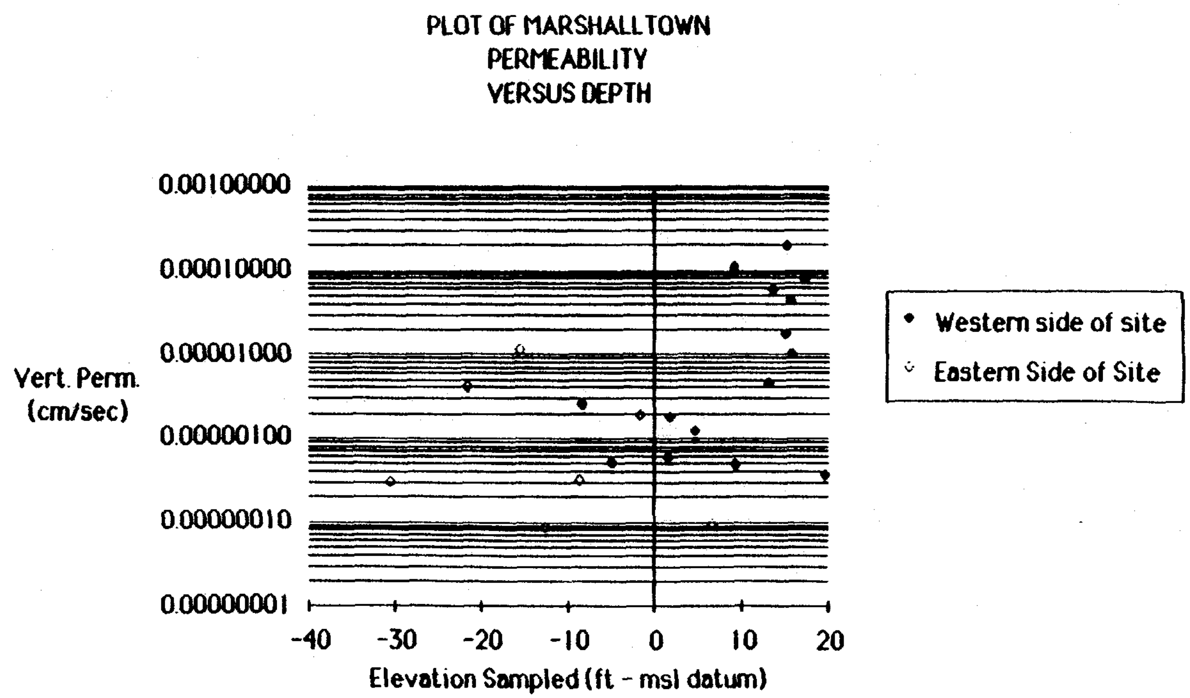
+ 'P' refers to the present investigation
'RI' refers to the remedial investigation (R. E. Wright, 1986)
* Values represent the result of the final run of each test
** Based on ground elevation for Boring X-4S

Table 4-6 indicates that there is no clear trend in vertical permeability with depth, or elevation at which the sample was obtained. This is also shown in Figure 4-15, which provides plots of permeability versus elevation at which the samples were taken. The two lowest permeability values determined (8.4×10^{-8} and 9.2×10^{-8} cm/sec) relate to samples taken from the eastern side of the site (Borings X-4D and SB-8, respectively). But the data are insufficient to determine whether or not a laterally-continuous low-permeability zone exists within the Marshalltown Formation. Should such a low-permeability zone exist, it would clearly control the rate of vertical movement through the formation, and the effective vertical permeability of the entire unit would be only slightly greater than that for the low-permeability zone. But if the low-permeability zone(s) within the formation is not laterally continuous for any significant horizontal distance beneath the landfill, the overall vertical permeability would be considerably greater.

5.0 FIELD INVESTIGATIONS

Field activities associated with this project were performed from October 16 through December 5, 1986. The field investigations included performing a geophysical survey along the landfill boundary, drilling and sampling 22 borings along the slurry wall and leachate/ground water collection drain alignment, converting four borings to piezometers, conducting in-field downhole testing of soil samples, obtaining water level measurements in piezometers, visiting several borrow pits to observe and sample potential cap and cover materials, construction of a field test fill section on the landfill surface and monitoring settlement under the fill load. All field activities were coordinated with URS and performed under Health and Safety Guidelines presented in Health and Safety Plans. Discussions of the field activities are presented below in Sections 5.1 through 5.4 and described in detail in the appendices.

Additional field work not in Dames & Moore's original contract was requested and authorized by URS. This work involved supervision of drilling and soil sampling activities for the pretreatment facility. These borings were advanced as part of the foundation investigation for the proposed ground water/leachate pretreatment facility. Logs of the borings were maintained in the field and URS will be selecting



Dames & Moore

FIGURE 4-15

samples for laboratory analysis of geotechnical properties. In addition, two shallow piezometers and three well point piezometers were drilled/installed at locations along Edwards Run. Slug tests to evaluate permeabilities of the screened portions of the Mt. Laurel-Wenonah Formations were performed in one piezometer and the three well point piezometers.

5.1 GEOPHYSICAL SURVEY

An electromagnetic survey was performed along the southern, northern and western perimeter of the landfill along the proposed slurry wall alignment. The survey was performed by Delta Geophysical Services of Clinton, New Jersey under the direction of Dames & Moore on October 16 and 17, 1986. The survey was performed to evaluate the extent of refuse and better define the landfill edge along those portions of the site which were surveyed. This information assisted in selecting boring locations and slurry wall alignment.

A total of 48 survey lines spaced approximately 100 feet apart were run using a Geonics EM-31 to measure subsurface conductivity. Survey lines were run perpendicular to chain link and snow fence which surrounds much of the site and the location of the interpreted landfill boundary were marked in the field with flagging. Location control was provided with a Brunton compass, tape and pacing. Selected survey lines were then located by licensed land surveys provided by URS. Prior to performing the on-site survey, two survey lines were run off-site to obtain background readings to assist in data evaluation.

The results of the electromagnetic survey indicate that the edge of the landfill extends to within approximately 10 to 50 feet of the chain link and snow fences which bound the site. Distance from the fence is generally within 15 to 30 feet. Along the southern boundary, the edge of the refuse shows greater variability with respect to distance from the fence. Buried refuse also extends slightly beyond the eastern limit of the survey along the southern perimater. Along the western boundary, the edge of the refuse is generally within approximately 20 feet of the fenceline on the west side of Leave Road. Along the northern boundary at the northwest corner, refuse is interpreted to extend slightly beyond the fence line immediately west of Leave Road.

Two small areas of buried ferrous material were identified outside the edge of the refuse but within the fenced area and it is possible that other such areas exist.

The Delta Geophysical Services Report is provided in Appendix 5-1 and Plate 5-1 illustrates the edge of buried refuse.

5.2 DRILLING AND SOIL SAMPLING

A total of 22 borings were drilled and sampled as part of the original contract field program. In addition, five temporary well point/piezometers were installed and six foundation borings drilled as out of scope items. The wellpoint piezometers and foundation borings were not originally included in the Dames & Moore contract with URS and were subsequently authorized by URS.

The 22 borings were advanced along the perimeter of the site beyond the landfill boundary. Locations were selected on the basis of the geophysical survey with the assistance of URS and were controlled to a degree by accessibility to an All Terrain Vehicle (ATV)-mounted drillrig and bulldozer. Selected boring locations were beyond the edge of buried refuse. The boring locations are provided on Plate 5-2 and in figures provided in Section 4. Efforts were made to provide approximately equal spacing between borings, however, difficult access conditions occasionally necessitated revised boring locations. After reviewing location and stratigraphic data, boring location SB-15 was selected to fill a gap along the southern boundary which resulted from access problems. Boring location SB-16 was also chosen on the basis of site access and to further evaluate stratigraphy along the collection drains alignment. The boring locations provide adequate coverage along all four boundaries of the site to allow for stratigraphic control.

Drilling services were provided by John Mathes & Associates, Inc. of Columbia, Illinois under contract to URS. One truck-mounted and one ATV-mounted

CME drill rig were used to advance borings using both rotary wash and hollow-stem auger techniques. For those borings which completely penetrated the Marshalltown Formation (SB-1, SB-4, SB-7, SB-12 and SB-14), steel casing was seated approximately 10 feet into the Marshalltown. The borings were then advanced using rotary wash technique. This method minimized the potential for introducing contaminants into the underlying Englishtown Formation. Most other borings were advanced initially using hollow-stem augers. Deeper drilling beneath the ground water table in all borings except SMW-2, SMW-4, SMW-5 and SMW-6 was conducted using rotary wash techniques. All borings were drilled at least 10 feet into the Marshalltown Formation and five borings completely penetrated the Marshalltown and were terminated in the underlying Englishtown Formation. Continuous undisturbed samples were obtained while drilling in the Marshalltown Formation and standard split spoon samples were collected while drilling in other formations. Total depths of the borings ranged from 24 to 120 feet.

Upon completion, four borings were converted to piezometers for observing ground water levels and collecting ground water/leachate for slurry wall compatibility testing. It was originally planned to install six piezometers, however, the need for all six was evaluated and piezometers were installed in Borings SMW-2, SMW-4, SMW-5 and SMW-6. A piezometer was not installed at SMW-1 because of its proximity to previously installed wells at location X-2. A piezometer was not installed at location SMW-3 because control was provided in this area by existing wells at location X-1 and piezometer location SMW-4. Piezometer SMW-6 was installed in order to provide a hydraulically downgradient point for obtaining ground water/leachate samples for slurry wall compatibility testing.

The remaining borings were backfilled with a bentonite/cement slurry using the tremie pipe method. That portion of the borehole which penetrated the Marshalltown Formation during drilling operations for the piezometers (SMW-4, SMW-5 and SMW-6 were filled with granular bentonite. Prior to installing the piezometer at location SMW-2, that portion of the borehole was backfilled with cuttings. A boring located approximately 40 feet north and east of Boring SB-8 was abandoned and backfilled with bentonite/cement grout after encountering approximately 10 feet of refuse immediately beneath ground surface.

Logs of the borings and piezometer construction details were maintained in the field by experienced and qualified geologists or soils engineers who observed drilling activities. Logs of the borings and piezometer schematics are presented in Appendix 5-2. Ground water measurements obtained while drilling are also included on the logs. Table 5-1 provides boring designations, coordinates, elevation, total depth and date backfilled.

During drilling operations, the presence of organic vapors at the drilling locations was monitored with an HNu or TIP photoionization detector and explosive vapors monitored with an explosimeter. Generally, the presenmce of gases above Health & Safety Plan action levels was not observed at breathing height during drilling. However, on the east side of the landfill, the presence of ground water/ leachate seeps and contaminated ground water necessitated Level B personnel protection at SB-14 and SMW-6 during drilling. Borings in which PID readings immediately above the backhole exceeded action levels includes SB-10, SB-11, SB-12, SB-13, SB-14, SMW-2, SMW-4 and SMW-6.

In-field testing during drilling operations included recording standard penetration blow counts while driving a standard split spoon sampler. Vane shear strength was measured in the field on selected Denison Samplers and Shelby tube samples. The results of these tests are provided on the boring logs. At some sampling locations, the Marshalltown Formation was either too dense or too sandy to permit Shelby tube sampling. In these instances where Shelby tubes were either crushed when pushed or had very poor recovery, a Denison sampler was used which usually met with better results. A detailed description of field activities is presented in Appendix 5-3.

5.3 FIELD TEST FILL SECTION

A 50 ft. x 50 ft. area of the landfill in the southwet portion of the site was selected for construction of a test fill section. The location of the test fill was selected to provide relatively easy access for earth moving equipment carrying fill to the test fill location which is in one of the areas of thickest waste deposits. Due to health and safety considerations, dump trucks carrying clean fill to the landfill dumped

TABLE 5-1

SUMMARY OF BORING DATA

HELEN KRAMER LANDFILL INVESTIGATION

Object	Location N	Location E	Elevation	Total Depth	Date Completed
SB-1	346862	1849529	68.11	98.5	11/5/86
SB-2	346567	1849470	69.57	58.0	11/5/86
SB-3	345845	1849331	76.74	68.5	11/6/86
SB-4	345440	1849260	74.23	44.0	10/28/86
SB-5	344919	1849159	79.75	64.5	10/30/86
SB-6	344263	1849007	84.07	76	11/10/86
*SB-7	343998	1850012	76.44	120.5	11/18/86
SB-8	344067	1850451	77.65	81.5	11/8/86
SB-9	343956	1850538	60.67	44.5	11/22/86
*SB-10	344433	1850880	21.85	34.0	11/13/86
SB-11	344935	1850425	34.05	45.0	11/21/86
SB-12	345361	1850615	23.34	53.0	11/11/86
SB-13	345881	1850731	25.12	24.1	11/12/86
SB-14	346290	1850332	25.68	38.1	11/7/86
SB-15	344084	1849843	80.18	80.0	11/20/86
SB-16	344919	1850319	41.19	50	11/25/86
SMW-1	346737	1849808	60.85	51.0	11/11/86
*SMW-2	346372	1849435	75.92	63.5*	11/20/86
SMW-3	344585	1849092	81.04	64.0	11/21/86
*SMW-4	344083	1849331	76.28	75.0*	11/22/86
*SMW-5	344035	1850248	77.02	6.0*	11/24/86
*SMW-6	345273	1850574	24.50	25.5*	11/23/86
FB-1	346730	1849984	50.56	45.0	12/3/86
FB-2	346880	1850019	53.28	45.0	11/25/86
FB-3	347001	1850047	52.23	42.5	11/25/86
FB-4	346709	1850104	40.37	33.5	12/3/86
FB-5	346876	1850092	53.69	84.5	12/4/86
FB-6	346990	1850135	51.07	40.0	12/2/86
*PW-1	346208	1850440	25.07	19.5*	11/24/86
*PW-2 & 2A	345878	1850624	36.16	13.5*	11/23/86
*PW-3	344840	1850455	32.07	27.0*	11/25/86
*PW-4	344539	1850864	22.27	10.5*	11/26/86

NOTES:

Survey Data provided by URS.

*Piezometer installed. All other borings backfilled to ground surface with bentonite/cement slurry.

Refer to Plate 2 for location and Appendix 5-2 for boring logs and well construction details.

the soil at the entrance to the site rather than attempt to drive over the landfill. Two front-end loaders ferried the fill to the test fill location. Prefabricated settlement plates were installed and fill placed on top of the plates and surrounding area. The elevations of the plates were monitored before, during and after placement of the fill to assist in evaluating settlement of the landfill surface under conditions similar to those expected during and after construction of the cap and cover. Six settlement plates were installed and four to eight feet of sandy fill were placed. After approximately two weeks, settlement under the 8-foot load was between 1 and 1-1/2 feet and settlement under the 4-foot load was approximately one foot or less. After this amount of time, settlement is observed to stabilize. Detailed discussions of the procedures and analysis of the test data is presented under Section 8.

5.4 HEALTH AND SAFETY

All field activities were performed under guidelines outlined in Dames & Moore's site specific Health and Safety Plan. A copy of the plan is included as Appendix 5-4. The plan conformed to guidelines presented in Corps-approved Site-Specific Safety Plan (SSSP) prepared by URS. The Health and Safety Plan indicates the required monitoring equipment, protective clothing, action levels, expected compounds and their characteristics, decontamination procedures and plan management techniques necessary for safe operations in the field.

The majority of field activities were performed under modified level C protection. Drilling activities along the eastern boundary of the site required level B protection at times. A Decontamination Pad was constructed by URS and was used for equipment decontamination prior to drilling at piezometer locations and prior to demobilizing equipment from the site.

6.0 LABORATORY INVESTIGATION

An extensive laboratory testing program was performed as part of the investigation. The laboratory program was designed to provide geotechnical data to assist evaluating site geology and in developing designs for the project. The laboratory analysis includes analysis to characterize the Mt. Laurel-Wenonah and Marshalltown Formations, testing for the slurry wall and testing for cap and cover, which are described below. The results of testing completed on soil samples obtained from the borings are included in Table 6-1 and additional data as well as descriptions of laboratory testing apparatus are included in Appendix 6-1. Cap and cover materials laboratory testing is described in Section 7.

The testing program is nearly completed but additional testing is currently under way. In order to best select soil samples and utilize data generated from the laboratory program, geologic and engineering assessments based on the drilling and sampling program was evaluated prior to committing to all laboratory testing. This resulted in slight revisions to the testing schedule. Although we do not anticipate substantial revisions to information and conclusions presented in this report, the results of future laboratory analysis will be forwarded to URS immediately upon completion.

6.1 LABORATORY TESTING PROCEDURES

Laboratory testing procedures were performed in accordance with the methods outlined below:

Test Type	Methods
Soil Borings and Cap Material	
Sieve Analysis	ASTM D-422
Hydrometer Analysis	ASTM D-422
Water Content	ASTM D-2216
Atterberg Limits	ASTM D-423 and 424
Proctor Density	ASTM D-1557
Permeabilities	Falling Head, Constant Head, Triaxial Cell Constant Head

Slurry Mixture

TABLE 6-1

SUMMARY OF AVAILABLE LABORATORY DATA

Boring No.	Sample No.	Sample Type	Sample Depth (ft)	Formation	Unified Soil Classification	% Fines	Moisture Content (%)	Atterberg Limits: Plastic Limit	Atterberg Limits: Liquid Limit	Permeability (cm/sec)
SB-1	7	SS	9-10.5	ML-W	SP-SM	7.6	15.2			
SB-1	18	SS	25-27	ML-W	SM	13.65	30.1			
SB-1	35	ST	51.5-53.5	MT	SM	37	28.9	NP	NP	4.45×10^{-5}
SB-1	36	ST	54-56	MT	SM	49	28.0	NP	NP	4.49×10^{-6}
SB-1	45	D	72-74	MT	SM		13.6	NP	NP	
SB-1	45	ST	72-74	MT	SM	24.8	13.6	NP	NP	5.12×10^{-7}
SB-2	18	SS	26.5-28	ML-W	SM	16.3	28.4			
SB-3	21	SS	35-36.5	ML-W	SM	12.84	27.9			
SB-3	30	ST	58.5-60.5	MT	SM	29.3	26.8	NP	NP	7.75×10^{-5}
SB-3	31	ST	60.5-62	MT	SM	32.5	31.6	NP	NP	
SB-4	5	SS	6-7.5	ML-W	SM-SP	9.75	8.6			
SB-4	20	SS	20-30	ML-W	SM-SP	11.5	27.4			
SB-4	33	SS	48-49.5	ML-W	SM	17.4	35.3			
SB-4	43	ST	69.5-71.5	MT	SM	432	35.4	NP	NP	
SB-4	44	ST	71.5-73.5	MT	SM		31.1			1.81×10^{-6}
SB-4	49	ST	80-81.5	MT	SM	27.3	19.1	NP	NP	
SB-4	49	ST	81.5-83.5	MT	SM		18.8			2.5×10^{-6}
SB-5	8	SS	10.5-12	ML-W	SP-SM	8.9	9.5			
SB-5	20	SS	38-40	ML-W	SM	12.9	26.2			
SB-5	D-3	D	62.5-64.5	MT	ML		26.1	NP	NP	
SB-6	8	SS	10.5-12	ML-W	SM	13.7	6.9			
SB-6	24	SS	48.5-50	ML-W	SM	12.53	27.0	NP	NP	
SB-6	37	ST	74-76	MT	SM		27.8			1.07×10^{-4}
SB-6	34	ST	68-70	MT	SM	235	26.1	NP	NP	1.74×10^{-5}
SB-6	37	ST	74-76	MT	SM	16.25	25.1	NP	NP	
SB-8	20	SS	28-30	ML-W	SP-SM	10.87	15			
SB-8	31	SS	62.5-64.1	ML-W	SM	12.38	25.4			
SB-8	36	SS	70-72	MT	SM	22.3	33.6	NP	NP	
SB-8	36	D	70-72	MT	SM		26.9			9.16×10^{-8}

DR 000353

TABLE 6-1 (continued)

SUMMARY OF AVAILABLE LABORATORY DATA

Boring No.	Sample No.	Sample Type	Sample Depth (ft)	Formation	Unified Soil Classification	% Fines	Moisture Content (%)	Atterberg Limits: Plastic Limit	Atterberg Limits: Liquid Limit	Permeability (cm/sec)
SB-9	13	SS	18-19.5	ML-W	SP-SM	10.3	35.0			
SB-9	19	ST	28-29	MT	SM		32.4	NP	NP	
SB-9	25	ST	37.5-38.5	MT	SM		24.7	NP	NP	
SB-10	6	SS	7.5-9	ML-W	SM	16.41	31.3			
SB-10	12	ST	17.5-19.5	MT	SM	--				4.58×10^{-5}
SB-10	12	ST	17.5-19.5	MT	SM		31.2	NP	NP	
SB-10	15	ST	23-25	MT	SM		26.5	NP	NP	
SB-11	14	SS	22-24.5	MT	SM		31.0	NP	NP	
SB-11	23	ST	39-41	MT	SM		28.4	NP	NP	
SB-12	6	SS	7.5-9.0	ML-W	SC	14.6	34.0			
SB-12	7	SS	9-10	ML-W	SM	15.81	37.3			
SB-12	14	D	20-22	MT	SM		27.2	NP	NP	
SB-12	15	D	22-24	MT	SM		27.3	NP	NP	
SB-12	20	ST	32-34	MT	SM		24.4	NP	NP	
SB-12	30	SS	49.5-50.5	ET	ML	87.2	32.8	NP	NP	
SB-13	8	ST	12-14	MT	SM		37.5	NP	NP	
SB-13	11	ST	17-19	MT	SM		25.1	NP	NP	
SB-15	19	SS	27-28.5	ML-W	SP-SM	11.9	9.7			
SB-15	32	SS	60.5-62	ML-W	SM	13.2	28.3			
SB-15	36	D	70.5-72.5	MT	SM	21.5	31.8	NP	NP	
SB-15	42	ST	78-80	MT	SM		26.9	NP	NP	
SMW-1	19	SS	27-28.5	ML-W	SM	14.4	32.4			
SMW-1	25	ST	44-46	MT	SM					1.02×10^{-5}
SMW-2	10	SS	13.5-15	MW-W	SP-SM	7.0	6.4			
SMW-3	33	ST	63-65	MT	SM		31.3	NP	NP	
SMW-3	30	ST	58-60	MT	SM		31.6	NP	NP	
SMW-4	35	ST	78-80	MT	SM		27.4	NP	NP	
SMW-4	31	ST	64-66	MT	SM		30.4	NP	NP	
SMW-5	33	ST	65.5-67.5	MT	SM		28.0	NP	NP	

NOTES:

1. Sample type: SS = split spoon; ST = Shelby tube; D = Denison sampler.
2. Formation: ML-W = Mt. Laurel-Wenonah; MT = Marshalltown; ET = Englishtown.
3. % Fines = Percent of sample passing #200 sieve.
4. Classification based on field and laboratory visual classification and/or grain size distribution analysis.

DR 000354

Sieve Hydrometer Analysis	ASTM D-422
Water Content	ASTM D-2216
Unit Weight	ASTM D-2049
Permeability	Falling Head (bulk soil mix), Constant Head Filter Press (backfill mixes and compatibility testing), Triaxial Flexible Wall Cell Constant Head (confirmation testing of backfill)
Consolidation	ASTM D-2435
Slump	Marsh Funnel

6.2 LABORATORY SOIL TESTING FOR SLURRY WALL

Selected soil samples obtained from borings advanced along the slurry wall alignment were tested to evaluate the geotechnical properties. The testing includes determining grain size distribution (sieve and hydrometer analysis), water content, Atterberg limits classification and permeabilities. The permeability testing is restricted to relatively undisturbed samples of Marshalltown Formation obtained using Shelby tubes and Denison samplers. Other properties testing were performed on soil samples obtained in both the Marshalltown and overlying Mt. Laurel-Wenonah Formations.

In addition to the soils testing, laboratory testing was performed on the possible slurry mixtures for use in the slurry wall. This testing is used to evaluate the optimum slurry mixtures and is accomplished by mixing a bentonite slurry with the borrow soils (on-site soils which will be excavated during trench construction) adding appropriate amounts of fines to the mix and adding various percentages of dry bentonite to the mix. Testing performed on the various mixtures includes grain size determination (sieve and hydrometer analysis) water content, mix unit weight bulk soil unit weight, backfill permeability, backfill consolidation and slump testing.

Initial permeability tests utilized tap water obtained near the site from the East Greenwich Fire Department. Subsequent testing on the selected design mix is underway and will include passing tap water and then leachate/ground water through the selected mix. Seven to eight pore volumes of leachate/ground water will be passed through the mix and any change in permeability with time will be noted. Leachate/ground water will be passed through the mix until stable permeabilities are recorded. The information obtained from these procedures will assist in evaluating slurry wall compatibility.

6.3 RESULTS OF SLURRY WALL LABORATORY TESTING

Laboratory testing results are summarized on Table 6-1. The results of the testing program are integrated with Section 4, Geohydrology and Section 12, Slurry Wall Design. Laboratory analysis shows that:

- Mt. Laurel-Wenonah Formation consists of fine to medium sands with varying amounts of fines.
- The Marshaltown Formation consists primarily of fine sand with varying amounts of fines.
- Moisture content in the Mt. Laurel-Wenonah Formation ranged from 8 to 31 percent and from 19 to 25 percent in the Marshalltown.
- Permeability, as determined from tests performed on relatively undisturbed samples obtained in the Marshalltown are on the order of 10^{-5} to 10^{-6} cm/sec, but range from 1×10^{-4} to 9×10^{-8} cm/sec. Permeability of Marshalltown Formation as reported in the RI/FS ranged from 1×10^{-4} to 1×10^{-8} cm/sec.
- The results of slurry wall backfill permeability testing using tap water obtained near the site indicate that a basic mix consisting of on-site soils, 6% bentonite slurry and 20% off-site fines have permeabilities of 4.2×10^{-7} cm/sec, 1.4×10^{-7} cm/sec and 6.02×10^{-8} cm/sec when mixed with 0, 2 and 4% dry bentonite by weight, respectively.

6.4 LABORATORY TESTING AND CAP MATERIALS

Two clay borrow pits and two sand borrow pits suitable for providing materials for use in cap and cover construction were identified. Selected borrow pits were visited and bulk samples of site soil collected for analysis. Laboratory analysis of clays obtained from two borrow pits included determination grain size distribution (sieve and hydrometer), Atterberg Limits, water content, proctor density and permeabilities. In addition, grain size distribution for sand fill obtained from one borrow pit was also performed. Borrow pit owners have also provided laboratory data on soil samples. Three other clay sources have been identified but samples have not been analyzed due to quantity, access or distance restrictions at these sites. Resources are listed below and Section 7.0 provides further details concerning borrow materials.

6.5 RESULTS OF CAP MATERIAL TESTING

The results of cap material testing have been integrated into Section 7, Borrow Material Sources and Section 11, Cap and Cover Design of this report. Laboratory data generated from analysis of soil samples collected during this investigation as well as information provided by the owners of the borrow pits are described in Section 7. The results indicate that clays obtained from Bill Magaha Borrow Pit in Mannington Township and Schepps Sand and Gravel Pit in Salem, New Jersey are suitable for use as capping material. Both pits can provide soils which can achieve design permeabilities after compaction and have adequate plasticity indexes and natural moisture content to allow for use as capping materials.

7.0 BORROW MATERIALS

This section presents the results of borrow source investigations and borrow material characteristics for the landfill cap.

7.1 BORROW SOURCES

A systematic effort was made to identify local borrow sources by contacting local private material suppliers and State agencies familiar with projects involving selection of such borrow sources. Sources include NJDEP, New Jersey Department of Labor, Contractors Listings, U.S. Dept. of Agriculture Soil Conservation Service and Township Engineers. Based on these inquiries and interviews, two suitable clay borrow sources were identified (Bill Magaha Pit operated by Son Don Construction in Mannington Township, New Jersey and Shepps Sand and Gravel Pit in Salem, New Jersey). Table 7-1 shows four potential clay borrow sources identified for the landfill cover.

Additional pits were identified during our search but not further evaluated because of either their location, lack of required quantity, or due to the fact that these pits are currently not operational. Furthermore, the two clay sources identified appear to meet requirements for this project. Figure 7-1 shows locations of these and other borrow sources relative to the site.

Dames & Moore inspected a third pit operated by Son Don Construction in Deptford Township. Although bulk soil samples were collected, no analysis was peformed becasue of apparent quantity limitations at this source. In addition, Dames & Moore met with representatives of Jarco Construction Company which owns property in Deptford, New Jersey with more than one million cubic yards of clay material. These pits are in close proximity to the site but are not yet operational. Therefore, no laboratory testing was initiated for the Jarco sites.

General geologic and stratigraphic data describing the extent and distribution of suitable borrow materials from the two selected clay borrow sources for the present investigations are described below.

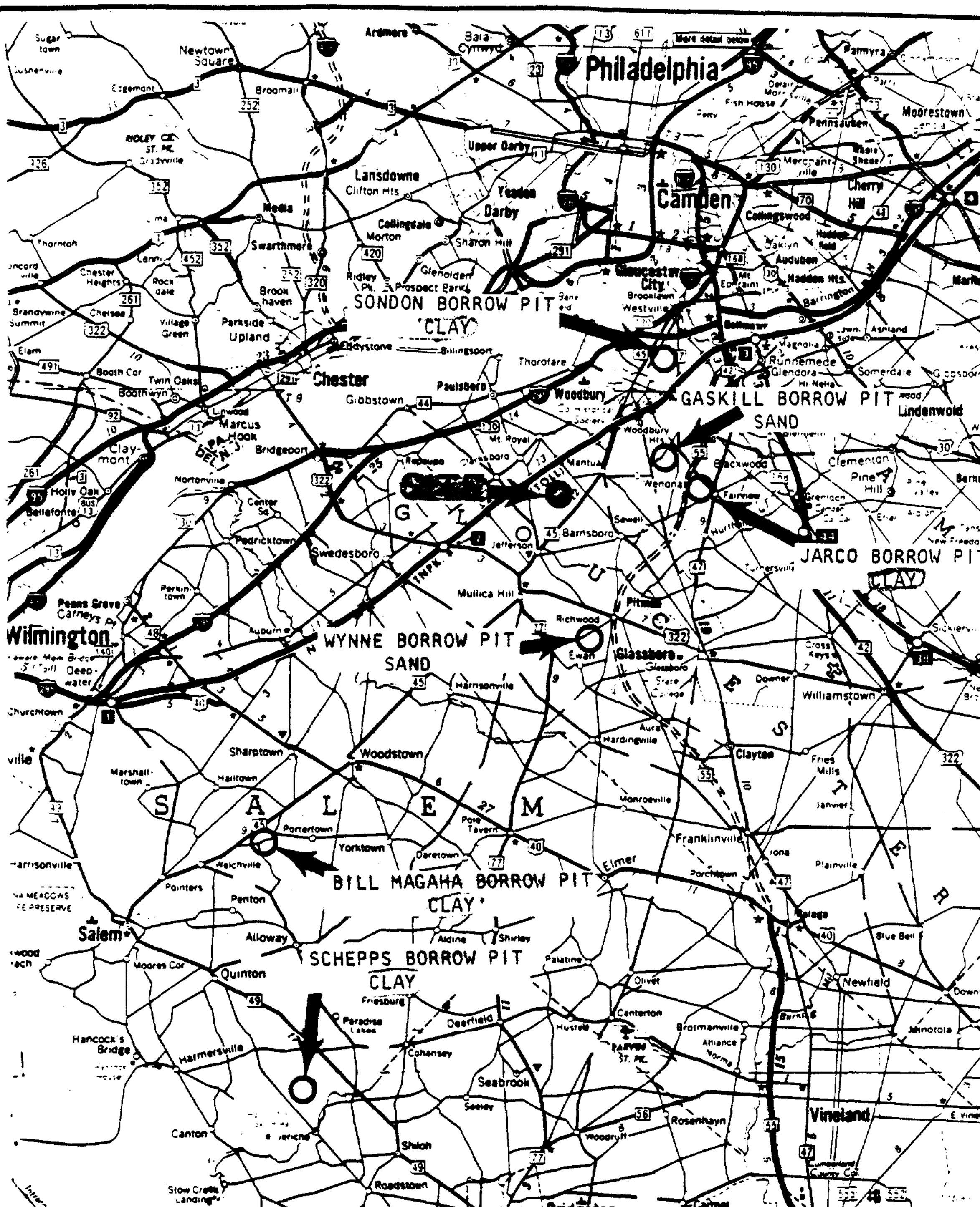
7.1.1 Salem, New Jersey Clay Borrow Source

Valley Sand Gravel Company operates a borrow pit located between Jericho and Gravelly Hill Roads in Salem, New Jersey. The pit is approximately 30 acres in area and covered by a thin mantle of sand and gravel. The thickness of clay as reported by borings advanced at the site by other indicates the clay strata is more than 120 feet in thickness. This indicates that available material is on the order of 5 million cubic yards.

TABLE 7-1

POTENTIAL BORROW SOURCES – CLAY COVER MATERIALS

No.	Borrow Source Location	Supplier	Material	Distance From the Site (miles)	Estimated Quantity Available (cu. yds.)	
1	Salem, NJ	Valley Sand & Gravel Co. (Mr. D. Schepps)	Clay	< 20	5,000,000	Suitable quality and quantity
2	Mannington Township, NJ	Magaha Farm/Son Don Construction Co. (Mr. Bill Magaha)	Clay	< 20	700,000	Suitable quality and quantity
3	Blackwood, NJ	Jarco Construction	Clay	< 10	1,000,000	Currently not operating
4	Deptford, NJ	Son Don Construction Co.	Clay and Sand	< 20	Unknown	Not suitable quantity
5	Hamilton Township, NJ	Hess Bros. Construction Co.	Clay	> 20	500,000	Currently not operating and not in close proximity to site
6	Richwood, NJ	William Wynne	Sand	< 20	Unknown	Suitable for common fill
7	Deptford, NJ	Graskill Construction Co.	Sand	< 20	Unknown	Suitable for common fill



BORROW PIT LOCATIONS

HELEN KRAMER LANDFILL

MANTUA, N.J.

Scale?

Dames & Moore

FIGURE 7-1

The site lies near the contact zone between outcrops of the Kirkwood Clay and Cohansey Sand Formation. Clay mined at the site is reportedly taken from the Kirkwood Formation. Material obtained from this borrow source has reportedly been used as cover material for the Pinelands Park landfill.

Previous Data

Schepps Environmental Clay, as the materials from this borrow source have been referred to in previous documentations, has been tested by L. J. Rusciani Associates, Inc. (dated March 31, 1982), Underwood, Furman & Snyder Testing Laboratories, Inc. (January 19, 1983), and Testwell Craig Testing Co. (October 18-23, 1984), and Laboratories, Inc. (June 16, 1983). This material has been classified as CL material (ASTM D-2487).

Documented test results by these laboratories, furnished by Valley Sand & Gravel Co., have been reproduced in Appendix 7-1. The test results are summarized in Table 7-2.

Recent Dames & Moore Data

Recent data, based upon testing of samples obtained during this (1986) investigation, are summarized in Table 7-3. Laboratory testing results indicate this material to have a natural moisture content of 41%, plasticity index of 49%, liquid limit of 74%, and optimum moisture content of 19.5%. Permeability testing is underway, however the results of permeability testing by others show that the material has permeabilities of 10^{-8} and 10^{-9} cm/sec. The material's characteristics are therefore suitable for use at the site.

Detailed laboratory results are presented in Appendix 7-1.

7.1.2 Mannington, New Jersey Clay Borrow Source

Son Don Construction Company operates a borrow pit on the Bill Magaha Farm property located on Compromise Road in Mannington Township, New Jersey.

TABLE 7-2

SUMMARY OF PREVIOUS LABORATORY DATA

(FURNISHED BY VALLEY SAND AND GRAVEL CO.)

MATERIAL CHARACTERISTICS – SALEM, NJ BORROW SOURCE

				Atterberg Limits			Compaction		Permeability			
									Test Specimen			
No.	Laboratory	Date	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Maximum Dry Density (pcf)	Optimum Water Content (%)	Water Content (%)	Dry Density (pcf)	Coefficient of Permeability, K (cm/sec)	Remarks
1	L.J. Rusciani Assoc., Inc.	March 31, 1982	--	49.5	22.5	27.0	93.0(1)	28.8	26.9	—	3.93×10^{-8}	
2	L.J. Rusciani Assoc., Inc.	March 31, 1982	--	56.5	30.0	26.0	118.6	33.5	32.1	—	1.62×10^{-8}	
3	Underwood, Furman & Snyder Testing Laboratories, Inc.	Jan. 19, 1983	--	51.9	27.3	24.6	--	--	--		2.4×10^{-8}	
4	Underwood, Furman & Snyder Testing Laboratories, Inc.	Oct. 18-24, 1984	13.1	49.0	24.8	24.2	97.1(1)	20.5	19.5	—	$6.8\ 10^{-8}$	pH = 4.8
5	Testwell Craig Testing Laboratories, Inc.	June 16, 1983	--	54.2	31.5	22.7	--	--	--		2.4×10^{-8}	Test Boring #5, 55 ft.
6	Testwell Craig Testing Laboratories, Inc.	June 16, 1983	--	56.6	30.5	26.1	--	--	--		2.4×10^{-8}	Test Boring #5, 120 ft.
7	Ambrick Testing Assoc. of New Jersey, Inc.	Oct. 13, 1986	--	--	--	--	106.9	17.6	--	—	4.48×10^{-9}	97.9% Passing #200 Sieve
8	L. J. Rusciani Assoc., Inc.	April 28, 1983	--	--	--	--	--	--	48.3	—	9.18×10^{-8}	Test Boring #4, 80 ft.
9	L. J. Rusciani Assoc., Inc.	April 28, 1983	--	--	--	--	--	--	55.8	—	7.10×10^{-8}	Test Boring #4, 120 ft.
10	L. J. Rusciani Assoc., Inc.	April 28, 1983	--	--	--	--	--	--	42.1	—	4.42×10^{-8}	Test Boring #6, 120 ft.

NOTES:

— No data available.

(1) Reported as "Proctor" density.

Not known if permeability testing performed on undisturbed or recompacted sample.

TABLE 7-3

SUMMARY OF DAMES & MOORE LABORATORY DATA (1986)

MATERIAL CHARACTERISTICS – SALEM, NJ BORROW SOURCE

				Atterberg Limits			Compaction			Permeability			
										Test Specimen[1]			
No.	Laboratory	Date	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Maximum Dry Density (pcf)	Optimum Water Content (%)	Compaction (%)	Water Content (%)	Dry Density (pcf)	Coefficient of Permeability, K (cm/sec)	Unified Soil Classification
1	Dames & Moore, Soil Laboratory, Cranford, NJ	12/1/86	41	74	25	49	106.0	19.5					CH

NOTE:

(1) Percent (%) compaction to be determined on basis of permeability testing.

DR 000363

Material at the site consists of red-brown silty clay with black and blue silty clay pockets. The clay is reported by the owners/operators to cover more than 20 acres at a thickness of more than 22 feet, indicating that more than 700,000 cubic yards of clay is available. The clay pit is located in the outcrop area of the Kirkwood Formation. The material is reportedly used as cover for the Kingsley and Pinelands Park landfills in New Jersey.

Previous Data

Clay from this borrow source has been tested by L. J. Rusciani Associates, Inc. (November 22, 1982).

Documented test results, furnished by the owners/operators, have been reproduced in Appendix 7-2. The test results are summarized in Table 7-4.

Recent Dames & Moore Data

Recent data, based upon testing of samples obtained during the recent (1986) investigations are summarized in Table 7-5. Laboratory testing results indicate this material to have natural moisture content of 51%, plasticity index of 41%, liquid limit of 74%, and optimum moisture content of 24.9%. Permeability testing is underway, however, the results of permeability teting by other show that the material has a permeability of 1×10^{-7} cm/sec. The material characteristics are therefore suitable for use at the site.

Detailed laboratory results are presented in Appendix 7-2.

7.2 SAND BORROW SOURCES

Gaskill Construction Co. Pit and William Wynne Pit, two sources of sandy fill located in the immediate site vicinity were visited. Their locations are presented in Figure 7-1. Laboratory data for sands obtained at the Gaskill Construction Co. pit in Deptford and William Wynne Borrow Pit in Richwood are presented in Appendix 7-3.

TABLE 7-4

SUMMARY OF PREVIOUS LABORATORY DATA

(FURNISHED BY SON DON CONSTRUCTION CO.)

MATERIAL CHARACTERISTICS — MANNINGTON TOWNSHIP, NJ BORROW SOURCE

			Atterberg Limits			Compaction		Permeability			
								Test Specimen			
No.	Laboratory	Date	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Maximum[1] Dry Density (pcf)	Optimum Water Content (%)	Water Content (%)	Dry Density (PCF)	Coefficient of Permeability, K (cm/sec)	Remarks
1	L.J. Rusciani Assoc., Inc.	Nov. 22, 1982	43.6	22.8	20.8	103.0 [1]	20.6	21.5	—	1.28×10^{-7}	76% material passing #200 sieve Unified Soil Classification = CL

NOTES:

— No data available.

(1) R ported as "Proctor" density.

Natural Water Content not provided.

Not known if permeability testing performed on undisturbed or recompacted sample.

TABLE 7-5

SUMMARY OF DAMES & MOORE LABORATORY DATA (1986)

MATERIAL CHARACTERISTICS — MANNINGTON TOWNSHIP, NJ BORROW SOURCE

				Atterberg Limits			Compaction			Permeability				
										Test Specimen[1]				
No.	Laboratory	Date	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Maximum Dry Density (pcf)	Optimum Water Content (%)	Compaction (%)	Water Content (%)	Dry Density (pcf)	Coefficient of Permeability, K (cm/sec)	Unified Soil Classification
1	Dames & Moore, Soil Laboratory, Cranford, NJ	12/1/86	51	74	32	42	101.8	24.9					CH

NOTE:

(1) Percent (%) compaction to be determined on basis of permeability testing.

There are many sand pit operations in the site area which can likely be utilized as common fill at the site.

7.3 MATERIAL QUANTITY REQUIREMENTS

Based on the areal extent of the landfill (about 66 acres), it is estimated that approximately 320,000 to 640,000 cubic yards of borrow materials for a cover depth of three to six feet. Additional fill will be required to regrade lowlying areas of the site. Approximately 215,000 cubic yards of clay will be required for a 2-foot cap.

It is expected (Table 7-1) that the two borrow sources (Salem and Mannington, New Jersey) will yield enough clay required for a typical cover depth of about two feet. Other sources which have been identified but not inspected may also be suitable, if necessary.

7.4 RESULTS OF BORROW PIT EVALUATION

Clay obtained from the Bill Magaha and Valley Sand & Gravel Pits can be used as capping material at the site. Clay from both these sources can be compacted to attain design permeabilities of 10^{-7} cm/sec. The material has adequate plasticity indexes and moisture content to allow for relative ease in compaction and handling. Both these sites are located within approximately 15 miles of the site and material obtained from each is reportedly used as cover materials at other landfills in the area. It is possible that the material may not be available when closure construction activities begin at the Helen Kramer site. It may, therefore, be practical to enter into agreements with the borrow pit owners to ensure adequate quantity is available for use at the site.

8.0 TEST FILL

8.1 PURPOSE

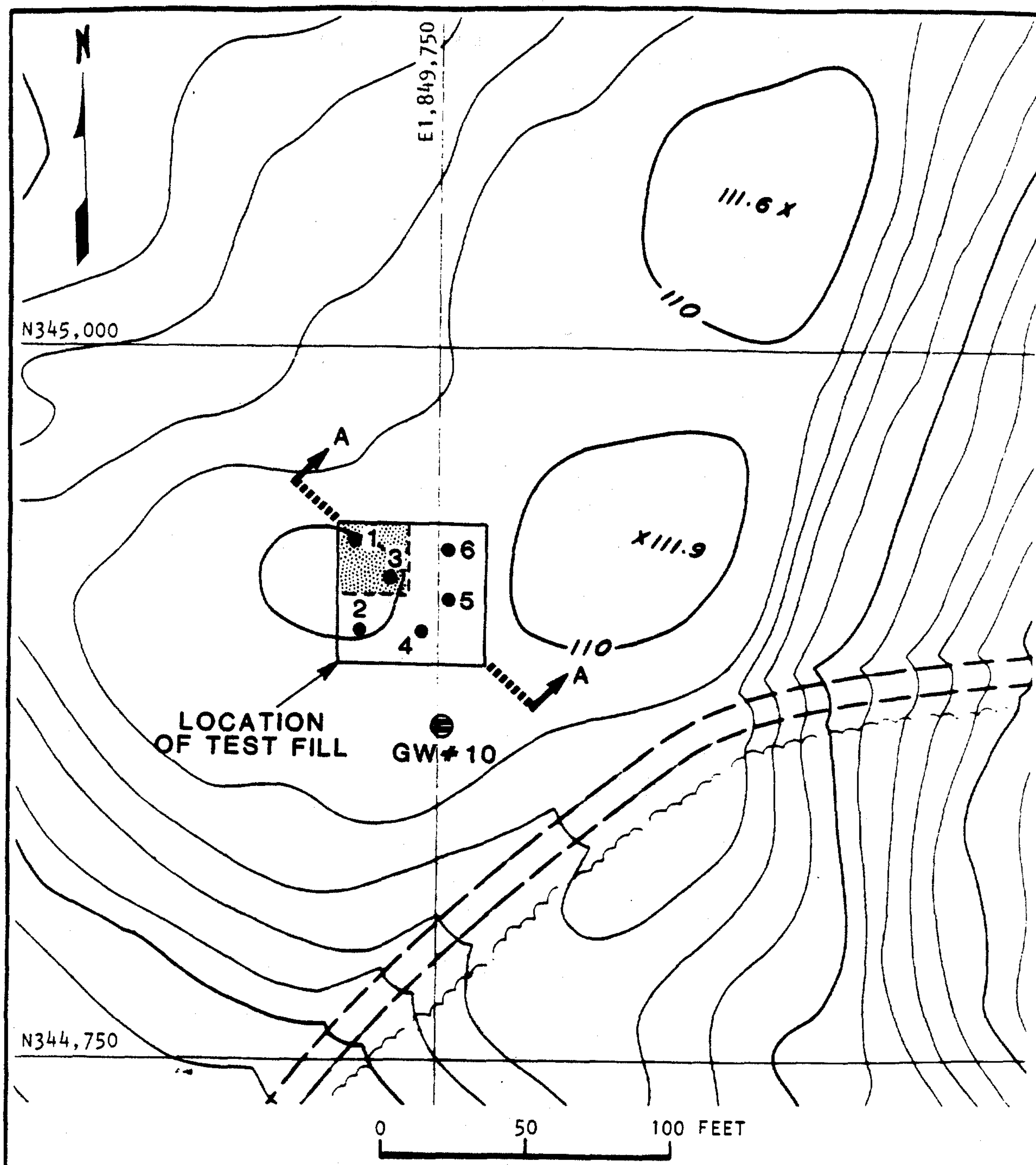
The purpose of the test fill was to investigate the effects that two different heights of fill base on the required cover would have on the existing landfill surface. The two heights were established to simulate different weights of the required cover, four feet of fill and eight feet of fill. The test fill, covering an area 50 feet by 50 feet, was constructed to an average height of four feet with a 25 foot by 25 foot corner of this area being constructed to an average height of eight feet. The fill material was placed from December 4 to December 9, 1986. Settlement monuments were installed prior to fill placement and elevation readings were recorded during construction and one week after completion of the test fill.

8.2 LOCATION OF THE TEST FILL

The location of the test fill was selected based on accessibility and the existing thickness of the landfill. The selected site is shown on Figure 8-1 and Plate 5-2. Based on the isopach map showing the thickness of the landfill (Figure 3-2), the test fill is located on the thickest portion of the landfill which was closest to the entrance on Boody Mill Road.

8.3 CONSTRUCTION OF THE TEST FILL

The selected area, approximately 60 feet by 60 feet, was cleared of vegetation, debris and loose material using a front end loader. The settlement monuments were installed by imbedding six steel plates in concrete at the locations shown on Figure 8-1. Figure 8-2 presents a generalized cross section through the test fill site. The steel riser pipes were threaded into the plates and surrounded by large diameter PVC pipes to protect the risers from the test fill placement operations. Each of the installed plates was initially covered by about one foot of fill by shoveling and hand tamping. The remainder of the fill material was placed in uniform lifts and compacted by several passes of the front end loader. Enroserv of Clayton, New Jersey provided dump trainers to haul fill to the site. Enroserv also provided one track-mounted Catepillar D-9 front-end loader and one rubber tire Case W-30 front end loader to move and compact material at the site. The entire test fill operation was performed under the supervision of a Dames & Moore engineer. Field density measurements were made in order to determine the unit weight of the fill material. The average wet unit weight was 120 lbs/ft^3.



TEST FILL
PLOT PLAN & LOCATION OF CROSS SECTION
HELEN KRAMER LANDFILL
MANTUA, N.J.

KEY:

- ● LOCATION OF SETTLEMENT MONUMENTS
- ⊖ GASWELL USED AS ELEVATION REFERENCE
- (shaded) 8' FILL THICKNESS (REMAINING AREA 4' THICK)

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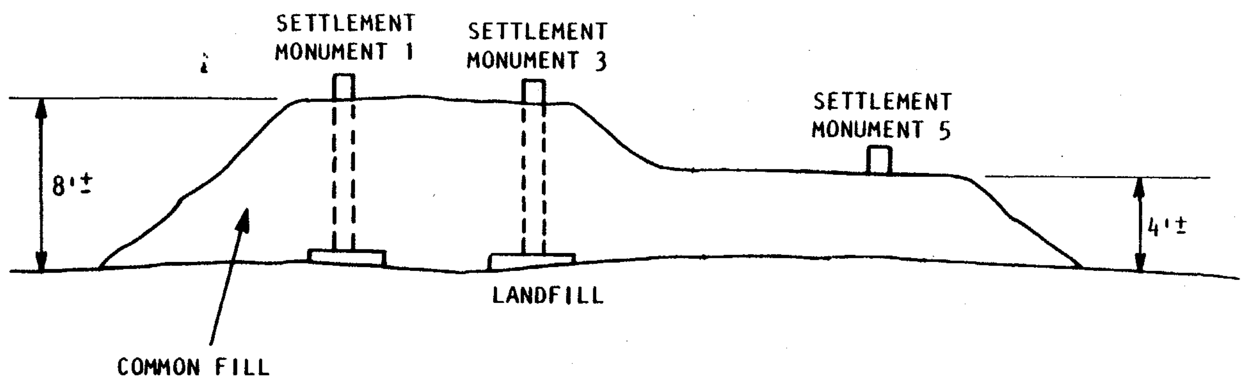
NOTE: SEE FIGURE 8-2 FOR CROSS SECTION

FIGURE 8-1



(NOT TO SCALE)

GENERALIZED CROSS SECTION A-A
TEST FILL

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FIGURE 8-2

8.4 TEST FILL MATERIAL

The material used for the test fill was a well-graded silty sand with some gravel obtained from the William Wynne Borrow Pit in Richwood, New Jersey. See Figure 7-1 for the borrow pit location with respect to the landfill.

Appendix 7-3 presents a representative grain size distribution curve for this borrow material.

8.5 INTERPRETATION OF RESULTS

The data resulting from the measurement of the six settlement monuments are recorded on Table 8-1 and plots of settlement versus time are contained in Appendix 8-1. This data indicate that the majority of the settlement of the landfill surface cover under the fill load will occur over a relatively short time during placement of the cover material. This amount is estimated to range from approximately 9 inches to 12 inches for loads equivalent to approximately 480 and 960 pounds per square foot, respectively. The remaining settlement approximately four to six inches will occur very slowly over the lifetime of the landfill. This time dependent settlement will be masked due to the decomposition settlement of the uncompacted material in the landfill which is indeterminate. Based on performance of other landfills, this may exceed three feet (Section 9.4)

Initial settlement under the cap and cover can be compensated by either overbuilding by approximately one foot or by taking this initial settlement into account when describing the final design grade elevation. Since the expense of overbuilding the cap by one foot of common fill will be high, final design grade will be approximately one foot lower in elevation than the as-placed design grade of the cap and cover materials.

TABLE 8-1

SUMMARY OF SETTLEMENT MONUMENT DATA

Date Time Height of Fill	12/4/86 8:00 1'-Fill	12 12:00 —	/4/86 16:00 —	12/4/86 8:00 3'-Fill	12/5/86 16:00 4'-Fill	12/5/86 9:00 4'-Fill	12/8/86 12:00 —	12/8/86 13:00 Fill Completed	12/ /86 9:00 Fill Completed	12/16/86 Difference (ft) 12/4/86 to 12/16/86
Settlement Monument										
1	115.45	115.25	115.15	115.06	114.88	114.56	114.45	114.37	114.06	1.39
2	115.27	115.11	115.05	114.79	114.84	114.59	114.61	114.60	114.37	0.90
3	114.84	114.59	114.49	114.38	114.18	113.83	113.77	113.70	113.39	1.45
4	116.25	116.09	116.01	115.93	115.78	115.57	115.60	115.62	115.39	0.86
5	116.20	116.01	115.89	115.79	115.68	115.46	115.47	115.47	115.24	0.96
6	114.90	114.67	114.44	114.41	114.37	114.21	114.19	114.17	113.91	0.99
Weather	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Rain	Clear	

NOTES:

1. Settlement monuments 1 and 3 covered by 8 feet of fill.
2. Settlement monuments 2, 4, 5 and 6 covered by 4 feet of fill.
3. See Appendix 8-1 for Time-Settlement Plots.
4. Settlement values were obtained using a Keuffler & Esser transit Model #P5085C and Stalia Rod Model #153240.

9.0 SETTLEMENT ANALYSIS

9.1 GENERAL

Settlement of the landfill surface is a manifestation of combined effect of several factors that include: waste types, imposed landfill loads, landfill construction history, and compressibility characteristics of the subsurface materials within the effective stress zone. Settlement analysis consequently is a difficult task, especially due to the interdependence of these factors and the time-dependent volume change processes associated with the decomposition of the wastes. However, for estimating settlement, simplified methods have been used as described in the following sections. In addition, a test fill was also performed for better understanding of the settlement response of the landfill due to the future cap loading (Section 8).

9.2 SETTLEMENT OF SUBGRADE MATERIALS

Figure 4-2 presents a generalized stratigraphy for settlement analysis. The following geologic formations were considered: Mt. Laurel, Marshalltown, Englishtown and Woodbury Clay (in sequence from youngest to oldest formation).

Due to the predominantly cohesionless materials associated with the upper three formations (Mt. Laurel, Marshalltown and Englishtown), only instantaneous settlements were considered. Schmertman's strain factor method was used to estimate instantaneous settlements.

For the Woodbury Clay Formation, Terzaghi's one-dimensional consolidation theory can be used to estimate settlement due to consolidation. In the absence of engineering test data for the Woodbury Clay Formation, meaningful estimates of consolidation settlements cannot be made.

However, the Woodbury Clay has been subject to past consolidation pressures far in excess of the existing effective overburden pressure, due to the erosion history of the overlying Englishtown Formation prior to deposition of the

Marshalltown Formation. The Woodbury Clay is considered overconsolidated and therefore, its contribution to the overall subgrade settlement caused by the landfill cap should be negligible.

9.2.1 Landfill Loading

Total estimated landfill loading was idealized as an average rectangular loading and the settlements were computed at the center of this idealized loaded area. The average load was equal to 0.5 tsf, equivalent to about a 35 ft. thick fill with an assumed average landfill unit weight = 30 PCF (Oweis, 1985) acting on a landfill base area 2,200 ft. long by 1,350 ft. wide.

9.2.2 Settlement Estimates

Based on the stratigraphic data and loading conditions considered, the instantaneous settlement of the Mt. Laurel, Marshalltown and Englishtown Formations due to the addition of the landfill cap is estimated to be approximately one inch. The settlement contribution of the Woodbury Clay is expected to be negligible.

9.3 SETTLEMENT OF THE LANDFILL WASTE

As described in Section 8, a test fill was performed and the settlement data are presented in Table 8-1.

Cumulative settlement (as of December 16, 1986) recorded by these monuments are plotted versus time (see Appendix 8-1).

Based on these data, it is concluded that:

- o The majority of the settlement of landfill surface due to the cap load should occur within a few days after cap placement.

- o Predicted response would be non-linear with increasing cap load.

6' x 110 lb/cuft
6
660 pcf

DR 000375

- o Initial landfill settlement due to the cap load will range approximately between 9 inches and 12 inches corresponding to cap loads of approximately 480 PSF and 960 PSF, respectively.

Based on the observed behavior of the landfill surface during construction of the test fill section, it was noted that the landfill surface experiences visible plastic deformations due to the earth moving equipment. This deformation was noted to be a few inches within the test fill area during its construction duration of three to four days. This deformation is likely to vary within the landfill area depending on distribution of the waste types and their decomposition status and environmental conditions.

The significance of this obsevation is that, in addition to the effect of cap load alone, the landfill surface will experience additional, indeterminate settlement due to operation of earthmoving equipment on the landfill surface. This could be minimized by the use of large landfill compactors on the surface prior to placement of the cap material. The use of landfill compactors prior to placing fill on the landfill will reduce initial settlements under the cap and cover and help facilitate equipment access during cap and cover construction. This will not significantly reduce long-term settlement due to waste decomposition.

9.4 LANDFILL PERFORMANCE DATA

Available published data (Tchobanoblous, et al, 1977) indicate that even with controlled placement of landfills, the surface settlement varies depending on the degree of waste compaction, with 90 percent of the ultimate landfill settlement occurring within the first five years (between about 25 percent and 50 percent of the original landfill depth). This settlement was noted to be time dependent due to the chemistry, physical condition and character of the constituent wastes and the interaction effects due to environmental conditions. Assuming that 90 percent of the ultimate settlement has occurred at the Helen Kramer Landfill, the remaining settlement could range from 2.5 to 5 percent of the waste thickness (or one to three feet for a waste thickness of 50 feet). The settlement is presented for illustrative purposes and is not intended to represent actual estimates of settlement for the Helen Kramer Landfill.

Site-specific data, particularly a critical review of the landfill topo survey data (surveyed in April 1985 and December 1986) will be further evaluated to define the landfill performance relative to the actual settlement. If earlier topographic data is made available, this will be incorporated in additional evaluations.

As noted above (Section 9.1), these performance data are expected to indicate the overall settlement of the landfill surface due to combined effect of all factors. However, based on the estimated settlement of one-inch associated with the geologic formations (Section 9.2), it is obvious that the major contributing factor associated with the landfill surface settlement would be the waste types, distribution, and their decomposition characteristics.

9.5 DIFFERENTIAL SETTLEMENT

Evaluation of differential settlement of the landfill surface depends upon a review of the available performance data (Section 9.4), distribution of waste types and subgrade characteristics and geometry.

Further evaluation will be made upon availability of pertinent data, including waste type distribution and actual observed settlement over time. However, it appears that records of landfill construction are absent.

We have recently (December 18, 1986) received preliminary data from a topographic survey across two lines on the landfill. We will also continue efforts to obtain data concerning landfill history. This information will be compared with topographic data obtained during previous years to assist in better defining the actual, observed differential settlement.

Differential settlement resulting from loads imposed on the underlying geologic formations is not anticipated since it is likely that the majority of future settlement will result from waste decomposition, the varying thickness of waste, waste type distribution and compaction history. Waste thickness ranges from 0 to more the 50 feet across the site and waste type distribution across the site is largely unknown. It is, therefore, difficult to estimate the degree of differential settlement and one must conservatively assume a high potential exists. The best means of maintaining the integrity of cap and cover system in such an environment is through implementation of a post-closure monitoring and maintenance system which is described in Section 11.3 of this report.

10.0 CAP COMPATIBILITY

Limited data are available relative to the long-term performance of clay cap due to the effects of landfill gas.

Based on available information, several primary factors have been recognized such as the type of gas, its concentration duration of exposure, etc. However, the state-of-the-art has not advanced to a level for a clear understanding of the mechanisms and quantifying these effects. This limitation is also applicable to changes in cap permeability and rheological characteristics of clay.

URS will be providing the results of gas sample analysis. When available, we will use this data to pursue further this aspect of the project, although there appears to be limited data concerning cap compatibility. To the extent possible, assessment shall include evaluating the potential for condensation of gas on the bottom of the clay cover and the potential impact on cap performance. This analysis will need to be coordinated with URS plans for active gas recovery system. If necessary, leachate samples may be passed through the capping materials in a permeameter to assess compatibility of cap with potential exposures to leachate.

11.0 CAP DESIGN

A preliminary design of the cap is presented in Figure 11-1. The design is as described in the R. E. Wright and Associates RI/FS report and accepted in the Record of Decision. From bottom to top, the cap and cover consists of:

- Compacted sand cushion and fill to provide a level, more stable working base.

- One foot gravel for gas venting.

- Two feet of compacted clay liner ($K = 1 \times 10^{-7}$ cm/sec).

- One foot of drainage layer ($K = 1 \times 10^{-3}$ cm/sec).

- One and one-half (1-1/2) feet of clean fill.

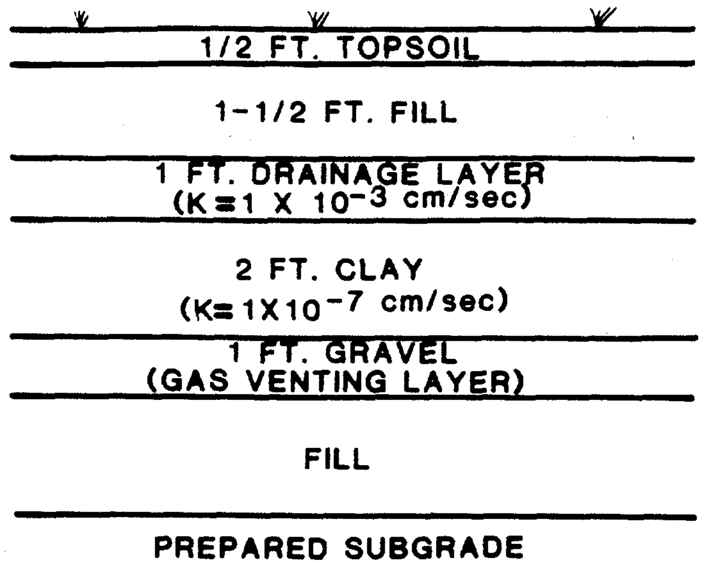
- One-half (1/2) foot of topsoil with vegetation.

This cap design will be used to cover all areas of buried wastes. In those areas where the cap and cover will extend beyond the buried refuse, the gravel layer will be omitted and only one foot of clay cap material used. This will provide a protective layer and help prevent drying out of wall materials.

It is recommended that the entire area within the slurry wall be covered with the design as described above in order to minimize infiltration and leachate production.

Other area discuss reducing clay layer from 2 ft to one foot outside of refuse

On the eastern portion of the landfill where steep slopes are encountered, it may be necessary to terrace or step the cover materials in lieu of filling with the cover materials. Surface water runoff on the east side of the landfill can be controlled with drains along the toe of the cap. Runoff to the west can be controlled with drainage ditches placed beyond the slurry wall at the toe of the cover. Water can be discharged to the Edwards Run or to ponds located east of the site. Leachate seep collection drains along the east side of the landfill will contain leachate for discharge to the pretreatment system.



PRELIMINARY CAP AND COVER DESIGN

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DR 000380

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FIGURE 11-1

11.1 CONSTRUCTION METHODS

Preliminary construction methods for landfill cap and cover are presented below.

11.1.1 Site Preparation

Site preparation work will consist of removal of weeds and other vegetation from the landfill surface. This can be accomplished by sterilization of the soils using approved herbicides. Stripping is not recommended. Soil sterilization is considered a preferable method since this will minimize the possibility of vegetation growing under and disrupting the cap and cover. This will also eliminate the potential for exposing wastes from stripping operations.

Regrading efforts to smooth out the undulating landfill surface should also be initiated. Because buried wastes are near the surface and in some places are exposed, regrading efforts should consist primarily of leveling small valleys with clean fill rather than cutting areas of higher elevations. This will minimize exposing workers and residents to fugitive dust and vapor emissions during closure operations. Clean sandy fill for use in regrading can likely be obtained near the site.

11.1.2 Staged Construction

The majority of settlement due to compaction under the cap and cover is anticipated to take place within several days of application of the load. Long-term settlement due to waste decomposition will occur throughout the life of the landfill. Accordingly, staging construction activities to take into account long-term settlement is unwarranted. However, prior to constructing the cap, lowlying areas which require filling can be compacted with landfill compactors and then covered by common borrow. The landfill compactions will create a more stable working base and reduce initial settlement due to the cap load. The landfill compactors can then move to work the remainder of the site prior to building the cap. If the landfill compactors expose buried waste materials, common borrow can be placed during their use to minimize release of vapors and dust. In areas where significant thicknesses of clean fill are required to prepare a more level working base, the additional load imposed by the fill will increase settlement. It is recommended that common borrow material used to bring the subgrade to design elevation be placed and the initial settlement be monitored and allowed to stabilize prior to proceeding with construction of the cap.

11.1.3 Equipment

It is anticipated that standard earth moving equipment can be utilized for cap construction. Equipment will consist of landfill compactors, bulldozers, loaders and dump trailers to move and place the fill and clay. It is recommended that earth moving equipment be track-mounted to allow for ease of movement, particularly on clay surfaces. Temporary gravel access roads will be required to allow dump trailers transporting clay and fill access to all portions of the site. Compaction of clay to achieve design permeabilities can be accomplished with a sheepsfoot roller. Landfill compactors and equipment used to transport and place fill will tend to compact the landfill surface and provide a more stable base as operations continue.

The two clay sources identified in Section 7, Valley Sand & Gravel and Son Don/Bill Magaha Borrow Pits were both tested in the laboratory. Natural moisture content of these soils was greater than the optimum moisture content required for maximum density. Therefore, it is likely that the clay can be spread and compacted without adding water. The clay should be placed and compacted on the wet side of the optimum moisture content. Spreading and compacting the material will likely allow it to dry sufficiently for proper placement. In-field testing will be required to ensure proper placement of the clay.

11.2 QUALITY CONTROL

Contractors retained to construct the cap and cover should be qualified and experienced in performing projects of similar scope. All earthwork should be monitored by a full time soils engineer to verify proper site preparation, fill emplacement, clay placement and compaction. In field density, moisture content and permeability, tests should be performed to ensure the cap and cover materials are placed to meet design specifications. Sand fill used on-site should be free of organic material and boulders and clay fill shall be free of sand and other deleterious material. As placed soil densities, moisture content, classification and permeabilities must be tested during landfill construction and a complete quality control soil testing program implemented. A Grid System can be established on the landfill surface and testing be performed at each grid location.

11.3 POST CONSTRUCTION MONITORING

A post closure monitoring and maintenance program should be designed and implemented to provide for maintenance of the landfill cap. The program will include periodic monitoring of landfill elevation to identify areas of incurred settlement. Dames & Moore's past experience has shown that site walkthroughs after rainstorms are a rapid and effective means of evaluating post construction performance. Lowlying areas which allow for rain water to pond and surface water drainage pathways which allow for increased erosion can be identified. Proper maintenance can then be applied to remedy problems identified. Site inspections can also identify areas where settlement cracks develop and where seeps may break through landfill sides.

12.0 SLURRY WALL

12.1 SLURRY WALL DESIGN CRITERIA

This section of the report presents preliminary designs for slurry wall construction. This section is subdivided into sections describing purpose and general specifications, slurry wall key unit (Marshalltown Formation), slurry wall design criteria, construction methods and compatibility.

Preliminary design criteria for the slurry mix and backfill mix are presented below. The criteria are based on available site and laboratory data generated as part of this project as well as previous experience, case histories and information in available literature. As additional data is available from completion of the laboratory testing program, revisions to the criteria presented below will be made as needed. Comprehensive, detailed designs shall be presented as part of the Phase III portion of this project.

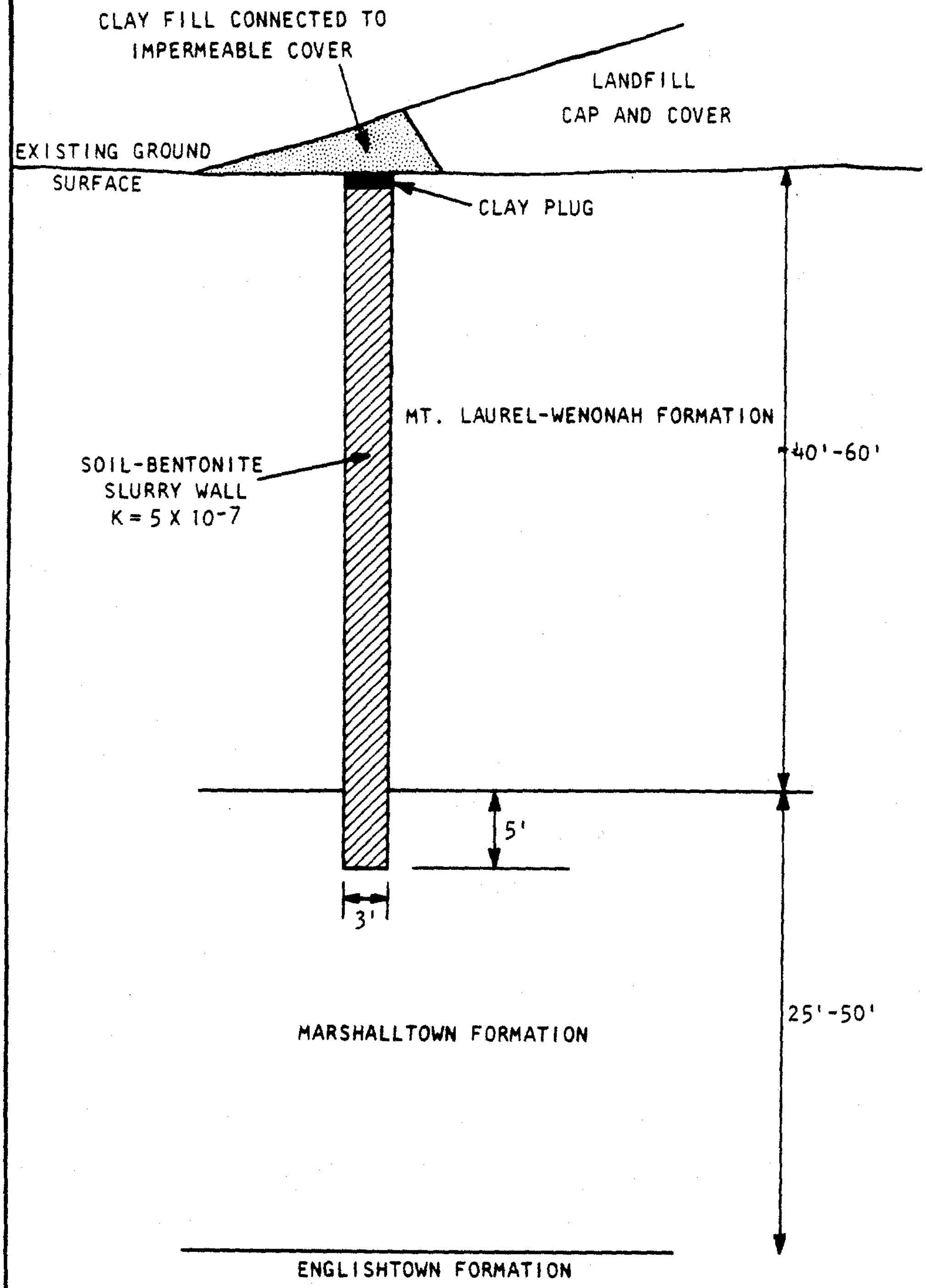
12.1.1 Purpose and General Specifications

The purpose of the upgradient slurry wall is to act in concert with the proposed landfill cap to minimize leachate generation and thus the volume and duration of leachate/ground water treatment. It should be noted that the slurry wall will be keyed into the Marshalltown aquitard which appears to have variable permeability and that the slurry wall will not completely stop ground water migration but merely minimize the rate of ground water infiltration to the landfill. The differential ground water elevation head on the inside and outside the slurry wall will allow for inifiltration of ground water through the Marshalltown into the landfill as well as allow minor seepage through the slurry wall.

The slurry wall shall be constructed in a trench excavated beyond the edge of buried refuse along the landfill's north, west and southern boundaries. The slurry wall will extend approximately 450 feet along the northern perimeter, 2,600 feet along the western perimeter and 1,700 feet along the southern perimeter. The slurry wall location is shown on Plate 1 and a representative cross section shown on Figure 12-1. The slurry wall will be three feet in width and have an in-place permeability of 5×10^{-7} cm/sec.

The slurry wall will be keyed five feet into the Marshalltown Formation aquitard which consists of a continuous silty sand strata which underlies the landfill. Total depth of the slurry wall will range from approximately 30 to 70 feet.

The wall location is generally 50 feet from the landfill edge. The 50-foot buffer will facilitate construction equipment access and provide a sufficient distance beyond the buried refuse. The alignment in the south does not parallel the edge of the landfill but runs along areas of gentle topography. The alignment along the northern limb of the slurry wall will surround buried wastes interpreted to extend beyond the



SLURRY WALL CROSS SECTION

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DR 000385

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FIGURE 12-1

fenceline and will not require the destruction of two existing buildings located in this area.

12.1.2 Slurry Wall Key Unit

The slurry wall will be keyed into the underlying Marshalltown Formation. The Marshalltown Formation consists of a silty fine to very fine sand. Percent of fines in the material ranges to as high as 50% but clay content does not exceed 10%. Silt or clay layers were encountered only in borings SB-5, SB-7 and SB-12. The formation is a dark gray to greenish black to black color which contrasts with the overlying Mt. Laurel/Wenonah sands.

Permeabilities as determined by laboratory testing of relatively undisturbed samples of the Marshalltown Formation performed as part of this and in previous investigations range from 1×10^{-4} cm/sec to 9×10^{-8} cm/sec. Permeability data obtained to date indicate that Marshalltown permeabilities are generally on the order of 10^{-5} and 10^{-6} cm/sec along the slurry wall alignment. Permeability of this order of magnitude have been observed within five feet of the sharp contact between the Mt. Laurel-Wenonah and Marshalltown Formations. The slurry wall should, therefore, extend five feet into the Marshalltown Formation. The 5-foot depth allows for confirmation that the wall has penetrated the Marshalltown. Total depth of the slurry wall will range from approximately 53 to 68 feet total depth along the western boundary of the landfill, 30 to 70 feet total depth along the southern boundary of the landfill, and 35 to 55 feet total depth along the northern boundary of the landfill. As additional laboratory data becomes available, these depths may be refined.

It should be noted that a wide range of permeabilities of the Marshalltown has been documented. The data indicate that no clear trend of decreasing permeability with decreasing elevation exists. Furthermore, the data are inisufficient to show whether or not a laterally continuous, low permeability zone is present within the Marshalltown. If such a zone exists, it would control the rate of vertical ground water movement through the formation. The absence of a continuous low permeability zone will result in greater overall permeability through the formation. Therefore, although the slurry wall will greatly reduce horizontal seepage through the Mt. Laurel-Wenonah Formation, the potential remains for significant underflow beneath the slurry wall and through the Marshalltown. This could result in an overall lowered effectiveness of this remedial element and allow for greater leachate production than originally planned. This aspect of the overall site remediation strategy is worthy of additional study. Numerical modeling incorporating all elements of the remedial strategy and existing hydrogeologic data is recommended.

12.1.3 Slurry Mix

The slurry mix introduced into the trench excavation shall be suitable to provide for trench wall stability and creation of a filter cake along trench walls. The slurry shall be prepared outside of the trench in ponds or other appropriate mixing basin using tap water obtained off-site and high sodium montmorillonite bentonite.

Water used to hydrate the bentonite must meet the following standards:

Hardness	50 ppm
Total Dissolved Solids	500 ppm
Organics Content	50 ppm
Free of oil or other substances	
pH	approximately neutral

It is possible that ground water upgradient of the site may be suitable and it is recommended that existing wells be tested prior to selecting an off-site water source or drilling a production well to evaluate the use of existing wells as a water source during slurry wall construction.

Mixing of the bentonite water slurry shall ensure that the bentonite is fully hydrated. Slurry shall not be introduced into the trench until the following criteria have been met for each batch.

Viscosity	40 seconds Marsh

Unit Weight	65-85 lbs. per ft^3
bentonite content	4-8 percent by weight
pH	Neutral to slightly basic

If significant slurry loss is observed in the trench, slurry viscoscity may be increased providing that the slurry does not interfer with excavation efforts or placement of the backfill. Slurry additives to improve slurry gel strength, filter cake formations and resistence to floculation may be introduced in accordance with the bentonite manufacturer's recommendations, but only after approval of the soils engineer.

After achieving the parameters described above, the slurry may be introduced into the excavation. In place slurry samples obtained near the base of the excavation must have unit weights at least 15 lbs. per cubic foot less than the backfill or not greater than approximately 85 lbs/ft^3 and be capable of passing through the Marsh funnel. It is likely that after placement, the density of the fresh slurry will increase. Therefore, the fresh slurry should be mixed at the lower limits of unit weight unless inplace testing indicates the need for a heavier slurry.

12.1.4 Backfill Mix

The backfill mix for slurry wall construction will utilize on-site soils obtained from trench excavation, off-site fine-grained soils, and sodium bentonite. These soils will be mixed at the site and placed into the slurry trench in accordance with guidelines described in Section 12.2.2.

The backfill should consist of a homogeneous mix of on-site soils, off-site clays and bentonite which yields an in-place permeability of 5×10^{-7} cm/sec. Our preliminary design criteria for the mix are outlined below:

6-10%	bentonite content
15-35%	moisture content
35% or greater	plastic fines content

2-7 inches	slump
Density	15 lbs per cubic ft. greater than slurry mix (estimated 110 lbs. per cubic ft.)

The results of initial permeability testing of various backfill mixes utilizing tap water obtained near the site are presented below:

	Mix	Permeability (cm/sec)	Initial Moisture Content (%)	Initial Unit Weight (pcf)
A.	Mixed on-site soils	3.26×10^{-4}	100.0	111.3
B	A+ 20% off-site fines (from Schepps Borrow Pit)	1.75×10^{-4}	16.5	110.6
C.	B+ 6% bentonite	4.14×1^{-7}	67.2	101.4
D.	B+ 8% bentonite	1.46×10^{-7}	67.0	104.9
E.	B+ 10% bentonite	6.02×10^{-8}	67.4	100.6

Grain size curves for these mixes are presented in Appendix 12-1.

Because laboratory mixing and testing allows for greater control than in the field and to ensure that inplace backfill meets the required permeability, it is appropriate that laboratory-obtained permeabilities are approximately one order of magnitude greater than necessary. Some increase of permeability is expected to be observed during compatibility testing. Therefore, these results indicate that the backfill mix will require additional bentonite and/or off-site fines than used in mix "E". Off-site fines are likely to be less expensive then bentonite. Reducing the moisture content of the mix may also help decrease permeabilities.

On-site soils for use in backfill mix generally have between 5% and 15% fines in the Mt. Laurel-Wenonah Formation and up to approximately 50% fines in the Marshalltown Formation. The bulk of excavated soils will be the Mt. Laurel-Wenonah Formations with a relatively low percent of silt and clay. It, therefore, will be necessary to mix clay from off-site sources to achieve the required backfill characteristics. In addition, the ground water table lies within the Mt. Laurel-Wenonah

Formation and natural moisture content of soils are generally 20% or greater. Therefore, to avoid too wet a backfill mix which results in increased in-place permeability, the excavated soils can be spread in thin lifts and covered with bentonite prior to mixing to help in achieving design moisture content.

Upon completion of the slurry wall, the exposed surface of the trench will be covered with a clay plug. Final cover will be provided by extending the landfill clay and topsoil over the slurry wall.

12.2 CONSTRUCTION METHODS

Slurry wall construction will be accomplished by first excavating an open trench along the slurry wall alignment and subsequently backfilling the excavation with suitable soil-bentonite and clay mix. The slurry trench will be excavated with a clamshell, backhoe or other suitable earth-working equipment capable of excavating a 3-foot wide trench to a depth of five feet into the Marshalltown Formation. Total depth of the excavation is anticipated to range from about 30 to 70 feet along the alignment. The trench will have vertical walls.

12.2.1 Slurry Mix

To prevent collapse and sloughing of excavation sidewalls and ends, a bentonite-water slurry will be introduced into the trench simultaneously with excavating. The bentonite used in the slurry should be granular or powdered high-swelling montmorillonite base products consistent with API Specification 13A. Water used for the slurry should be free of oil, organic matter and any contaminants and have a pH between 7 and 8 standard units, and additional requirements specified by bentonite supplier to properly hydrate the bentonite. The slurry mix should be prepared on site using a suitable mixer until the mix appears homogeneous and bentonite particles are fully hydrated. No mixing shall be allowed in the trench. Mixing can be accomplished using a high shear mixing apparatus. Any additives should be mixed separately before being placed with the slurry and the entire slurry mix recirculated to assure homogeneity. The mix should be allowed to stand to ensure full hydration of bentonite.

The slurry shall be maintained a minimum of three feet above ground water levels and within three feet of the ground surface. The in trench density of the slurry shall be between 65 and 85 pounds per cubic foot. If the excavation sidewalls are not maintained with the initial slurry, a heavier mix or elevated slurry level in the trench should be utilized.

The depth of the excavation will be controlled by obtaining direct measurements along its length. Excavation equipment behavior during the trenching operations will be observed, soils removed from the base of the excavation will be examined and direct measurements of trench depth recorded. This procedure will verify that the excavation is of sufficient depth and the key unit has been penetrated.

12.2.2 Backfill Mix

The backfill mix shall be prepared to meet the specifications described in Section 12.1.4. The backfill material consisting of on-site soils from the trench excavation, bentonite and off-site clay source shall be mixed with bentonite slurry taken either directly from the trench as backfill is added or with slurry mixed to the same specifications as the slurry in the trench. The backfill mix will be prepared by discing, windrowing, bulldozing and other suitable methods to create a homogeneous mix free of sand, clay and bentonite lumps and pockets.

Immediately prior to placing the backfill mix, the trench depth and width will be checked by obtaining direct measurements and by running excavation equipment along the trench width and length. The base of the excavation must be cleaned and free of sands which may settle through the slurry mix. If necessary, airlift pump or additional passes with the excavation equipment may be used to clean the trench bottom. The removed material will be pumped and placed along the trench where the sand settles and the slurry allowed to drain back into the trench.

After attaining the design backfill mix, backfill can be placed into the excavation. The backfill should not be allowed to fall freely through the slurry. Rather, it should be placed directly on the trench bottom by clamshell or backhoe until the backfill rises above the slurry level and the slope of the backfill in the trench is approximately 6 to 8 horizontal and 1 vertical. Once this has been achieved, additional backfill can be placed in the trench by stockpiling backfill mix at the point where in-place backfill emerges from the slurry and allowing a bulldozer to push the stockpiled mix onto the exposed surface of the backfill. This method can force the existing backfill surface to slough forward in the excavation, thereby extending the cutoff wall. It has been reported that this method of construction may allow for the newly placed backfill rather than the in-place backfill to slide down the existing slope, thereby allowing for pockets of bentonite-water slurry to become entrapped in the slurry wall. This effect can negatively impact wall performance. It should be noted that successful slurry walls have been constructed using this technique, however, this aspect of construction will be further evaluated during preparation of our Phase III report.

Placement of the backfill can proceed simultaneously with excavation of the trench. The toe of the backfill slope should be kept a minimum of 100 feet behind the active face of the trench to minimize the possibility of disturbed soils mixing with the backfill and allow for cleaning of the trench bottom prior to backfill placement.

At each corner of the slurry wall alignment, the portions of the trench which run perpendicular to each other should extend at least five feet past one another to form an "X" pattern rather than an "L" pattern.

All stockpiled soils from trench excavation, bottom cleaning and mixing should be stored on the inside (landfill side) of the excavation. This will help prevent off-site migration of potential contaminants contained in the excavated soils. Construction of the slurry walls east-west limbs should also be completed before working on the north-south limb. This will minimize ground water mounding during construction and potentially allow for the use of less bentonite-water slurry during construction.

It is recommended that prior to beginning construction, exploratory test pits are excavated along the slurry wall alignment. The test pits will verify the edge of buried refuse. If localized areas of thin refuse deposits are identified, refuse in these areas can be bulldozed onto the landfill, compacted and covered with soil until installation of the cap and cover. Any resulting excavations should be backfilled with clean fill.

12.2.3 Quality Control

During slurry wall construction, a full quality control program should be implemented. The slurry wall contractor must be experienced and qualified to complete the installation in an efficient manner. The contractor must maintain and document his own quality control program and it is recommended that an independent engineer maintain a separate program to verify results provided by the contractor.

Salient aspects requiring quality control include depth of trench, clean trench bottom without holes or pockets, verification that the key unit has been penetrated, slurry mix parameters before and after placement into the rench, and backfill mix parameters. A quality control testing program is outlined in Table 12.1. The results of all testing shall be documented in writing. Daily profiles of the trench excavation and backfill placement should be maintained.

12.3 COMPATIBILITY

The compatibility of soil bentonite slurry walls and other clay barriers with organic contaminants has been the subject of many recent studies. The function of the barrier is to minimize and/or prevent aqueous and liquid phase contaminants from migrating beyond the confines created by the barriers and in the case of this project, to also prevent uncontaminated ground water from entering the Helen Kramer Landfill, thereby minimizing leachate production. This section of the report presents our initial assessment of slurry wall compatibility based on preliminary literature review and laboratory testing. A detailed capatiability assessment will be provided during Phase III of this project.

Increased permeabilities of clay using selected organic permeants as compared to permeability obtained using water have been documented in the literature

TABLE 12-1

QUALITY CONTROL TESTING PROGRAM

Item		Standard	Type of Test
Materials	Water		- Chloride - Total dissolved solids - pH - Total hardness - Total volatile organics
	Additives		Manufacturer certificate of compliance with stated characteristics
	Bentonite	API Std 13A	Manufacturer certificate of compliance
Slurry	Prepared for placement into the trench	API Std 13B	- Unit weight - Viscosity - Filtrate loss - Gel strength - Filtercake - thickness - pH
	In trench	API Std 13B1	- Unit Weight - Sand content
Backfill Mix	At trench	ASTM C143 API Std 13B ASTM D422-63 ASTM C138 EM1110-2-1906 Appendix VII	- Moisture content - Slump - Cation exchange capacity - Gradation - Density - Triaxial hydraulic conductivity

(Evans, et al, 1985). Permeant-based permeability increases on soil-bentonite mixes have also been noted. The increase is generally more pronounced for selected free phase organics than for aqueous phase solutions and, for some compounds, the increase is negligible for aqueous phase solutions. The permeability increases result from changes in soil characteristics caused by the organic liquids. These changes include dissolution or piping, desiccation, shrinkage and other effects.

Although the literature indicates that soil types, degree of compaction, permeant type and concentration, pH and polarity are variables which impact the degree of permeability increase, it appears that the maximum degree of change tends toward equilibrium. After an initial increase in permeability seen after passing several pore volumes of organics permeants through the barrier medium, the permeability tends to stabilize. This trend was not observed in laboratory tests utilizing basic and neutral polar fluids. The limit of permeability increase is expected to be less than that of the base soil used for barrier wall construction because of permeant impact on bentonite and clays.

Appropriate choice of slurry mix parameters and laboratory testing program is essential for designing a slurry wall which is compatable with the ambient environment. To this end, the laboratory compatability testing program designed for this project includes evaluating permeabilities using both tap water and actual leachate collected from the site. These tests are currently in progress. It is anticipated that these tests will show an initial decrease in permeability as the leachate passes through the design mix and that after several pore volumes pass through the mix, the permeability will stabilize. If the observed permeabilities are below design criteria, the design mix will be altered until sufficiently low permeabilities are realized. It is anticipated that a successful backfill mix can be achieved using generalized design specifications presented earlier.

The limit of increased permeabilities is dependent to a degree upon the base soils used in the backfill mix. Therefore, a well graded base soil will help to maintain low permeabilities. The existing soils on-site consist of fine to medium sands with approximately 5 to 15 percent fines (Mt. Laurel-Wenonah Formations) and fine sands with up to 50 percent fines (Marshalltown Formation). This soil will be mixed with approximately 20 percent or more silt and clay obtained off-site and will form the base soils which will be mixed with bentonite to form the soil-bentonite cutoff wall. The resulting mix should be sufficiently well graded to maintain low in-place permeability.

The on-site soils along the slurry wall alignment may contain residual contaminants dissolved in ground water. The use of these soils may negatively impact the slurry and backfill mix initially. However, this impact can be controlled, to a degree prior to backfill placement. Furthermore, the use of contaminated on-site soils may reduce long term changes in permeability associated with the leachate by early exposure of the bentonite to contaminants at a time when the mix parameters can be controlled to minimize the effects.

As the results of compatability testing become available the data and evaluation will be provided. A more detailed discussion of slurry wall compatability will be provided under Task III of this project.

13.0 CONCLUSIONS AND RECOMMENDATIONS

On the basis our our investigation and analysis, the following conclusions and recommendations are provided:

13.1 EXTENT OF REFUSE

With the exception of the northwest corner of the site, the edge of buried refuse is interpreted from the geophysical survey to lie within the fenceline surrounding the site. The refuse generally extends to within 15 to 30 feet of the fenceline.

Stratigraphy

- o The uppermost soils beneath the site consist of the Mt. Laurel-Wenonah, Marshalltown and Englishtown Formations.

- o The Mt. Laurel-Wenonah consists of fine to medium sands with varying amounts of silt and clay. The content of fines tends to increase with depth. Slug tests were performed in wellpoints/piezometers installed in the base of the Mt. Laurel-Wenonah Formation. Permeabilities based on these slug tests are 4×10^{-3} to 1×10^{-5} cm/sec.

- o The Marshalltown Formation forms a continuous stratum of silty fine sand beneath the site. This unit ranges from approximately 25 to 55 feet beneath the ground surface and thickens to the south and southeast. Permeabilities of soil samples obtained during this investigation and previous studies range from 1×10^{-4} to 9×10^{-8} cm/sec. A topographic depression in this formation exists along the southeast length of the landfill and a topographic mound exists in the southeast corner of the site. This structure's impact on site hydrology should be evaluated.

13.2 BORROW SOURCES

- o Five clay borrow pits were identified as potential sources for clay materials. The sources include Schepps Sand & Gravel Pit in Salem, New Jersey; Son Don/Bill Magaha Pit in Mannington Township, New Jersey; Hess Bros. Pit in Hamilton Township, New Jersey; Son Don Pit in Deptford, New Jersey; and Jarco Construction Pit in Blackwood, New Jersey. Three of these locations were visited and bulk samples collected. Of these three, Schepps Sand & Gravel and Bill Magaha Pit can provide clays of suitable quality and quantity for cap materials. The Deptford pit is not suitable due to apparent quantity restrictions, the Hamilton Township pit is not suitable because of its location, and the Jarco pit is currently not operational, yet is closest to the site.

- William Wynne Borrow Pit in Richwood, New Jersey and Graskill Construction Co. Pit in Deptford, New Jersey can supply suitable sandy fill for use as common borrow for cap and cover.

13.3 LANDFILL SETTLEMENT

- Settlement of the landfill is due to many contributing factors, including waste type, waste distribution, waste decomposition, degree of waste compaction, and settlement of underlying geologic formations.

- Settlements as high as 50% of original waste thickness may occur due to compaction and decomposition of wastes. The majority of this settlement occurs within the first five years after placement.

- Settlement of the landfill surface due to loading of the underlying geologic formations is estimated to be minimal, approximately one inch.

- A test fill was constructed on the landfill surface and settlement under a four and eight foot section was monitored. The landfill surface settled approximately one foot under the 4-foot thick test section and approximately 1-1/2-foot under the 8-foot thick test section after one week. The majority of settlement under the test fill occurs within several days of application of the load.

13.4 LANDFILL CAP AND COVER

- Preliminary designs for the landfill cap and cover consist of the following units from top to bottom:

1/2 foot	topsoil	
1-1/2 feet	fill	
1 foot	sand drainage layer	$K = 1 \times 10^{-3}$
2 feet	clay	$K = 1 \times 10^{-7}$

1 foot gravel	gas venting gravel layer
variable thickness of fill	

- o The cap and cover will extend to cover all areas of buried refuse. A clay and topsoil cover will extend over the slurry wall.

- o Construction of the cap and cover can be accomplished by common earthworking equipment. For those areas of the landfill surface which require extensive filling to level the landfill surface, settlement under the fill load should be allowed to stabilize prior to proceeding with construction of the overlying sections. Large landfill compactors can be used to provide a more stable working base and reduce initial settlement due to cap and cover.

- o A surveillance and maintenance program consisting of site inspections to identify cracks, lowlying areas and erosional features and instituting necessary repairs is required to maintain the cap and cover integrity during the life of the landfill.

13.5 SLURRY WALL

- o The slurry wall will be constructed along the entire west perimeter and portions of the north and south perimaters of the landfill. Wall length will be approximately 2,600 feet along the western limb, 1,700 feet along the southern limb and 500 feet along the northern limb. The wall will be three feet wide and be keyed five feet into the Marshalltown Formation.

- o The slurry wall key unit, the Marshalltown Formation exhibits a range of permeabilities. Permeabilities vary between 1×10^{-4} cm/sec and 9×10^{-8} cm/sec and do not appear to be dependent upon depth or elevation of the sample tested. Although the slurry wall will be of sufficiently low permeability to minimize ground water flow through the wall, the differential ground water elevation head inside and outside the wall may allow for significant underflow through the Marshalltown. The variable permeabilities of the Marshalltown may adversely effect the overall remedial strategy for the site and allow for greater volume of leachate generation than anticipated. It is recommended that ground water modeling of the entire system be performed. The system includes the existing landfill and underlying upper three geologic formations, together with the remedial features — slurry wall, end relief drains and the leachate trench. The modeling would incorporate hydrologic and lithologic information collected from previous investigations as well as the current investigation. It would be desirable to increase the effectiveness of the modeling to have a pump test performed in the northwest section of the site. The modeling would provide a reliable estimate of the leachate/water volume and would assess, in addition, the overall effectiveness of the planned remedial actions through simulation of system behavior through time.

- The slurry wall backfill mix will consist of on-site soils excavated during slurry trench construction, off-site fines, and bentonite. Wall permeability shall be 5×10^{-7} cm/sec or less.

- The slurry wall will be constructed approximately 50 feet or more beyond the edge of refuse. Along the north limb of the wall, the buffer zone is less to avoid having to raze existing structures. Along the south limb, the alignment exceeds the 50-foot buffer in order to maintain a relatively straight alignment along more gently sloping topography than found closer to the refuse.

- Increases in slurry wall and soil permeability have been described in the literature when organic liquids rather than water are used as the permeant. Permeability testing using ground water/leachate collected on-site will document the increase in permeabilities for the proposed mix and the final mix will take the increase into account.

- The use of a well graded base soil for the slurry backfill mix will help minimize any increase in permeability due to leachate effect on soil/ bentonite slurry wall. The slurry wall will utilize on-site silty sands and off-site clays and silts to maintain a well graded grain size distribution.

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APPENDICES TO REPORT
GEOTECHNICAL INVESTIGATION FOR
PRELIMINARY DESIGN
SLURRY WALL AND CAP AND COVER
HELEN KRAMER LANDFILL SUPERFUND SITE
MANTUA TOWNSHIP, NEW JERSEY

JANUARY 5, 1987
JOB NO. 0836-024-10

Dames & Moore
CRANFORD, NEW JERSEY

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APPENDIX 4-1

SLUG TESTS FIELD PROCEDURE

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APPENDIX 4-1

FIELD PROCEDURE USED IN CONDUCTING SLUG TESTS

Falling-Head Portion

- Fill out the upper portion of the Slug-Test Data Form
- Measure the static water level in the well; record on the Slug-Test Data Form
- Wash the steel cylindrical slug with distilled water
- Lower the slug rapidly but smoothly into the water column of the well, and note the time of slug introduction
- At frequent intervals, measure and record the decline of the water level as it returns to the static level. Record on the Slug-Test Data Form the depth to the water level below the reference point in feet to the nearest 0.01 ft, and the time in seconds since the introduction of the slug
- Continue taking readings for at least half an hour; terminate the readings as soon as the water level has recovered such that the drawup is 10 percent or less of the initial drawup. ('Drawup' refers to the vertical rise in the water level above the static water level.)

Rising-Head Portion

- Rapidly remove the slug from the water and the well; note the time
- At frequent intervals, measure and record the depth to the water level as it returns to the static level; record on the Slug-Test Data Form the water levels in feet to the nearest 0.01 ft and the time in seconds since the removal of the slug
- Continue taking readings for at least half an hour; terminate readings as soon as the water level has recovered such that the drawdown is 10 percent or less of the initial drawdown.

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APPENDIX 4-2

EQUATIONS FOR COMPUTING HORIZONTAL PERMEABILITY FROM SLUG TESTS

APPENDIX 4-2

EQUATIONS FROM LAMBE AND WHITMAN (1969) FOR COMPUTING HORIZONTAL HYDRAULIC CONDUCTIVITY FROM SLUG-TEST DATA

The equation for the water-table case is given as:

$$K_h = \frac{d^2 \ln[mL/D + [1 + (ml/D)^2]^{0.5}] \ln(H_1/H_2)}{8L(t_2 - t_1)}, \qquad (1)$$

where,

- d = diameter of the well casing or riser pipe
- D = diameter of the well screen or intake portion of well
- L = length of well screen or intake portion
- $m = (K_h/K_v)^{0.5}$
- K_h = horizontal permeability
- K_v = vertical permeability
- H_1 = piezometric head at $t = t_1$
- H_2 = piezometric head at $t = t_2$
- t = time since the introduction or removal of the slug.

The corresponding equation for computing the horizontal permeability in a confined aquifer is:

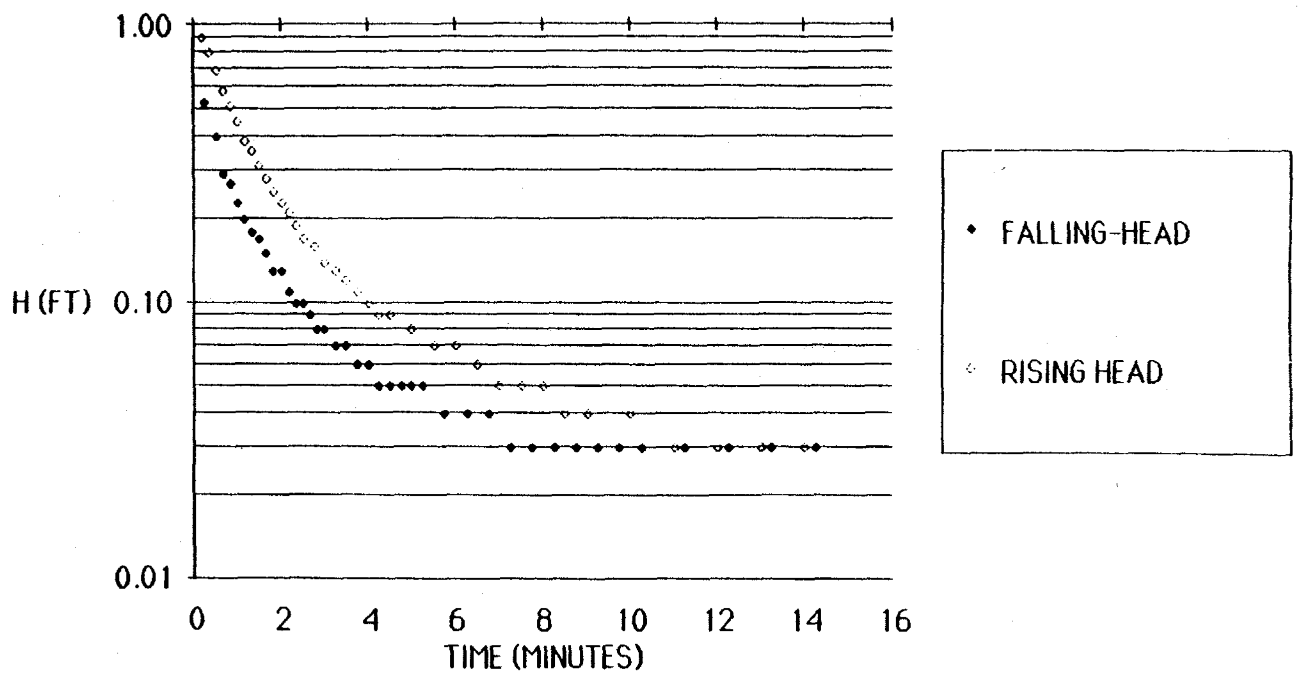
$$K_h = \frac{d^2 \ln[2mL/D + [1 + (2ml/D)^2]^{0.5}] \ln(H_1/H_2)}{8L(t_2 - t_1)}. \qquad (2)$$

Note: The above equations taken from Lambe and Whitman (1969) are based on Hvorslev (1951).

APPENDIX 4-3

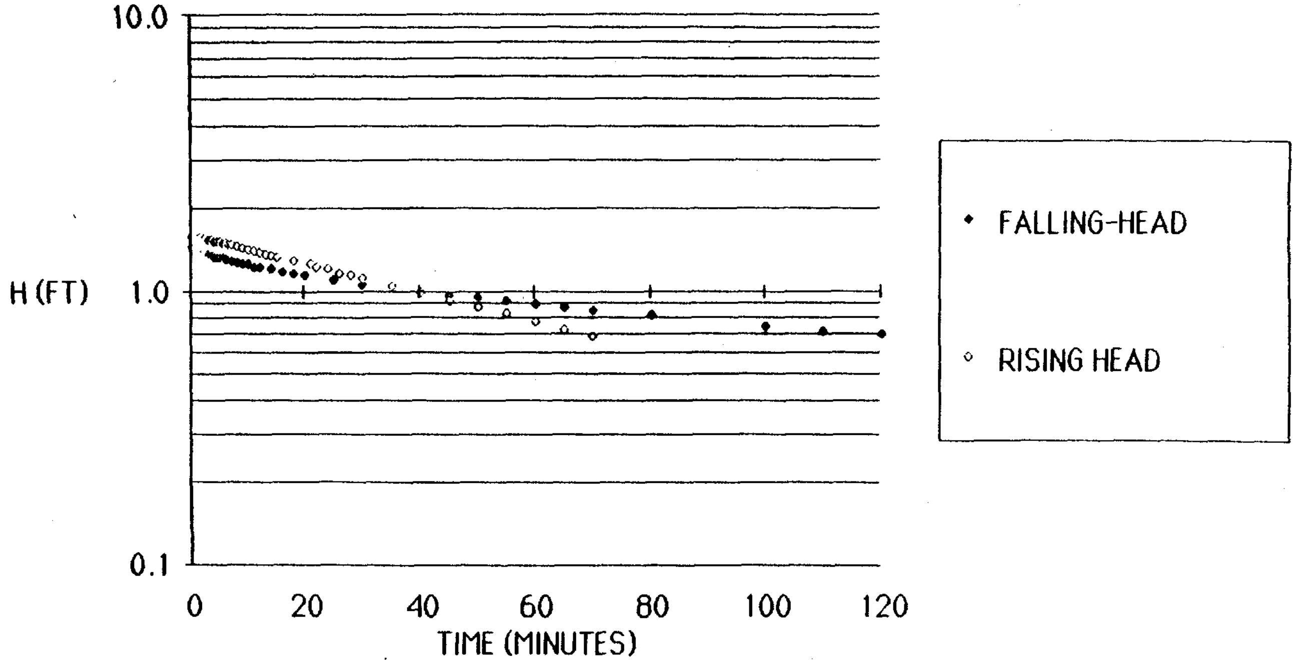
SLUG TEST DATA AND DRAW DOWN/DRAW UP CURVES

SLUG-TEST RESULTS
WELL PW-1

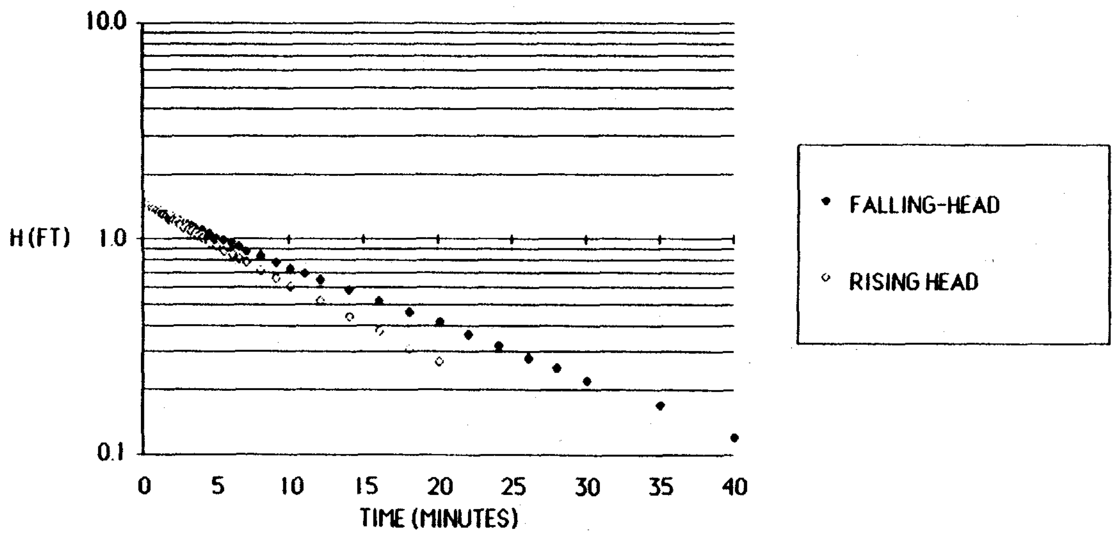


DR 000413

SLUG-TEST RESULTS
WELL PW-2A

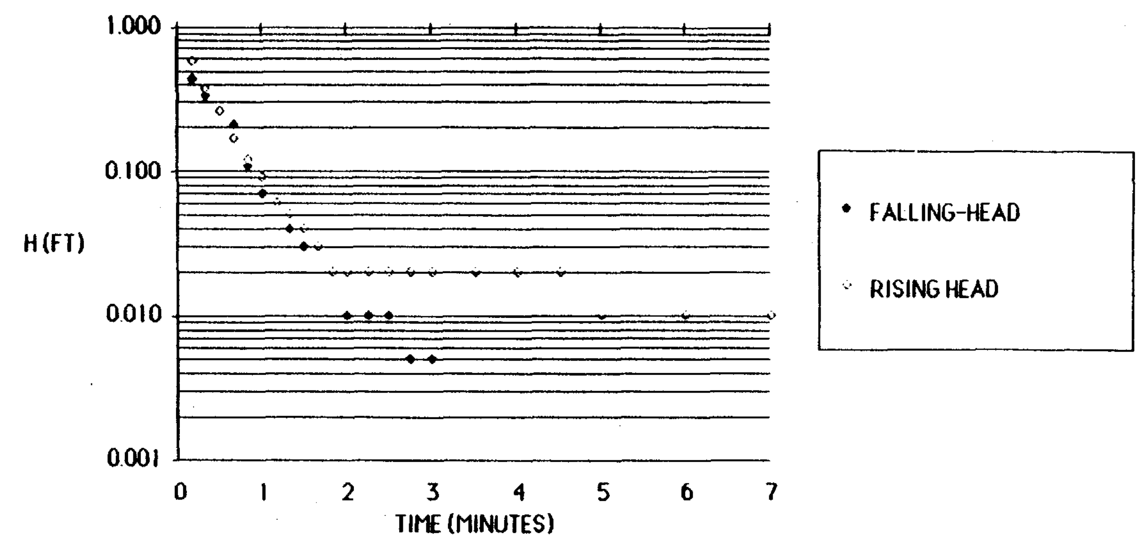


SLUG-TEST RESULTS
WELL PW-3

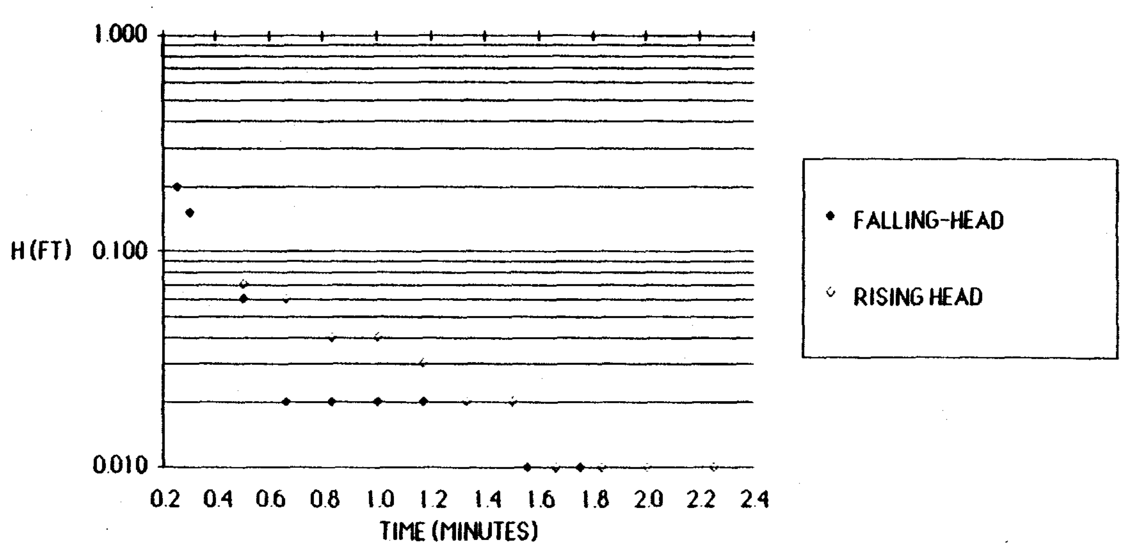


DR 000415

SLUG-TEST RESULTS
WELL PW-4

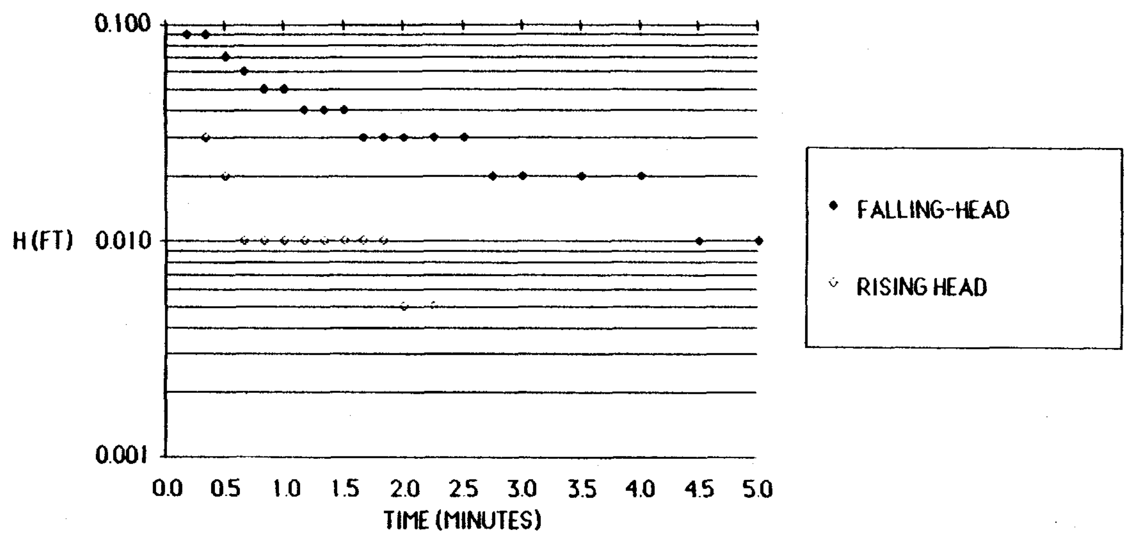


SLUG-TEST RESULTS
WELL SMW-2



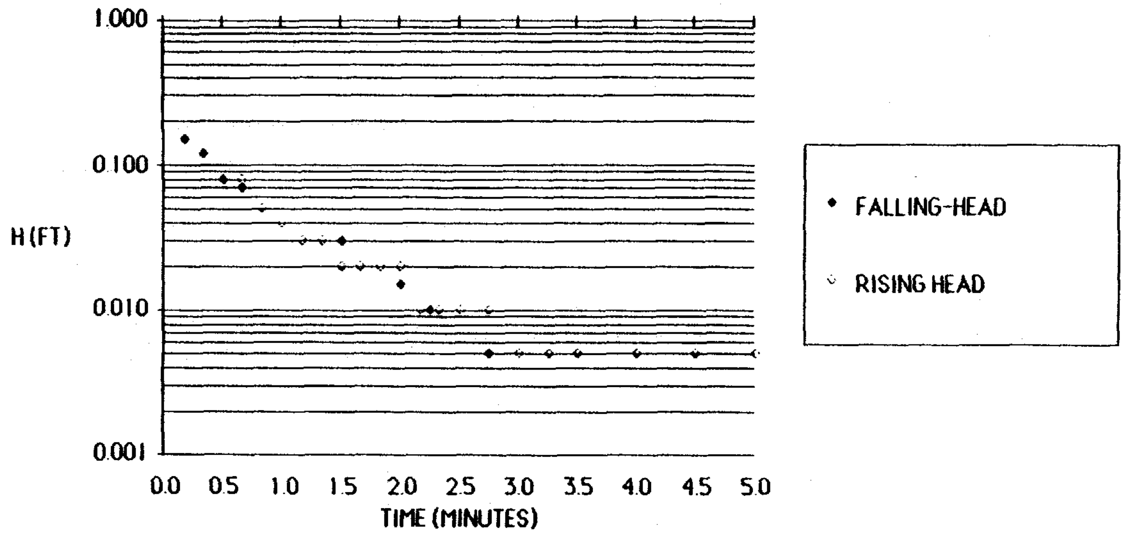
DR 000417

SLUG-TEST RESULTS
WELL SMW-4



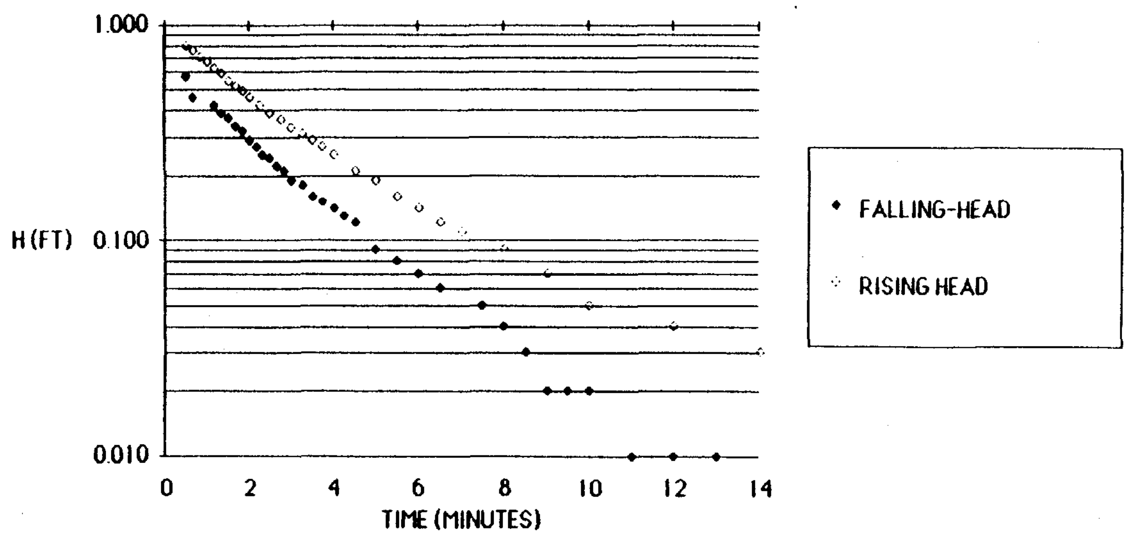
DR 000418

SLUG-TEST RESULTS
WELL SMW-5



DR 0000419

SLUG-TEST RESULTS
WELL SMW-6



APPENDIX 4-4

COMPUTER OUTPUT FROM SLUGT AND INSITU PROGRAMS

DR 000421

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: PW-1 DATE OF TEST: 12-4-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D. RAUBVOGEL/S. VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.35 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 17.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 3.50 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 40

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.25	2.970	.530
.50	3.100	.400
.66	3.210	.290
.83	3.230	.270
1.00	3.270	.230
1.17	3.300	.200
1.33	3.320	.180
1.50	3.330	.170
1.66	3.350	.150
1.83	3.370	.130
2.00	3.370	.130
2.17	3.390	.110
2.33	3.400	.100
2.50	3.400	.100
2.66	3.410	.090
2.83	3.420	.080
3.00	3.425	.075
3.25	3.430	.070
3.50	3.430	.070
3.75	3.440	.060

DR 000422

[illegible]	[illegible]	[illegible]
4.25	3.450	.050
4.50	3.450	.050
4.75	3.450	.050
5.00	3.450	.050
5.25	3.450	.050
5.75	3.460	.040
6.25	3.460	.040
6.75	3.460	.040
7.25	3.470	.030
7.75	3.470	.030
8.25	3.470	.030
8.75	3.470	.030
9.25	3.470	.030
9.75	3.470	.030
10.25	3.470	.030
11.25	3.470	.030
12.25	3.470	.030
13.25	3.470	.030
14.25	3.470	.030

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR H0 (FEET)
.1803
.1911
.2028
.2148
.2265
.2365

WELL NO: PW-1 FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .54 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	4.664E-03	2.743E-04	1.317424	1.45
1.000E-02	1.000E-02	6.938E-03	4.081E-04	1.270726	1.86
1.000E-03	1.000E-03	9.197E-03	5.410E-04	1.302088	2.14
1.000E-04	1.000E-04	1.124E-02	6.612E-04	1.384309	2.55
1.000E-05	1.000E-05	1.294E-02	7.613E-04	1.503237	3.10
1.000E-06	1.000E-06	1.470E-02	8.645E-04	1.581667	3.12
1.000E-07	1.000E-07	1.667E-02	9.804E-04	1.621147	2.88
1.000E-08	1.000E-08	1.888E-02	1.110E-03	1.630472	2.65
1.000E-09	1.000E-09	2.129E-02	1.252E-03	1.620163	2.51
1.000E-10	1.000E-10	2.343E-02	1.378E-03	1.629951	2.63

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 5.19E-04 FT/MINUTES = 1.58E-02 CM/MINUTES

TRANSMISSIVITY = 8.82E-03 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 7.39E-04 FT/MINUTES = 2.25E-02 CM/MINUTES

TRANSMISSIVITY = 1.26E-02 FT**2/MINUTES

WELL NO.: PW-1 DATE OF TEST: 12-4-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.35 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 17.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 3.50 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 37

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	4.400	.900
.33	4.300	.800
.50	4.190	.690
.66	4.080	.580
.83	4.010	.510
1.00	3.950	.450
1.17	3.880	.380
1.33	3.850	.350
1.50	3.810	.310
1.66	3.780	.280
1.83	3.750	.250
2.00	3.730	.230
2.17	3.710	.210
2.33	3.690	.190
2.50	3.670	.170
2.75	3.660	.160
3.00	3.640	.140
3.25	3.630	.130
3.50	3.620	.120
3.75	3.610	.110
4.00	3.600	.100
4.25	3.590	.090
4.50	3.590	.090
5.00	3.580	.080
5.50	3.570	.070
6.00	3.570	.070
6.50	3.560	.060
7.00	3.550	.050
7.50	3.550	.050
8.00	3.550	.050
8.50	3.540	.040
9.00	3.540	.040
10.00	3.540	.040

DR 000425

12.00	3.530	.030
13.00	3.530	.030
14.00	3.530	.030

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

.4069
.4310
.4560
.4805
.5019

WELL NO: PW-1 RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .91 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	3TORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	4.564E-03	2.685E-04	1.305770	1.16
1.000E-02	1.000E-02	6.679E-03	3.929E-04	1.225590	.82
1.000E-03	1.000E-03	8.719E-03	5.129E-04	1.251529	1.50
1.000E-04	1.000E-04	1.060E-02	6.237E-04	1.275119	1.97
1.000E-05	1.000E-05	1.246E-02	7.330E-04	1.292204	2.09
1.000E-06	1.000E-06	1.440E-02	8.473E-04	1.315088	1.95
1.000E-07	1.000E-07	1.643E-02	9.667E-04	1.329625	1.78
1.000E-08	1.000E-08	1.842E-02	1.084E-03	1.342314	1.94
1.000E-09	1.000E-09	2.052E-02	1.207E-03	1.344868	1.99
1.000E-10	1.000E-10	2.266E-02	1.333E-03	1.344116	1.99

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 6.07E-04 FT/MINUTES = 1.85E-02 CM/MINUTES

TRANSMISSIVITY = 1.03E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 8.64E-04 FT/MINUTES = 2.63E-02 CM/MINUTES

TRANSMISSIVITY = 1.47E-02 FT**2/MINUTES

WELL NO.: PW-1(EARLY TIME   DATE OF TEST: 12-4-86

PROJECT NO.: 0836-024   CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D. RAUBVOGEL/S. VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.35 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 17.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 3.50 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 28

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.25	2.970	.530
.50	3.100	.400
.66	3.210	.290
.83	3.230	.270
1.00	3.270	.230
1.17	3.300	.200
1.33	3.320	.180
1.50	3.330	.170
1.66	3.350	.150
1.83	3.370	.130
2.00	3.370	.130
2.17	3.390	.110
2.33	3.400	.100
2.50	3.400	.100
2.66	3.410	.090
2.83	3.420	.080
3.00	3.425	.075
3.25	3.430	.070
3.50	3.430	.070
3.75	3.440	.060
4.00	3.440	.060
4.25	3.450	.050
4.50	3.450	.050
4.75	3.450	.050
5.00	3.450	.050
5.25	3.450	.050
5.75	3.460	.040
6.25	3.460	.040

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED

(FEET)

.3225
.3384

DR 000429

WELL NO: PW-1(EARLY TIME FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .54 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	4.837E-03	2.845E-04	1.270283	.49
1.000E-02	1.000E-02	7.583E-03	4.461E-04	1.162630	.30
1.000E-03	1.000E-03	1.032E-02	6.068E-04	1.160914	.37
1.000E-04	1.000E-04	1.303E-02	7.662E-04	1.194574	.45
1.000E-05	1.000E-05	1.562E-02	9.189E-04	1.245469	.59
1.000E-06	1.000E-06	1.778E-02	1.046E-03	1.307678	.85
1.000E-07	1.000E-07	1.980E-02	1.165E-03	1.364803	.96
1.000E-08	1.000E-08	2.204E-02	1.296E-03	1.396560	.89
1.000E-09	1.000E-09	2.462E-02	1.448E-03	1.400931	.77
1.000E-10	1.000E-10	2.735E-02	1.609E-03	1.396641	.67

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 8.14E-04 FT/MINUTES = 2.48E-02 CM/MINUTES

TRANSMISSIVITY = 1.38E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 1.16E-03 FT/MINUTES = 3.53E-02 CM/MINUTES

TRANSMISSIVITY = 1.97E-02 FT**2/MINUTES

WELL NO.: PW-1(EARLY TIME

DATE OF TEST: 12-4-86

PROJECT NO.: 0836-024

CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.35 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 17.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 3.50 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 26

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	4.400	.900
.33	4.300	.800
.50	4.190	.690
.66	4.080	.580
.83	4.010	.510
1.00	3.950	.450
1.17	3.880	.380
1.33	3.850	.350
1.50	3.810	.310
1.66	3.780	.280
1.83	3.750	.250
2.00	3.730	.230
2.17	3.710	.210
2.33	3.690	.190
2.50	3.670	.170
2.75	3.660	.160
3.00	3.640	.140
3.25	3.630	.130
3.50	3.620	.120
3.75	3.610	.110
4.00	3.600	.100
4.25	3.590	.090
4.50	3.590	.090
5.00	3.580	.080
5.50	3.570	.070
6.00	3.570	.070

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

DR 000431

.6718
.7088
.7393

WELL NO: PW-1(EARLY TIME   RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 =   .91 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	4.189E-03	2.464E-04	1.387148	.39
1.000E-02	1.000E-02	6.731E-03	3.959E-04	1.216186	.45
1.000E-03	1.000E-03	9.295E-03	5.468E-04	1.173893	.31
1.000E-04	1.000E-04	1.184E-02	6.963E-04	1.142264	.29
1.000E-05	1.000E-05	1.428E-02	8.402E-04	1.127374	.38
1.000E-06	1.000E-06	1.638E-02	9.638E-04	1.156149	.64
1.000E-07	1.000E-07	1.838E-02	1.081E-03	1.189152	.72
1.000E-08	1.000E-08	2.053E-02	1.208E-03	1.204455	.65
1.000E-09	1.000E-09	2.293E-02	1.349E-03	1.203804	.54
1.000E-10	1.000E-10	2.546E-02	1.498E-03	1.196383	.45

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 9.73E-04 FT/MINUTES   = 2.97E-02 CM/MINUTES

TRANSMISSIVITY = 1.65E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 1.39E-03 FT/MINUTES   = 4.22E-02 CM/MINUTES

TRANSMISSIVITY = 2.35E-02 FT**2/MINUTES

WELL NO.: PW-2A

DATE OF TEST: 12-4-86

PROJECT NO.: 0836-024

CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 10.80 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.90 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.36 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 45

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	3.920	1.440
.33	3.930	1.430
.50	3.940	1.420
.66	3.950	1.410
.83	3.950	1.410
1.00	3.960	1.400
1.17	3.960	1.400
1.33	3.970	1.390
1.50	3.970	1.390
1.75	3.970	1.390
2.00	3.970	1.390
2.25	3.980	1.380
2.50	3.980	1.380
2.75	3.990	1.370
3.00	3.990	1.370
3.50	4.000	1.360
4.00	4.020	1.340
4.50	4.020	1.340
5.00	4.030	1.330
5.50	4.030	1.330
6.00	4.040	1.320
7.00	4.060	1.300
8.00	4.070	1.290
9.00	4.090	1.270
10.00	4.100	1.260
11.00	4.120	1.240
12.00	4.130	1.230
14.00	4.150	1.210
16.00	4.170	1.190
18.00	4.190	1.170
20.00	4.210	1.150
25.00	4.250	1.110
30.00	4.290	1.070

DR 000434

40.00	4.370	.990
45.00	4.390	.970
50.00	4.410	.950
55.00	4.430	.930
60.00	4.450	.910
65.00	4.475	.885
70.00	4.500	.860
80.00	4.540	.820
100.00	4.610	.750
110.00	4.640	.720
120.00	4.660	.700

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.3679
1.3728

DR 000435

WELL NO: PW-2A FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = 1.45 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES.)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.018E-05	1.851E-06	.748657	12.09
1.000E-02	1.000E-02	6.932E-05	6.360E-06	.738053	7.11
1.000E-03	1.000E-03	1.487E-04	1.364E-05	1.389599	15.71
1.000E-04	1.000E-04	2.363E-04	2.168E-05	1.661124	19.10
1.000E-05	1.000E-05	3.230E-04	2.963E-05	1.924336	20.69
1.000E-06	1.000E-06	4.079E-04	3.742E-05	2.099809	21.57
1.000E-07	1.000E-07	4.915E-04	4.509E-05	2.209476	22.13
1.000E-08	1.000E-08	5.740E-04	5.266E-05	2.284483	22.52
1.000E-09	1.000E-09	6.560E-04	6.019E-05	2.343047	22.80
1.000E-10	1.000E-10	7.373E-04	6.764E-05	2.378533	23.01

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.63E-05 FT/MINUTES = 4.98E-04 CM/MINUTES

TRANSMISSIVITY = 1.78E-04 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 1.63E-05 FT/MINUTES = 4.98E-04 CM/MINUTES

TRANSMISSIVITY = 1.78E-04 FT**2/MINUTES

WELL NO.: PW-2A

DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024

CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D. RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 10.80 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.90 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.36 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 44

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	6.960	1.600
.50	6.960	1.600
.66	6.960	1.600
.83	6.960	1.600
1.00	6.950	1.590
1.25	6.950	1.590
1.50	6.950	1.590
1.75	6.940	1.580
2.00	6.940	1.580
2.25	6.930	1.570
2.50	6.920	1.560
2.75	6.920	1.560
3.00	6.920	1.560
3.50	6.910	1.550
4.00	6.900	1.540
4.50	6.890	1.530
5.00	6.880	1.520
5.50	6.870	1.510
6.00	6.860	1.500
6.50	6.850	1.490
7.00	6.850	1.490
8.00	6.830	1.470
9.00	6.810	1.450
10.00	6.790	1.430
11.00	6.770	1.410
12.00	6.760	1.400
13.00	6.740	1.380
14.00	6.720	1.360
15.00	6.690	1.330
18.00	6.660	1.300
21.00	6.620	1.260
22.00	6.600	1.240
24.00	6.570	1.210

26.00	6.530	[illegible]
28.00	6.510	1.150
30.00	6.480	1.120
35.00	6.410	1.050
40.00	6.360	1.000
45.00	6.290	.930
50.00	6.240	.880
55.00	6.190	.830
60.00	6.140	.780
65.00	6.090	.730
70.00	6.050	.690

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.6144
1.6144

WELL NO: PW-2A RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = 1.61 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	1.937E-05	1.777E-06	2.850661	38.43
1.000E-02	1.000E-02	5.462E-05	5.011E-06	1.855121	21.30
1.000E-03	1.000E-03	1.077E-04	9.879E-06	1.488349	11.11
1.000E-04	1.000E-04	1.667E-04	1.530E-05	2.052813	6.45
1.000E-05	1.000E-05	2.254E-04	2.068E-05	2.360754	4.15
1.000E-06	1.000E-06	2.831E-04	2.597E-05	2.545649	2.86
1.000E-07	1.000E-07	3.398E-04	3.118E-05	2.668069	2.05
1.000E-08	1.000E-08	3.959E-04	3.632E-05	2.752661	1.52
1.000E-09	1.000E-09	4.516E-04	4.143E-05	2.820851	1.13
1.000E-10	1.000E-10	5.067E-04	4.649E-05	2.859143	.89

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METHOD OF BOUWER AND RICE

** COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 2.98E-05 FT/MINUTES = 9.10E-04 CM/MINUTES

TRANSMISSIVITY = 3.25E-04 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 2.98E-05 FT/MINUTES = 9.10E-04 CM/MINUTES

TRANSMISSIVITY = 3.25E-04 FT**2/MINUTES

WELL NO.: PW-3 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 18.52 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 19.22 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 7.20 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 41

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	5.750	1.450
.33	5.770	1.430
.50	5.790	1.410
.66	5.820	1.380
.83	5.840	1.360
1.00	5.860	1.340
1.17	5.870	1.330
1.33	5.890	1.310
1.50	5.910	1.290
1.66	5.930	1.270
1.83	5.940	1.260
2.00	5.950	1.250
2.25	5.980	1.220
2.50	6.000	1.200
2.75	6.030	1.170
3.00	6.040	1.160
3.25	6.060	1.140
3.50	6.080	1.120
4.00	6.110	1.090
4.50	6.150	1.050
5.00	6.190	1.010
5.50	6.220	.980
6.00	6.250	.950
6.50	6.280	.920
7.00	6.320	.880
8.00	6.370	.830
9.00	6.430	.770
10.00	6.470	.730
11.00	6.510	.690
12.00	6.560	.640
14.00	6.620	.580
16.00	6.690	.510
18.00	6.740	.460

DR 000440

[illegible]	[illegible]	[illegible]
22.00	6.840	.360
24.00	6.880	.320
26.00	6.920	.280
28.00	6.950	.250
30.00	6.980	.220
35.00	7.030	.170
40.00	7.030	.120

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.3999
1.4009

DR 000441

WELL NO: PW-3 FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = 1.46 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.464E-04	1.282E-05	2.917999	17.83
1.000E-02	1.000E-02	5.190E-04	2.700E-05	1.799590	8.41
1.000E-03	1.000E-03	8.404E-04	4.373E-05	1.203444	4.34
1.000E-04	1.000E-04	1.167E-03	6.071E-05	.865937	2.45
1.000E-05	1.000E-05	1.487E-03	7.737E-05	.652548	1.36
1.000E-06	1.000E-06	1.793E-03	9.330E-05	.512196	.90
1.000E-07	1.000E-07	2.097E-03	1.091E-04	.491654	1.29
1.000E-08	1.000E-08	2.400E-03	1.249E-04	.481162	1.39
1.000E-09	1.000E-09	2.703E-03	1.406E-04	.473102	1.37
1.000E-10	1.000E-10	3.006E-03	1.564E-04	.468649	1.35

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.55E-04 FT/MINUTES = 4.73E-03 CM/MINUTES

TRANSMISSIVITY = 2.98E-03 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 1.55E-04 FT/MINUTES = 4.73E-03 CM/MINUTES

TRANSMISSIVITY = 2.98E-03 FT**2/MINUTES

WELL NO.: PW-3 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 18.52 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 19.22 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 7.20 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 35

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.25	8.620	1.420
.33	8.610	1.410
.50	8.590	1.390
.66	8.570	1.370
.83	8.550	1.350
1.00	8.520	1.320
1.17	8.500	1.300
1.33	8.480	1.280
1.50	8.460	1.260
1.66	8.430	1.230
1.83	8.420	1.220
2.00	8.400	1.200
2.17	8.380	1.180
2.33	8.360	1.160
2.50	8.340	1.140
2.75	8.320	1.120
3.00	8.290	1.090
3.25	8.270	1.070
3.50	8.250	1.050
3.75	8.220	1.020
4.00	8.200	1.000
4.50	8.150	.950
5.00	8.120	.920
5.50	8.070	.870
6.00	8.040	.840
6.50	8.000	.800
7.00	7.970	.770
8.00	7.910	.710
9.00	7.850	.650
10.00	7.800	.600
12.00	7.710	.510
14.00	7.630	.430
16.00	7.570	.370

20.00	7.470	.270

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.4196
1.4238

WELL NO: PW-3 RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = 1.42 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.381E-04	1.239E-05	2.702130	9.13
1.000E-02	1.000E-02	5.402E-04	2.811E-05	1.866125	4.96
1.000E-03	1.000E-03	8.925E-04	4.644E-05	1.517050	3.17
1.000E-04	1.000E-04	1.248E-03	6.494E-05	1.339396	2.34
1.000E-05	1.000E-05	1.598E-03	8.312E-05	1.237468	1.89
1.000E-06	1.000E-06	1.941E-03	1.010E-04	1.178392	1.62
1.000E-07	1.000E-07	2.281E-03	1.187E-04	1.138120	1.44
1.000E-08	1.000E-08	2.618E-03	1.362E-04	1.109764	1.31
1.000E-09	1.000E-09	2.953E-03	1.536E-04	1.087520	1.21
1.000E-10	1.000E-10	3.279E-03	1.706E-04	1.072648	1.05

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 2.15E-04 FT/MINUTES = 6.56E-03 CM/MINUTES

TRANSMISSIVITY = 4.14E-03 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 2.15E-04 FT/MINUTES = 6.56E-03 CM/MINUTES

TRANSMISSIVITY = 4.14E-03 FT**2/MINUTES

WELL NO.: PW-4 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 9.58 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 6.58 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.81 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 15

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	5.380	.430
.33	5.470	.340
.66	5.600	.210
.83	5.700	.110
1.00	5.740	.070
1.17	5.750	.060
1.33	5.770	.040
1.50	5.780	.030
1.66	5.780	.030
1.83	5.790	.020
2.00	5.800	.010
2.25	5.800	.010
2.50	5.800	.010
2.75	5.805	.005
3.00	5.805	.005

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.4562
.4993
.5191

WELL NO: PW-4 FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .52 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.915E-02	4.431E-03	2.377727	1.52
1.000E-02	1.000E-02	3.532E-02	5.368E-03	1.974488	1.19
1.000E-03	1.000E-03	4.113E-02	6.250E-03	1.651971	.95
1.000E-04	1.000E-04	4.675E-02	7.104E-03	1.419431	.81
1.000E-05	1.000E-05	5.047E-02	7.670E-03	1.292571	.74
1.000E-06	1.000E-06	5.572E-02	8.467E-03	1.162313	.64
1.000E-07	1.000E-07	6.272E-02	9.531E-03	1.036535	.54
1.000E-08	1.000E-08	6.980E-02	1.061E-02	.945777	.47
1.000E-09	1.000E-09	7.704E-02	1.171E-02	.854706	.41
1.000E-10	1.000E-10	8.333E-02	1.266E-02	.797206	.35

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 4.37E-03 FT/MINUTES = 1.33E-01 CM/MINUTES

TRANSMISSIVITY = 2.88E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 4.37E-03 FT/MINUTES = 1.33E-01 CM/MINUTES

TRANSMISSIVITY = 2.88E-02 FT**2/MINUTES

WELL NO.: PW-4 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 9.58 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 6.58 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.81 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 22

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	6.390	.580
.33	6.180	.370
.50	6.070	.260
.66	5.980	.170
.83	5.930	.120
1.00	5.900	.090
1.17	5.870	.060
1.33	5.860	.050
1.50	5.850	.040
1.66	5.840	.030
1.83	5.830	.020
2.00	5.830	.020
2.25	5.830	.020
2.50	5.830	.020
2.75	5.830	.020
3.00	5.830	.020
3.50	5.830	.020
4.00	5.830	.020
4.50	5.830	.020
5.00	5.820	.010
6.00	5.820	.010
7.00	5.820	.010

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.1402
.1626
.1864

DR 000448

[illegible]
.2430
.2977
.3629
.4206
.4897
.5669
.6389
.6796
.6866

WELL NO: PW-4 RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .69 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.192E-02	3.331E-03	1.710115	.69
1.000E-02	1.000E-02	2.640E-02	4.012E-03	1.379899	.69
1.000E-03	1.000E-03	3.071E-02	4.667E-03	1.119452	.80
1.000E-04	1.000E-04	3.558E-02	5.407E-03	1.005076	.89
1.000E-05	1.000E-05	4.130E-02	6.277E-03	1.006040	.95
1.000E-06	1.000E-06	4.763E-02	7.239E-03	1.033451	.99
1.000E-07	1.000E-07	5.227E-02	7.943E-03	.900715	1.01
1.000E-08	1.000E-08	5.758E-02	8.751E-03	.860748	1.09
1.000E-09	1.000E-09	6.418E-02	9.754E-03	.860100	1.14
1.000E-10	1.000E-10	7.139E-02	1.085E-02	.898351	1.17

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 4.83E-03 FT/MINUTES = 1.47E-01 CM/MINUTES

TRANSMISSIVITY = 3.18E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 4.83E-03 FT/MINUTES = 1.47E-01 CM/MINUTES

TRANSMISSIVITY = 3.18E-02 FT**2/MINUTES

WELL NO.: PW-4(EARLY TIME   DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024   CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 9.58 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 6.58 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.81 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 12

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	5.380	.430
.33	5.470	.340
.66	5.600	.210
.83	5.700	.110
1.00	5.740	.070
1.17	5.750	.060
1.33	5.770	.040
1.50	5.780	.030
1.66	5.780	.030
1.83	5.790	.020
2.00	5.800	.010
2.25	5.800	.010

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.5858
.6207
.5931

WELL NO: PW-4(EARLY TIME FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .59 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.527E-02	3.840E-03	2.065026	1.02
1.000E-02	1.000E-02	3.253E-02	4.944E-03	1.570845	.75
1.000E-03	1.000E-03	3.948E-02	5.999E-03	1.235265	.59
1.000E-04	1.000E-04	4.469E-02	6.791E-03	.987849	.47
1.000E-05	1.000E-05	4.987E-02	7.580E-03	.825056	.42
1.000E-06	1.000E-06	5.712E-02	8.681E-03	.714888	.36
1.000E-07	1.000E-07	6.505E-02	9.885E-03	.668762	.33
1.000E-08	1.000E-08	7.297E-02	1.109E-02	.645988	.31
1.000E-09	1.000E-09	8.125E-02	1.235E-02	.553105	.24
1.000E-10	1.000E-10	8.807E-02	1.338E-02	.513787	.22

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 4.72E-03 FT/MINUTES = 1.44E-01 CM/MINUTES

TRANSMISSIVITY = 3.11E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 4.72E-03 FT/MINUTES = 1.44E-01 CM/MINUTES

TRANSMISSIVITY = 3.11E-02 FT**2/MINUTES

WELL NO.: PW-4(EARLY TIME DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 9.58 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 6.58 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.81 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 13

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	6.390	.580
.33	6.180	.370
.50	6.070	.260
.66	5.980	.170
.83	5.930	.120
1.00	5.900	.090
1.17	5.870	.060
1.33	5.860	.050
1.50	5.850	.040
1.66	5.840	.030
1.83	5.830	.020
2.00	5.830	.020
2.25	5.830	.020

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.5669
.6389
.6796
.6866

DR 000453

WELL NO: PW-4(EARLY TIME RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .69 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.165E-02	3.290E-03	1.731806	.67
1.000E-02	1.000E-02	2.821E-02	4.287E-03	1.291363	.39
1.000E-03	1.000E-03	3.459E-02	5.257E-03	.993936	.23
1.000E-04	1.000E-04	4.092E-02	6.219E-03	.873825	.17
1.000E-05	1.000E-05	4.747E-02	7.214E-03	.875349	.20
1.000E-06	1.000E-06	5.442E-02	8.271E-03	.904462	.23
1.000E-07	1.000E-07	6.099E-02	9.269E-03	.771925	.16
1.000E-08	1.000E-08	6.848E-02	1.041E-02	.721033	.13
1.000E-09	1.000E-09	7.660E-02	1.164E-02	.688668	.12
1.000E-10	1.000E-10	8.513E-02	1.294E-02	.705090	.12

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 4.83E-03 FT/MINUTES = 1.47E-01 CM/MINUTES

TRANSMISSIVITY = 3.18E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 4.83E-03 FT/MINUTES = 1.47E-01 CM/MINUTES

TRANSMISSIVITY = 3.18E-02 FT**2/MINUTES

WELL NO.: SMW-2 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 22.27 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 25.27 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 28.19 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 10

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.25	27.990	.200
.30	28.040	.150
.50	28.130	.060
.66	28.170	.020
.83	28.170	.020
1.00	28.170	.020
1.17	28.170	.020
1.33	28.170	.020
1.55	28.180	.010
1.75	28.180	.010

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.1602
.1821
.1975
.2553
.3548
.5298
.8037

DR 000455

WELL NO: SMW-2 FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .80 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	7.480E-02	2.960E-03	1.095531	.26
1.000E-02	1.000E-02	8.661E-02	3.427E-03	.768588	.20
1.000E-03	1.000E-03	9.937E-02	3.932E-03	.718852	.18
1.000E-04	1.000E-04	1.153E-01	4.565E-03	.714430	.18
1.000E-05	1.000E-05	1.328E-01	5.257E-03	.733015	.19
1.000E-06	1.000E-06	1.435E-01	5.677E-03	.728698	.20
1.000E-07	1.000E-07	1.539E-01	6.092E-03	.704848	.21
1.000E-08	1.000E-08	1.718E-01	6.800E-03	.701443	.22
1.000E-09	1.000E-09	1.931E-01	7.640E-03	.707184	.24
1.000E-10	1.000E-10	2.132E-01	8.438E-03	.716685	.25

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.21E-02 FT/MINUTES = 3.70E-01 CM/MINUTES

TRANSMISSIVITY = 3.07E-01 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 3.53E-03 FT/MINUTES = 1.08E-01 CM/MINUTES

TRANSMISSIVITY = 8.91E-02 FT**2/MINUTES

WELL NO.: SMW-2 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 22.27 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 25.27 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 28.19 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 11

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.50	28.260	.070
.66	28.250	.060
.83	28.230	.040
1.00	28.230	.040
1.17	28.220	.030
1.33	28.210	.020
1.50	28.210	.020
1.66	28.200	.010
1.83	28.200	.010
2.00	28.200	.010
2.25	28.200	.010

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.1260
.1472
.1602
.1616

DR 000457

WELL NO: SMW-2 RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .16 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	1.411E-02	5.584E-04	1.048052	.50
1.000E-02	1.000E-02	2.047E-02	8.099E-04	.724585	.32
1.000E-03	1.000E-03	2.676E-02	1.059E-03	.539551	.23
1.000E-04	1.000E-04	3.277E-02	1.297E-03	.419192	.18
1.000E-05	1.000E-05	3.560E-02	1.409E-03	.392541	.19
1.000E-06	1.000E-06	4.055E-02	1.605E-03	.455557	.24
1.000E-07	1.000E-07	4.708E-02	1.863E-03	.387454	.18
1.000E-08	1.000E-08	5.374E-02	2.127E-03	.308054	.16
1.000E-09	1.000E-09	6.103E-02	2.415E-03	.380989	.17
1.000E-10	1.000E-10	6.815E-02	2.697E-03	.390552	.17

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 3.42E-03 FT/MINUTES = 1.04E-01 CM/MINUTES

TRANSMISSIVITY = 8.64E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 9.94E-04 FT/MINUTES = 3.03E-02 CM/MINUTES

TRANSMISSIVITY = 2.51E-02 FT**2/MINUTES

WELL NO.: SMW-4 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 35.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 29.55 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 32.55 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 30.50 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 20

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	30.410	.090
.33	30.410	.090
.50	30.430	.070
.66	30.440	.060
.83	30.450	.050
1.00	30.450	.050
1.17	30.460	.040
1.33	30.460	.040
1.50	30.460	.040
1.66	30.470	.030
1.83	30.470	.030
2.00	30.470	.030
2.25	30.470	.030
2.50	30.470	.030
2.75	30.480	.020
3.00	30.480	.020
3.50	30.480	.020
4.00	30.480	.020
4.50	30.490	.010
5.00	30.490	.010

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.0777
.0787

WELL NO: SMW-4 FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .09 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.772E-03	8.516E-05	1.797438	1.14
1.000E-02	1.000E-02	4.928E-03	1.514E-04	1.431219	.64
1.000E-03	1.000E-03	7.138E-03	2.193E-04	1.348571	.46
1.000E-04	1.000E-04	9.329E-03	2.866E-04	1.334801	.39
1.000E-05	1.000E-05	1.148E-02	3.526E-04	1.329628	.36
1.000E-06	1.000E-06	1.360E-02	4.180E-04	1.333230	.35
1.000E-07	1.000E-07	1.548E-02	4.754E-04	1.355454	.37
1.000E-08	1.000E-08	1.745E-02	5.360E-04	1.366297	.42
1.000E-09	1.000E-09	1.954E-02	6.004E-04	1.367183	.41
1.000E-10	1.000E-10	2.170E-02	6.666E-04	1.364143	.38

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 7.85E-04 FT/MINUTES = 2.39E-02 CM/MINUTES

TRANSMISSIVITY = 2.56E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 2.25E-04 FT/MINUTES = 6.87E-03 CM/MINUTES

TRANSMISSIVITY = 7.34E-03 FT**2/MINUTES

DR 000460

WELL NO.: SMW-4 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 35.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 29.55 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 32.55 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 30.50 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 12

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.33	30.530	.030
.50	30.520	.020
.66	30.510	.010
.83	30.510	.010
1.00	30.510	.010
1.17	30.510	.010
1.33	30.510	.010
1.50	30.510	.010
1.66	30.510	.010
1.83	30.510	.010
2.00	30.505	.005
2.25	30.505	.005

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.0238
.0233

WELL NO: SMW-4 RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .03 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	5.175E-03	1.590E-04	1.861941	.46
1.000E-02	1.000E-02	8.984E-03	2.760E-04	1.889516	.38
1.000E-03	1.000E-03	1.286E-02	3.952E-04	1.895979	.35
1.000E-04	1.000E-04	1.671E-02	5.134E-04	1.896821	.34
1.000E-05	1.000E-05	2.045E-02	6.284E-04	1.895282	.33
1.000E-06	1.000E-06	2.417E-02	7.424E-04	1.894282	.33
1.000E-07	1.000E-07	2.786E-02	8.558E-04	1.893637	.33
1.000E-08	1.000E-08	3.152E-02	9.683E-04	1.893114	.33
1.000E-09	1.000E-09	3.472E-02	1.067E-03	1.916437	.33
1.000E-10	1.000E-10	3.806E-02	1.169E-03	1.928782	.34

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.16E-03 FT/MINUTES = 3.53E-02 CM/MINUTES

TRANSMISSIVITY = 3.77E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 3.33E-04 FT/MINUTES = 1.01E-02 CM/MINUTES

TRANSMISSIVITY = 1.08E-02 FT**2/MINUTES

WELL NO.: SMW-4/EARLY TIM DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 35.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 29.55 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 32.55 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 30.50 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 17

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	30.410	.090
.33	30.410	.090
.50	30.430	.070
.66	30.440	.060
.83	30.450	.050
1.00	30.450	.050
1.17	30.460	.040
1.33	30.460	.040
1.50	30.460	.040
1.66	30.470	.030
1.83	30.470	.030
2.00	30.470	.030
2.25	30.470	.030
2.50	30.470	.030
2.75	30.480	.020
3.00	30.480	.020
3.50	30.480	.020

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.0822
.0862

WELL NO: SMW-4\EARLY TIM FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .09 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	2.545E-03	7.818E-05	1.534932	.60
1.000E-02	1.000E-02	4.747E-03	1.458E-04	1.417991	.41
1.000E-03	1.000E-03	7.020E-03	2.157E-04	1.371148	.34
1.000E-04	1.000E-04	9.274E-03	2.849E-04	1.342697	.31
1.000E-05	1.000E-05	1.148E-02	3.527E-04	1.329508	.30
1.000E-06	1.000E-06	1.366E-02	4.197E-04	1.327883	.29
1.000E-07	1.000E-07	1.582E-02	4.861E-04	1.325828	.29
1.000E-08	1.000E-08	1.797E-02	5.520E-04	1.326636	.29
1.000E-09	1.000E-09	2.010E-02	6.175E-04	1.329348	.29
1.000E-10	1.000E-10	2.222E-02	6.828E-04	1.331814	.29

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 9.30E-04 FT/MINUTES = 2.83E-02 CM/MINUTES

TRANSMISSIVITY = 3.03E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 2.67E-04 FT/MINUTES = 8.14E-03 CM/MINUTES

TRANSMISSIVITY = 8.69E-03 FT**2/MINUTES

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM
SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:
(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967
(ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED
"RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS
CHARGE OF WATER")
(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN
VOL. 12, NO.3 OF WRR ENTITLED
"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: SMW-5 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 22.48 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 23.48 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 43.05 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 16

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	42.900	.150
.33	42.930	.120
.50	42.970	.080
.66	42.980	.070
.83	43.000	.050
1.00	43.010	.040
1.17	43.020	.030
1.33	43.020	.030
1.50	43.020	.030
1.66	43.030	.020
1.83	43.030	.020
2.00	43.035	.015
2.25	43.040	.010
2.50	43.040	.010
2.75	43.045	.005
3.00	43.045	.005

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED

VALUES FOR [illegible]
(FEET)

.1510
.1541

WELL NO: SMW-5 FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .15 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	1.054E-02	4.490E-04	2.271708	1.27
1.000E-02	1.000E-02	1.503E-02	6.400E-04	1.734083	.76
1.000E-03	1.000E-03	1.929E-02	8.214E-04	1.350522	.43
1.000E-04	1.000E-04	2.378E-02	1.013E-03	1.212757	.30
1.000E-05	1.000E-05	2.777E-02	1.183E-03	1.200452	.29
1.000E-06	1.000E-06	3.219E-02	1.371E-03	1.262936	.36
1.000E-07	1.000E-07	3.672E-02	1.564E-03	1.257834	.35
1.000E-08	1.000E-08	4.048E-02	1.724E-03	1.189770	.24
1.000E-09	1.000E-09	4.539E-02	1.933E-03	1.173897	.22
1.000E-10	1.000E-10	5.033E-02	2.143E-03	1.115858	.25

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 2.70E-03 FT/MINUTES = 8.24E-02 CM/MINUTES

TRANSMISSIVITY = 6.35E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 7.83E-04 FT/MINUTES = 2.39E-02 CM/MINUTES

TRANSMISSIVITY = 1.84E-02 FT**2/MINUTES

WELL NO.: SMW-5 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 22.48 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 23.48 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 43.05 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 19

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.66	43.130	.080
.83	43.100	.050
1.00	43.090	.040
1.17	43.080	.030
1.33	43.080	.030
1.50	43.070	.020
1.66	43.070	.020
1.83	43.070	.020
2.00	43.070	.020
2.17	43.060	.010
2.33	43.060	.010
2.50	43.060	.010
2.75	43.060	.010
3.00	43.055	.005
3.25	43.055	.005
3.50	43.055	.005
4.00	43.055	.005
4.50	43.055	.005
5.00	43.055	.005

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR H0 (FEET)

.0639
.0759
.0903
.1044
.1117
.1150

WELL NO: SMW-5 RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .11 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	9.851E-03	4.195E-04	1.581279	.91
1.000E-02	1.000E-02	1.374E-02	5.852E-04	1.248448	.61
1.000E-03	1.000E-03	1.720E-02	7.327E-04	.980093	.47
1.000E-04	1.000E-04	1.980E-02	8.431E-04	.909377	.57
1.000E-05	1.000E-05	2.322E-02	9.890E-04	.870140	.64
1.000E-06	1.000E-06	2.641E-02	1.125E-03	.795788	.50
1.000E-07	1.000E-07	3.041E-02	1.295E-03	.774525	.46
1.000E-08	1.000E-08	3.512E-02	1.496E-03	.756682	.44
1.000E-09	1.000E-09	3.810E-02	1.623E-03	.695409	.47
1.000E-10	1.000E-10	4.164E-02	1.774E-03	.695706	.50

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 2.29E-03 FT/MINUTES = 6.97E-02 CM/MINUTES

TRANSMISSIVITY = 5.37E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 6.62E-04 FT/MINUTES = 2.02E-02 CM/MINUTES

TRANSMISSIVITY = 1.56E-02 FT**2/MINUTES

WELL NO.: SMW-5(EARLY TIM

DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024

CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 22.48 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 23.48 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 43.05 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 15

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.66	43.130	.080
.83	43.100	.050
1.00	43.090	.040
1.17	43.080	.030
1.33	43.080	.030
1.50	43.070	.020
1.66	43.070	.020
1.83	43.070	.020
2.00	43.070	.020
2.17	43.060	.010
2.33	43.060	.010
2.50	43.060	.010
2.75	43.060	.010
3.00	43.055	.005
3.25	43.055	.005

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.1117
.1150

DR 000470

WELL NO: SMW-5(EARLY TIM   RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 =   .11 FEET

NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	9.205E-03	3.921E-04	1.692139	.99
1.000E-02	1.000E-02	1.340E-02	5.707E-04	1.280151	.65
1.000E-03	1.000E-03	1.737E-02	7.396E-04	.970958	.41
1.000E-04	1.000E-04	2.087E-02	8.886E-04	.862777	.26
1.000E-05	1.000E-05	2.477E-02	1.055E-03	.815780	.25
1.000E-06	1.000E-06	2.764E-02	1.177E-03	.760369	.21
1.000E-07	1.000E-07	3.130E-02	1.333E-03	.752685	.31
1.000E-08	1.000E-08	3.592E-02	1.530E-03	.739788	.32
1.000E-09	1.000E-09	3.963E-02	1.688E-03	.668581	.22
1.000E-10	1.000E-10	4.355E-02	1.855E-03	.665311	.20

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 2.29E-03 FT/MINUTES   = 6.97E-02 CM/MINUTES

TRANSMISSIVITY = 5.37E-02 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 6.62E-04 FT/MINUTES   = 2.02E-02 CM/MINUTES

TRANSMISSIVITY = 1.56E-02 FT**2/MINUTES

WELL NO.: SMW-6　　　　DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024　　　　CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 11.37 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 9.07 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.42 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 33

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.50	4.850	.570
.66	4.960	.460
1.17	5.000	.420
1.33	5.030	.390
1.50	5.050	.370
1.66	5.080	.340
1.83	5.100	.320
2.00	5.130	.290
2.17	5.150	.270
2.33	5.170	.250
2.50	5.180	.240
2.66	5.200	.220
2.83	5.210	.210
3.00	5.230	.190
3.25	5.240	.180
3.50	5.260	.160
3.75	5.270	.150
4.00	5.280	.140
4.25	5.290	.130
4.50	5.300	.120
5.00	5.330	.090
5.50	5.340	.080
6.00	5.350	.070
6.50	5.360	.060
7.50	5.370	.050
8.00	5.380	.040
8.50	5.390	.030
9.00	5.400	.020
9.50	5.400	.020
10.00	5.400	.020
11.00	5.410	.010
12.00	5.410	.010
13.00	5.410	.010

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

.5698
.5907

DR 000473

WELL NO: SMW-6 FALLING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .59 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	3.316E-03	3.656E-04	3.099772	7.42
1.000E-02	1.000E-02	4.691E-03	5.171E-04	2.412338	4.91
1.000E-03	1.000E-03	6.018E-03	6.635E-04	2.027444	3.51
1.000E-04	1.000E-04	7.275E-03	8.021E-04	1.702439	2.46
1.000E-05	1.000E-05	8.591E-03	9.472E-04	1.495630	1.87
1.000E-06	1.000E-06	9.975E-03	1.100E-03	1.381779	1.65
1.000E-07	1.000E-07	1.142E-02	1.259E-03	1.327853	1.59
1.000E-08	1.000E-08	1.268E-02	1.398E-03	1.319399	1.42
1.000E-09	1.000E-09	1.404E-02	1.548E-03	1.228156	1.14
1.000E-10	1.000E-10	1.548E-02	1.707E-03	1.173634	.98

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 3.33E-04 FT/MINUTES = 1.01E-02 CM/MINUTES

TRANSMISSIVITY = 3.02E-03 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 4.66E-04 FT/MINUTES = 1.42E-02 CM/MINUTES

TRANSMISSIVITY = 4.22E-03 FT**2/MINUTES

WELL NO.: SMW-6 DATE OF TEST: 12-5-86

PROJECT NO.: 0836-024 CLIENT: URS

SITE LOCATION: HELEN KRAMER LANDFILL

FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 7.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 11.37 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 9.07 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.42 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 29

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.50	6.210	.790
.66	6.170	.750
.83	6.120	.700
1.00	6.090	.670
1.17	6.050	.630
1.33	6.010	.590
1.50	5.970	.550
1.66	5.940	.520
1.83	5.910	.490
2.00	5.880	.460
2.25	5.840	.420
2.50	5.810	.390
2.75	5.780	.360
3.00	5.750	.330
3.25	5.730	.310
3.50	5.710	.290
3.75	5.690	.270
4.00	5.670	.250
4.50	5.630	.210
5.00	5.610	.190
5.50	5.580	.160
6.00	5.560	.140
6.50	5.540	.120
7.00	5.530	.110
8.00	5.510	.090
9.00	5.490	.070
10.00	5.470	.050
12.00	5.460	.040
14.00	5.450	.030

DR 000475

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED

VALUES FOR HO
(FEET)

.7650
.8030

DR 000476

WELL NO: SMW-6 RISING-HEAD CASE

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = .80 FEET

(NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/MINUTES AND PERMEABILITY UNITS ARE FT/MINUTES)

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS
1.000E-01	1.000E-01	1.653E-03	1.822E-04	2.520182	5.37
1.000E-02	1.000E-02	2.716E-03	2.995E-04	1.815851	3.44
1.000E-03	1.000E-03	3.793E-03	4.182E-04	1.519386	2.09
1.000E-04	1.000E-04	4.819E-03	5.313E-04	1.372395	1.37
1.000E-05	1.000E-05	5.810E-03	6.406E-04	1.224115	1.02
1.000E-06	1.000E-06	6.835E-03	7.536E-04	1.198725	.88
1.000E-07	1.000E-07	7.891E-03	8.701E-04	1.174019	.85
1.000E-08	1.000E-08	8.912E-03	9.826E-04	1.139321	.77
1.000E-09	1.000E-09	9.936E-03	1.095E-03	1.127440	.76
1.000E-10	1.000E-10	1.096E-02	1.209E-03	1.151974	.71

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 2.59E-04 FT/MINUTES = 7.89E-03 CM/MINUTES

TRANSMISSIVITY = 2.35E-03 FT**2/MINUTES

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 3.63E-04 FT/MINUTES = 1.11E-02 CM/MINUTES

TRANSMISSIVITY = 3.29E-03 FT**2/MINUTES

PROGRAM INSITU, VERSION 1.0, MAY 1986

THIS PROGRAM CALCULATES HORIZONTAL PERMEABILITY FROM
IN-SITU WELL DATA, SUCH AS SLUG-TEST DATA.
THE EQUATIONS EMPLOYED ARE TAKEN FROM SOIL MECHANICS BY
LAMBE AND WHITMAN (1969), AND FROM NAVFAC DM-7 (1971).

PROJECT NO.: 0936-024 DATE OF TEST: 12-4-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-1(FALLING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 17.00 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 3.50 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .294
NUMBER OF HEAD-TIME DATA POINTS = 40

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.25	2.970	.530
.50	3.100	.400
.66	3.210	.290
.83	3.230	.270
1.00	3.270	.230
1.17	3.300	.200
1.33	3.320	.180
1.50	3.330	.170
1.66	3.350	.150
1.83	3.370	.130
2.00	3.370	.130
2.17	3.390	.110
2.33	3.400	.100
2.50	3.400	.100
2.66	3.410	.090
2.83	3.420	.080
3.00	3.425	.075
3.25	3.430	.070
3.50	3.430	.070
3.75	3.440	.060
4.00	3.440	.060
4.25	3.450	.050
4.50	3.450	.050
4.75	3.450	.050
5.00	3.450	.050
5.25	3.450	.050
5.75	3.460	.040
6.25	3.460	.040
6.75	3.460	.040
7.25	3.470	.030
7.75	3.470	.030
[illegible]	3.470	.030

DR 000478

8.75	3.470	.030
9.25	3.470	.030
9.75	3.470	.030
10.25	3.470	.030
11.25	3.470	.030
12.25	3.470	.030
13.25	3.470	.030
14.25	3.470	.030

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 5.095E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 5.987E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

DR 000479

PROJECT NO.: 0836-024 DATE OF TEST: 12-4-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL G.VANDERHOVEN

WELL NO.: PW-1(RISING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 17.00 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 3.50 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .294
NUMBER OF HEAD-TIME DATA POINTS = 37

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	4.400	.900
.33	4.300	.800
.50	4.190	.690
.66	4.080	.580
.83	4.010	.510
1.00	3.950	.450
1.17	3.880	.380
1.33	3.850	.350
1.50	3.810	.310
1.66	3.780	.280
1.83	3.750	.250
2.00	3.730	.230
2.17	3.710	.210
2.33	3.690	.190
2.50	3.670	.170
2.75	3.660	.160
3.00	3.640	.140
3.25	3.630	.130
3.50	3.620	.120
3.75	3.610	.110
4.00	3.600	.100
4.25	3.590	.090
4.50	3.590	.090
5.00	3.580	.080
5.50	3.570	.070
6.00	3.570	.070
6.50	3.560	.060
7.00	3.550	.050
7.50	3.550	.050
8.00	3.550	.050
8.50	3.540	.040
9.00	3.540	.040
10.00	3.540	.040
11.00	3.530	.030
12.00	3.530	.030
13.00	3.530	.030
14.00	3.530	.030

DR 000480

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 6.772E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 7.957E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

PROJECT NO.: 0836-024 DATE OF TEST: 12-4-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/G.VANDERHOVEN

WELL NO.: PW-1(FALLING-EARLY)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 17.00 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 3.50 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .294
NUMBER OF HEAD-TIME DATA POINTS = 28

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.25	2.970	.530
.50	3.100	.400
.66	3.210	.290
.83	3.230	.270
1.00	3.270	.230
1.17	3.300	.200
1.33	3.320	.180
1.50	3.330	.170
1.66	3.350	.150
1.83	3.370	.130
2.00	3.370	.130
2.17	3.390	.110
2.33	3.400	.100
2.50	3.400	.100
2.66	3.410	.090
2.83	3.420	.080
3.00	3.425	.075
3.25	3.430	.070
3.50	3.430	.070
3.75	3.440	.060
4.00	3.440	.060
4.25	3.450	.050
4.50	3.450	.050
4.75	3.450	.050
5.00	3.450	.050
5.25	3.450	.050
5.75	3.460	.040
6.25	3.460	.040

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 1.109E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 1.303E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

PROJECT NO.: 0836-024 DATE OF TEST: 12-4-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-1(RISING-EARLY)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 17.00 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 3.50 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .294
NUMBER OF HEAD-TIME DATA POINTS = 26

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	4.400	.900
.33	4.300	.800
.50	4.190	.690
.66	4.080	.580
.83	4.010	.510
1.00	3.950	.450
1.17	3.880	.380
1.33	3.850	.350
1.50	3.810	.310
1.66	3.780	.280
1.83	3.750	.250
2.00	3.730	.230
2.17	3.710	.210
2.33	3.690	.190
2.50	3.670	.170
2.75	3.660	.160
3.00	3.640	.140
3.25	3.630	.130
3.50	3.620	.120
3.75	3.610	.110
4.00	3.600	.100
4.25	3.590	.090
4.50	3.590	.090
5.00	3.580	.080
5.50	3.570	.070
6.00	3.570	.070

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 1.251E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 1.471E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

DR 000483

PROJECT NO.: 0836-024 DATE OF TEST: 12-4-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-2A(FALLING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 10.90 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 5.36 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .459
NUMBER OF HEAD-TIME DATA POINTS = 45

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	3.920	1.440
.33	3.930	1.430
.50	3.940	1.420
.66	3.950	1.410
.83	3.950	1.410
1.00	3.960	1.400
1.17	3.960	1.400
1.33	3.970	1.390
1.50	3.970	1.390
1.75	3.970	1.390
2.00	3.970	1.390
2.25	3.980	1.380
2.50	3.980	1.380
2.75	3.990	1.370
3.00	3.990	1.370
3.50	4.000	1.360
4.00	4.020	1.340
4.50	4.020	1.340
5.00	4.030	1.330
5.50	4.030	1.330
6.00	4.040	1.320
7.00	4.060	1.300
8.00	4.070	1.290
9.00	4.090	1.270
10.00	4.100	1.260
11.00	4.120	1.240
12.00	4.130	1.230
14.00	4.150	1.210
16.00	4.170	1.190
18.00	4.190	1.170
20.00	4.210	1.150
25.00	4.250	1.110
30.00	4.290	1.070
35.00	4.330	1.030
40.00	4.370	.990
45.00	4.390	.970
50.00	4.410	.950
55.00	4.430	.930
60.00	4.450	.910
[illegible]	[illegible]	[illegible]

DR 000484

70.00	4.500	.860
90.00	4.540	.820
100.00	4.610	.750
110.00	4.640	.720
120.00	4.660	.700

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 2.324E-05 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 2.631E-05 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-2A(RISING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 10.90 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 5.36 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .459
NUMBER OF HEAD-TIME DATA POINTS = 44

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	6.960	1.600
.50	6.960	1.600
.66	6.960	1.600
.83	6.960	1.600
1.00	6.950	1.590
1.25	6.950	1.590
1.50	6.950	1.590
1.75	6.940	1.580
2.00	6.940	1.580
2.25	6.930	1.570
2.50	6.920	1.560
2.75	6.920	1.560
3.00	6.920	1.560
3.50	6.910	1.550
4.00	6.900	1.540
4.50	6.890	1.530
5.00	6.880	1.520
5.50	6.870	1.510
6.00	6.860	1.500
6.50	6.850	1.490
7.00	6.850	1.490
8.00	6.830	1.470
9.00	6.810	1.450
10.00	6.790	1.430
11.00	6.770	1.410
12.00	6.760	1.400
13.00	6.740	1.380
14.00	6.720	1.360
15.00	6.690	1.330
18.00	6.660	1.300
21.00	6.620	1.260
22.00	6.600	1.240
24.00	6.570	1.210
26.00	6.530	1.170
28.00	6.510	1.150
30.00	6.480	1.120
35.00	6.410	1.050
40.00	6.360	1.000
45.00	6.290	.930
[illegible]	[illegible]	[illegible]

DR 000486

55.00	6.190	.830
60.00	6.140	.780
65.00	6.090	.730
70.00	6.050	.690

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 4.425E-05 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 5.010E-05 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-3(FALLING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 19.22 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 7.20 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .260
NUMBER OF HEAD-TIME DATA POINTS = 41

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	5.750	1.450
.33	5.770	1.430
.50	5.790	1.410
.66	5.820	1.380
.83	5.840	1.360
1.00	5.860	1.340
1.17	5.870	1.330
1.33	5.890	1.310
1.50	5.910	1.290
1.66	5.930	1.270
1.83	5.940	1.260
2.00	5.950	1.250
2.25	5.980	1.220
2.50	6.000	1.200
2.75	6.030	1.170
3.00	6.040	1.160
3.25	6.060	1.140
3.50	6.080	1.120
4.00	6.110	1.090
4.50	6.150	1.050
5.00	6.190	1.010
5.50	6.220	.980
6.00	6.250	.950
6.50	6.280	.920
7.00	6.320	.880
8.00	6.370	.830
9.00	6.430	.770
10.00	6.470	.730
11.00	6.510	.690
12.00	6.560	.640
14.00	6.620	.580
16.00	6.690	.510
18.00	6.740	.460
20.00	6.790	.410
22.00	6.840	.360
24.00	6.880	.320
26.00	6.920	.280
28.00	6.950	.250
30.00	6.980	.220

DR 000488

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        40.00                7.080              .120

               ******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE =  2.250E-04 FT/MINUTES
   (LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE =  2.547E-04 FT/MINUTES
   (LAMBE AND WHITMAN"S CASE F)
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PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-3(RISING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 19.22 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 7.20 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .260
NUMBER OF HEAD-TIME DATA POINTS = 35

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.25	8.620	1.420
.33	8.610	1.410
.50	8.590	1.390
.66	8.570	1.370
.83	8.550	1.350
1.00	8.520	1.320
1.17	8.500	1.300
1.33	8.480	1.280
1.50	8.460	1.260
1.66	8.430	1.230
1.83	8.420	1.220
2.00	8.400	1.200
2.17	8.380	1.180
2.33	8.360	1.160
2.50	8.340	1.140
2.75	8.320	1.120
3.00	8.290	1.090
3.25	8.270	1.070
3.50	8.250	1.050
3.75	8.220	1.020
4.00	8.200	1.000
4.50	8.150	.950
5.00	8.120	.920
5.50	8.070	.870
6.00	8.040	.840
6.50	8.000	.800
7.00	7.970	.770
8.00	7.910	.710
9.00	7.850	.650
10.00	7.800	.600
12.00	7.710	.510
14.00	7.630	.430
16.00	7.570	.370
18.00	7.510	.310
20.00	7.470	.270

DR 000490

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 3.095E-04 FT/MINUTES

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 3.504E-04 FT/MINUTES
(LANGE AND WHITMAN'S CASE F)

DR 000491

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-4(FALLING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 6.58 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 5.81 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .760
NUMBER OF HEAD-TIME DATA POINTS = 15

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	5.380	.430
.33	5.470	.340
.66	5.600	.210
.83	5.700	.110
1.00	5.740	.070
1.00	5.750	.060
1.33	5.770	.040
1.50	5.780	.030
1.66	5.780	.030
1.83	5.790	.020
2.00	5.800	.010
2.25	5.800	.010
2.50	5.800	.010
2.75	5.805	.005
3.00	5.805	.005

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 5.959E-03 FT/MINUTES
(LAMBE AND WHITMAN'S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 6.747E-03 FT/MINUTES
(LAMBE AND WHITMAN'S CASE F)

PROJECT NO.: 0836-024　　DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL G.VANDERHOVEN

WELL NO.: PW-4(RISING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 6.58 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 5.81 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .760
NUMBER OF HEAD-TIME DATA POINTS = 22

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	6.390	.580
.33	6.180	.370
.50	6.070	.260
.66	5.980	.170
.83	5.930	.120
1.00	5.900	.090
1.17	5.870	.060
1.33	5.860	.050
1.50	5.850	.040
1.66	5.840	.030
1.83	5.830	.020
2.00	5.830	.020
2.25	5.830	.020
2.50	5.830	.020
2.75	5.830	.020
3.00	5.830	.020
3.50	5.830	.020
4.00	5.830	.020
4.50	5.830	.020
5.00	5.820	.010
6.00	5.820	.010
7.00	5.820	.010

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 1.875E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 2.123E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-4(FALLING-EARLY)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 6.58 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 5.81 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .760
NUMBER OF HEAD-TIME DATA POINTS = 12

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	5.380	.430
.33	5.470	.340
.66	5.600	.210
.83	5.700	.110
1.00	5.740	.070
1.00	5.750	.060
1.33	5.770	.040
1.50	5.780	.030
1.66	5.780	.030
1.83	5.790	.020
2.00	5.800	.010
2.25	5.805	.005

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 7.438E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 8.421E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: PW-4(RISING-EARLY)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 6.58 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 5.81 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = .760
NUMBER OF HEAD-TIME DATA POINTS = 13

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	6.390	.580
.33	6.180	.370
.50	6.070	.260
.66	5.980	.170
.83	5.930	.120
1.00	5.900	.090
1.17	5.870	.060
1.33	5.860	.050
1.50	5.850	.040
1.66	5.840	.030
1.83	5.830	.020
2.00	5.830	.020
2.25	5.830	.020

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 6.237E-03 FT/MINUTES
(LAMBE AND WHITMAN'S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 7.062E-03 FT/MINUTES
(LAMBE AND WHITMAN'S CASE F)

DR 000495

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: SMW-2(FALLING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 25.27 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 28.19 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.187
NUMBER OF HEAD-TIME DATA POINTS = 10

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.25	27.990	.200
.30	28.040	.150
.50	28.130	.060
.66	28.170	.020
.83	28.170	.020
1.00	28.170	.020
1.17	28.170	.020
1.33	28.170	.020
1.55	28.180	.010
1.75	28.180	.010

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 1.195E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 1.339E-03 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 1.101E-03 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: SMW-2(RISING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 25.27 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 28.19 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.187
NUMBER OF HEAD-TIME DATA POINTS = 11

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.50	28.260	.070
.66	28.250	.060
.83	28.230	.040
1.00	28.230	.040
1.17	28.220	.030
1.33	28.210	.020
1.50	28.210	.020
1.66	28.200	.010
1.83	28.200	.010
2.00	28.200	.010
2.25	28.200	.010

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 8.526E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 9.553E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 7.856E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: SMW-4(FALLING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 35.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 32.55 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 30.50 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.075
NUMBER OF HEAD-TIME DATA POINTS = 20

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	30.410	.090
.33	30.410	.090
.50	30.430	.070
.66	30.440	.060
.83	30.450	.050
1.00	30.450	.050
1.17	30.460	.040
1.33	30.460	.040
1.50	30.460	.040
1.66	30.470	.030
1.83	30.470	.030
2.00	30.470	.030
2.25	30.470	.030
2.50	30.470	.030
2.75	30.480	.020
3.00	30.480	.020
3.50	30.480	.020
4.00	30.480	.020
4.50	30.490	.010
5.00	30.490	.010

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 2.493E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 2.786E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 2.238E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL G.VANDERHOVEN

WELL NO.: SMW-4(FALLING-EARLY)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 35.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 32.55 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 30.50 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.075
NUMBER OF HEAD-TIME DATA POINTS = 17

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	30.410	.090
.33	30.410	.090
.50	30.430	.070
.66	30.440	.060
.83	30.450	.050
1.00	30.450	.050
1.17	30.460	.040
1.33	30.460	.040
1.50	30.460	.040
1.66	30.470	.030
1.83	30.470	.030
2.00	30.470	.030
2.25	30.470	.030
2.50	30.470	.030
2.75	30.480	.020
3.00	30.480	.020
3.50	30.480	.020

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 2.765E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 3.089E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 2.481E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: SMW-4(RISING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 35.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 32.55 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 30.50 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.075
NUMBER OF HEAD-TIME DATA POINTS = 12

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.33	30.530	.030
.50	30.520	.020
.66	30.510	.010
.83	30.510	.010
1.00	30.510	.010
1.17	30.510	.010
1.33	30.510	.010
1.50	30.510	.010
1.66	30.510	.010
1.83	30.510	.010
2.00	30.505	.005
2.25	30.505	.005

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 3.887E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 4.343E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 3.488E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: SMW-5(FALLING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 23.48 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 43.05 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.278
NUMBER OF HEAD-TIME DATA POINTS = 16

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.17	42.900	.150
.33	42.930	.120
.50	42.970	.080
.66	42.980	.070
.83	43.000	.050
1.00	43.010	.040
1.17	43.020	.030
1.33	43.020	.030
1.50	43.020	.030
1.66	43.030	.020
1.83	43.030	.020
2.00	43.035	.015
2.25	43.040	.010
2.50	43.040	.010
2.75	43.045	.005
3.00	43.045	.005

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 7.801E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 8.741E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 7.188E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: SMW-5(RISING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 23.48 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 43.05 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.278
NUMBER OF HEAD-TIME DATA POINTS = 19

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.66	43.130	.080
.83	43.100	.050
1.00	43.090	.040
1.17	43.080	.030
1.33	43.080	.030
1.50	43.070	.020
1.66	43.070	.020
1.83	43.070	.020
2.00	43.070	.020
2.17	43.060	.010
2.33	43.060	.010
2.50	43.060	.010
2.75	43.060	.010
3.00	43.055	.005
3.25	43.055	.005
3.50	43.055	.005
4.00	43.055	.005
4.50	43.055	.005
5.00	43.055	.005

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 4.342E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 4.865E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 4.001E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/G.VANDERHOVEN

WELL NO.: GMW-5(RISING-EARLY)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 23.48 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 43.05 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.278
NUMBER OF HEAD-TIME DATA POINTS = 15

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.66	43.130	.080
.83	43.100	.050
1.00	43.090	.040
1.17	43.080	.030
1.33	43.080	.030
1.50	43.070	.020
1.66	43.070	.020
1.83	43.070	.020
2.00	43.070	.020
2.17	43.060	.010
2.33	43.060	.010
2.50	43.060	.010
2.75	43.060	.010
3.00	43.055	.005
3.25	43.055	.005

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 6.550E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 7.340E-04 FT/MINUTES
(LAMBE AND WHITMAN'S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 6.036E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: SMW-6(FALLING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 9.07 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 5.42 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.103
NUMBER OF HEAD-TIME DATA POINTS = 35

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.50	4.850	.570
.66	4.960	.460
1.17	5.000	.420
1.33	5.030	.390
1.50	5.050	.370
1.66	5.080	.340
1.83	5.100	.320
2.00	5.130	.290
2.17	5.150	.270
2.33	5.170	.250
2.50	5.180	.240
2.66	5.200	.220
2.83	5.210	.210
3.00	5.230	.190
3.25	5.240	.180
3.50	5.260	.160
3.75	5.270	.150
4.00	5.280	.140
4.25	5.290	.130
4.50	5.300	.120
5.00	5.330	.090
5.50	5.340	.080
6.00	5.350	.070
6.50	5.360	.060
7.50	5.370	.050
8.00	5.380	.040
8.50	5.390	.030
9.00	5.400	.020
9.50	5.400	.020
10.00	5.400	.020
11.00	5.410	.010
12.00	5.410	.010
13.00	5.410	.010
14.00	5.410	.010
15.00	5.415	.005

DR 000504

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 5.241E-04 FT/MINUTES

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 5.022E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 5.971E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

DR 000505

PROJECT NO.: 0836-024 DATE OF TEST: 12-5-86
CLIENT: URS
SITE LOCATION: HELEN KRAMER LANDFILL
FIELD INVESTIGATOR: D.RAUBVOGEL/S.VANDERHOVEN

WELL NO.: SMW-6(RISING)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FT
INNER SCREEN OR OPEN-HOLE DIAMETER = 7.25 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 9.07 FT
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT. 5.42 FT
RATIO OF HORIZONTAL TO VERTICAL PERMEABILITY = 10.000
RATIO OF SCREEN LENGTH TO AQUIFER THICKNESS = 1.103
NUMBER OF HEAD-TIME DATA POINTS = 29

TIME (MINUTES)	DEPTH TO WATER (FEET)	HEAD (FEET)
.50	6.210	.790
.66	6.170	.750
.83	6.120	.700
1.00	6.090	.670
1.17	6.050	.630
1.33	6.010	.590
1.50	5.970	.550
1.66	5.940	.520
1.83	5.910	.490
2.00	5.880	.460
2.25	5.840	.420
2.50	5.810	.390
2.75	5.780	.360
3.00	5.750	.330
3.25	5.730	.310
3.50	5.710	.290
3.75	5.690	.270
4.00	5.670	.250
4.50	5.630	.210
5.00	5.610	.190
5.50	5.580	.160
6.00	5.560	.140
6.50	5.540	.120
7.00	5.530	.110
8.00	5.510	.090
9.00	5.490	.070
10.00	5.470	.050
12.00	5.460	.040
14.00	5.450	.030

******* COMPUTED RESULTS *******

HORIZONTAL PERMEABILITY FOR WATER-TABLE CASE = 4.190E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE G)

HORIZONTAL PERMEABILITY FOR GENERAL CONFINED CASE = 4.814E-04 FT/MINUTES
(LAMBE AND WHITMAN"S CASE F)

HORIZONTAL PERMEABILITY FOR CONFINED CASE,
WHERE WELL PENETRATES FULL THICKNESS OF AQUIFER = 4.773E-04 FT/MINUTES
(NAVFAC DM-7 CASE F(3))

[redacted]

APPENDIX 5-1

ELECTROMAGNETIC SURVEY
HELEN KRAMER LANDFILL
OCTOBER 1986

BY

DELTA GEOPHYSICAL SERVICES

DR 000509

ELECTROMAGNETIC SURVEY

HELEN KRAMER LANDFILL
NEW JERSEY

FOR

DAMES AND MOORE
CRANFORD, NEW JERSEY

OCTOBER 1986

DR 000510

DELTA
GEOPHYSICAL SERVICES

October 21, 1986

DELTA GEOPHYSICAL SERVICES
A GEONICS COMPANY

Mr. Anthony O. Kaufman
Dames & Moore
6 Commerce Drive
Cranford, NJ 07016

REPORT: Electromagnetic Survey
Helen Kramer Landfill
Mantua Township, NJ

Dear Mr. Kaufman:

We have completed the electromagnetic survey at the Helen Kramer Landfill near Jefferson, New Jersey. The purpose of the survey was to delineate the landfill boundary along the southern, western, and part of the northern perimeters of the site.

The electromagnetic survey was made using a Geonics, Inc. EM-31, which measures subsurface conductivity (mmhos/m) to a depth of approximately 20 feet. Besides mapping soil and water conductivities, the EM-31 is an effective tool in locating buried metal objects, trash, etc.

> The EM-31 is portable, rapid and non-destructive. It has a fixed transmitter and receiver boom so that handling and data gathering is easily achieved by one operator.
>
> The instrument induces very small (primary field) currents into the earth from a magnetic dipole transmitter. From these currents a weak secondary field is produced. The equipment compares the secondary field with the primary field using advanced circuit techniques to produce direct terrain conductivity readings which are continuously displayed.

Conductivity data were collected along survey lines oriented perpendicular to the perimeter fence and spaced approximately 100 feet apart. Distances were paced and directions measured with a Brunton compass. Each survey line is marked on the fence by flagging (except survey lines 44 and 45 which are marked by wood stakes). Data were collected and recorded at a minimum 20-foot interval along each survey line. Near the suspected landfill boundary, the instrument was continuously monitored to most accurately define the boundary location.

Data were collected from a total of of 48 survey lines and along two offsite lines. The two offsite lines (T1 and T2) were used to obtain background conductivity data. Survey line 43 was marked in the field as a reference point, but no conductivity data were collected due to the large amount of surface metal in the area (vehicles, building, etc.).

116 WEST MAIN ST., CLINTON, NEW JERSEY 08809, TELEPHONE 201·735·9390

The survey lines and landfill boundary locations for each line are shown on the enclosed sketch map.

RESULTS

Based on field inspection of the conductivity data, the landfill boundary was located along each survey line, and marked in the field by a red flag so that the boundary could be located by the surveying crew. The boundary location along survey line 45 was not determined due to the close proximity of seeps which limited the amount of time spent in the area for safety reasons. The trash does extend however to at least the top edge of the steep slope on this line.

Along survey line 12, the boundary flag is offset approximately 20 feet east due to surface metal along the line. Along survey line 36, two boundary flags were placed, and along lines 37 and 38, three boundary flags were placed. The data along these lines possibly indicate two seperate areas of trash on either side of Leave Road. Further analysis of the data from the other survey lines in this area allowed us to better determine the boundaries, which are shown on the map by the blue dashed line.

Two small areas outside of the landfill boundary containing possible buried metal were located near survey line 8, and are marked in the field by yellow flagging. These areas were located primarily by chance, and are quite possibly not the only areas with scattered buried metal lying outside of the actual landfill.

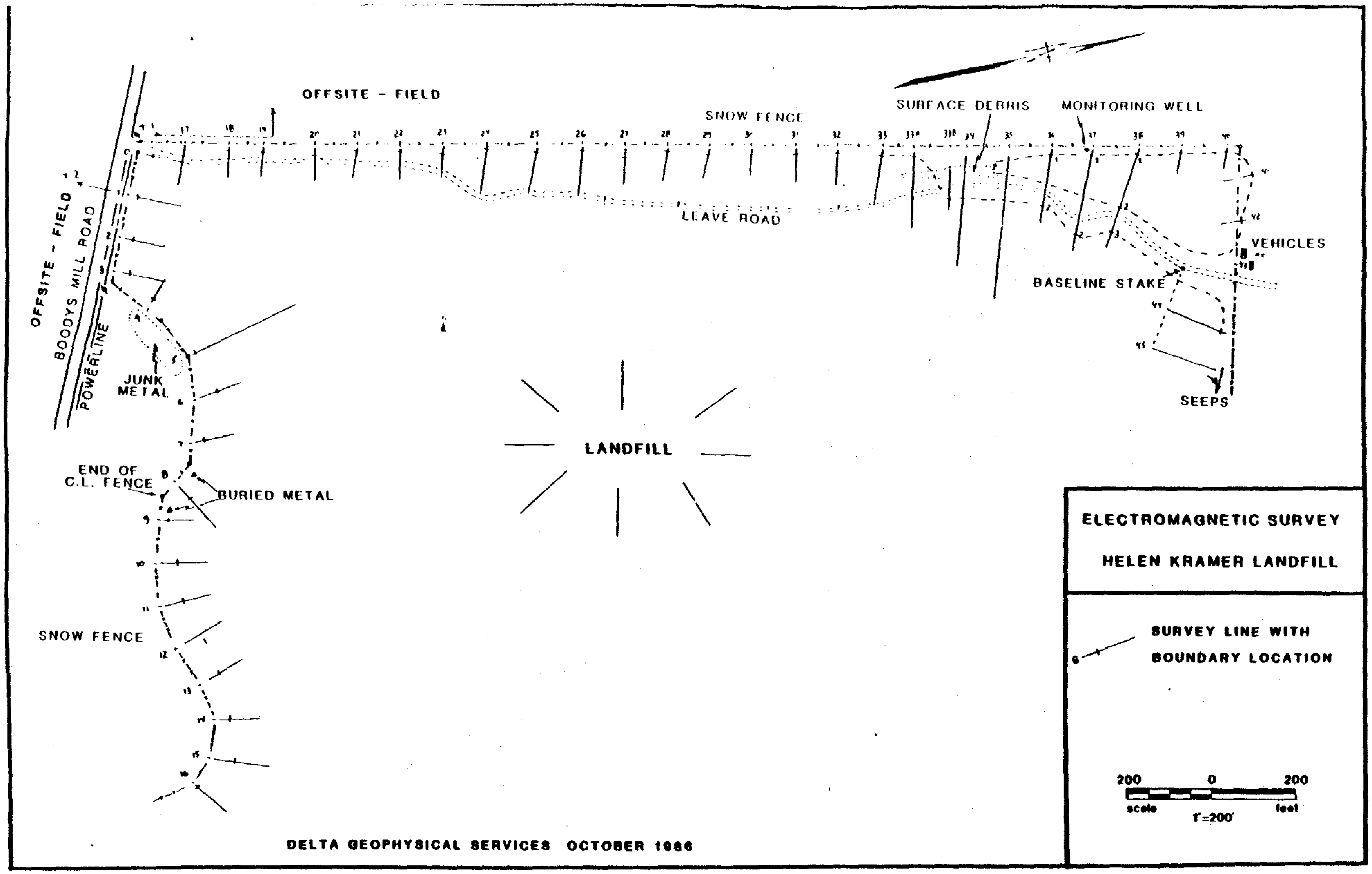
The flagged boundary locations are accurate to approximately five feet, depending upon local external interferences (fences, powerlines, surface metal, etc.) and the thickness of trash at the boundary. Survey lines 4 & 5 were influenced by junk metal on the adjoining property, and survey lines 33A, 33B, and 34 may have been influenced by surface debris (mostly wood) in this area. However, the boundary locations on these lines are still interpreted to be quite accurate. If deemed necessary, test pits could be excavated to provide better delineation of the landfill boundary in these areas, and to evaluate the accuracy of the electromagnetic survey.

If you have any further questions or comments concerning this report, please do not hesitate to contact us. It was a pleasure to have worked with you on this project. Thank you for your confidence in Delta.

Very truly yours,
Delta Geophysical Services

Philip H. Duoos
Geophysical Engineer

PHD:hp


OFFSITE - FIELD
SNOW FENCE
SURFACE DEBRIS
MONITORING WELL
OFFSITE - FIELD
BOODYS MILL ROAD
POWERLINE
LEAVE ROAD
VEHICLES
BASELINE STAKE
JUNK METAL
SEEPS
LANDFILL
END OF C.L. FENCE
BURIED METAL
SNOW FENCE
ELECTROMAGNETIC SURVEY
HELEN KRAMER LANDFILL
SURVEY LINE WITH BOUNDARY LOCATION
200 0 200
scale feet
1"=200'
DELTA GEOPHYSICAL SERVICES OCTOBER 1986

APPENDIX 5-2

LOGS OF BORINGS AND PIEZOMETER CONSTRUCTION DETAILS

DR 000514

NOTES:

1. THE FIGURES IN THE COLUMN LABELED "BLOW COUNT" REFER TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT. THE STANDARD SPLIT-SPOON SAMPLER IS 2 INCHES O.D. AND 1 3/8 INCHES I.D. THE STANDARD SPLIT-SPOON SAMPLER USED A 140 LB HAMMER AT A 30 INCH DROP.

2. THE FIGURES IN THE BLOW COUNT COLUMN INDICATES THE FOLLOWING:

   ■ -INDICATES THAT THE SHELBY TUBE SAMPLER WAS USED FOR UNDISTURBED SAMPLING.

   ⊠ -INDICATES THAT THE DENNISON SAMPLER WAS USED FOR UNDISTURBED SAMPLING.

   ◪ -INDICATES THAT THE STANDARD SPLIT-SPOON SAMPLER WAS USED FOR SAMPLING.

   □ -INDICATES THAT SAMPLING WAS ATTEMPTED BUT NO SAMPLE WAS RECOVERED.

3. ELEVATIONS REFER TO THE NGVD DATUM.

4. EXPLOSIVE VAPORS FROM SAMPLES MONITORED WITH AN EXPLOSIMETER AND REPORTED IN % OF LOWWER EXPLOSIVE LIMIT.(EXP-__) ORGANIC VAPORS FROM SAMPLES MONITORED WITH AN H Nu PHOTO IONIZATION DETECTOR AND REPORTED IN PPM (PID-__).

5. UNDRAINED SHEAR STRENGTH OF UNDISTURBED SAMPLES WAS CHECKED USING A POCKET TORVANE AND REPORTED IN TONS PER SQUARE FEET (S_u-__).

6. THE DISCUSSION IN THE TEXT OF THIS REPORT IS NECESSARY FOR A PROPER UNDERSTANDING OF THE NATURE OF THE SUBSURFACE MATERIALS.

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		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
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

FORM NO. 467.3 (4-78)

DAMES & MOORE

PLATE

BORING SB-1

SURFACE ELEVATION

Symbols	Descriptions	Geologic Formation
SP	YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, LOOSE GRADING TRACE CLAY, MEDIUM DENSE	MT. LAUREL - WENONAH
SC	YELLOWISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, TRACE SILT, MOIST, MEDIUM DENSE	MT. LAUREL - WENONAH
SP/SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, TRACE FERRUGINOUS, MOIST, MEDIUM DENSE	MT. LAUREL - WENONAH
SM	GRAYISH BROWN TO BROWN SILTY FINE TO MEDIUM SAND, TRACE FERRUGINOUS, MOIST, MEDIUM DENSE GRADING GRAYISH BROWN TO ORANGE BROWN SILTY FINE SAND GRADING GRAYISH BROWN TO BROWN, OCCASIONAL LOOSE GRADING TRACE FERRUGINOUS	MT. LAUREL - WENONAH
SM	BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, MOIST, MEDIUM DENSE GRADING TRACE TO LITTLE CLAY GRADING VERY DENSE (Su=0.39) (Su=0.85) (Su=1.0) (Su=0.41) GRADING DENSE (Su=0.33) (Su0.49) (Su=0.39) (Su=0.53)	MARSHALLTOWN
SP	LIGHT GRAY FINE SAND, TRACE SILT, MOIST, VERY DENSE	ENGLISHTOWN
ML	GRAY MICACEOUS CLAYEY SILT, TRACE TO LITTLE FINE SAND, DRY, HARD	ENGLISHTOWN
SP	LIGHT GRAY FINE SAND, TRACE SILT, POCKETS GRAY CLAYEY SILT, MOIST, VERY DENSE	ENGLISHTOWN

Depth in feet: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90

Blow count (samples): 7, 6, 13, 17, 17, 18, 22, 20, 20, 14, 21, 18, 15, 16, 16, 13, 12, 11, 12, 10, 9, 14, 15, 18, 11, 10, 11, 9, 9, 12, 9, 12, 12, ... 87, 58, 104, 140, 83, 135

1. BORING COMPLETED AT 89 FEET ON 11/5/86.
2. GROUNDWATER LEVEL RECORDED AT 20 FEET 10/29/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/5/86.

DR 000517

BORING SB-2

SURFACE ELEVATION

DEPTH IN FEET | SAMPLES | BLOW COUNT | SYMBOLS | DESCRIPTIONS | GEOLOGIC FORMATION

Blow Count
7
6
7
7
12
15
16
20
17
19
21
20
19
26
16
21
18
13
13
13
17
8
11
15

Depth (ft)	Symbol	Description	Geologic Formation
0 – ~2.5	SC	YELLOWISH BROWN CLAYEY FINE SAND, TRACE SILT, TRACE ROOT, MOIST, LOOSE GRADING LITTLE CLAY	MT. LAUREL - WENONAH
~2.5 – ~5.5	SM	YELLOWISH BROWN SILTY FINE TO MEDIUM SAND, TRACE CLAY, MOIST, LOOSE	MT. LAUREL - WENONAH
~5.5 – ~18	SP	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, MEDIUM DENSE GRADING TRACE FERRUGINOUS, MOIST	MT. LAUREL - WENONAH
~18 – ~48	SM	GRAYISH BROWN TO BROWN SILTY FINE SAND, TRACE FERRUGINOUS, MOIST, MEDIUM DENSE	MT. LAUREL - WENONAH
~48 – 58	SM	BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, WET, DENSE (Su=1.0) GRADING MEDIUM DENSE (Su=0.28) (Su=0.24) (Su=0.32)	MARSHALLTOWN

1. BORING COMPLETED AT 58 FEET ON 11/5/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/5/86.

DR 000518

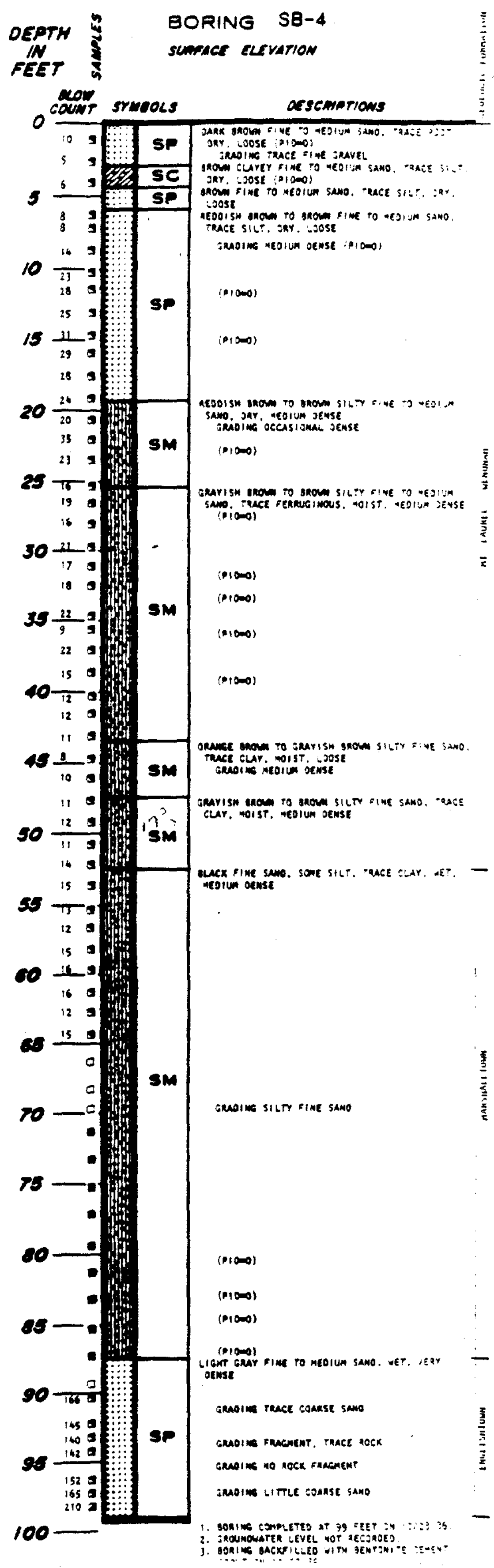
BORING SB-3

SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SYMBOLS	DESCRIPTIONS
0	5	SP	BROWN FINE TO MEDIUM SAND, TRACE ROOT, MOIST, LOOSE
	8	SP	ORANGE BROWN TO BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE SILT, MOIST, LOOSE
	12	SC	ORANGE BROWN TO BROWN CLAYEY FINE TO MEDIUM SAND, TRACE SILT, MOIST, MEDIUM DENSE
5	9	SP	ORANGE BROWN TO BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE SILT, MOIST, LOOSE
	19	SP	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, MOIST, MEDIUM DENSE
	23		
10	21		
	24		GRADING OCCASIONAL DENSE
	35		
15	23		
	28		
	31		
	30		GRADING DENSE
20		SP	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, DRY, DENSE
	36		
	29		GRADING MEDIUM DENSE
		SM	ALTERNATE GRAYISH BROWN AND ORANGE BROWN FINE TO MEDIUM SAND, LITTLE SILT, DRY, MEDIUM DENSE
25	22		
	22		GRADING DENSE
	36		GRADING MEDIUM DENSE
	12		
30			
35	14		
40	7		GRADING LOOSE
45	10	SM	GRAYISH BROWN SILTY FINE TO MEDIUM SAND, MOIST, MEDIUM DENSE (MODERATELY CONTAMINATED)
50	12		
	13		
55	14		
	10	SM	BLACK SILTY FINE SAND, TRACE TO LITTLE CLAY, WET, MEDIUM DENSE (Su=0.18)
60			Su=0.21)
			GRADING DENSE (Su=0.34)
			(Su=0.34)
65			(Su=0.20)
70			

GEOLOGIC FORMATION: MT. LAUREL - WENONAH; MARSHALLTOWN

1. BORING COMPLETED AT 68.5 FEET ON 11/6/86.
2. GROUNDWATER LEVEL RECORDED AT 26 FEET ON 11/5/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/6/86.



BORING SB-4
SURFACE ELEVATION
DEPTH IN FEET
SAMPLES
BLOW COUNT
SYMBOLS
DESCRIPTIONS
SP
DARK BROWN FINE TO MEDIUM SAND, TRACE ROOT, DRY, LOOSE (PID=0)
GRADING TRACE FINE GRAVEL
SC
BROWN CLAYEY FINE TO MEDIUM SAND, TRACE SILT, DRY, LOOSE (PID=0)
SP
BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, LOOSE
SP
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, LOOSE
GRADING MEDIUM DENSE (PID=0)
(PID=0)
(PID=0)
SM
REDDISH BROWN TO BROWN SILTY FINE TO MEDIUM SAND, DRY, MEDIUM DENSE
GRADING OCCASIONAL DENSE
(PID=0)
SM
GRAYISH BROWN TO BROWN SILTY FINE TO MEDIUM SAND, TRACE FERRUGINOUS, MOIST, MEDIUM DENSE
(PID=0)
(PID=0)
(PID=0)
(PID=0)
(PID=0)
SM
ORANGE BROWN TO GRAYISH BROWN SILTY FINE SAND, TRACE CLAY, MOIST, LOOSE
GRADING MEDIUM DENSE
SM
GRAYISH BROWN TO BROWN SILTY FINE SAND, TRACE CLAY, MOIST, MEDIUM DENSE
SM
BLACK FINE SAND, SOME SILT, TRACE CLAY, WET, MEDIUM DENSE
GRADING SILTY FINE SAND
(PID=0)
(PID=0)
(PID=0)
(PID=0)
SP
LIGHT GRAY FINE TO MEDIUM SAND, WET, VERY DENSE
GRADING TRACE COARSE SAND
GRADING FRAGMENT, TRACE ROCK
GRADING NO ROCK FRAGMENT
GRADING LITTLE COARSE SAND
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
10
5
6
8
8
14
23
28
25
31
29
28
24
20
35
23
16
19
16
21
17
18
22
9
22
15
12
12
11
8
10
11
12
11
14
15
13
12
15
16
16
12
15
166
145
140
142
152
165
210
1. BORING COMPLETED AT 99 FEET ON
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT

DR 000520

BORING SB-5

SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
0	6	■	SM	YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE SILT, TRACE CLAY, TRACE ROOT, OCCASIONAL FINE GRAVEL, MOIST, LOOSE	
	11	■	SP-SM	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, MEDIUM DENSE	
	7	■	SP/SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, LOOSE	
5	8	■			
	7	■			
	8	■			
10	14	■		GRADING MEDIUM DENSE	
	12	■			
	12	■			
15	14	■			
	16	■			
	22	■			
	24	■	SP	YELLOWISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, MEDIUM DENSE	MT. LAUREL - WENONAH
20	23	■		GRADING DENSE	
	31	■			
25	24	■		GRADING MEDIUM DENSE	
	11	■		GRADING YELLOWISH BROWN TO BROWN FINE TO MEDIUM SAND, MOIST	
30	14	■			
35	29	■	SP/SM	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, TRACE CLAY, MOIST, MEDIUM DENSE	
40	21	■			
45	7	■		GRADING LOOSE	
50	8	■	SM	REDDISH BROWN TO BROWN SILTY FINE SAND, TRACE CLAY, MOIST, LOOSE	
55	8	■	ML	BLACK SANDY SILT, TRACE TO LITTLE CLAY, TRACE MICA, WET, MEDIUM STIFF	MARSHALLTOWN
		■			
		□			
60		■			
		■			
		■		GRADING VERY STIFF	
65					
70					

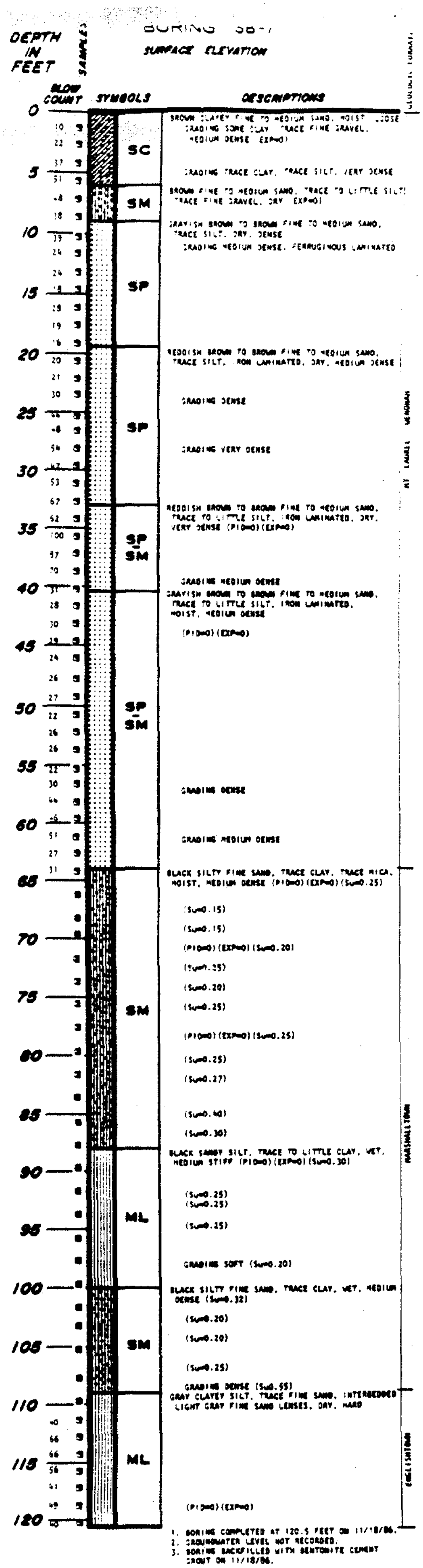
1. BORING COMPLETED AT 64.5 FEET ON 10/30/86.
2. GROUNDWATER LEVEL RECORDED AT 26.2 FEET ON 10/29/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 10/30/86.

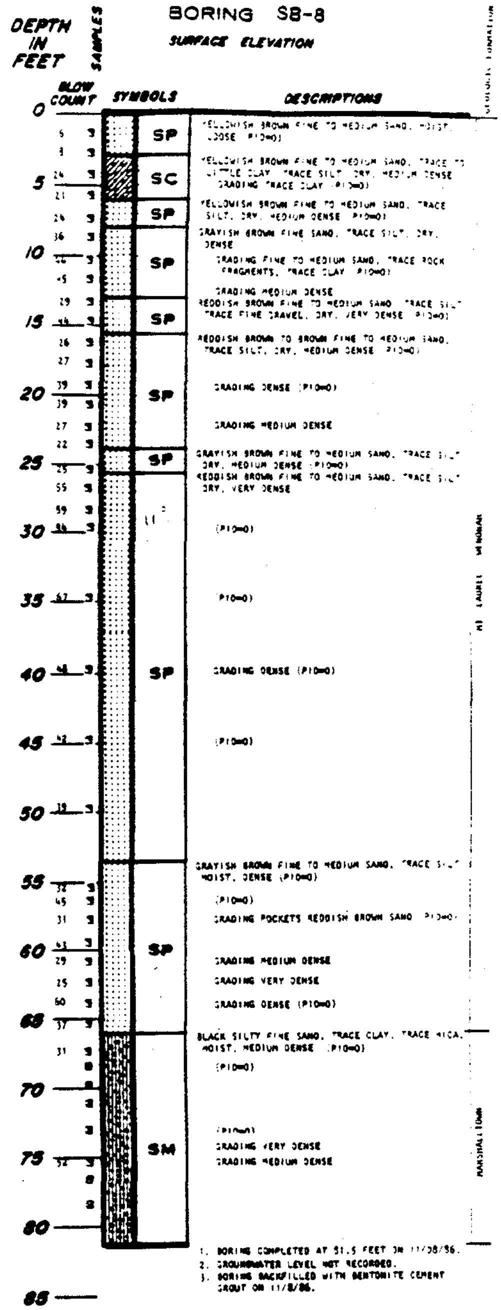
BORING SB-6

SURFACE ELEVATION

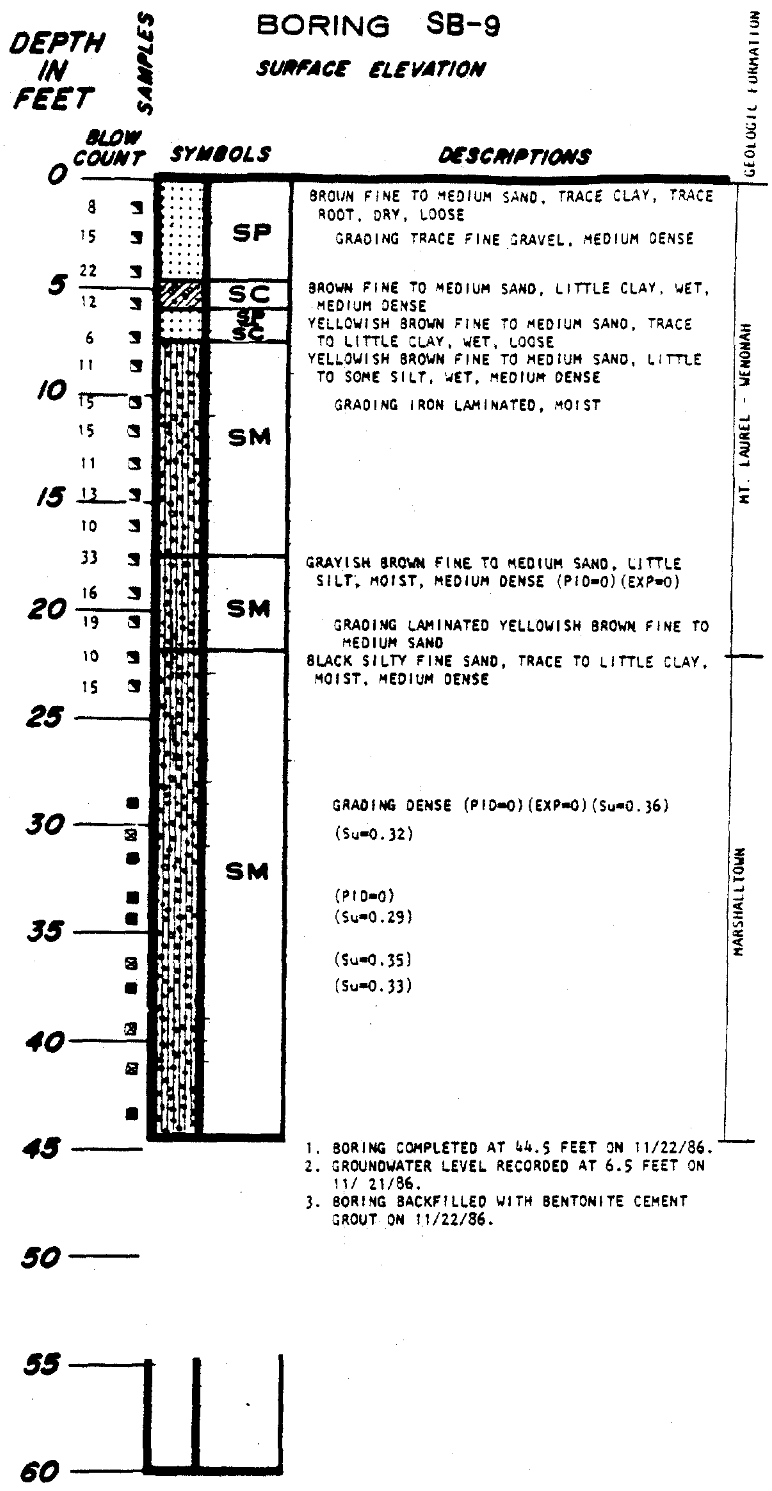
DEPTH IN FEET	BLOW COUNT	SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
0	11	SC	BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, MOIST, MEDIUM DENSE	MT. LAUREL - WENONAH
	28	SC	YELLOWISH BROWN TO BROWN CLAYEY FINE SAND, TRACE SILT, TRACE ROOTS, DRY, MEDIUM DENSE	
	33		GRADING CLAYEY FINE TO MEDIUM SAND, DENSE	
5	28		GRADING TRACE TO LITTLE CLAY	
	27	SP	YELLOWISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE CLAY, DRY, MEDIUM DENSE	
	25			
10			GRADING DENSE	
	35	SP	REDDISH BROWN FERRUGINOUS FINE TO MEDIUM SAND, TRACE SILT, DRY, DENSE	
	33			
	26	SP	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, VERY DENSE	
15	57			
	56			
	31	SP	YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE FERRUGINOUS, DRY, MEDIUM DENSE	
	29		GRADING DENSE	
20	34	SP	REDDISH BROWN FINE TO MEDIUM SAND, TRACE FERRUGINOUS, DRY, DENSE	
	39			
	57		GRADING VERY DENSE	
25	134		GRADING LITTLE FERRUGINOUS	
	63		GRADING MOIST	
	57			
30	48		GRADING DENSE	
35	32		GRADING VERY DENSE	
40	61			
45	19	SP	GRAYISH BROWN FINE TO MEDIUM SAND, TRACE SILT, FERRUGINOUS LAMINATION, MOIST, MEDIUM DENSE	
50	18	SP	REDDISH BROWN FINE TO MEDIUM SAND, TRACE SILT, FERRUGINOUS LAMINATION, MOIST, MEDIUM DENSE TRACE FINE GRAVEL	
55	33		GRADING DENSE	
	30			
	52		GRADING VERY DENSE	
	36		GRADING DENSE	
60	32		GRADING MEDIUM DENSE	
	18			
	24	SM	BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, MOIST, MEDIUM DENSE	MARSHALLTOWN
65				
70			GRADING TRACE TO LITTLE CLAY (Su=0.15)	
			(Su=0.20)	
			(Su=0.15)	
75				
80				

1. BORING COMPLETED AT 76 FEET ON 11/10/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/10/86.


BORING SB-7
SURFACE ELEVATION
DEPTH IN FEET
SAMPLES
BLOW COUNT
SYMBOLS
DESCRIPTIONS
GEOLOGIC FORMAT.
SC
BROWN CLAYEY FINE TO MEDIUM SAND, MOIST, LOOSE
GRADING SOME CLAY, TRACE FINE GRAVEL, MEDIUM DENSE (EXP=0)
GRADING TRACE CLAY, TRACE SILT, VERY DENSE
SM
BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, TRACE FINE GRAVEL, DRY (EXP=0)
SP
GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, DENSE
GRADING MEDIUM DENSE, FERRUGINOUS LAMINATED
SP
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, IRON LAMINATED, DRY, MEDIUM DENSE
GRADING DENSE
GRADING VERY DENSE
SP-SM
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, IRON LAMINATED, DRY, VERY DENSE (PI=0)(EXP=0)
GRADING MEDIUM DENSE
SP-SM
GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, IRON LAMINATED, MOIST, MEDIUM DENSE
(PI=0)(EXP=0)
GRADING DENSE
GRADING MEDIUM DENSE
MT LAUREL WENONAH
SM
BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, MOIST, MEDIUM DENSE (PI=0)(EXP=0)(Su=0.25)
(Su=0.15)
(Su=0.15)
(PI=0)(EXP=0)(Su=0.20)
(Su=0.25)
(Su=0.20)
(Su=0.25)
(PI=0)(EXP=0)(Su=0.25)
(Su=0.25)
(Su=0.27)
(Su=0.40)
(Su=0.30)
ML
BLACK SANDY SILT, TRACE TO LITTLE CLAY, WET, MEDIUM STIFF (PI=0)(EXP=0)(Su=0.30)
(Su=0.25)
(Su=0.25)
(Su=0.25)
GRADING SOFT (Su=0.20)
SM
BLACK SILTY FINE SAND, TRACE CLAY, WET, MEDIUM DENSE (Su=0.32)
(Su=0.20)
(Su=0.20)
(Su=0.25)
GRADING DENSE (Su=0.55)
MARSHALLTOWN
ML
GRAY CLAYEY SILT, TRACE FINE SAND, INTERBEDDED LIGHT GRAY FINE SAND LENSES, DRY, HARD
(PI=0)(EXP=0)
ENGLISHTOWN
1. BORING COMPLETED AT 120.5 FEET ON 11/18/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/18/86.


BORING SB-8
SURFACE ELEVATION
DEPTH IN FEET
SAMPLES
BLOW COUNT
SYMBOLS
DESCRIPTIONS
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
SP
SC
SP
SP
SP
SP
SP
SP
SP
SM
YELLOWISH BROWN FINE TO MEDIUM SAND, MOIST, LOOSE (PID=0)
YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, TRACE SILT, DRY, MEDIUM DENSE
GRADING TRACE CLAY (PID=0)
YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, MEDIUM DENSE (PID=0)
GRAYISH BROWN FINE SAND, TRACE SILT, DRY, DENSE
GRADING FINE TO MEDIUM SAND, TRACE ROCK FRAGMENTS, TRACE CLAY (PID=0)
GRADING MEDIUM DENSE
REDDISH BROWN FINE TO MEDIUM SAND, TRACE SILT TRACE FINE GRAVEL, DRY, VERY DENSE (PID=0)
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, MEDIUM DENSE (PID=0)
GRADING DENSE (PID=0)
GRADING MEDIUM DENSE
GRAYISH BROWN FINE TO MEDIUM SAND, TRACE SILT DRY, MEDIUM DENSE (PID=0)
REDDISH BROWN FINE TO MEDIUM SAND, TRACE SILT DRY, VERY DENSE
(PID=0)
(PID=0)
GRADING DENSE (PID=0)
(PID=0)
GRAYISH BROWN FINE TO MEDIUM SAND, TRACE SILT MOIST, DENSE (PID=0)
(PID=0)
GRADING POCKETS REDDISH BROWN SAND (PID=0)
GRADING MEDIUM DENSE
GRADING VERY DENSE
GRADING DENSE (PID=0)
BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, MOIST, MEDIUM DENSE (PID=0)
(PID=0)
(PID=0)
GRADING VERY DENSE
GRADING MEDIUM DENSE
1. BORING COMPLETED AT 81.5 FEET ON 11/08/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/8/86.
GEOLOGIC FORMATION
NJ LAUREL WENONAH
MARSHALLTOWN

DR 000524



BORING SB-9
SURFACE ELEVATION
DEPTH IN FEET
SAMPLES
BLOW COUNT
SYMBOLS
DESCRIPTIONS
GEOLOGIC FORMATION
0
8
15
22
5
12
6
11
10
15
15
11
15
13
10
33
16
20
19
10
15
25
30
35
40
45
50
55
60
SP
SC
SP
SC
SM
SM
SM
BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE ROOT, DRY, LOOSE
GRADING TRACE FINE GRAVEL, MEDIUM DENSE
BROWN FINE TO MEDIUM SAND, LITTLE CLAY, WET, MEDIUM DENSE
YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, WET, LOOSE
YELLOWISH BROWN FINE TO MEDIUM SAND, LITTLE TO SOME SILT, WET, MEDIUM DENSE
GRADING IRON LAMINATED, MOIST
GRAYISH BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, MEDIUM DENSE (PID=0)(EXP=0)
GRADING LAMINATED YELLOWISH BROWN FINE TO MEDIUM SAND
BLACK SILTY FINE SAND, TRACE TO LITTLE CLAY, MOIST, MEDIUM DENSE
GRADING DENSE (PID=0)(EXP=0)(Su=0.36)
(Su=0.32)
(PID=0)
(Su=0.29)
(Su=0.35)
(Su=0.33)
MT. LAUREL - WENONAH
MARSHALLTOWN
1. BORING COMPLETED AT 44.5 FEET ON 11/22/86.
2. GROUNDWATER LEVEL RECORDED AT 6.5 FEET ON 11/21/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/22/86.

DR 000525

BORING SB-10

SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
0	3	SP	MOTTLED YELLOWISH BROWN TO BROWN FINE TO MEDIUM SAND, POCKETS GREENISH BROWN CLAYEY SAND, WET, VERY LOOSE	MT. LAUREL - WENONAH
	7	SC	GREENISH BROWN CLAYEY FINE TO MEDIUM SAND, TRACE SILT, WET, MEDIUM DENSE	
	13	SC	MOTTLED GREEN AND BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, TRACE SILT, WET, MEDIUM DENSE	
5	14, 12	SP	MOTTLED GREEN AND BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE FINE GRAVEL, TRACE SILT, WET, MEDIUM DENSE	
10	12, 9, 5	SM	YELLOWISH BROWN SILTY FINE SAND, MOIST, MEDIUM DENSE GRADING YELLOWTSH BROWN TO BROWN VERY FINE SAND, TRACE SILT, LOOSE	
15	6	SM	BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, MOIST, LOOSE (PID=15) (EXP=0)	MARSHALLTOWN
20			GRADING MEDIUM DENSE (Su=0.17) (PID=1.0)	
25			(Su=0.22) (Su=0.30) GRADING DENSE (Su=0.36)	
30			(Su=0.58) (Su=0.50) (Su=0.52)	
35			GRADING VERY DENSE (Su=0.64)	
40				

1. BORING COMPLETED AT 39 FEET ON 11/13/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/13/86.

DR 000526

BORING SB-11

SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
0	7 14		SP	REDDISH BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE ROOT, DRY, LOOSE (PID=5) GRADING MEDIUM DENSE	MT. LAUREL - WENONAH
5	4 10 11 14		SP	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, LOOSE GRADING MEDIUM DENSE (EXP=0)	MT. LAUREL - WENONAH
10 – 45	13		SM	BLACK SILTY FINE SAND, TRACE TO LITTLE CLAY, WET, MEDIUM DENSE (Su=0.16) (Su=0.13) (Su=0.16) (Su=0.13) (Su=0.14) GRADING DENSE (Su=0.43) (Su=0.59) (Su=0.49)	MARSHALLTOWN

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

1. BORING COMPLETED AT 45 FEET ON 11/21/86.
2. GROUNDWATER LEVEL RECORDED AT 9 FEET ON 11/20/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/21/86.

BORING SB-14

SURFACE ELEVATION

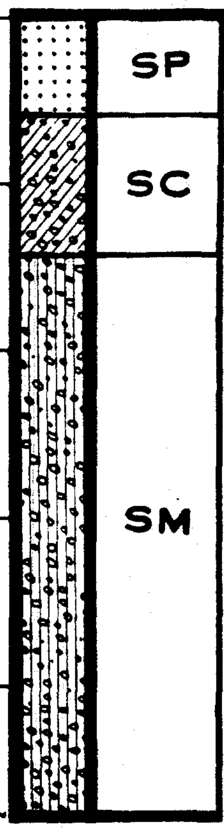
DEPTH IN FEET	BLOW COUNT	SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
0	3	SC	YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, TRACE SILT, MOIST, VERY LOOSE	MT. LAUREL - WENONAH
	3	SP-SC	YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE SILT, MOIST, VERY LOOSE	
5	6, 2, 3, 2	SC	BROWN FINE TO MEDIUM SAND AND GREENISH GRAY SANDY CLAY, MOIST, LOOSE GRADING INTERBEDDED WITH ORGANIC BLACK FINE SANDY SILT, WET, VERY LOOSE GRADING NO BLACK FINE SANDY SILT	
10	9, 10	SP	BROWN FINE TO MEDIUM SAND, TRACE SILT, MOIST, LOOSE GRADING CONTAINING CLUSTERS OF BLACK FINE SANDY SILT (PID=0)	
15–35	2, 2	SM	BLACK SILTY FINE SAND, TRACE WOOD, MOIST, VERY LOOSE (PID=0) GRADING NO WOOD, WET GRADING VERY DENSE (PID=1.0) (Su=0.42) (PID=0.8) (Su=0.83) (Su=0.63) GRADING DENSE (PID=0) (Su=0.37) (PID=0) (Su=0.33) (PID=0) (Su=0.31) (PID=0) (Su=0.38) (Su=0.25) (Su=0.41)	MARSHALLTOWN
35	78, 102	SP	LIGHT GRAY FINE SAND, TRACE SILT, MOIST, VERY DENSE GRADING FINE TO MEDIUM SAND	ENGLISHTOWN
40				

1. BORING COMPLETED AT 38.5 FEET ON 11/7/86.
2. GROUNDWATER LEVEL RECORDED AT 2 FEET ON 11/5/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/7/86

BORING SB-13

SURFACE ELEVATION

DEPTH IN FEET | **SAMPLES** | **BLOW COUNT** | **SYMBOLS** | **DESCRIPTIONS** | GEOLOGIC FORMATION



Depth	Blow Count	Description	Geologic Formation
0	4, 8	BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE ROOT, MOIST, LOOSE	MT. LAUREL - WENONAH
5	7, 20	BROWN TO GRAYISH BROWN CLAYEY FINE TO MEDIUM SAND, MOIST, LOOSE (PID=4) GRADING LITTLE CLAY GRADING MOTTLED GRAYISH BROWN AND ORANGE BROWN COLOR POCKETS BLACK FINE SAND	MT. LAUREL - WENONAH
	7	BLACK SILTY FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, WET, DENSE (PID=10)(Su=0.34)	MARSHALLTOWN
10			MARSHALLTOWN
15		(EXP=20) (Su=0.45)	MARSHALLTOWN
20		(Su=0.54)	MARSHALLTOWN
		(Su=0.43)	MARSHALLTOWN
25			
30			

1. BORING COMPLETED AT 24.1 FEET ON 11/17/86.
2. GROUNDWATER LEVEL RECORDED AT 6 FEET ON 11/12/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUNT ON 11/12/86.

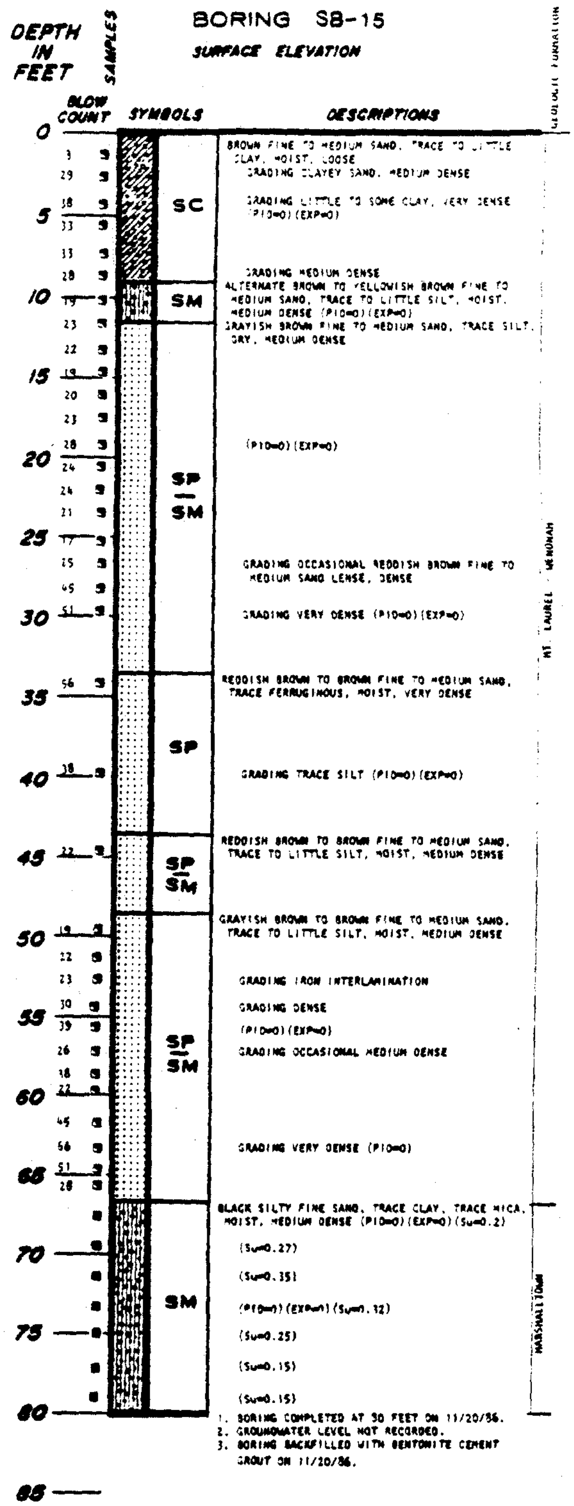
DR 000529

BORING SB-12

SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
0	5, 9, 10	SP	MOTTLED GREEN AND BROWN FINE SAND, TRACE SILT, TRACE CLAY, WET, LOOSE GRADING FINE TO MEDIUM SAND	MT. LAUREL - WENONAH
5	4, 2, 8, 3, 2	SC	MOTTLED GREEN AND BROWN CLAYEY FINE SAND, TRACE SILT, TRACE WOOD, WET, VERY LOOSE GRADING TRACE TO LITTLE CLAY GRADING LOOSE GRADING VERY LOOSE	MT. LAUREL - WENONAH
13		SM	BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, MOIST, LOOSE (PID=15) (EXP=0) GRADING DENSE (Su=0.38) (Su=0.41) (EXP=0) (Su=0.40) (Su=0.43) (Su=0.44) (Su=0.36) (Su=0.30) (Su=0.36) (Su=0.43) (Su=0.30) GRADING TRACE TO LITTLE CLAY	MARSHALLTOWN
40	62	ML	BLACK SILT, LITTLE FINE SAND, TRACE TO LITTLE CLAY, TRACE MICA, MOIST, HARD GRADING SOME FINE SAND	MARSHALLTOWN
43	30, 32, 31, 25, 29, 30, 37, 24	ML	DARK GRAY CLAYEY SILT INTERBEDDED VERY FINE SAND LENSES, DRY, HARD GRADING VERY STIFF GRADING HARD GRADING VERY STIFF	ENGLISHTOWN
60				

1. BORING COMPLETED AT 58 FEET ON 11/11/86.
2. CASING USED TO 18 FEET.
3. GROUNDWATER LEVEL NOT RECORDED.
4. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/12/86.



BORING SB-15
SURFACE ELEVATION
DEPTH IN FEET
SAMPLES
BLOW COUNT
SYMBOLS
DESCRIPTIONS
GEOLOGIC FORMATION
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
3
29
38
33
33
28
19
23
22
19
20
23
28
24
24
21
17
25
45
51
56
38
22
19
22
23
30
39
26
38
22
45
56
51
28
SC
SM
SP/SM
SP
SP/SM
SP/SM
SM
BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, MOIST, LOOSE
GRADING CLAYEY SAND, MEDIUM DENSE
GRADING LITTLE TO SOME CLAY, VERY DENSE (PID=0) (EXP=0)
GRADING MEDIUM DENSE
ALTERNATE BROWN TO YELLOWISH BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, MEDIUM DENSE (PID=0) (EXP=0)
GRAYISH BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, MEDIUM DENSE
(PID=0) (EXP=0)
GRADING OCCASIONAL REDDISH BROWN FINE TO MEDIUM SAND LENSE, DENSE
GRADING VERY DENSE (PID=0) (EXP=0)
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE FERRUGINOUS, MOIST, VERY DENSE
GRADING TRACE SILT (PID=0) (EXP=0)
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, MEDIUM DENSE
GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, MEDIUM DENSE
GRADING IRON INTERLAMINATION
GRADING DENSE
(PID=0) (EXP=0)
GRADING OCCASIONAL MEDIUM DENSE
GRADING VERY DENSE (PID=0)
BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, MOIST, MEDIUM DENSE (PID=0) (EXP=0) (Su=0.2)
(Su=0.27)
(Su=0.35)
(PID=0) (EXP=0) (Su=0.32)
(Su=0.25)
(Su=0.15)
(Su=0.15)
1. BORING COMPLETED AT 80 FEET ON 11/20/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/20/86.
MT. LAUREL - WENONAH
MARSHALLTOWN

DR 000531

BORING SB-16

SURFACE ELEVATION

DEPTH IN FEET | **SAMPLES** | **BLOW COUNT** | **SYMBOLS** | **DESCRIPTIONS** | **GEOLOGIC FORMATION**

Blow counts (in order from the surface down): 2, 2, 10, 14, 12, 7, 9, 9, 23, 27, 38, 19, 12, 12, 5, 8, 5, 11, 8, 14, 11

Depth (ft)	Symbol	Description	Geologic Formation
0–5	SP	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE CLAY, MOIST, VERY LOOSE GRADING TRACE SILT, NO CLAY GRADING LOOSE	MT. LAUREL - WENONAH
5–10	SP/SM	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, MEDIUM DENSE GRADING LOOSE (EXP=0)	MT. LAUREL - WENONAH
10–30	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, LOOSE GRADING MEDIUM DENSE (PID=0)(EXP=0) GRADING OCCASIONAL DENSE GRADING LOOSE GRADING MEDIUM DENSE GRADING OCCASIONAL LOOSE	MT. LAUREL - WENONAH
30–50	SM	BLACK SILTY FINE SAND, TRACE CLAY, MOIST, MEDIUM DENSE GRADING TRACE TO LITTLE CLAY	MARSHALLTOWN

1. BORING COMPLETED AT 50 FEET ON 11/25/86.
2. GROUNDWATER LEVEL RECORDED AT 12.5 FEET ON 11/24/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/25/86.

BORING SMW-1

SURFACE ELEVATION

DEPTH IN FEET | SAMPLES | BLOW COUNT | SYMBOLS | DESCRIPTIONS | GEOLOGIC FORMATION

BLOW COUNT
40
6
5
4
4
6
9
10
18
20
20
15
18
15
18
21
17
14
12
9
9
11
64

SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
SC	GRAYISH BROWN TO BROWN, FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, TRACE SILT,, TRACE ROOT, MOIST, LOOSE	MT. LAUREL - WENONAH
SC	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE SILT, MOIST, LOOSE	MT. LAUREL - WENONAH
SC	ORANGE BROWN CLAYEY FINE SAND, TRACE SILT, MOIST, LOOSE	MT. LAUREL - WENONAH
SC	ORANGE BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE SILT, MOIST, LOOSE GRADING MEDIUM DENSE	MT. LAUREL - WENONAH
SP	MOTTLED BROWN AND BLACK FINE TO MEDIUM SAND, TRACE SILT, MOIST, MEDIUM DENSE (PID =0.8 EXP=0)	MT. LAUREL - WENONAH
SC	BLACK FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, WET,MEDIUM DENSE	MT. LAUREL - WENONAH
SC	GRAYISH BROWN FINE SAND, TRACE TO LITTLE CLAY, MOIST, MEDIUM DENSE GRADING WITH CLUSTERS OF GREENISH GRAY SILTY FINE SAND	MT. LAUREL - WENONAH
SP-SM	GRAYISH BROWN TO BROWN FINE SAND, TRACE TO LITTLE SILT, MOIST, MEDIUM DENSE	MT. LAUREL - WENONAH
SM	GRAYISH BROWN TO BROWN, FINETTO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, LOOSE	MT. LAUREL - WENONAH
SM	BLACK SILTY FINE SAND, TRACE TO LITTLE CLAY, MOIST, MEDIUM DENSE GRADING VERY SOFT (Su=0.5) (Su=0.20) (Su=0.20) (Su=0.25) (Su=0.10) GRADING DRY,HARD	MARSHALLTOWN

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55

1. BORING COMPLETED AT 51 FEET ON 11/11/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/11/86.

DR 000533

BORING SMW-2

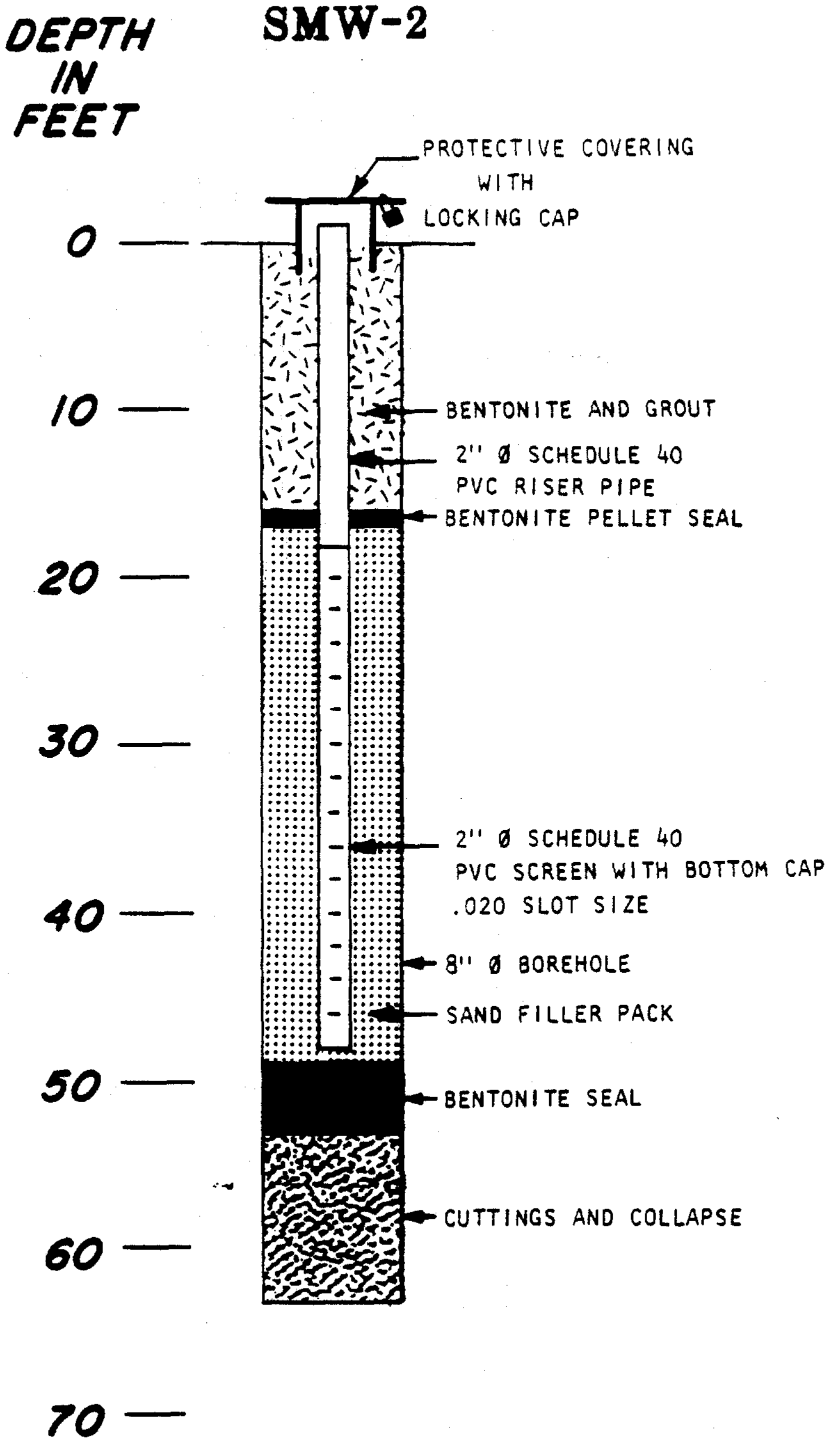
SURFACE ELEVATION

DEPTH IN FEET | SAMPLES | BLOW COUNT | SYMBOLS | DESCRIPTIONS | GEOLOGIC FORMATION

Depth (ft)	Blow Count	Symbol	Descriptions	Geologic Formation
0	8	SP	DARK BROWN FINE TO MEDIUM SAND, TRACE ROOT, MOIST, LOOSE	MT. LAUREL - WENONAH
	13, 13, 6	SP	BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, MOIST, MEDIUM DENSE GRADING LOOSE	
5	18, 23, 22, 34, 32, 32, 27, 23, 22	SP	GRAYISH BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, MEDIUM DENSE GRADING MODERATELY CONTAMINATED (PID=5) (PID=25) GRADING DENSE (PID=50) GRADING MEDIUM DENSE	
20	15, 20, 18, 11	SP	REDDISH BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, DRY, MEDIUM DENSE	
26	14, 19, 12, 12, 3, 20, 12, 20, 14	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, MEDIUM DENSE (EXP=40) (EXP=0) GRADING LOOSE (EXP=0) GRADING MEDIUM DENSE (EXP=0) (EXP=0) (PID=0) (EXP=0)	
50	19	SM	BLACK SILTY FINE SAND, TRACE CLAY, MOIST, MEDIUM DENSE (Su=0.2) (Su=0.13) GRADING DENSE (Su=0.40) (Su=0.25) (Su=0.34) (EXP=0) (Su=0.43)	MARSHALLTOWN
65				

1. BORING COMPLETED AT 63.5 FEET ON 11/20/86.
2. GROUNDWATER LEVEL RECORDED AT 25.5 FEET ON 11/18/86.
3. PIEZOMETER INSTALLED ON 11/20/86.

SMW-2



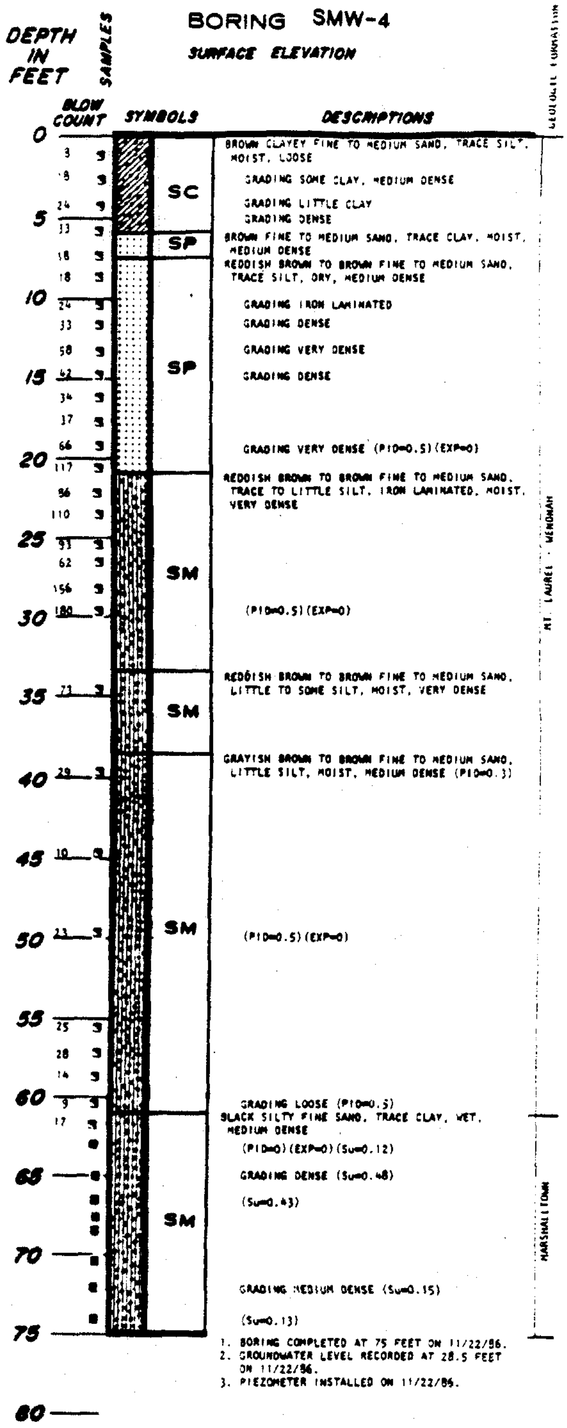
DR 000535

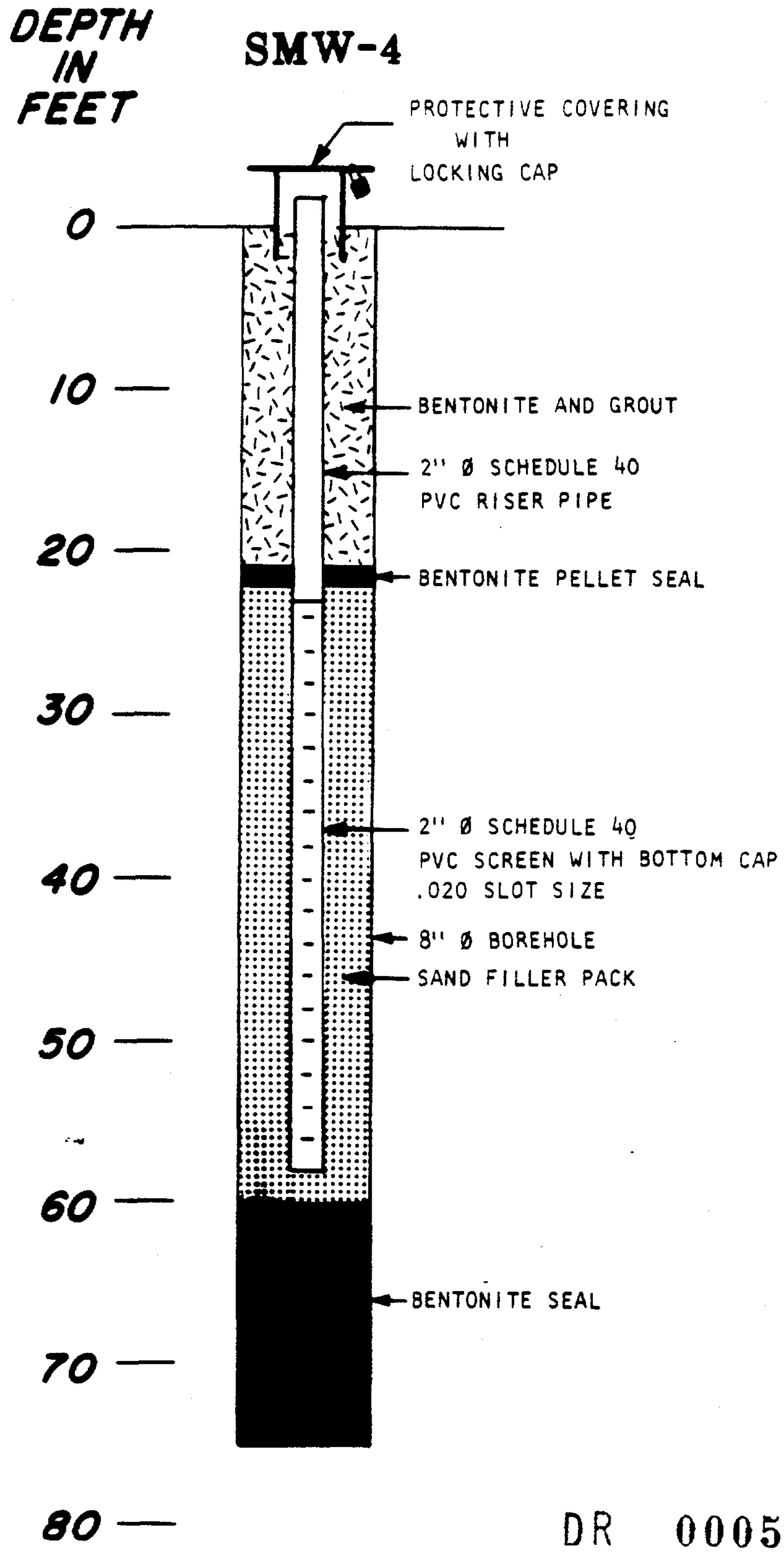
BORING SMW-3

SURFACE ELEVATION

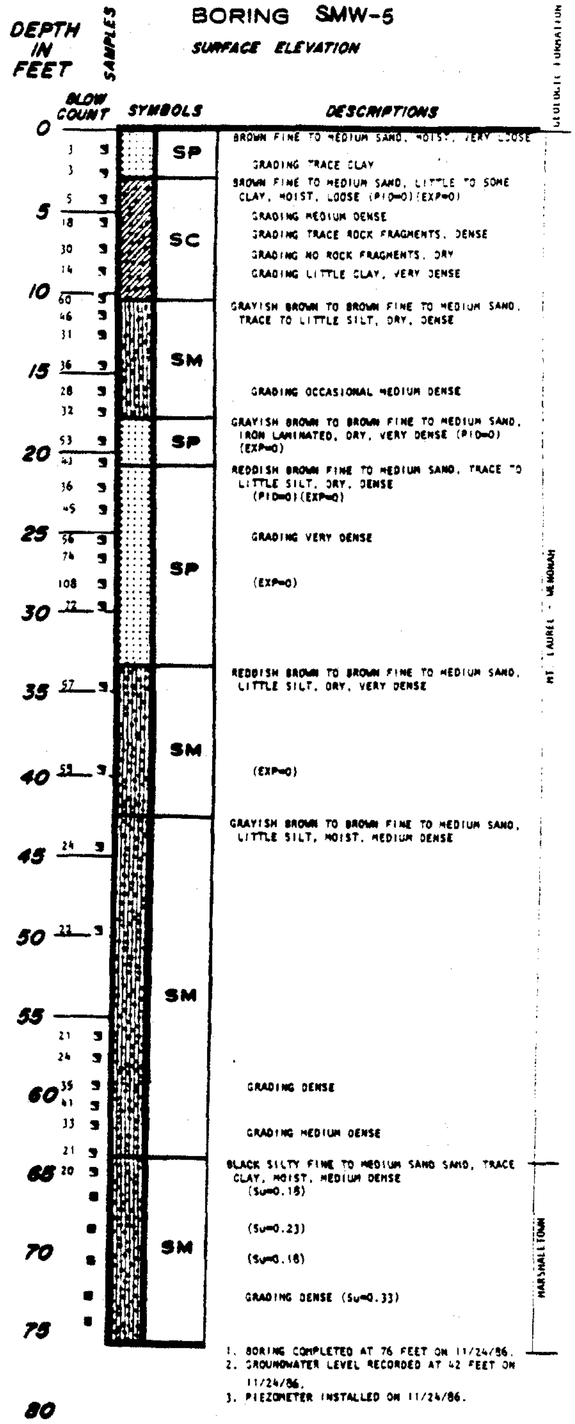
DEPTH IN FEET	SAMPLES / BLOW COUNT	SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
0				MT. LAUREL - WENONAH
	8	SC	BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE CLAY, MOIST, LOOSE	
	20		GRADING TRACE FINE GRAVEL, TRACE WOOD, MEDIUM DENSE	
	43		GRADING DRY, VERY DENSE	
5	42	SP	BROWN FINE TO MEDIUM SAND, TRACE SILT, IRON LAMINATED, DRY, DENSE	
	27		GRADING MEDIUM DENSE	
	31	SP	YELLOWISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, DENSE	
10	23		GRADING MEDIUM DENSE	
	15	SP	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, MEDIUM DENSE	
	18			
15	24			
	36		GRADING DENSE	
	44			
	52		GRADING VERY DENSE	
20	49			
	56	SP	GRADING OCCASIONAL GRAYISH BROWN SAND	
	80			
25	82		GRADING LAMINATED (PID=0)	
	102		GRADING DENSE	
	39			
30	41		(PID=20)(EXP=0)	
35	49		(PID=0)(EXP=0)	
40	36			
45	29	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, MOIST, MEDIUM DENSE	
50	36	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, VERY DENSE	
	67			
	56			
	65	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, VERY DENSE	
55	23	SM	BLACK SILTY FINE SAND, TRACE CLAY, TRACE MICA, MOIST, MEDIUM DENSE (Su=0.10)	MARSHALLTOWN
			(Su=0.32)	
60			(Su=0.37)	
65			(PID=0)(EXP=0)(Su=0.30)	
			(Su=0.22)	
			(Su=0.17)	
70				

1. BORING COMPLETED AT 69 FEET ON 11/21/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. PIEZOMETER INSTALLED ON 11/21/86.


BORING SMW-4
SURFACE ELEVATION
DEPTH IN FEET
SAMPLES
BLOW COUNT
SYMBOLS
DESCRIPTIONS
GEOLOGIC FORMATION
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
3
8
24
33
18
18
24
33
58
42
34
17
66
117
96
110
93
62
156
180
73
29
10
23
25
28
14
9
17
SC
SP
SP
SM
SM
SM
SM
BROWN CLAYEY FINE TO MEDIUM SAND, TRACE SILT, MOIST, LOOSE
GRADING SOME CLAY, MEDIUM DENSE
GRADING LITTLE CLAY
GRADING DENSE
BROWN FINE TO MEDIUM SAND, TRACE CLAY, MOIST, MEDIUM DENSE
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, MEDIUM DENSE
GRADING IRON LAMINATED
GRADING DENSE
GRADING VERY DENSE
GRADING DENSE
GRADING VERY DENSE (PID=0.5)(EXP=0)
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, IRON LAMINATED, MOIST, VERY DENSE
(PID=0.5)(EXP=0)
REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE TO SOME SILT, MOIST, VERY DENSE
GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, MEDIUM DENSE (PID=0.3)
(PID=0.5)(EXP=0)
GRADING LOOSE (PID=0.5)
BLACK SILTY FINE SAND, TRACE CLAY, WET, MEDIUM DENSE
(PID=0)(EXP=0)(Su=0.12)
GRADING DENSE (Su=0.48)
(Su=0.43)
GRADING MEDIUM DENSE (Su=0.15)
(Su=0.13)
MT. LAUREL - WENONAH
MARSHALLTOWN
1. BORING COMPLETED AT 75 FEET ON 11/22/86.
2. GROUNDWATER LEVEL RECORDED AT 28.5 FEET ON 11/22/86.
3. PIEZOMETER INSTALLED ON 11/22/86.

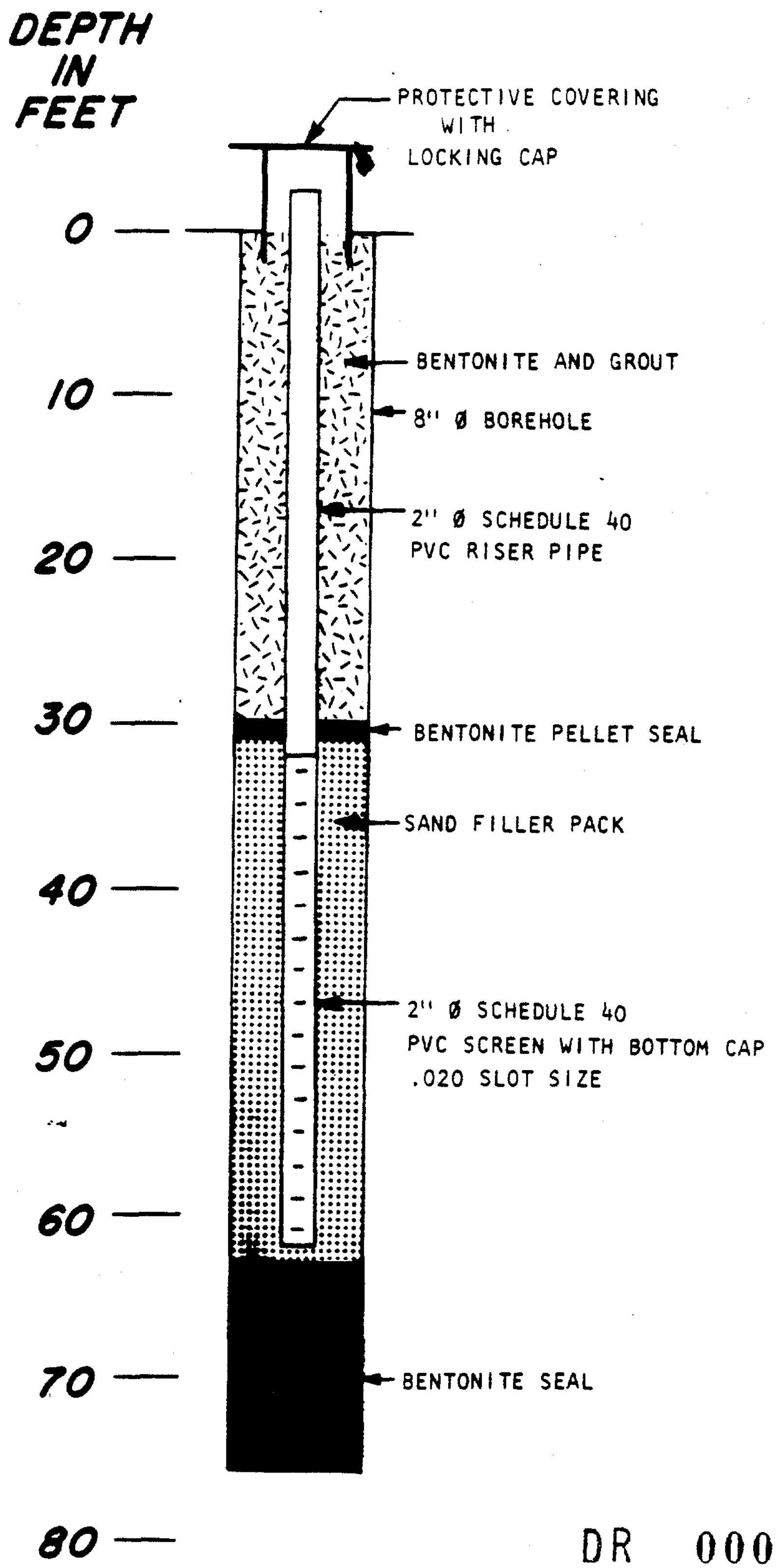

DEPTH
IN
FEET
SMW-4
PROTECTIVE COVERING
WITH
LOCKING CAP
0
10
20
30
40
50
60
70
80
BENTONITE AND GROUT
2" Ø SCHEDULE 40
PVC RISER PIPE
BENTONITE PELLET SEAL
2" Ø SCHEDULE 40
PVC SCREEN WITH BOTTOM CAP
.020 SLOT SIZE
8" Ø BOREHOLE
SAND FILLER PACK
BENTONITE SEAL

DR 000538



1. BORING COMPLETED AT 76 FEET ON 11/24/86.
2. GROUNDWATER LEVEL RECORDED AT 42 FEET ON 11/24/86.
3. PIEZOMETER INSTALLED ON 11/24/86.

SMW-5


DEPTH IN FEET
0
10
20
30
40
50
60
70
80
PROTECTIVE COVERING WITH LOCKING CAP
BENTONITE AND GROUT
8" Ø BOREHOLE
2" Ø SCHEDULE 40 PVC RISER PIPE
BENTONITE PELLET SEAL
SAND FILLER PACK
2" Ø SCHEDULE 40 PVC SCREEN WITH BOTTOM CAP .020 SLOT SIZE
BENTONITE SEAL

BORING SMW-6

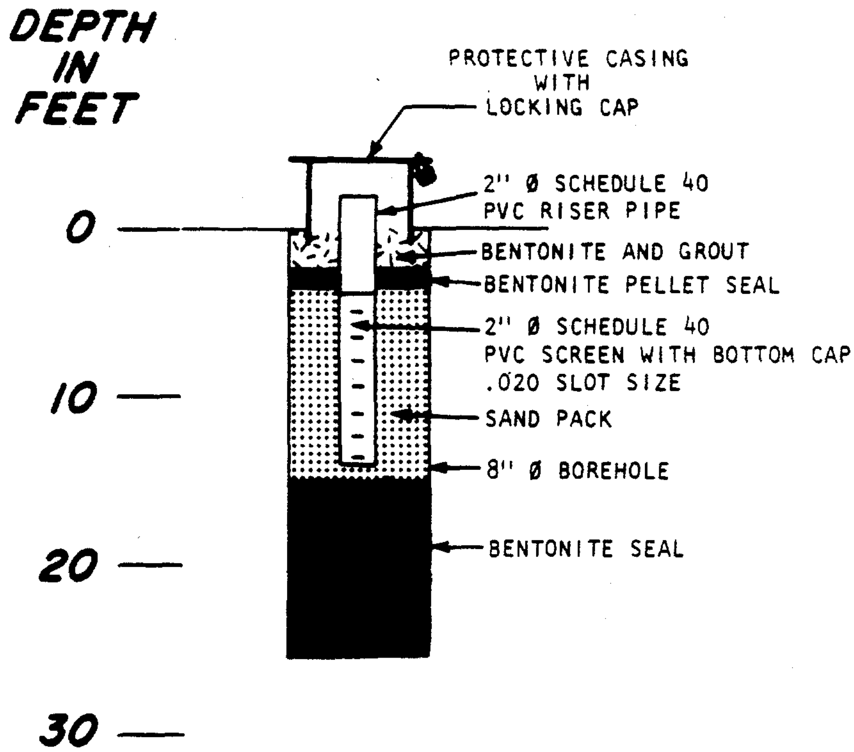
SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTIONS	GEOLOGIC FORMATION
0	6		SP	BROWN FINE TO MEDIUM SAND, TRACE CLAY, TRACE WOOD, MOIST, LOOSE	MT. LAUREL - WENONAH
	4		SC	BROWN FINE TO MEDIUM SAND, LITTLE CLAY, TRACE ROOT, MOIST, LOOSE (PID=300)	MT. LAUREL - WENONAH
5	4, 3, 6		SC	GRAYISH BROWN FINE TO MEDIUM SAND, LITTLE CLAY POCKETS, ORGANIC, MOIST, LOOSE (PID=50)	MT. LAUREL - WENONAH
10	1, 6		SM	GRAYISH BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, VERY LOOSE	MT. LAUREL - WENONAH
	4		SM	MOTTLED REDDISH BROWN AND GRAY FINE SAND, MOIST, VERY LOOSE	MT. LAUREL - WENONAH
15	5		SM	BLACK SILTY FINE SAND, TRACE TO LITTLE CLAY, TRACE MICA, WET, LOOSE (PID=120) (Su=0.22)	MARSHALLTOWN
20			SM	GRADING DENSE (Su=0.32)	MARSHALLTOWN
			SM	(Su=0.39)	MARSHALLTOWN
25			SM	GRADING VERY DENSE (Su=0.64)	MARSHALLTOWN
30					

1. BORING COMPLETED AT 25.5 FEET ON 11/23/86.
2. GROUNDWATER LEVEL RECORDED AT 4 FEET ON 11/22/86.
3. PIEZOMETER INSTALLED ON 11/23/86.

DR 000541

SMW-6

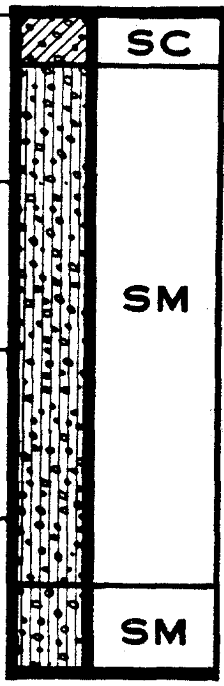

DEPTH
IN
FEET
PROTECTIVE CASING
WITH
LOCKING CAP
2" Ø SCHEDULE 40
PVC RISER PIPE
0
BENTONITE AND GROUT
BENTONITE PELLET SEAL
2" Ø SCHEDULE 40
PVC SCREEN WITH BOTTOM CAP
.020 SLOT SIZE
10
SAND PACK
8" Ø BOREHOLE
BENTONITE SEAL
20
30

BORING PW-1

SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SAMPLES
0		
	13	■
	11	■
	13	■
5		
	2	■
	1	■
	2	■
10		
	5	■
	4	■
	2	■
15	1	■
	1	■
	30	■
20		
25		

SYMBOLS



DESCRIPTIONS

BROWN FINE TO MEDIUM SAND, LITTLE CLAY, TRACE WOOD FRAGMENTS, MOIST, MEDIUM DENSE

GRAYISH BROWN FINE SAND, LITTLE SILT, MOIST, MEDIUM DENSE

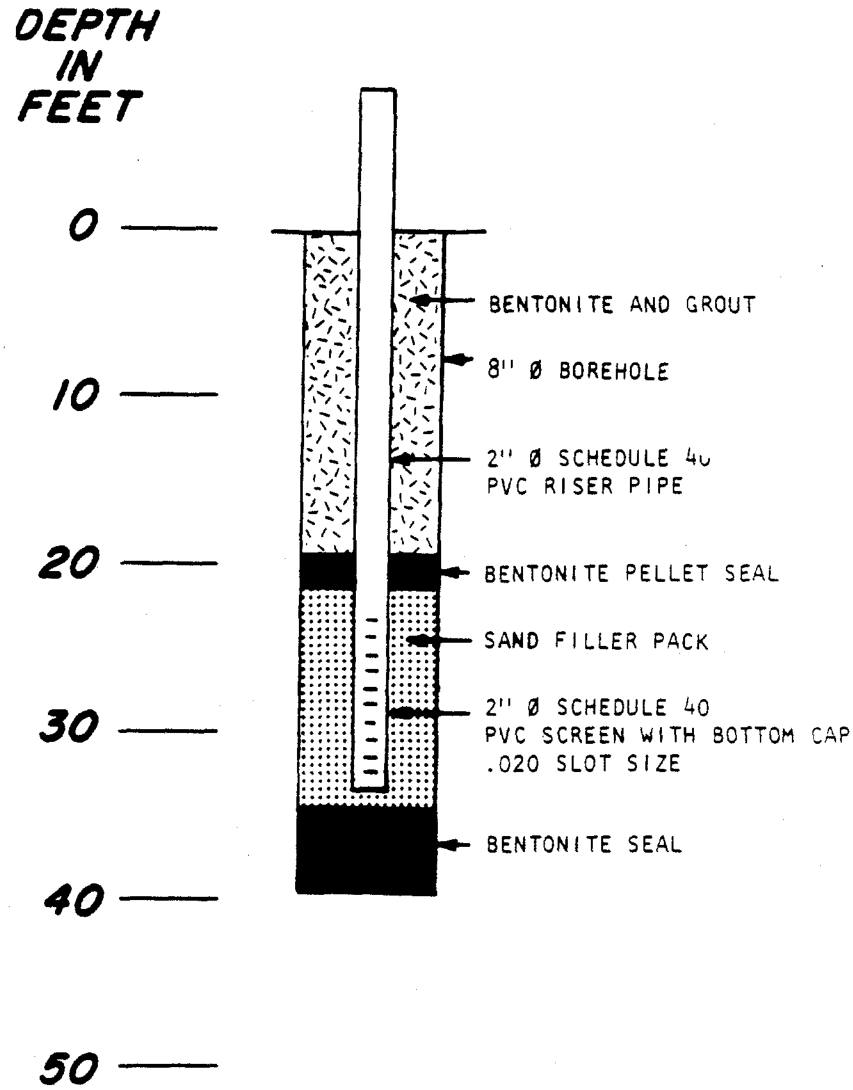
GRADING VERY LOOSE TO LOOSE

BLACK SILTY FINE SAND, TRACE CLAY, MOIST, MEDIUM DENSE

1. BORING COMPLETED AT 19.5 FEET ON 11/24/86.
2. GROUNDWATER LEVEL RECORDED AT 4.5 FEET ON 11/24/86.
3. PIEZOMETER INSTALLED ON 11/24/86.

DR 000543

PW-1



DR 000544

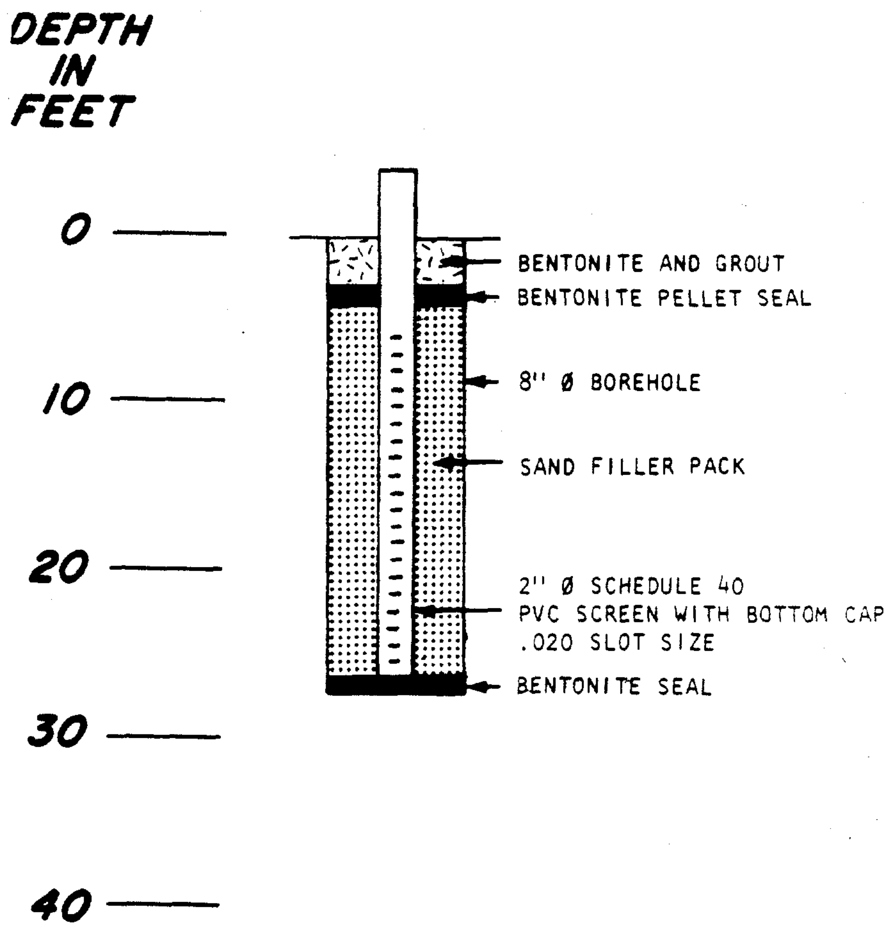
BORING PW-2A

SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTIONS
0	8	■	SC	BROWN FINE TO MEDIUM SAND, LITTLE CLAY, MOIST, LOOSE
	7	■	SM	GRAYISH BROWN FINE SAND, LITTLE SILT, TRACE CLAY, MOIST, LOOSE
	9	■		GRADING NO CLAY
5	9	■		GRADING HEAVILY CONTAMINATED
	7	■		
	7	■		
10	5	■		GRADING SLIGHTLY CONTAMINATED, MEDIUM DENSE
	19	■		
	11	■		BLACK SILTY FINE SAND (MARSHALLTOWN FORMATION) ENCOUNTERED AT 13.1 FEET
15				
20				

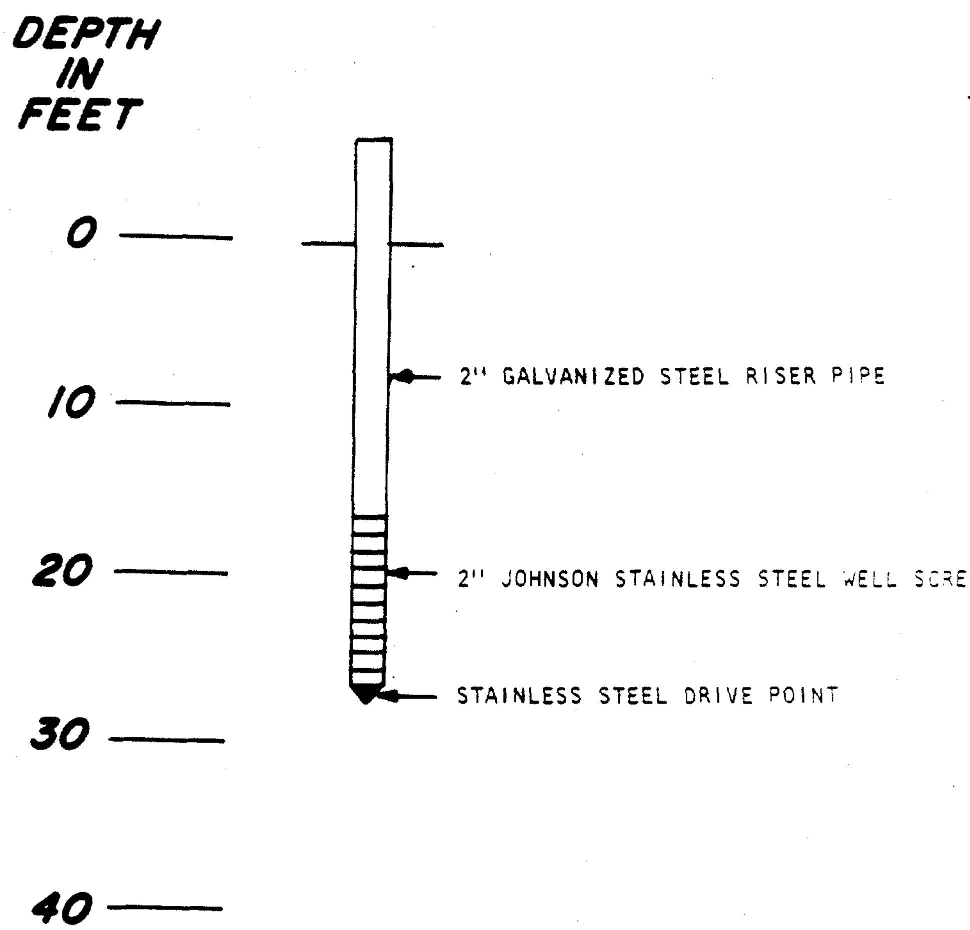
1. BORING COMPLETED AT 13.5 FEET ON 11/23/86.
2. GROUNDWATER LEVEL RECORDED AT 5.9 FEET ON 11/23/86.
3. WELL POINT INSTALLED ON 11/23/86.

PW-2



DR 000546

PW-2A



DR 000547

BORING PW-3

SURFACE ELEVATION

DEPTH IN FEET — ***SAMPLES*** — ***BLOW COUNT*** — ***SYMBOLS*** — ***DESCRIPTIONS***

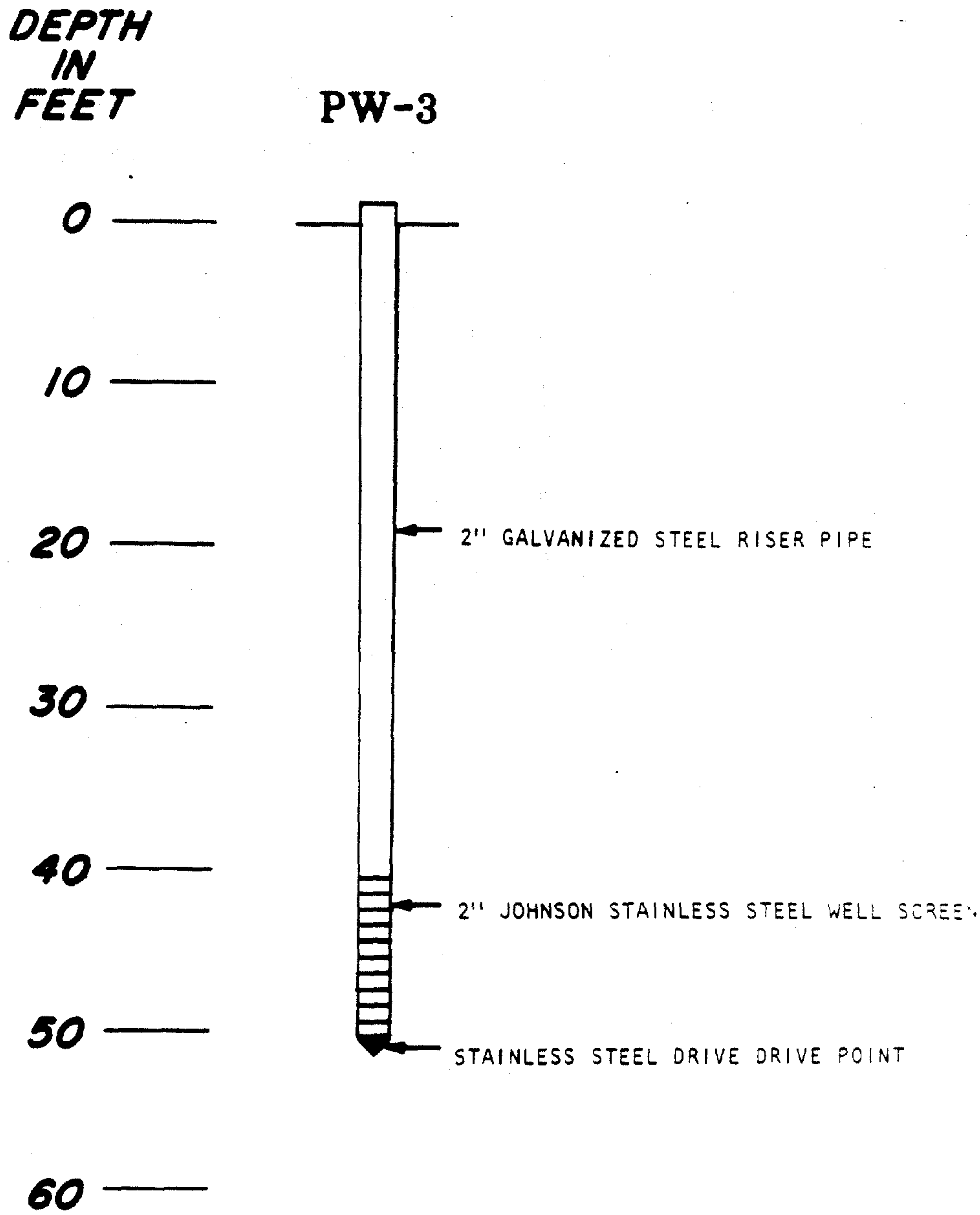
Depth scale: 0, 5, 10, 15, 20, 25, 30

BLOW COUNT	SAMPLES
2	◩
2	◩
6	◩
4	◩
13	◩
10	◩
6	◩
7	◩
8	◩
5	◩
3	◩
5	◩
3	◩
11	◩
5	◩
10	◩

SYMBOLS	DESCRIPTIONS
SP	BLACK FINE SAND, TRACE ROOT, DRY, VERY LOOSE (PID=0)
SP	BROWN FINE TO MEDIUM SAND, TRACE SILT, DRY, VERY LOOSE GRADING TRACE WASTE GRADING MEDIUM DENSE
SM	GRAYISH BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, MEDIUM DENSE GRADING LOOSE GRADING GRAYISH BROWN TO BROWN GRADING MEDIUM DENSE GRADING LOOSE

1. BORING COMPLETED AT 25.7 FEET ON 11/26/86.
2. GROUNDWATER LEVEL RECORDED AT 7.5 FEET ON 11/25/86.
3. WELL POINT INSTALLED ON 11/26/86.

DR 000548


DEPTH IN FEET
PW-3
0
10
20
30
40
50
60
2" GALVANIZED STEEL RISER PIPE
2" JOHNSON STAINLESS STEEL WELL SCREE
STAINLESS STEEL DRIVE DRIVE POINT

DR 000549

BORING PW-4

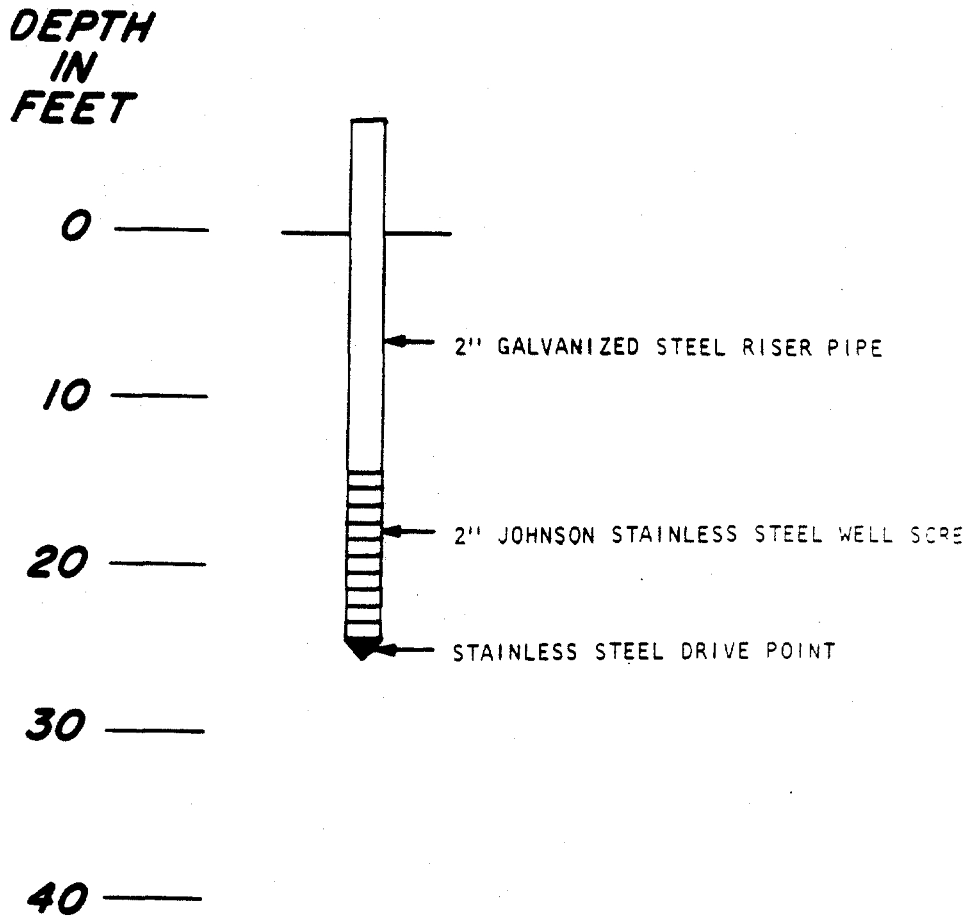
SURFACE ELEVATION

DEPTH IN FEET	BLOW COUNT	SAMPLES	SYMBOLS	DESCRIPTIONS
0	2	■	SP	MOTTLED BROWN AND BLACK FINE TO MEDIUM SAND, TRACE ROOT, MOIST, VERY LOOSE
	3 4	■ ■	SC	BROWN FINE TO MEDIUM SAND, LITTLE CLAY, MOIST, VERY LOOSE
5	8	■	SM	GRAYISH BROWN FINE SAND, TRACE SILT, TRACE CLAY, MOIST, LOOSE
	8 9	■ ■	SP	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, MOIST, LOOSE GRADING MOTTLED BLACK AND GRAYISH BROWN COLOR
10	2	■	SM	BLACK SILTY FINE SAND, TRACE CLAY, WET, VERY LOOSE
15				

1. BORING COMPLETED AT 12.5 FEET ON 11/26/86.
2. GROUNDWATER LEVEL RECORDED AT 6 FEET ON 11/26/86.
3. WELL POINT INSTALLED ON 11/26/86.

DR 000550

PW-4



DR 000551

BORING FB-1

SURFACE ELEVATION

DEPTH IN FEET | **SAMPLES** | **BLOW COUNT** | **SYMBOLS** | **DESCRIPTIONS**

Depth (ft)	Blow count	Symbol	Descriptions
0–5.5	10, 11, 12, 15	SP	ORANGEISH BROWN FINE TO MEDIUM SAND, TRACE SILT, TRACE ROOT, MOIST, MEDIUM DENSE GRADING TRACE CLAY (PID=0.5) (EXP=0)
5.5–11.5	11, 15, 19, 16	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, MEDIUM DENSE GRADING OCCASIONAL REDDISH BROWN COLOR
11.5–27.5	7, 12, 17, 15, 9, 7, 6, 8, 6, 9, 11	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, LOOSE (PID=0.4) (EXP=0) (PID=0) (EXP=0) GRADING LOOSE GRADING GRAYISH BROWN
27.5–45		SM	BLACK SILTY FINE SAND, TRACE CLAY, MOIST, MEDIUM DENSE (PID=5.0) (EXP=0)

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

1. BORING COMPLETED AT 45 FEET ON 12/3/86.
2. GROUNDWATER LEVEL RECORDED AT 15.5 FEET ON 12/3/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 12/3/86.

BORING FB-2

SURFACE ELEVATION

DEPTH IN FEET | SAMPLES | BLOW COUNT | SYMBOLS | DESCRIPTIONS | GEOLOGIC FORMATION

Depth (ft)	Blow Count
0–5	5, 5, 7
5–10	9, 11, 13, 13
10–15	13, 13, 14
15–20	15, 14, 21
20–25	27, 20, 8, 9
25–30	9, 7, 17
30–35	18

Depth (ft)	Symbols	Descriptions	Geologic Formation
0–1.5	SP	BROWN FINE TO MEDIUM SAND, TRACE CLAY, MOIST, LOOSE	MT. LAUREL - WENONAH
1.5–6	SP/SM	BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, LOOSE	MT. LAUREL - WENONAH
6–13.5	SP/SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, IRON LAMINATED, DRY, MEDIUM DENSE	MT. LAUREL - WENONAH
13.5–32.5	SM	GRAYISH BROWN TO BROWN FINE SAND, LITTLE SILT, MOIST, MEDIUM DENSE (PID=0)(EXP=0) GRADING LOOSE (PID=7.0)(EXP=0) (PID=0.5) GRADING MEDIUM DENSE (PID=6.0)(EXP=0)	MT. LAUREL - WENONAH
32.5–45	SM	BLACK SILTY FINE SAND, TRACE TO LITTLE CLAY, WET, MEDIUM DENSE (PID=0.5) (Su=0.15) (Su=0.18)	MARSHALLTOWN

1. BORING COMPLETED AT 45 FEET ON 11/25/86.
2. GROUNDWATER LEVEL RECORDED AT 14 FEET ON 11/25/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT 11/26/86.

50

BORING FB-3

SURFACE ELEVATION

DEPTH IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

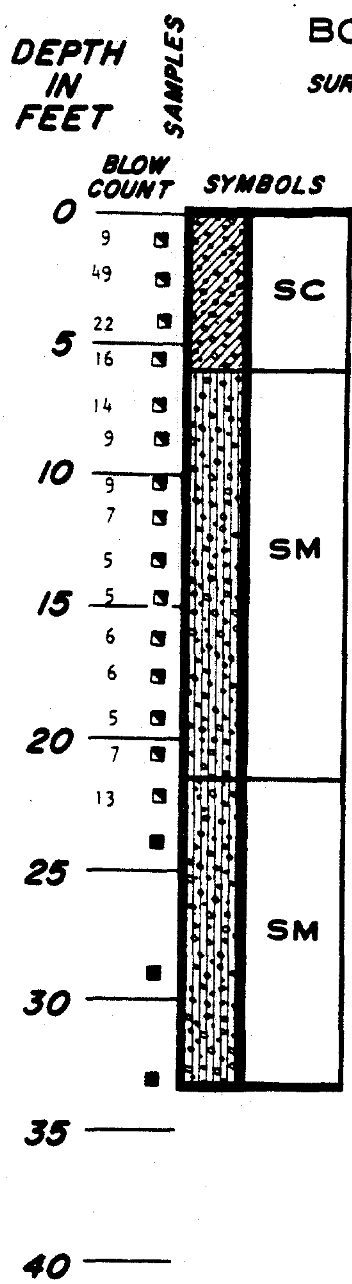
BLOW COUNT	SYMBOLS	DESCRIPTIONS
6	SP	BROWN FINE TO MEDIUM SAND, TRACE CLAY, MOIST, LOOSE
6, 10	SC	BROWN FINE TO MEDIUM SAND, LITTLE CLAY, MOIST, LOOSE
11, 13, 16	SP-SM	BROWN FINE TO MEDIUM SAND, TRACE TO LITTLE SILT, MOIST, MEDIUM DENSE
16, 15, 12, 9	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, IRON LAMINATED, DRY, MEDIUM DENSE GRADING LOOSE
14, 19, 18	SM	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, MEDIUM DENSE
23, 8, 10, 7, 15, 11, 10	SM	GBAYISH BROWN TO BROWN SILTY FINE SAND, MOIST, LOOSE GRADING MEDIUM DENSE
14	SM	BLACK SILTY FINE SAND,MOIST, MEDIUM DENSE (Su=0.6) GRADING DENSE

1. BORING COMPLETED AT 42.5 FEET ON 11/20/86.
2. GROUNDWATER LEVEL NOT RECORDED.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 11/20/86.

DR 000554

BORING FB-4

SURFACE ELEVATION



DESCRIPTIONS

BROWN FINE TO MEDIUM SAND, LITTLE CLAY, TRACE ROOT, MOIST, LOOSE

GRADING DENSE

GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, MEDIUM DENSE

GRADING LOOSE

GRADING OCCASIONAL ORANGE BROWN COLOR

BLACK SILTY FINE SAND, TRACE CLAY, MOIST, MEDIUM DENSE

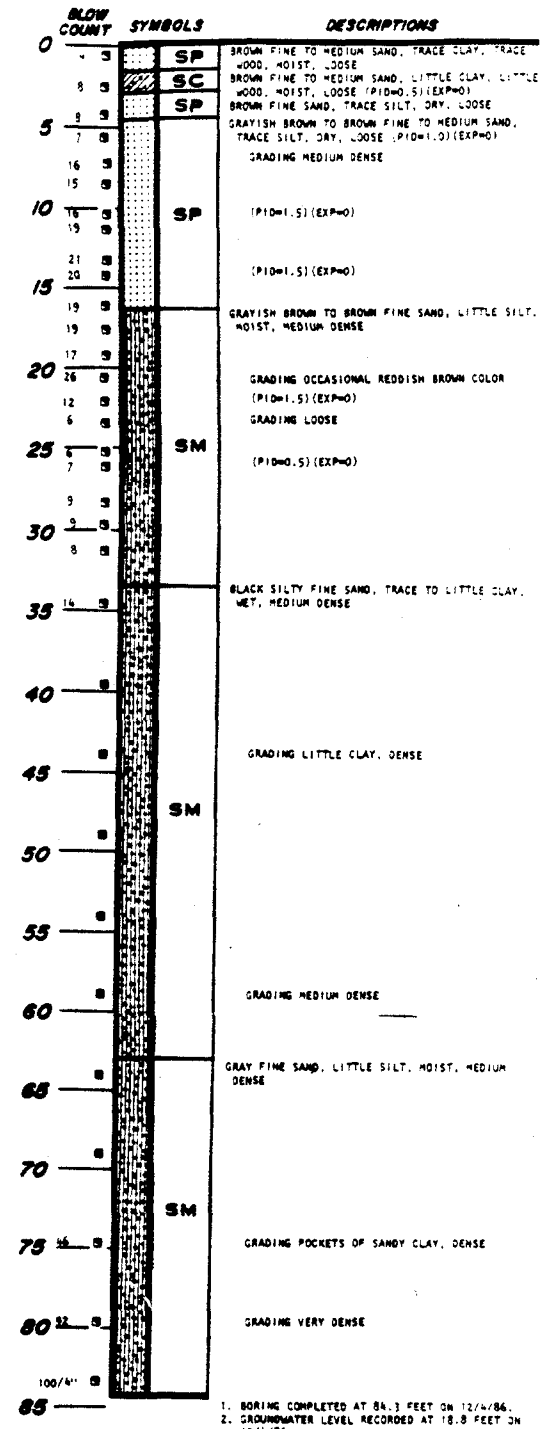
GRADING DENSE

1. BORING COMPLETED AT 33.5 FEET ON 12/3/86.
2. GROUNDWATER LEVEL RECORDED AT 13.5 FEET ON 12/2/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 12/3/86.

DR 000555

BORING FB-5

SURFACE ELEVATION



1. BORING COMPLETED AT 84.3 FEET ON 12/4/86.
2. GROUNDWATER LEVEL RECORDED AT 18.8 FEET ON 12/4/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 12/5/86.

DR 000556

BORING FB-6

SURFACE ELEVATION

DEPTH IN FEET | SAMPLES | BLOW COUNT | SYMBOLS | DESCRIPTIONS

Depth (ft)	Symbol	Descriptions
0	SC	BROWN FINE TO MEDIUM SAND, LITTLE CLAY, MOIST, LOOSE (PID=0.5)(EXP=0) GRADING BROWN TO REDDISH BROWN COLOR
5	SP	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE CLAY, DRY, LOOSE (PID=0.5)(EXP=0) GRADING MEDIUM DENSE
10	SP	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, TRACE SILT, IRON LAMINATED, DRY, MEDIUM DENSE (PID=0)(EXP=0)
15–20	SM	REDDISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, MOIST, MEDIUM DENSE GRADING WET (PID=0)(EXP=0) (PID=0.5)(EXP=0)
20–30	SM	GRAYISH BROWN TO BROWN FINE TO MEDIUM SAND, LITTLE SILT, WET, LOOSE
30–40	SM	BLACK SILTY FINE SAND, TRACE CLAY, WET, MEDIUM DENSE

Blow counts (top to bottom): 6, 8, 10, 9, 12, 16, 13, 14, 16, 13, 18, 21, 13, 7, 6, 4, 6, 7, 5, 13, 11

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

1. BORING COMPLETED AT 40 FEET ON 12/2/86.
2. GROUNDWATER LEVEL RECORDED AT 17.5 FEET ON 12/2/86.
3. BORING BACKFILLED WITH BENTONITE CEMENT GROUT ON 12/2/86.

APPENDIX 5-3
FIELD PROCEDURES

1.0 GENERAL

The geotechnical investigation conducted by Dames & Moore at the Helen Kramer Landfill, Mantua, New Jersey included:

1. The installation of five ground water observation piezometers (SMW-2, 4, 5, 6 and PW-1).

2. The installation of three well point piezometers (PW-2, 3 and 4).

3. The drilling and sampling of 16 borings (SB-1 through SB-16) along the proposed slurry wall and ground water collection drain/trench alignments.

4. The drilling and sampling of six foundation borings (FB-1 through FB-6) at the proposed location of the leachate water treatment facility.

Field methods for advancing soil borings, installing piezometers, and installing well point piezometers are described below.

1.1 PERIMETER DRILLING PROCEDURES

Method of Drilling:	Hollow stem augers utilizing a truck-mounted and ATV-mounted CME-55, drill rig.
Drilling Fluid:	No drilling fluids were utilized while drilling the piezometers. Sands encountered due to "caving" during drilling at SMW-4. Potable water was used to flush out formation.
Formation Sampling:	Soil samples were collected continuously within the top 30 feet of the Mt. Laurel-Wenonah Formation and at 5-foot intervals from 30 ft. to the top of the Marshalltown. However, approximately five feet before the anticipated contact between the Mt. Laurel/Wenonah/Marshalltown, continuous sampling was instituted to "pinpoint" the exact contact depth. Polaroid photographs of the Mt. Laurel-Wenonah/Marshalltown contact were taken to document the depth at each monitoring well.
	Shelby tubes samples were the taken continuously for a minimum of 10 feet within the Marshalltown Formation.

Diameter of Boring:	The hollow-stem auger cutting head utilized in the drilling of the monitoring well had an O.D. of approximately 8.0 inches.
Decontamination Procedure:	The entire rig (i.e., rotary table, derrick and Kelley), including the auger flights, tools and tremie pipes were steam cleaned at the designated decontamination area before drilling was initiated at the piezometer.

1.2 PIEZOMETER CONSTRUCTION PROCEDURES

The well screen inverval in the monitoring wells was from two feet above the Mt. Laural-Wenonah/Marshalltown contact to approximately five feet above the water table. The top of the screen was generally placed a minimum of five feet below the ground surface, unless the ground water table was encountered within five feet of the ground surface. An appropriate length of riser pipe was attached to the well screen so that it extended about two feet above the ground surface.

The piezometers were completed as described below under General Specifications and Procedures.

1.2.1 General Specifications and Procedures

Riser Pipe and Well Screen:	2-inch I.D. threaded Schedule 40 PVC.
Screen Slot Size:	0.010 inch, machine slotted.
Storage of Riser Pipe and Screen:	The PVC riser pipe and screen were stored in factory sealed plastic bags. The well string was connected one piece at a time and lowered down the hole.
Bottom Cap:	A bottom cap was connected on the bottom well screen in all of the monitoring wells.
Gravel Pack:	By weight, 90% of the gravel pack material was larger than the screen slot size.
Gravel Pack Placement:	The gravel pack was placed in the annular space from beneath the bottom of the screen to one foot above the top of the well screen, with the exception of SMW-6, where the gravel pack was placed six inches above the top of the well screen. The depth of the gravel pack was confirmed by measuring with a weighted tape down the annular space of the borehole. The gravel pack was emplaced at approximately one foot intervals through the auger flights as they were lifted to the surface. This method was utilized to ensure that the borehole remained open and no "sand bridging" occurred while pouring the gravel into the annular space.
Backfill:	Boreholes were backfilled with Baroid Hole Plug Bentonite to the top of the Marshalltown.

Sand Bridge: To ensure that the well screen did not become plugged with bentonite, a 6-inch gravel pack sand bridge was poured on top of the hole plug bentonite prior to inserting the well screen.

Bentonite Pellet Seal: In general, a one-foot bentonite pellet (Pelltonite-Wyoming Bentonite) seal was placed in the annular space above the gravel pack in each well.

Grouting Annular Space: A cement-bentonite grout with about one bag of Portland Type I cement to 1/8 bag of Baroid Quick-Gel bentonite per 12 gallons of potable water was pumped into the annular space to fill the space from the top of the bentonite pellet seal to the ground surface. At depth, the grout was tremie piped into the annular space. The grout was pumped until it completely displaced the ground water in the annular space.

Protective Casing: A 4- to 6-foot long section of 4-inch I.D. steel casing with a locking cap was inserted around the 2-inch riser pipe. The protective casing was set two to four feet into a stiff cement mixture in the annular space and protruded about two feet above the ground surface.

Well Development: Each piezometer was developed for 30 a minimum of to 70 minutes or until the pumped water was relatively clear. The wells were developed by air surging. A 60 CFM air compressor was utilized to lift the water to the surface. A specially designed well cap with a airline and discharge line connection was screwed onto the top of the piezometers. The supplied air was regulated with a value on the compressor. The wells were initially completely blown out with a strong burst of air and were then allowed to recharge. After recharging, the air supply was regulated in a fashion so that surging of the well occurred. The pumped water was discharged to the ground and was not allowed to enter Edwards Run.

Surveying: The elevation of the top of the PVC well casing of each well was surveyed determined to $\pm$0.01 ft. by URS and the reference point was marked. Elevations are referenced to mean sea level.

2.0 WELL POINT PIEZOMETER INSTALLATION

Prior to installing the well point piezometers, soil borings were installed to verify the depth of the Mt. Laurel-Wenonah/Marshalltown contact.

2.1 INSTALLATION PROCEDURE

Method of Driving: Pushed with the rig top-head drive until refusal, then driven by a hammer weighing 140 lbs. falling 30 inches.

Surveying:	The elevation of the top of the galvanized steel riser pipe of each well point piezometer was surveyed to ±0.01 ft. by URS and the reference point was marked. Elevations are referenced to mean sea level.
Decommissioning:	Following the permeability tests, all of the well point piezometers were extracted from the ground and these holes were backfilled with Baroid-Hole Plug-Bentonite.

2.2 WELL POINT PIEZOMETER CONSTRUCTION PROCEDURE

The well point piezometers were screened for a total of five feet across the Lower portion of the Mt. Laurel-Wenonah Formation. The bottom of the screens were driven to the top of the Marshalltown Formation. An appropriate length of riser pipe was connected to the screens and generally extended to greater than four inches above the ground surface.

The well points piezometers were completed as described below under General Specifications and Procedures.

2.2.1 General Specifications and Procedures

Well Point Screen and Riser Pipe:	Two-inch I.D. Johnson stainless steel well point with a stainless steel drive point. Two-inch I.D. Johnson galvanized steel riser pipe with galvanized steel coupling.
Screen Slot Size:	0.010 inch.
Cleaning of Well Point Screen and Riser Pipe:	Well point screens and riser pipes were steam cleaned prior to installation.
Well Point Development:	Each of the well point piezometers were developed utilizing the same procedure as was outlined in previous section well development.

3.0 SLURRY WALL, GROUND WATER COLLECTION DRAIN AND FOUNDATION BORINGS DRILLING AND SAMPLING PROCEDURES

The general requirements for the slurry wall and ground water collection trench borings are outlined in URS Contract dated November 8, 1986. Supplemental work authorized by URS included foundation borings and the installation of well point piezometers.

The drilling, sampling and backfilling procedures for the borings are described below. Table 5-1 in the text details the pertinent drilling data for each boring.

3.1 DRILLING PROCEDURES

Method of Drilling:	Hollow stem auger or mud rotary with tricone bit.
Source of Drilling Water:	Potable water supply from Each Greenwich Township, Clarksboro Fire Station, Clarksboro, New Jersey.
Drilling Fluid:	Johnson Revert Biodegradable Drilling Mud Additive was mixed with potable water following Johnson's mixing instructions.
Formation Sampling:	The borings along the proposed slurry wall and ground water collection drain (SB-1 - SB-16) were sampled continuously with split spoons within the top 30 feet of the Mt. Laurel-Wenonah and at 5 foot intervals to the top of the Marshalltown. However, approximately five feet before the estimated top of the Marshalltown, continuous split spoon samples were taken to determine the exact contact depth. Shelby tube samples were taken for at least 10 feet into the Marshalltown. Borings SB-1, SB-4, SB-7, SB-12 and SB-14 were sampled with Shelby tubes through the entire thickness of the Marshalltown to the top of the Englishtown Formation. Split spoon samples were then taken continuously for 10 feet into the Englishtown. The foundation borings were sampled continuously with split spoons within the top 30 feet and at 5-foot intervals from 30 feet to the top of the Marshalltown. Shelby tube samples were taken at 5-foot intervals within the Marshalltown and the borings were terminated at varying depths. The well point piezometer borings were sampled continuously with split spoons to the top of the Marshalltown. At the top of the Marshalltown the borings were terminated.
Measurements:	Shear strength measurements at the end of each Shelby tube sample were taken with a Soiltest Torvane Shear Device.
Decontamination:	In borings where contaminated ground water/leachate was encountered, the entire rig (i.e., rotary table, derrick and Kelley), including the auger flights, tools and tremie pipes were steam cleaned at the designated decontamination area.
Backfilling of Boring:	A cement-bentonite grout with about one bag of Portland Type I cement to 1/8 bag of Baroid Quick-Gel bentonite per 12 gallons of potable water was utilized to backfill each borehole. At depth, the grout was tremie piped into the borehole. The grout was pumped until it completely displaced the drilling fluid or ground water in the borehole.

APPENDIX 5-3

FIELD PROCEDURES

HEALTH-SAFET

DR 000565

APPENDIX 5-4

HEALTH AND SAFETY PLAN

DAMES & MOORE

HEALTH AND SAFETY PLAN

Project Name and Number:	Slurry Wall Test Borings - Helen Kramer Landfill 0836-024-10
Project Site Location:	Gloucester County, New Jersey
Project Manager:	William F. Mercurio
On-Site Safety Officer:	
Plan Preparer:	Christina Grill
Plan Reviewer:	William Levitan
Preparation Date:	September 3, 1986

Plan Approvals:

Health & Safety Program Director

William M. Leit (Acting) 9/29/86 (Date)

Managing Principal-in-Charge

William F. Mercurio 10/6/86
REVIEWED (Date)

Office Safety Coordinator

Christina Grill 10/6/86 (Date)

Project Manager

William F. Mercurio 10/6/86 (Date)

H&S Plan Approval No. CR-HS52-86

DR 000567

1.0 PURPOSE

The purpose of this Health and Safety Plan (HASP) is to assign responsibilities, establish personnel protection standards and mandatory safety practices and procedures, and provide for contingencies that may arise while operations are being conducted at the site.

2.0 APPLICABILITY

The provisions of the Plan are mandatory for all on-site Dames & Moore employees and subcontractors engaged in hazardous material management activities including, but not limited to, initial site reconnaissance, preliminary field investigations, mobilization, project operations, and demobilization.

Contractors shall provide a Health & Safety Plan for its employees covering any exposure to hazardous materials and shall complete all work in accordance with that plan. The contractor may choose to use the Dames & Moore Health & Safety Plan as a guide in developing its own plan or may choose to adopt Dames & Moore's plan. In either case, the contractor shall hold Dames & Moore harmless from, and indemnify it against, all liability in the case of any injury. Dames & Moore reserves the right to review and approve the contractor's plan at any time.

Grossly inadequate H&S precautions on the part of the Contractor or the belief that the Contractor's personnel are or may be exposed to an immediate health hazard, can be cause for Dames & Moore to suspend the Contractor's site work and ask the Contractor's personnel to evacuate the hazard area.

The Contractor shall provide its own safety equipment in accordance with Health & Safety Plan requirements. The Contractor will comply with all regulations, including OSHA 29 CFR 1910.134 (Respiratory Protection).

3.0 RESPONSIBILITIES

3.1 PROJECT MANAGER

The Project Manager (PM) shall direct on-site investigations and operational efforts. At the site, the PM, assisted by the On-Site Safety Officer, has primary responsibility for:

1. Assuring that appropriate personnel protective equipment and monitoring equipment is available and properly utilized by all on-site personnel.

2. Assuring that personnel receiving this plan have read the plan, understand the provisions of this plan, are instructed in the work practices necessary to ensure safety, and are familiar with planned procedures for dealing with emergencies.

3. Assuring that all field personnel has a minimum of 24 hours of Health & Safety training.

4. Assuring that personnel are aware of the potential hazards associated with site operations.

5. Monitoring the safety performance of all personnel to ensure that the required work practices are employed.

6. Correcting any work practices or conditions known that may result in injury or exposure to hazardous substances.

7. Preparing any necessary accident/incident reports (see attached Accident Report Form).

8. Assuring the completion of Plan Acceptance and Feedback forms attached herein.

3.2 ON-SITE SAFETY OFFICER

The On-Site Safety Officer (OSSO) shall:

1. Implement project Health and Safety Plans and report to the PM for action on any deviations from the anticipated conditions described in the Plan.

2. Assuring that all monitoring equipment will be operated according to manufacturers instructions.

3. Be responsible for identifying all Waste Management Site (WMS) personnel with special medical problems (i.e., allergies).

3.3 PROJECT PERSONNEL

Project personnel involved in on-site investigations and operations are responsible for:

1. Understanding and adhering to the site Health & Safety Plan.

2. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.

3. Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the OSSO and PM.

4. Notifying the PM and OSSO of any special medial problems (i.e., allergies) and insuring that all on-site personnel are aware of any such problems.

4.0 BACKGROUND

4.1 SITE HISTORY

The Helen Kramer Landfill is located in Mantua Township, Gloucester County, New Jersey.

The site encompasses a 66-acre refuse area and a 33-acre stressed area between the east limit of the refuse and Edwards Run, a surface water tributary to Mantua Creek and the Delaware River.

The Helen Kramer Landfill site was originally operated as a sand and gravel pit. The site became an operating landfill between 1963 and 1965, during which landfilling occurred simultaneously with sand excavation. In the early 1970's, New Jersey Department of Environmental Protection (NJDEP) inspections noted that chemical wate was being disposed in excavated trenches on the site. In 1974, continued evidence of chemical waste disposal was noted and leachate was observed discharging into Edwards Run from the landfill. Various plans were submitted over the years to NJIDEP, but all were rejected as insufficient to remediate the problems. Landfilling and disposal of wastes continued until 1981 when the landfill permit was revoked.

4.2 Dames & Moore Activity

The scope of this project will generally include:

- Drilling and sampling of 20 borings, 70 feet deep each, with a hollow stem auger.
- Grouting of holes upon completion.
- Six (6) of the borings will be utilized to construct ground water monitoring wells.

DR 000571

4.3 Suspected Hazards

The slurry wall test borings (Figure 1) are considered to be generally upgradient with respect to ground water and subsurface gas flow. The area where these borings are located is not considered highly contaminated.

An exclusion zone will be identified to distinguish between the Level D working areas and the Level C working areas. The zone boundary will be marked by high-visibility signs. Level C area will be determined by readings of 1 ppm above background measured by the Photoionization Detector. These two areas will be defined for non-intrusive work only, geophysical surveying and site surveying by URS. All intrusive work performed within the landfill will require following the action levels and protective measures as presented in Table 3.

The primary suspected chemical hazards associated within the landfill are listed in Table 1.

5.0 EMERGENCY CONTACTS AND PROCEDURES

5.1 CONTACTS

Should any situation or unplanned occurrence require outside or support services, the appropriate contact should be made as shown in Table 5.

5.2 PROCEDURES

Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse effects of symptoms of exposure while on site.

- A condition is discovered that suggests the existence of a situation more hazardous than anticipated.

In the event that an emergency occurs on site, the following applicable procedures are to be implemented:

(a) Personnel on-site shall use the "buddy" system (pairs). Buddies shall pre-arrange hand signals or other means of emergency signals for communication in case of lack of radios or radio breakdown. In emergencies, the following hand signals are recommended:

- o Hand gripping throat: out of air, can't breath.
- o Grip partner's wrist or place both hands around waist: leave areas immediately, no debate!
- o Hands on top of head: need assistance.
- o Thumbs up: Ok, I'm alright, I understand.
- o Thumbs down: No, negative.

After all appropriate measures are taken during an emergency situation, the Project Manager should be notified as soon as reasonably possible.

(b) Site work area entrance and exit routes shall be planned, and emergency escape routes identified by the OSSO.

(c) Visual contact shall be maintained between "pairs" on-site with the team remaining in close proximity in order to assist each other in case of emergency.

(d) In the event that any member of the field crew experiences any adverse effects or symptoms of exposure while on-site, the entire field crew shall immediately halt work and act according to the instructions provided by the OSSO. The Project Manager should be alerted to the situation immediately.

(e) All on-site personnel should be aware of wind indicators visible to indicate possible routes for upwind escape.

(f) The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated, should result in the evacuation of the field team and re-evaluation of the hazard and the level of protection required.

(g) In the event that an accident occurs, the PM is to complete an Accident Report Form for submittal to the Office Safety Coordinator (OSC), who will forward a copy to the Firmwide Health and Safety Officer (FWHSO). The OSC should assure that the followup action is taken to correct the situation that caused the accident.

(h) In the event that an accident occurs, the PM is to complete an Accident Report Form for submittal to the Managing Principal In Charge (MPIC) of the office, with a copy to the Health and Safety Program office. The MPIC should assure that follow-up action is taken to correct the situation that caused the accident.

6.0 HAZARD CHARACTERISTICS AND PROTECTION REQUIRED

6.1 EXPOSURE LIMITS AND RECOGNITION QUALITIES

Information concerning exposure limits and recognition qualities (Odors, Thresholds, Lower Explosive Limits (LEL), Upper Explosive Limits (UEL), and Photoionization detector (PID) sensitivities) of the contaminants that are suspected to be on site is presented in Table 1.

6.2 SYMPTOMS OF OVEREXPOSURE, POTENTIAL CHRONIC EFFECTS, AND FIRST AID TREATMENT

Routes of entry, symptoms of overexposure to the suspected contaminants, potential chronic effects of these substances, and first aid treatment information are presented in Table 2.

6.3 MONITORING METHODS, ACTION LEVELS, AND PROTECTIVE MEASURES

Methods for monitoring for suspected contaminants, action levels, and protective measures to be used for various contaminant concentration levels are presented in Table 3.

DR 000574

6.4 PROTECTIVE EQUIPMENT REQUIRED FOR ON-SITE ACTIVITIES

The protective equipment required may vary; it is dependent on the concentrations and dispersion of contaminants encountered during each phase of work. Table 4 specifies level of protection required for on-site activities.

7.0 STANDARD SAFE WORK PRACTICES

7.1 GENERAL

1. Eating, drinking, chewing tobacco, smoking, and carrying lighters or matches is prohibited in a contaminated or potentially contaminated area where the possibility for transfer of contamination exists.

2. Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling on the ground, leaning or sitting on equipment or ground. Do not place monitoring equipment on potentially contaminated surface (i.e., ground, etc.).

3. To the extent possible, prevent spillage. In the event that a spillage occurs, contain liquid, if possible.

4. Prevent spashing of contaminated materials.

5. All field crew members shall make use of all their senses to be alert to potentially dangerous situations in which they should not become involved (i.e., presence of strong and irritating or nauseating odors).

6. Field crew members shall be familiar with the physical characteristics of investigations, including but not limited to:

   - wind direction in relation to the ground zero area

- accessibility to associates, equipment, vehicles
- communication
- hot zone (areas of known or suspected contamination)
- site access
- nearest water sources

7. The number of personnel and equipment in a suspected contaminated area shall be minimized consistent with site operations.

8. All wastes generated during D&M and/or subcontractor activities on the site shall be disposed of as directed by the Project Manager following approval of the client.

7.2 DRILLING AND SAMPLING PRACTICES

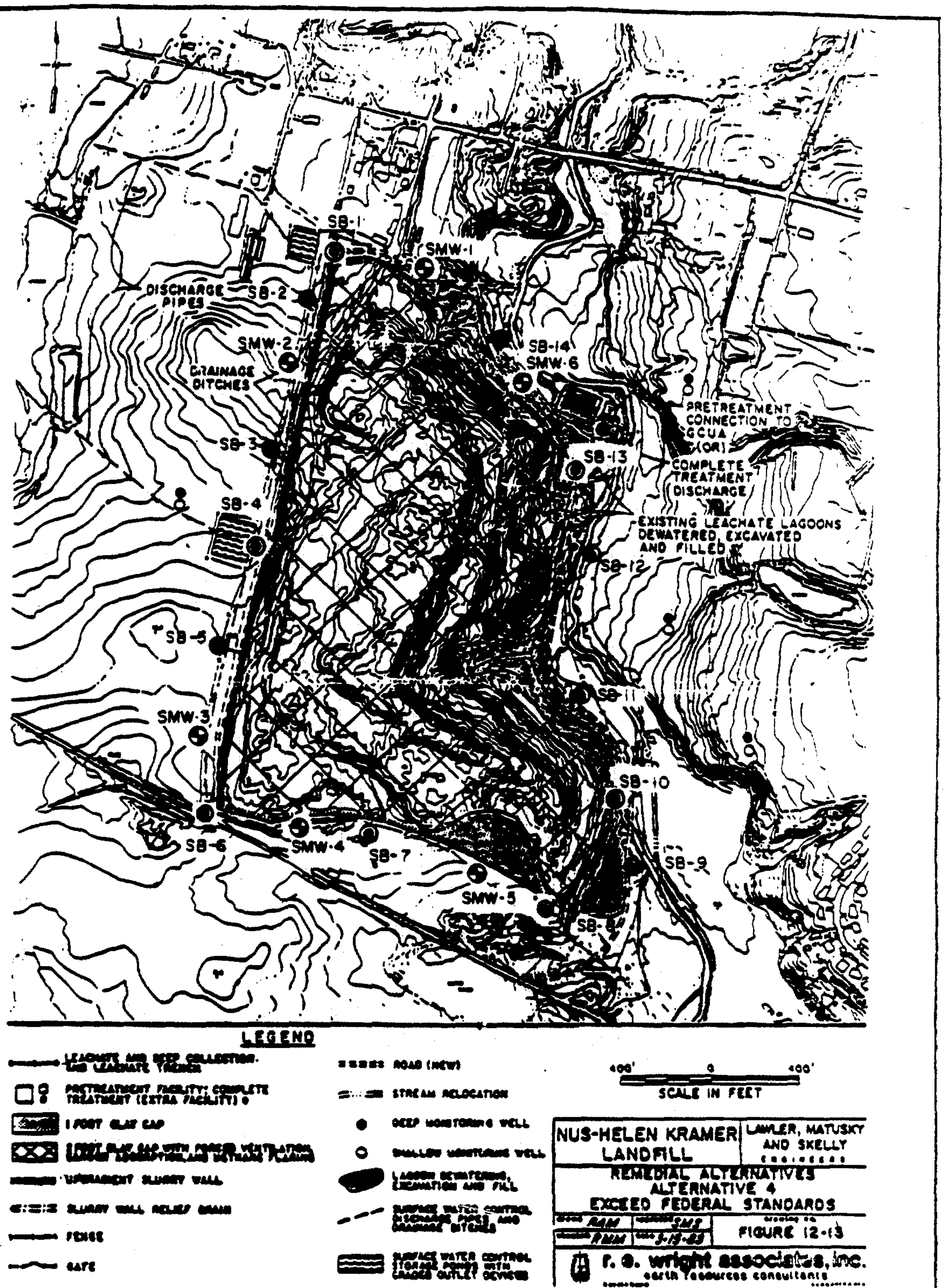
For all drilling and sampling activities, the following standard safety procedures shall be employed:

1. All drilling and sampling equipment shall be cleaned before entering the site and will be cleaned before use.

2. At the drilling or sampling site, equipment will be decontaminated after each sampling.

3. Work will be conducted in "cleaner" areas first, when feasible.

4. The minimum number of personnel necessary to achieve work objectives shall be within 25 feet of the drilling or sampling activity.



UNDER ALTERNATIVES TWO AND THREE, SB15 AND SB16 WILL BE ADDED AT CRITICAL LOCATIONS

PHASE 2 BORING PLAN

DAMES & MOORE

A 2/27

FIGURE 1

DR 000577

8.0 RESPIRATOR INSTRUCTIONS

8.1 FULL FACE RESPIRATOR

8.1.1 Inspection Procedure

1. Inspection to be done daily (at a minimum).

2. Look at the shape of the facepiece for possible distortion that may occur if it is not protected during storage.

3. Check the facepiece for dirt, cracks, tears, or holes. The rubber should be flexible, not stiff. Also check the lens for cracks.

4. All straps and buckles must be attached. Check straps for elasticity and worn serrations.

5. Check the exhalation valve located near the chin between the cartridges by the following:
   - unsnap the cover
   - lift the valve and inspect the seat and valve for cracks, tears, dirt and distortion.
   - replace the cover; it should spin freely.

6. Make sure the cartridge holders are clean. Make sure the gaskets are in place and the threads are not worn. Also look for cracks and other damage.

7. Check the cartridges for dents or other damages, especially in the threaded part.

DR 000578

8.1.2 Donning Procedure

1. Screw the cartridge into the holder hand tight so there is a good seal with the gasket in the bottom of the holder, but don't force it. If the cartridge won't go in easily back it out and try again.

   Always use cartridges made by the same manufacturer who made the respirator.

2. Fold the straps back over the window piece.

3. Hold the facepiece with one hand and the strap piece (in front of the window) with the other.

4. Put your chin in first. Lift the strap piece out and over your head.

8.2 HALF-FACE RESPIRATORS

8.2.1 Inspection Procedure

1. Look at the shape of the face piece for possible distortion that may occur if it is not protected during storage.

2. Check the face piece for dirt, cracks, tears, or holes. The rubber should be flexible, not stiff.

3. All straps and buckles must be attached. Check straps for elasticity and worn serrations.

4. Check the exhalation valve located near the chin between the cartridges by the following:

   - unsnap the cover.

- lift the valve and inspect the seat and valve for cracks, tears, dirt and distortion.

- replace the cover; it should spin freely.

5. Check both inhalation valves (inside the cartridge holders). Look for same signs as above.

6. Make sure the cartridge holders are clean. Make sure the gaskets are in place and the threads are not worn. Also look for cracks and other damage.

7. Check the cartridges for dents or other damages, especially in the threaded part.

8.2.2 <u>Donning Procedure</u>

1. Screw the cartridge into the holder hand tight so there is a good seal with the gasket in the bottom of the holder, but don't force it. If the cartridge won't go in easily back it out and try again.

   Always use cartridges made by the same manufacturer who made the respirator.

2. Place the facepiece over the bridge of your nose and swing the bottom in so that it rests against your chin.

3. Hold the respirator in place and fasten the top strap over the crown of your head.

4. Fit the respirator on your face and fasten the strap around your neck. Don't twist the straps. Use the metal slide to tighten or loosen the fit...but not too tight.

5. Test the fit by:

   - lightly covering the exhalation valve with the palm of your hand. Exhale...if there is a leak, you will feel the air on your face.

   and

   - covering the cartridges with the palms of your hands. Again don't press too hard. Inhale...the face piece should collapse against your face.

   - If there is a leak with either test, adjust the headbands or reposition the face piece and test until no leakage is detected.

8.3 SANITIZING PROCEDURES

1. Remove all cartridges and seals not affixed to their seats.

2. Remove elastic headbands.

3. Remove exhalation cover.

4. Remove speaking diaphragm or speaking diaphragm-exhalation valve assembly.

5. Remove inhalation valves.

6. Wash face piece and breathing tube in cleaner/sanitizer powder mixed with warm water, preferably at 120° to 140° F. Wash components separately from the facemask, as necessary. Remove heavy soil from surfaces with a hand brush.

7. Remove all parts from the wash water and rinse twice in clean warm water.

8. Air dry parts in a designated clean area.

9. Wipe face pieces, valves, and seats with a damp lint-free cloth to remove any remaining soap or other foreign materials.

9.0 MONITORING EQUIPMENT INSTRUMENTS

Monitoring equipment recommended for use at the Helen Kramer Landfill site includes the HNU (photoionization detector) Combustible Gas Indicator, Colorimetric detector tubes, pump, and Hydrogen Sulfide detector tubes. These instruments are recommended as a minimum health and safety precaution for Dames & Moore personnel performing field activities.

Colorimetric IndicatorTubes and Pumps

In addition to the instructions found below, a set of instructions specific to the tubes is provided in each box of colorimetric indicator tubes. These instructions should be referred to and followed.

All colorimetric indicator tubes and pumps should be field calibrated prior to use. This calibration tests for leaks in the following manner:

- Insert unbroken tube into pump's tube holder.
- Squeeze bellows on bellows-type pump. After 60 seconds, bellow should not regain its original shape or chain should not be taut.
- Pull back and lock handle on piston-type pump.
- Rotate handle 1/4 turn. Handle should return to within 1/4 inches of zero cc mark.

DR 000582

If a pump fails these tests, it should be serviced according to manufacturer's instructions.

a. MSA Model A Samplair Pump

1. Break off both tips of a fresh colormetric indicator tube in the tube breaker hole in the face of the pump head.

2. Insert tube into tube holder with arrow on tube pointing toward pumping.

3. Align index marks on handle and cap of pump.

4. Pull handle straight back to desired volume of 25, 50, 75, or 100 cc's. Handle automatically locks at these volumes.

5. Wait for time specified in tube's instructions.

6. Rotate handle 90° to unlocking and push handle in.

7. Realign index marks for next stroke or test. Refer to tube's instructions for required number of strokes.

8. Read concentration of material in air stained-unstained interface.

b. Drager Indicator Tube Pump

1. Break off both tips of a fresh colormetric indicator tube in break-off eyelet on front cover plate or in break-off hust (an accessory).

2. Insert tube into pump head with arrow on tube pointing toward pump.

3. Hold pump with holding plate between thumb and the base or index finger and front cover plate contacting finger.

4. Compress the bellows completely with a squeezing motion assuring that total volume of bellows is used.

5. Release grip and allow chain to become taut, signifying that 100 cc of air have been pulled through tube.

6. Complete Steps 4 and 5 as many times as tube's instructions state.

7. Read concentration of material in air at stained-unstained interface.

c. Usage Frequency

The frequency of detector tub usage should be as follows:

1. Upon entering site area.

2. At initial breaking of ground surface during drilling and excavating activities.

3. When major stratigraphic changes are encountered (i.e., sand to clay).

4. At the discretion of the on-site Safety Officer as warranted by site conditions.

HNU (Photoionization Detector)

This instrument is intended to detect compounds with an ionization potential of less than 10.2 eV.

1. Before attaching the probe, check the function switch on the control panel to make sure it is in the off position.

2. Attach the probe by plugging in the 12 pin plug to the interface on the readout module.

3. Turn the six position function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scale. If not, recharge the battery. If the red indicator comes on, the battery should be recharged.

4. Turn the function switch to any range setting. Look into the end of the probe briefly to see if the lamp is on. If it is on, it will give a purple glow. Do not look at the light source closer than six inches with unprotected eyes or for any length of time as UV light can damage your eyes. It is also possible to "hear" that the lamp is on. The instrument is now ready for operation.

5. To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the span produces a downscale deflection while counter-clockwise rotations yields an upscale deflection. Note: No zero gas is needed since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Wait 15 to 20 seconds to ensure that the zero reading is stable, if necessary, readjust the zero.

6. Set function switch at the 0-20, 0-200, or 0-2000 ppm position.

7. Set the function switch at the lowest scale first (0-20 ppm) and place probe in the atmosphere or source to be monitored. If the needle moves to the upper limit of the scale change the function switch to the next position.

Combustible Gas Indicators (CGIs)/Explosimeters

In addition to the instructions found below, all CGIs should be calibrated prior to use, in a noncontaminated, fresh air environment. Furthermore, units incorporating an aspirator bulb or other air-drawing device should be checked for leaks in the following manner:

- Attach all hoses, probes, and other air-drawing devices to CGI.
- Place a finger over probe or hose end.
- Operate pump or squeeze aspirator bulb.

In a leak-free system bulb remains collapsed or pump labors. In a leaking system, bulb regains its shape or pump does not labor.

a. MSA Explosimeter Combustible Gas Indicator

1. Turn Explosimeter on by lifting end on "On-Off" bar on "Rheostat" knob and rotating "Rheostat" knob clockwise 1/4 turn.

2. Flush instrument with fresh air by squeezing and releasing aspirator bulb about five times.

3. Rotate "Rheostat" knob until meter needle rests at zero. (Avoid large clockwise rotation, which sends large current through filament, perhaps shortening its useful life).

4. To sample, place hose or probe end in atmosphere to be measured and operate aspirator bulb about five times.

5. Read percent of lower explosive limit (LEL) as meter needle fluctuates from a steady-state level to a higher level each time the aspirator bulb is flexed. The steady-state reading indicates the "true" value.

6. Turn Explosimeter off by lifting end of "On-Off" bar on "Rheostat" knob and rotating it counterclockwise until it "clicks". "On-Off" bar retracts into "Rheostat" knob.

10.0 DECONTAMINATION

1. Locate a decontamination area between the Hot Line (upwind boundary of the Exclusionary Area) and the Clean Area boundary.

2. Establish a personnel decontamination station (PDS).

3. Upon leaving the contamination area, all personnel will proceed through the appropriate Contamination Reduction Sequence.

4. All protection gear should be left on-site during lunch break following decontamination procedures.

The maximum decontamination layout for Level C is shown in the attached diagram and a description is given below.

Maximum Measures for Level C Decontamination

Station 1:	Segregated Equipment Drop	1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2. Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3. Rinse off decon solution from Station 2 using copious amounts of water.

Station 4:	Tape Removal	4. Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5. Remove boot covers and deposit in containers with plastic liner.
Station 6:	Outer Glove Removal	6. Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	7. Wash splash suit, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution.
Station 8:	Suit and Boot, and Glove Rinse	8. Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Canister or Mask Change	9. If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers donned, and joints taped worker returns to duty.
Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	Splash Suit Removal	11. With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 12:	Inner Glove Rinse	12. Wash inner gloves with decon solution.
Station 13:	Inner Glove Wash	13. Rinse inner gloves with water.

Station 14:	Face Piece Removal	14. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 15:	Inner Glove Removal	15. Remove inner gloves and deposit in lined container.
Station 16:	Inner Clothing Removal	16. Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off-site since there is a possibility that small amounts of contaminants might have been transferred in removing the fully-encapsulating suit.
Station 17:	Field Wash	17. Shower if highly toxic, skin-corrosive or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 18:	Redress	18. Put on clean clothes.

Minimal Decontamination

Less extensive procedures for decontamination can be subsequently or initially established when the type and degree of contamination becomes known or the potential for transfer is judged to be minimal. These procedures generally involve one or two washdowns only. The layout for a minimal decontamination operation is shown in the attached diagram.

Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation should be double-bagged and either contained on-site or removed to an approved off-site disposal facility. Decon and rinse solution could be contained on-site or removed to an approved disposal facility. Reusable rubber clothing should be dried and prepared for future use. (If gross contamination had occurred, additional decontamination of these items may be required.) Cloth items should be bagged and removed from the site for final cleaning. All wash tubs, pail containers, etc., should be thoroughly washed, rinsed, and dried prior to removal for the site.

11.0 SAMPLE LABELING, PACKAGING, AND SHIPPING

Ground water samples and selected soil samples will be collected at the site and transported to the laboratory for chemical analysis.

ENVIRONMENTAL SAMPLES

Labeling/Marking

The sample label must be legible and written with an indelible pencil or waterproof ink. The information should also be recorded in a log book. Each label should contain the following information:

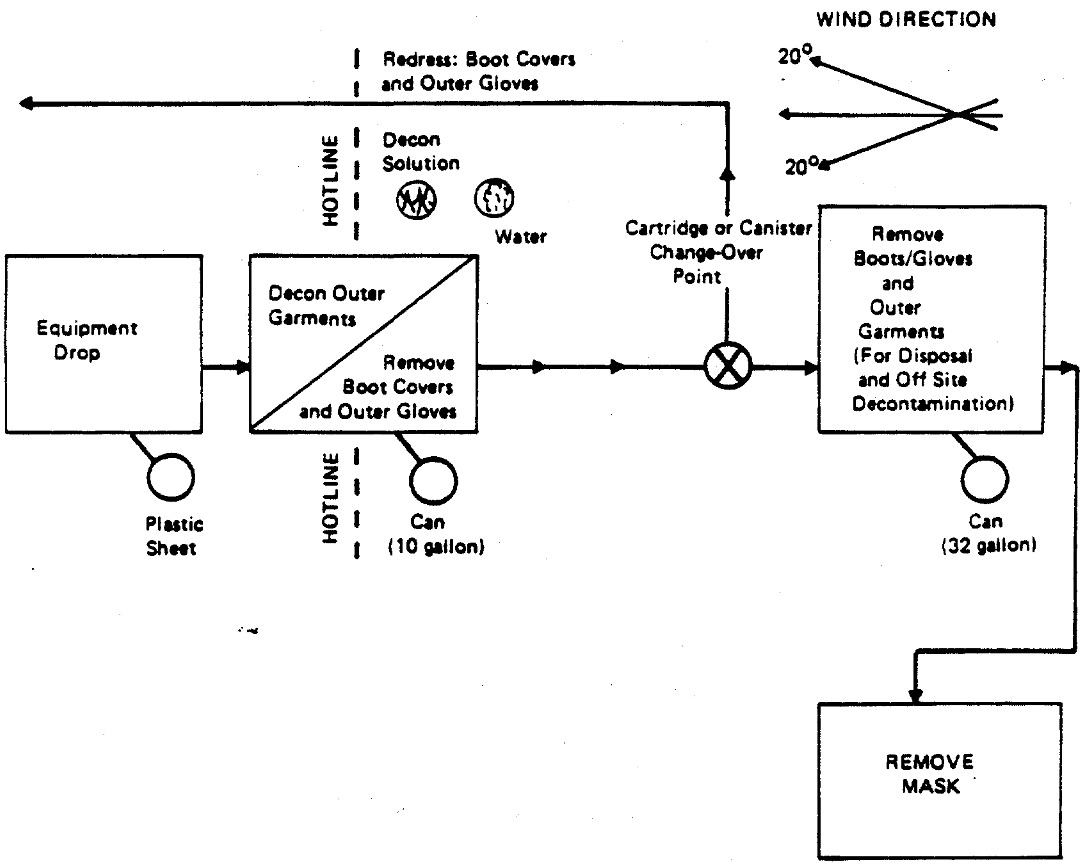
- Job Number (0836-024-10)
- Owner/Client (Helen Kramer Landfill)
- Exact location of sample or monitoring well number, whichever applies.
- Sample number or designation
- Time and date sample was collected
- Name of sampler
- Type of sample
- Type of laboratory analysis
- Laboratory number (if applicable)
- Any other pertinent information

Samples collected for laboratory analysis will accompanied by a chain-of-custody form initiated by the laboratory and accompanying samples through to final disposition at the labortory.

Environmental samples should be packaged and shipped according to the following procedure:

MINIMUM DECONTAMINATION LAYOUT

LEVEL C PROTECTION



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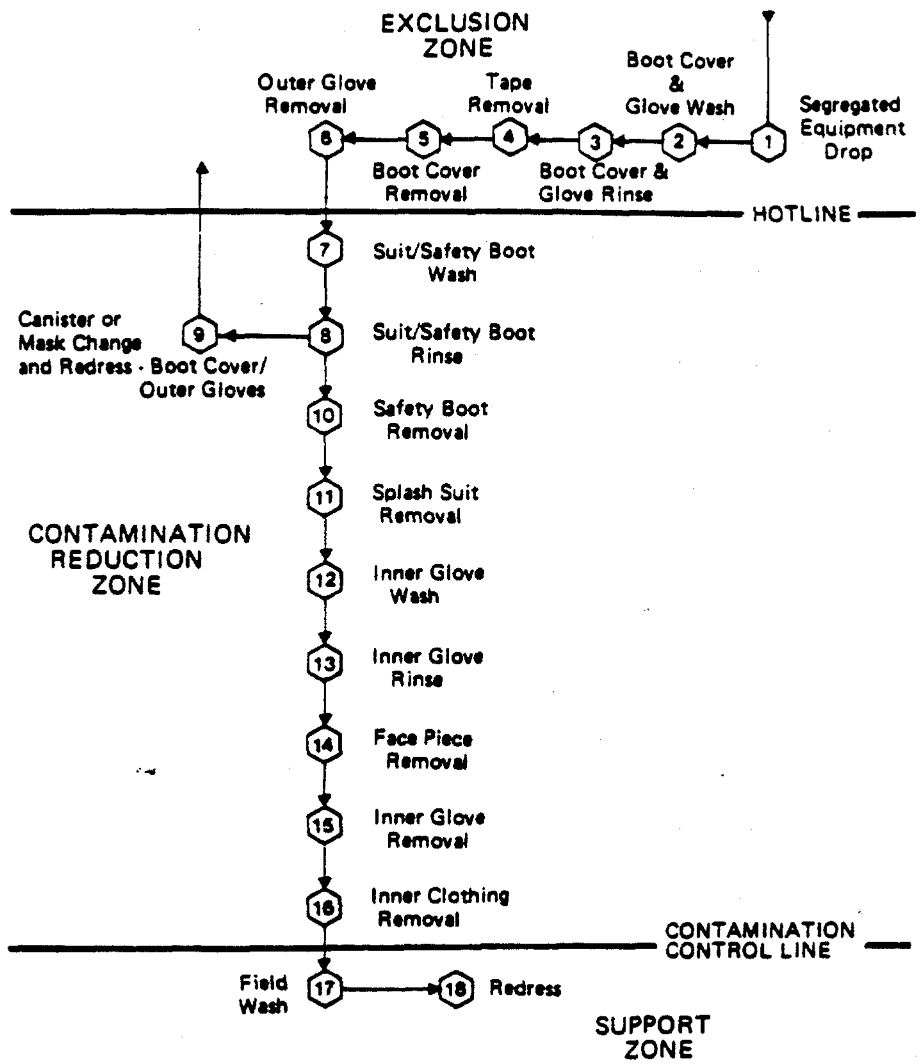
MAXIMUM DECONTAMINATION LAYOUT

LEVEL C PROTECTION



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Packaging

1. Place appropriately labelled sample container in the sample shipping containers (shuttles) provided by the contract analytical laboratory.

2. The shuttle should be insulated and packed with enough noncombustible, absorbent, cushioning material to minimize the possibility of container breakage.

3. Seal or close outside container.

4. Chain-of-custody forms accompany samples.

Sample containers must have a completed sample identification tag and the outside container should be marked "Environmental Sample". The appropriate side of the container should be marked "This End Up" and arrows should be drawn accordingly. No DOT marking and labeling is required.

There are no DOT restrictions on mode of transportation. All samples to be collected by Dames & Moore shall be transported by the laboratory personnel or in a privately owned vehicle to the laboratory for analytical testing.

12.0 FORMS

The following forms are enclosed in this section:

Plan Acceptance Form
Plan Feedback Form
Accident Report Form
Exposure History Form (to be completed by PM only)
Calibration Check Sheet

The Plan Acceptance Form should be filled out by all employees working on the site. The Plan Feedback Form should be filled out by the Site Safety Officer and any other on-site employee who wishes to fill one out. The Accident Report Form should be filled out by the Project Manager if an accident occurs.

ALL COMPLETED FORMS SHOULD BE RETURNED TO THE OFFICE SAFETY COORDINATOR WHO WILL FORWARD THEM TO THE FWHSO.

EXPOSURE HISTORY FORM
(To Be Completed by Project Manager)

Job Name: SLURRY WALL TEST BORINGS - HELEN KRAMER LANDFILL

Job Number: 836-024-10

Dates From/To: ______________________

O&M Personnel on-site:

1. ______	5. ______
2. ______	6. ______
3. ______	7. ______
4. ______	8. ______

Suspected Contaminants	Verified Contaminants and Airborne Concentration Thereof

DR 000594

Return to: (1) OSC (2) WRHSO (IN WESTERN REGION) (3) FHSPO

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

Instructions: This form is to be completed by each person to work on the subject project work site and returned to the Program Director-Firmwide Health & Safety Program Office.

Job No. 836-024-10

Client SLURRY WALL TEST BORINGS
Project HELEN KRAMER LANDFILL

Date ____________________

I represent that I have read and understand the contents of the above plan and agree to perform my work in accordance with it.

____
Signed

____
Print Name

____
Company/Office

____
Date

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PLAN FEEDBACK FORM

Job Number: 836-024-10

Job Name: SLURRY WALL TEST BORINGS
HELEN KRAMER LANDFILL

Date: ____________

Problems with plan requirements:

____
____
____
____
____

Unexpected situations encountered:

____
____
____
____
____

Recommendations for future revisions:

____
____
____
____
____

PLEASE RETURN TO THE FIRMWIDE HEALTH AND SAFETY OFFICE
(Pearl River, New York)

DAILY INSTRUMENT CALIBRATION CHECK SHEET

INSTRUMENT ____________________

SERIAL # ____________________

DATE	PURE AIR Y/N	CALIBRATION GAS (PPM)	BATTERY CHECK (GOOD/BAD)	CALIBRATED BY	REMARKS

DR 000597

H&S-MASTER

ACCIDENT REPORT FORM

SUPERVISOR'S REPORT OF ACCIDENT	DO NOT USE FOR MOTOR VEHICLE OR AIRCRAFT ACCIDENTS
TO	FROM TELEPHONE (include area code)
NAME OF INJURED OR ILL EMPLOYEE	
DATE OF ACCIDENT / TIME OF ACCIDENT	EXACT LOCATION OF ACCIDENT
NARRATIVE DESCRIPTION OF ACCIDENT	
NATURE OF ILLNESS OR INJURY AND PART OF BODY INVOLVED	LOST TIME YES NO
PROBABLE DISABILITY (Check One) FATAL — LOST WORK DAY WITH DAYS AWAY FROM WORK — LOST WORK DAY WITH DAYS OF RESTRICTED ACTIVITY — NO LOST WORK DAY — FIRST AID ONLY	
CORRECTIVE ACTION TAKEN BY REPORTING UNIT	
CORRECTIVE ACTION WHICH REMAINS TO BE TAKEN (By whom and by when)	
NAME OF SUPERVISOR	TITLE
SIGNATURE	DATE

DR 000598

TABLE 2

SYMPTOMS OF OVEREXPOSURE AND FIRST AID TREATMENT

Compound	Eye	Skin	Inhalation/Ingestion
Chlorobenzene	Irritation	Irritation	Drowsiness, incoordination, headache, cyanosis.
Chloroform	Irritation	Irritation	Dizziness, mental dullness, nausea, headache, fatigue.
1,1-Dichloroethane	Irritation	Irritation	Depression, drowsiness, unconscious.
1,1,2-Trichloroethane	Irritation	Irritation	Depression, affects central nervous system.
Methylene Chloride	Irritation	Irritation	Fatigue, weak, sleep, lightheaded, limbs numb, tingle.
Acetone	Irritation	Irritation	Headache, dizziness, dermatitis.
1,2-Dichloroethylene	Irritation	Irritation	Depression, dizziness, narcosis.
1,2-Dichloroethane	Irritation	Irritation	Depression, nausea, vomit, dermatitis.
1,1,1-Trichloroethane	Irritation	Irritation	Headache, lassitude, depression, poor equilibrium.
1,1,2,2-Tetrachloroethane	Irritation	Irritation	Nausea, vomit, abdominal pain, tremor in fingers.
Vinyl Chloride	Irritation	Irritation	Headache, dizziness, weak, abdominal pain, corneal burns.
Benzene	Irritation	Dermatitis	Giddy, headache, nausea, fatigue, staggering gait.
Tetrachloroethane	Irritation	Irritation	Nausea, flush face and neck, dizziness, incoordination.
Toluene	Irritation	Dermatitis	Fatigue, weak, confusion, euphoria, dilated pupils.
2-Butanone (MEK)	Irritation	Irritation	Dizziness, vomit.
2-Hexanone	Irritation	Dermatitis	Weakness, drowziness, headache.
Ethyl Benzene	Irritation	Dermatitis	Headache, narcosis, coma.
Total Xylenes	Irritation	Irritation	Dizziness, excitement, staggering gait, abdominal pain, vomit.
Phenol	Irritation	Irritation	Anorexia, weak, muscle ache, dark urine.
Bis(2-Chloroethyl)Ether	Irritation		
1,2-Dichlorobenzene	Irritation	Irritation	Headache, dizziness, nausea, swelling of hands, feet or ankles.
4-Methyl Phenol (P-Cresol)	Irritation	Irritation	Confusion, depression, irregular rapid respiratory.
Isophorone	Irritation	Dermatitis	Headache, dizziness, narcosis.
Napthalene	Irritation	Irritation	Vomit, abdominal pain, profuse sweat, confusion.
Carbon Tetrachloride	Irritation	Irritation	Nausea, vomit, abdominal cramps, nervousness.
1,2-Dibromoethane	Irritation	Irritation	Irritates respiratory system, dermatitis.
Dioxane	Irritation	Irritation	Drowziness, nausea, vomit.
Styrene	Irritation	Irritation	Drowziness, weak, unsteady gait.
P-Dichlorobenzene	Irritation	Irritation	Swelling, nausea, vomit, profuse rhinorrhea.
Nitrobenzene	Irritation	Irritation	Anemia, dizziness, nausea, vomit.
Heptachlor	Irritation	Irritation	Tremors, convulsions.

TABLE 4

PROTECTIVE EQUIPMENT FOR ON-SITE ACTIVITIES

Activity	Level	Protective Equipment
Site Surveying, Geophysical Surveying	D	o Coveralls o Boots/shoes, leather or chemical resistant o Gloves (optional)
Drilling, Soil and Ground Water Sampling	D+	o Safety glasses o Chemical-resistant (Tyvek) clothing o Outer (chemical-resistant) and inner (chemical-resistant) gloves o Steel-toed boots (chemical-resistant) o Neoprene or butyl rubber outer boots o Hard hat
Drilling, Soil and Ground Water Sampling	C	o Same as above plus o Joints between gloves, boots and suit shall be taped o Full-face respirator with organic vapor/high-efficiency dust and mist cartridges[(1)] o If PID reading is >5 ppm or chloroform detector tube is > 2 ppm or carbon tetrachloride is > 5 ppm or hydrogen sulfide detector tubes is >10 ppm, STOP WORK EVACUATE AREA NOTIFY P.M. AND CLIENT SAFETY OFFICER

TABLE 1

EXPOSURE LIMITS AND RECOGNITION QUALITIES

Compound	Exposure Standard	IDLH Level	Color	Odor (Threshold)	LEL % (ppm)	UEL % (ppm
Chlorobenzene	75 ppm(1)(3)	2400 ppm	Colorless	Mild Aromatic	12.3	7.1
Chloroform	10 ppm(3) 50 ppm(1)	1000 ppm	Colorless	Pleasant Sweet Odor	--	--
1,1-Dichloroethane	100 ppm(1) 200 ppm(3)	4000 ppm	Colorless	Chloroformlike Odor	6	16
1,1,2-Trichloroethane	10 ppm(1)	500 ppm	Colorless	Chloroformlike Odor	6	15.5
Methylene Chloride	100 ppm(3) 500 ppm(1)	5000 ppm	Colorless	Chloroformlike Odor	12	19
Acetone	750 ppm(3) 1000 ppm(1)	20,000 ppm	Colorless	Mintlike Odor	2.6	12.8
1,2-Dichloroethylene	200 ppm(1)	4000 ppm	Colorless	Chloroformlike Odor	9.7	12.8
1,2-(Ethylene Dichloride) Dichloroethane	10 ppm(3) 50 ppm(1)	1000 ppm	Clear	Chloroformlike Odor	6.2	16
1,1,1 (Methyl Chloroform) Trichloroethane	350 ppm(1)(2)	1000 ppm	Colorless	Chloroformlike Odor	7	16
1,1,2,2-Tetrachloroethane	1 ppm(3) 5 ppm(1)	150 ppm	Colorless to Pale Yellow	Chloroformlike Odor	--	--
Vinyl Chloride	1 ppm(1) 5 ppm(3)	—	Colorless Gas	3.6	33	
Benzene	10 ppm(1)	2000 ppm	—	Aromatic	1.37	7.1
Tetrachloroethylene (PCE)	50 ppm(3) 100 ppm(1)	500 ppm	Colorless	Chloroformlike Odor	--	--
Toluene	100 ppm(3)	2000 ppm	Colorless	Aromatic	1.3	1.37
2-Butanone	200 ppm(1)	3000 ppm	Clear	Mintlike Odor	2	10
2-Hexanone	5 ppm(3) 100 ppm(1)	5000 ppm	Colorless	—	1.2	8
Ethyl Benzene	100 ppm(1)	2000 ppm	Colorless	Aromatic	1	6.7
Total Xylenes	100 ppm(1)	10,000 ppm	Colorless	Aromatic	1.1	7.0
Phenol	5 ppm(1)	100 ppm	Colorless to Pink	Sweet	1.7	8.0
Bis(2-Chloroethyl)Ether						
1,2-Dichlorobenzene	50 ppm(1)	1700 ppm	Colorless to Pale Yellow	Pleasant Aromatic Odor	2.2	9.2
4-Methylphenol (p-Cresol)	5 ppm(1)	250 ppm	Colorless	Sweet Tarry Odor	--	NA
Isophorone	5 ppm(1)	800 ppm	Colorless to Pale	Camphorlike Odor	.8	3.8
Napthalene	10 ppm(1)	500 ppm	Colorless to Brown	Mothballs	.9	5.9
Carbon Tetrachloride	10 ppm(1)	300 ppm	Colorless	Etherlike	Not Combustible	
1,2-Dibromoethane	20 ppm(1)	400 ppm	Colorless	Mild Sweet Odor	Not Combustible	
Dioxane	25 ppm(3)	200 ppm	Colorless	Etherlike	2	22
Styrene	50 ppm(3)	5000 ppm	Colorless	Sweet Aromatic Odor at Low Concentration but Sharp Penetrating Odor at Higher Levels	1.1	6.1
P-Dichlorobenzene	75 ppm(1)	1000 ppm	Colorless	Mothballs	2.5	--
Nitrobenzene	1 ppm(1)	200 ppm	Pale Yellow to Dark Brown	Black Paste Shoe Polish	1.8	--
Heptachlor	.5 mg/m^3	100 mg/m^3	Light Tan	Camphor	Not Combustible	
Alpha BHC	No Standard	N.S.	—	—	--	--

(a) *OSHA permissible exposure limit or American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value

(b) Immediately Dangerous to Life and Health

(c) Lower Explosive Limit

(d) Upper Explosive Limit

(1) OSHA Time Weighted Average

(2) NIOSH Time Weighted Average

(3) ACGIH Time Weighted Average

DR 000601

TABLE 3

HAZARDOUS MONITORING METHOD ACTION LEVELS AND PROTECTIVE MEASURES

Hazard	Method	Action Level	Protective Measure	Monitoring Schedule
Toxic Vapors	PID	(1) Measurable above background based on judgment by SSO	Level D (see Table 4)	Continue drilling. Continuemonitoringevery 10 minutes/every sample retrieved.
		and		
	Hydrogen Sulfide Detector tubes	< 10 ppm		Continuous
		and		
	Chloroform Detector Tubes	< 2 ppm		
		and		
	Carbon Tetrachloride Tubes	< 5 ppm		
	PID	1 ppm - 5 ppm above background	Level C (see Table 4)	Continue drilling. Continuous monitoring/ every sample retrieved.
		and		
	Hydrogen Sulfide Detector Tubes	< 10 ppm		Continuous
		and		
	Chloroform Detector Tubes	< 2 ppm	Don full face respirator with organic vapor and high efficiency dust and mist cartridges.	
		and		
	Carbon Tetrachloride Tubes	< 5 ppm		
	PID	5 ppm - 500 ppm above background	STOP WORK - EVACUATE AREA NOTIFY P.M. AND CLIENT SAFETY OFFICER	
		or		
	Hydrogen Sulfide Detector Tubes	> 10 ppm		
		or		
	Chloroform Detector Tubes	> 2 ppm		
		or		
	Carbon Tetrachloride Tubes	> 5 ppm		
Explosive Atmosphere	Explosimeter	0-10% LEL	Continue drilling	Continue monitoring every 10 minutes/every sample retrieved.
		10% - 25% LEL		Continuous monitoring/ every sample retrieved.
		25% LEL	EVACUATE THE AREA EXPLOSION HAZARD	

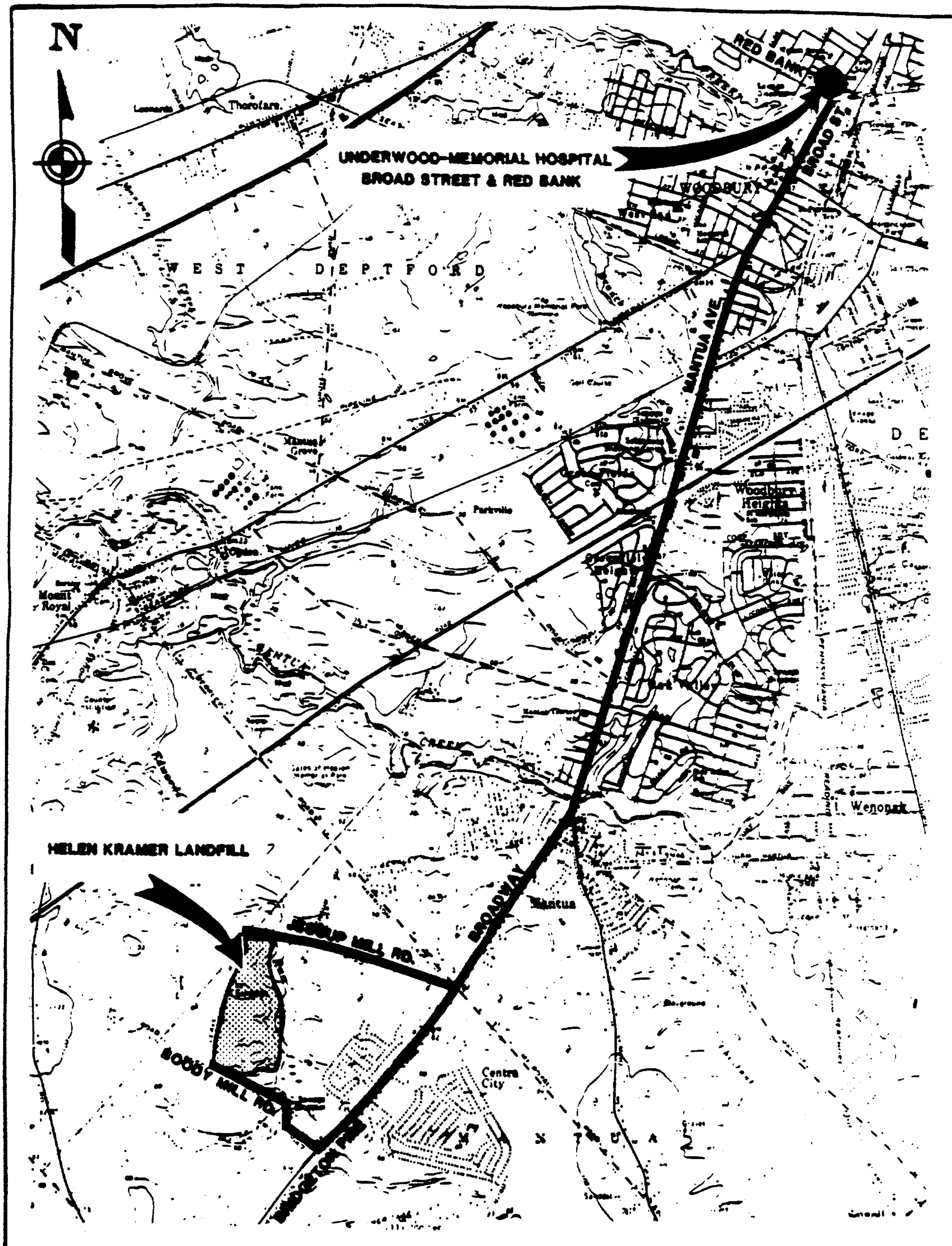
(1) The above action levels are not soley based on the criteria for selecting levels of protection by the 1984 EPA Standard Operating Procedures but also on the professional judgment and experience of the On-Site Safety Officer (OSSO).

** If encountered in a boring hole or monitoring well, purge boring or well with nitrogen until safe levels (< 10%) are obtained. If 25% LEL persists, abandon boring and evacuate area temporarily. After at least 1/2 hour, reapproach borehole from an upwind direction while continuously monitoring well explosimeter. If levels are still unsafe, backfill hole and abandon.

TABLE 5

EMERGENCY CONTACTS

Agency	Person to Contact	Telephone
Police		609-468-1900
Fire		911
Ambulance	Reliable Medical Transportation	609-845-3103
Hospital	Underwood-Memorial Hospital (see map)	609-853-2000
Poison Control		1-800-962-1253
Client Safety Officer	Andre LePrez (Site Engineer)	—
D&M Project Manager	William F. Mercurio	201-272-8300
Regional Health & Safety Plan Officer (acting)	William Levitan	914-735-1200



ROUTE TO THE HOSPITAL

DR 000604

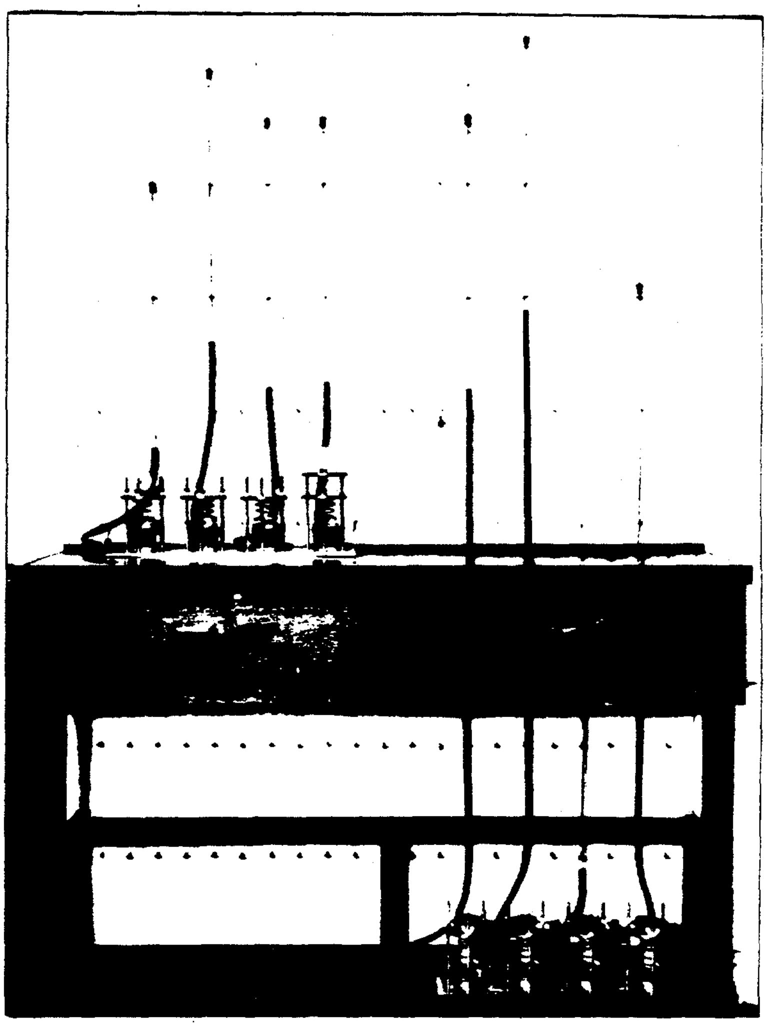
APPENDIX 6-1

LABORATORY DATA AND EQUIPMENT

DR 000605

[illegible]

The quantity and the velocity of flow of water which will escape through an earth structure or percolate through soil are dependent upon the permeability of the earth structure or soil. The permeability of soil has often been calculated by empirical formulas but is best determined by laboratory tests, especially in the case of compacted soils.



APPARATUS FOR PERFORMING PERCOLATIONS TESTS
Shows tests in progress on eight samples simultaneously.

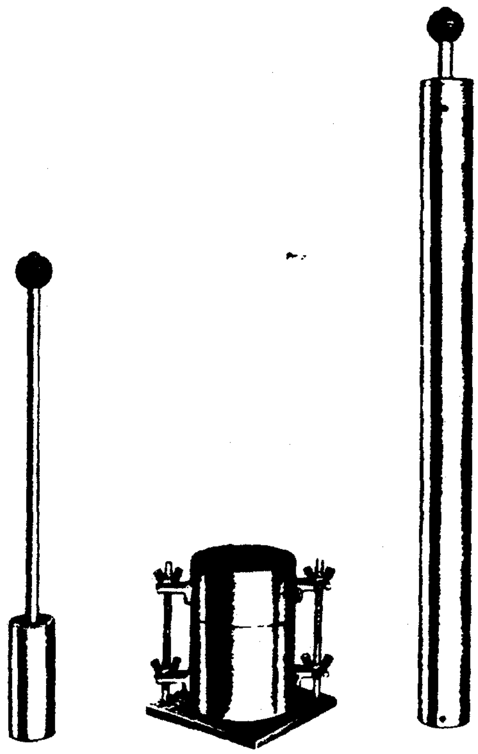
A one-inch length of the core sample is sealed in the percolation apparatus, placed under a confining load, or surcharge pressure, and subjected to the pressure of a known head of water. The percolation rate is computed from the measurements of the volume of water which flows through the sample in a series of time intervals. These rates are usually expressed as the velocity of flow in feet per year under a hydraulic gradient of one and at a temperature of 20 degrees Centigrade. The rate so expressed may be adjusted for any set of conditions involving the same soil by employing established physical laws. Generally, the percolation rate varies over a wide range at the beginning of the test and gradually approaches equilibrium as the test progresses.

During the performance of the test, continuous readings of the deflection of the sample are taken by means of micrometer dial gauges. The amount of compression or expansion, expressed as a percentage of the original length of the sample, is a valuable indication of the compression of the soil which will occur under the action of load or the expansion of the soil as saturation takes place.

Method Of Performing Compaction Tests
(STANDARD AND MODIFIED A.A.S.H.O. METHODS)

IT HAS BEEN ESTABLISHED THAT WHEN COMPACTING EFFORT IS HELD CONSTANT, THE DENSITY OF A ROLLED EARTH FILL INCREASES WITH ADDED MOISTURE UNTIL A MAXIMUM DRY DENSITY IS OBTAINED AT A MOISTURE CONTENT TERMED THE "OPTIMUM MOISTURE CONTENT," AFTER WHICH THE DRY DENSITY DECREASES. THE COMPACTION CURVE SHOWING THE RELATIONSHIP BETWEEN DENSITY AND MOISTURE CONTENT FOR A SPECIFIC COMPACTING EFFORT IS DETERMINED BY EXPERIMENTAL METHODS. TWO COMMONLY USED METHODS ARE DESCRIBED IN THE FOLLOWING PARAGRAPHS.

FOR THE "STANDARD A.A.S.H.O." (A.S.T.M. D698-66T & A.A.S.H.O. T99-61) METHOD OF COMPACTION A PORTION OF THE SOIL SAMPLE PASSING THE NO. 4 SIEVE IS COMPACTED AT A SPECIFIC MOISTURE CONTENT IN THREE EQUAL LAYERS IN A STANDARD COMPACTION CYLINDER HAVING A VOLUME OF 1/30 CUBIC FOOT, USING TWENTY-FIVE 12-INCH BLOWS OF A STANDARD 5-1/2 POUND RAMMER TO COMPACT EACH LAYER.



SOME APPARATUS FOR PERFORMING COMPACTION TESTS
Shows, from left to right, 5-1/2 pound rammer (sleeve controlling 12" height of drop removed), 1/30 cubic-foot cylinder with removable collar and base plate, and 10 pound rammer within sleeve.

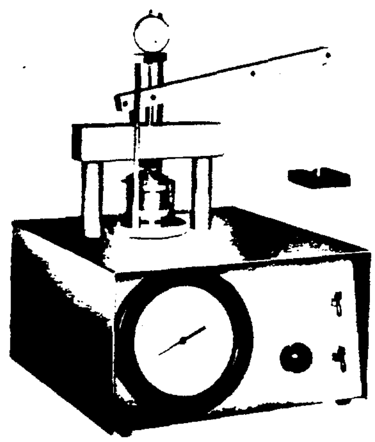
IN THE "MODIFIED A.A.S.H.O." (A.S.T.M. D-1557-66T & A.A.S.H.O. T 180-61) METHOD OF COMPACTION A PORTION OF THE SOIL SAMPLE PASSING THE NO. 4 SIEVE IS COMPACTED AT A SPECIFIC MOISTURE CONTENT IN FIVE EQUAL LAYERS IN A STANDARD COMPACTION CYLINDER HAVING A VOLUME OF 1/30 CUBIC FOOT, USING TWENTY-FIVE 18-INCH BLOWS OF A 10-POUND RAMMER TO COMPACT EACH LAYER. SEVERAL VARIATIONS OF THESE COMPACTION TESTING METHODS ARE OFTEN USED AND THESE ARE DESCRIBED IN A.A.S.H.O. & A.S.T.M. SPECIFICATIONS.

FOR BOTH METHODS, THE WET DENSITY OF THE COMPACTED SAMPLE IS DETERMINED BY WEIGHING THE KNOWN VOLUME OF SOIL; THE MOISTURE CONTENT, BY MEASURING THE LOSS OF WEIGHT OF A PORTION OF THE SAMPLE WHEN OVEN DRIED; AND THE DRY DENSITY, BY COMPUTING IT FROM THE WET DENSITY AND MOISTURE CONTENT. A SERIES OF SUCH COMPACTIONS IS PERFORMED AT INCREASING MOISTURE CONTENTS UNTIL A SUFFICIENT NUMBER OF POINTS DEFINING THE MOISTURE-DENSITY RELATIONSHIP HAVE BEEN OBTAINED TO PERMIT THE PLOTTING OF THE COMPACTION CURVE. THE MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT FOR THE PARTICULAR COMPACTING EFFORT ARE DETERMINED FROM THE COMPACTION CURVE.

Method Of Performing Consolidation Tests

Consolidation tests are performed to evaluate the volume changes of soils subjected to increased loads. Time-consolidation and pressure-consolidation curves may be plotted from the data obtained in the tests. Engineering analyses based on these curves permit estimates to be made of the probable magnitude and rate of settlement of the tested soils under applied loads.

Each sample is tested within brass rings two and one-half inches in diameter and one inch in length. Undisturbed samples of in-place soils are tested in rings taken from the sampling device in which the samples were obtained. Loose samples of soils to be used in constructing earth fills are compacted in rings to predetermined conditions and tested.



DEAD LOAD-PNEUMATIC CONSOLIDOMETER

In testing, the sample is rigidly confined laterally by the brass ring. Axial loads are transmitted to the ends of the sample by porous disks. The disks allow drainage of the loaded sample. The axial compression or expansion of the sample is measured by a micrometer dial indicator at appropriate time intervals after each load increment is applied. Each load is ordinarily twice the preceding load. The increments are selected to obtain consolidation data representing the field loading conditions for which the test is being performed. Each load increment is allowed to act over an interval of time dependent on the type and extent of the soil in the field.

FORM NO. 417.3 (Rev. 4-61)

I. CELL DESCRIPTION

A triaxial/permeability cell is a device in which a disc-shaped soil sample can be confined between two porous stones and surrounded by a rubber membrane (Fig. 1). The rubber membrane is forced against the sides of the sample by an external pressure. Drainage lines are provided at both ends of the sample so that permeant can be forced to flow through the sample. The permeability of the soil sample can be determined by measuring the quantity of permeant that flows through the sample versus time.

The main advantage of a triaxial-type permeameter over a rigid-wall permeameter is that, by pressing a rubber membrane against the sides of the sample, the permeant is forced to flow through the sample. In a rigid-wall permeameter, however, if the sample is not carefully trimmed into the cell wall or if the sample contracts during the test, permeant will flow around the sample in gaps or channels near the cell wall.

Another advantage of this particular triaxial/permeameter is that it can be used with permeants that are corrosive. The permeant comes in contact only with the cast acrylic end caps and the drainage tubing. Different types of tubing can be selected to be compatible with the permeant that is to be used. If the tubing or cast acrylic deteriorates, it can easily be replaced. Stainless steel caps are also available.

The major parts of the cell include (Fig. 1):

- Top and bottom plates
- Cell wall
- Three clamping rods with knurled nuts
- Three base legs
- Base pedestal and top cap

The bottom plate has four drainage lines which exit the bottom of the plate through 1/8" male tube connectors. The two outside drains connect to the top of the soil sample, and the two interior drains connect to the base of the sample.

The bottom plate is also provided with a quick-connect fitting through which the cell is filled and drained. A quick-connect at the top of the top plate is used to vent the cell when it is being filled or drained.

The 1/8" tube connectors in the top cap are made of stainless steel. All the fittings provided with the cell are Swagelok and can be obtained from a local supplier.

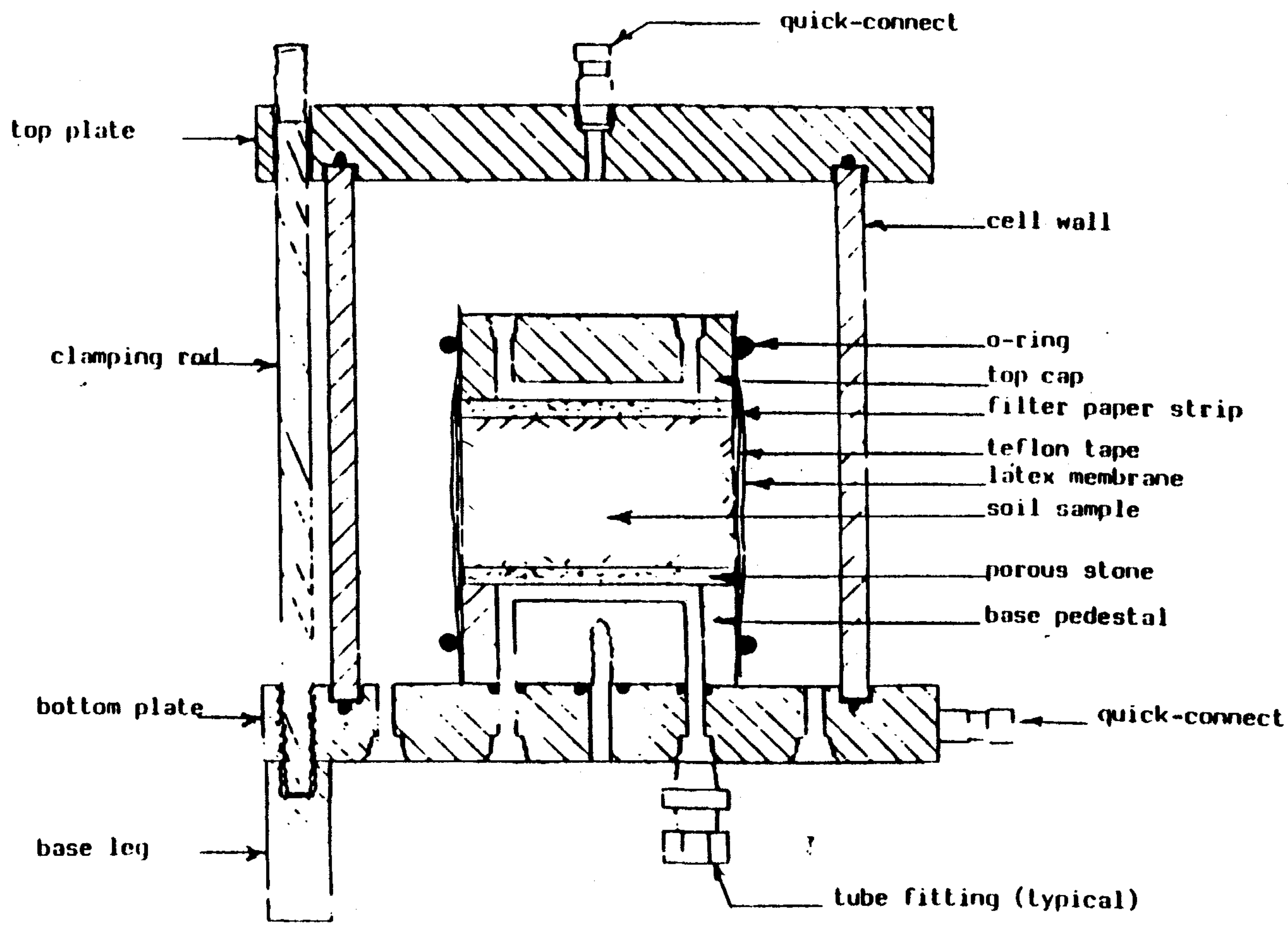


Figure 1. Schematic of Triaxial Permeability Cell

NL Baroid

201 MARSH FUNNEL VISCOMETER MODEL NO. 201

GENERAL INFORMATION

The NL Baroid Marsh Funnel Viscometer (Baroid Part #201) is a rugged, easy to operate instrument that is used for making rapid, on the spot measurements of drilling mud viscosity. The Marsh Funnel readings are only general measurements, but the frequent reporting of the Marsh Funnel Viscosity will alert the mud engineer to sudden changes in the mud viscosity that could require corrective action.

The Marsh Funnel Viscosity is the ratio of the speed of the mud as it passes through the outlet tube (the Shear Rate) to the amount of force - the weight of the mud itself - that is causing the mud to flow (the Shear Stress). Marsh Funnel Viscosity is reported as the number of seconds required for one quart of mud to flow out of a full Marsh Funnel.

MEASURING THE VISCOSITY OF DRILLING MUD

NOTE A

In addition to the Marsh Funnel, this procedure requires a container to collect a mud sample, a graduated container to receive the mud as it flows out of the funnel, some way to measure elapsed time (preferably a stop watch), and a centigrade or farenheit thermometer for measuring the temperature of the mud sample. (See the Parts List).

NOTE B

The Marsh Funnel should be clean and dry before beginning this procedure.

Perform these steps to measure the viscosity of drilling mud:

1. Collect a fresh mud sample.
2. Hold the funnel erect with a finger over the outlet tube, and pour the mud into the funnel through the screen until the mud level reaches the bottom of the screen. (The screen will filter out the larger particles that could clog the outlet tube).

NOTE C

When the Marsh Funnel is filled to the proper level it holds more than one quart of mud.

3. Quickly remove the finger from the outlet tube, and, at the same time, begin timing the mud outflow.

4. Allow one quart (946 cc) of mud to drain from the Marsh Funnel into a graduated container.

5. Record the number of seconds it takes for the quart of mud to flow out of the funnel, and report this value as the Marsh Funnel Viscosity. Also record the temperature of the mud sample in degrees F or C.

CARE OF THE FUNNEL

Follow these suggestions to care for the Marsh Funnel:

1. Clean and dry the funnel thoroughly after each use.

2. Take special care not to bend or flatten the brass outlet tube at the bottom of the funnel. The Marsh Funnel Viscosity readings are computed using the exact diameter of this outlet and if the outlet is distorted the readings will be inaccurate.

CALIBRATION CHECK

Periodically check the calibration of the Marsh Funnel by measuring the viscosity of fresh water. The funnel is dimensioned so that the outflow of one quart (946 cc) of fresh water at a temperature of 70±5 F (21±3 C) is 26±0.5 seconds. If the Marsh Funnel checks out of calibration, it should be cleaned again, using a pipe cleaner, to make sure that there is nothing obstructing the outlet. If the Marsh Funnel continues to give an incorrect reading for fresh water after cleaning then the outlet tube probably has been bent out of shape, and the funnel should be replaced.

PARTS LIST

The NL Baroid Marsh Funnel Viscometer is shipped with no accessories, but some of the additional equipment necessary for the measurement procedure can be obtained from NL Baroid, Testing Equipment, P.O. Box 4350, Houston, Texas, 77201, USA. The following is a list of part numbers:

DESCRIPTION	BAROID PART #
Marsh Funnel Viscometer	201
Measuring Cup (Plastic)	202
Measuring Cup (Stainless Steel)	202-11
Stopwatch	207
Rubber Case for the Stopwatch	208-01
Digital Stopwatch	207-02
Metal Dial Thermometer (Fahrenheit)	979
Digital Thermometer (Fahrenheit and Centigrade)	982-02

Printed in U.S.A.

NL Baroid Series 300

Standard API Filter Press

Instruction Booklet Part No.:
30001 001EA

NL

NL Baroid/NL Industries, Inc.

SECTION 3
FILTER PRESS TEST PROCEDURES

Follow the steps in this procedure to operate the filter press with a compressed gas or dead-weight hydraulic pressure source:

1. Assemble the dry parts of the filter cell in the following order: base cap, rubber gasket, screen, a sheet of filter paper, rubber gasket, and filter cell (see Fig. 7). Secure the cell to the base cap by rotating it clockwise.

2. Fill the cell with the test sample to within approximately 1/4" (6 mm) of the top. (Filling the cell to this level lessens the pressure volume required from the pressure source.)

3. Set the filter press in place within the frame.

4. Check the top cap to make sure the rubber gasket is in place. Place the top cap, already connected to the pressure source, onto the filter cell and secure the cell in place with the T-screw.

5. Place a dry graduated cylinder under the filtrate tube, either on the support or in the clip.

6. Depending upon the pressure source being used, apply pressure to the cell following the appropriate pressure source procedure as outlined in Section 2.

7. At the end of 30 minutes (or 7-1/2 minutes--see NOTE C), close the pressure source valve or back off the regulator, and open the safety-bleeder valve. This releases the pressure on the entire system.

NOTE C

After steps 6 and 7, the amount of filtrate collected after 7-1/2 minutes can be noted and, when this amount is multiplied by two, it will give a rough estimate of the amount that will be collected in 30 minutes. The estimated value is usually one or more milliliters short of the actual value and this estimation procedure should not be attempted on muds having a filtrate loss of less than 5 ml in the 7-1/2 minute period.

8. Measure the volume of filtrate collected in the graduated cylinder and record the filtrate loss in milliliters as the API (30-minute) filtrate loss of the mud, or milliliters x 2 for the 7-1/2 minute test.

9. Loosen the T-screw, remove the cell top, and then remove the cell from the frame.

10. Discard the mud.

11. Disassemble the filter cell and carefully remove the filter cake and filter paper from the base cap.

12. With a gentle stream of water (or, in the case of oil muds, with diesel oil), carefully wash excess mud from the cake.

13. Measure and record the thickness of the filter cake to the nearest 1/32" (0.8 mm).

14. If desired, record properties of the filter cake such as texture, hardness, flexibility, etc.

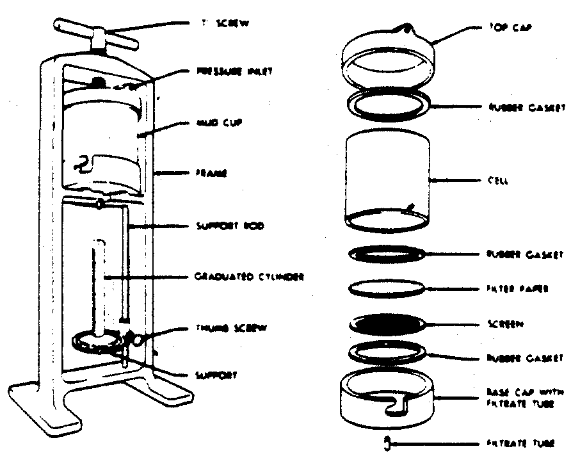


Figure 7.- The Filter Cell (Mud Reservoir) Assembly.

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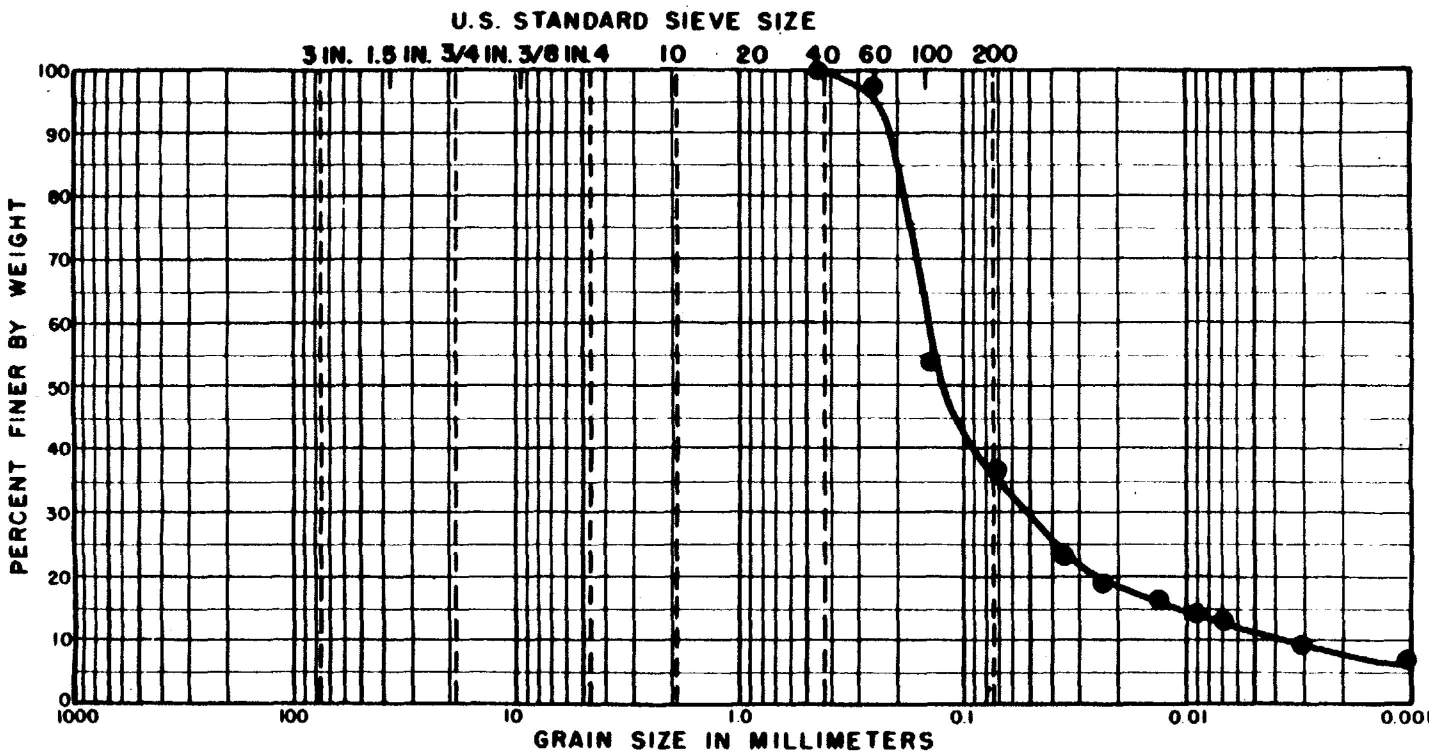

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-1	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-35	51.5-53.5'							

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Dames & Moore

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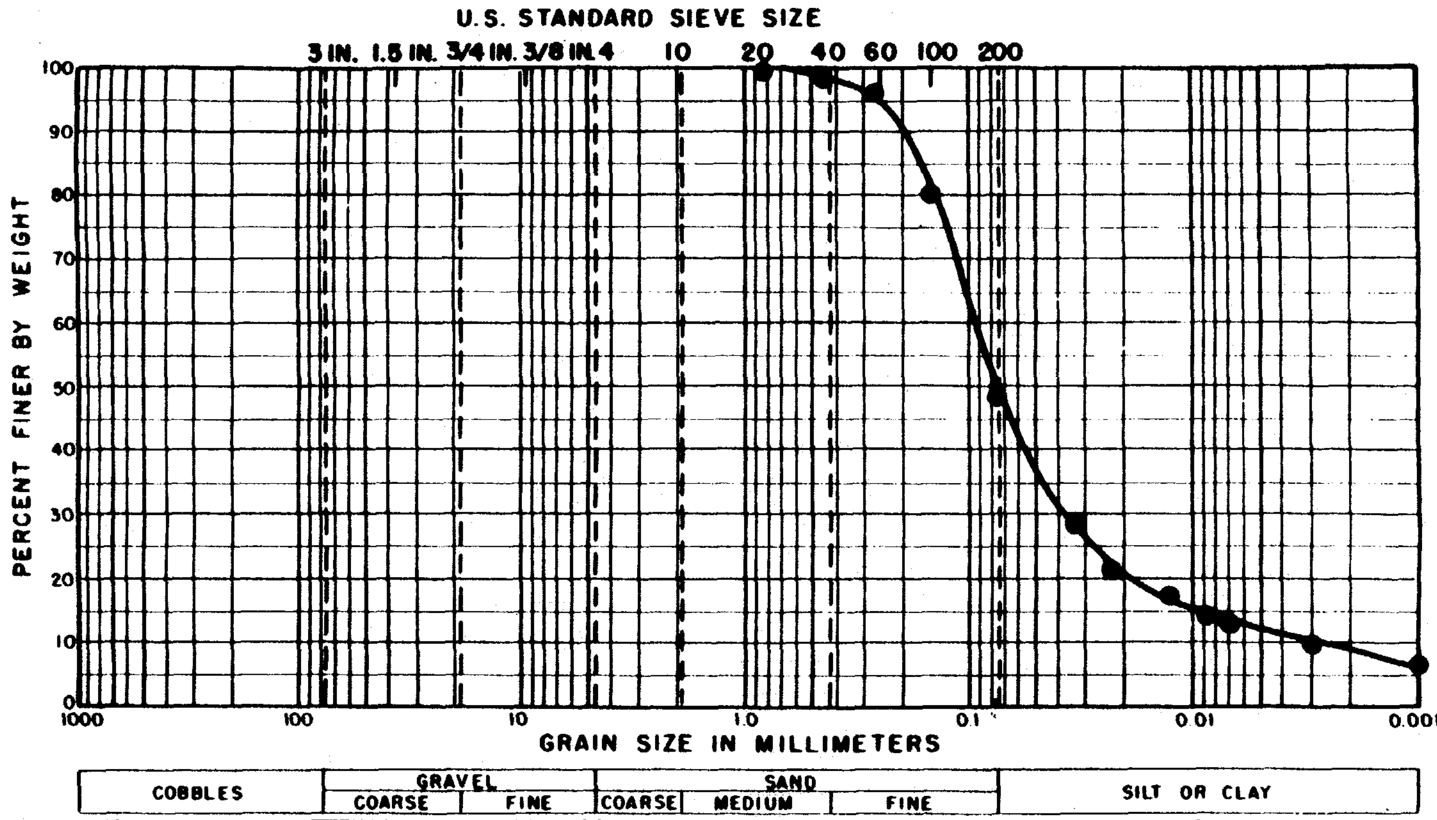

SB-1	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-36	54-56'							

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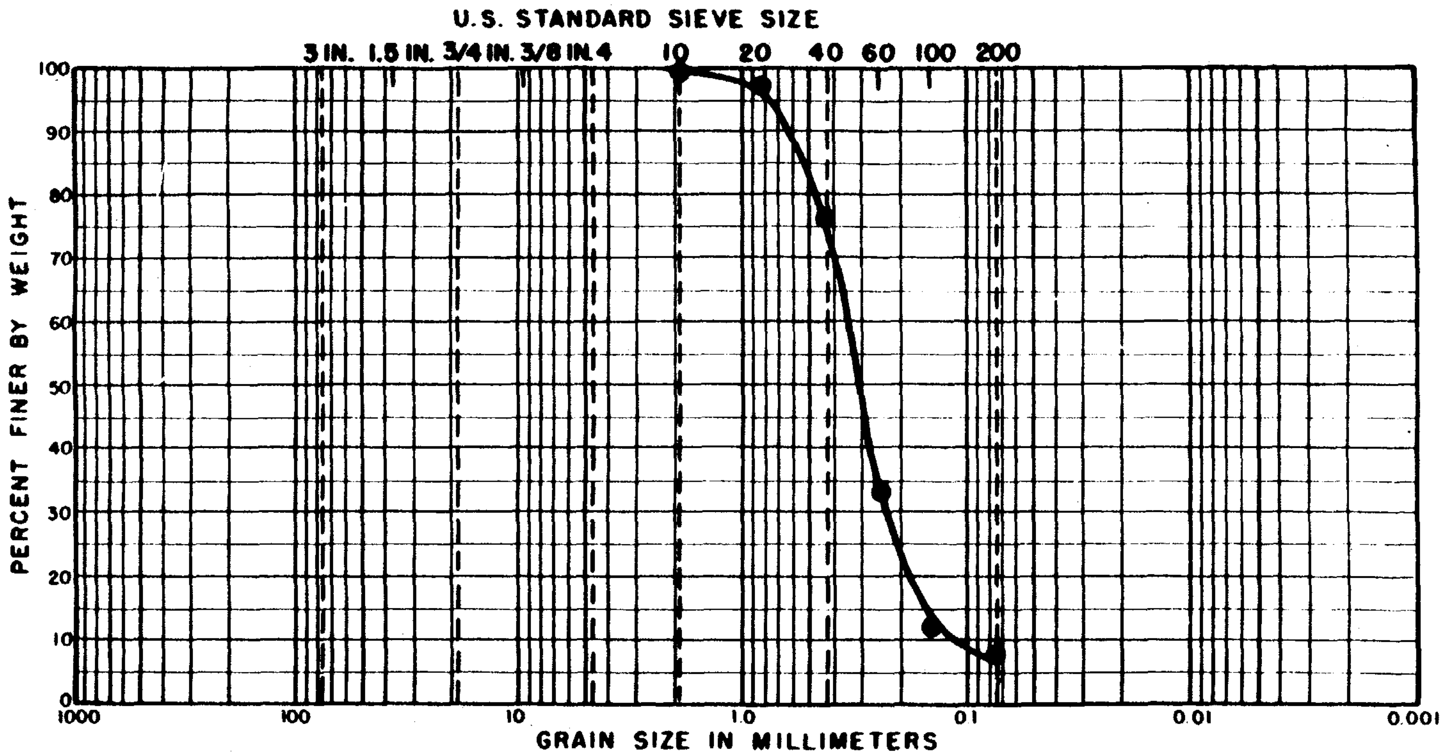

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-1	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-7	9-10.5'							

DR 0000618

Dames & Moore

GRADATION CURVE

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BY DATE
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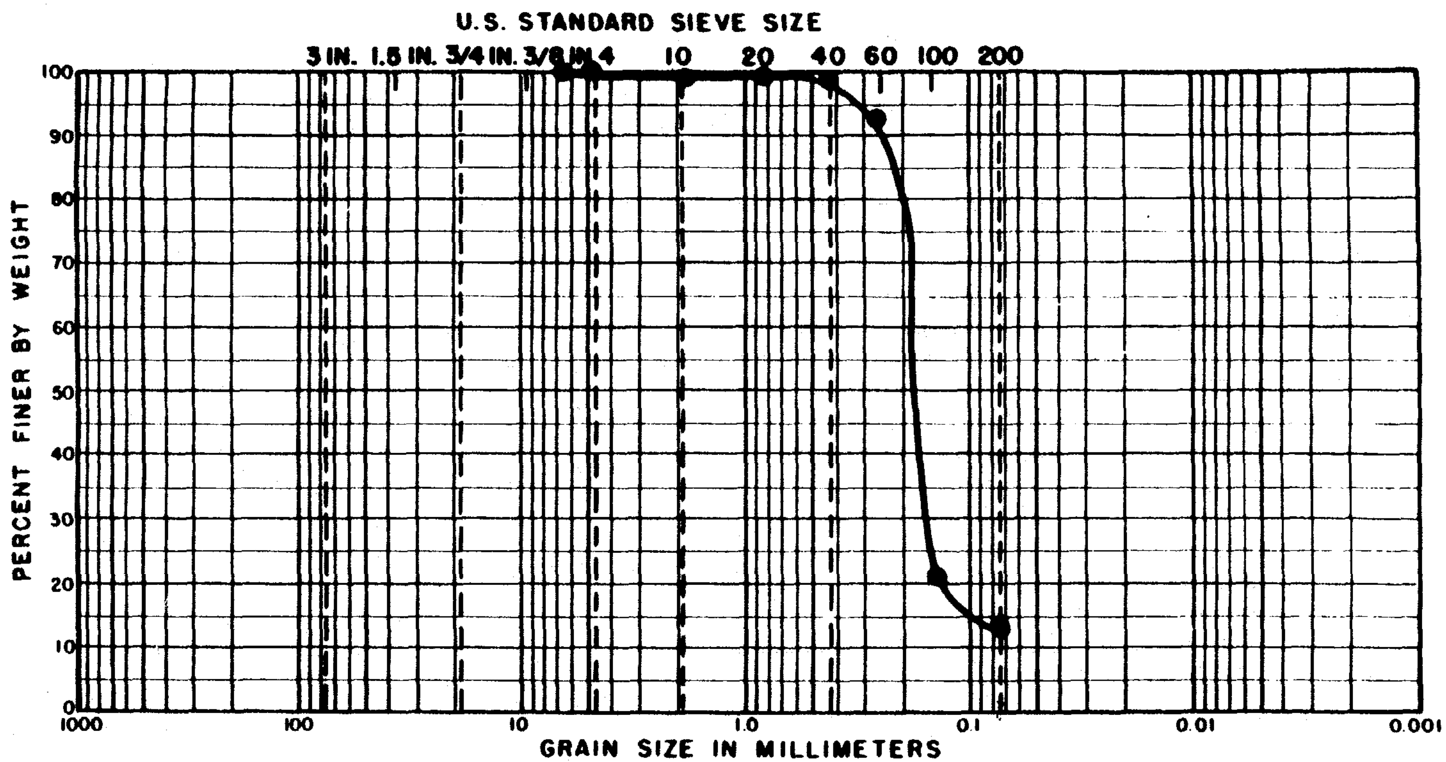
REVISIONS
BY DATE
BY DATE
PLATE OF

757-2 REV 4-62



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-1	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-18	25.5-27'							

DR 000619

Dames & Moore

GRADATION CURVE

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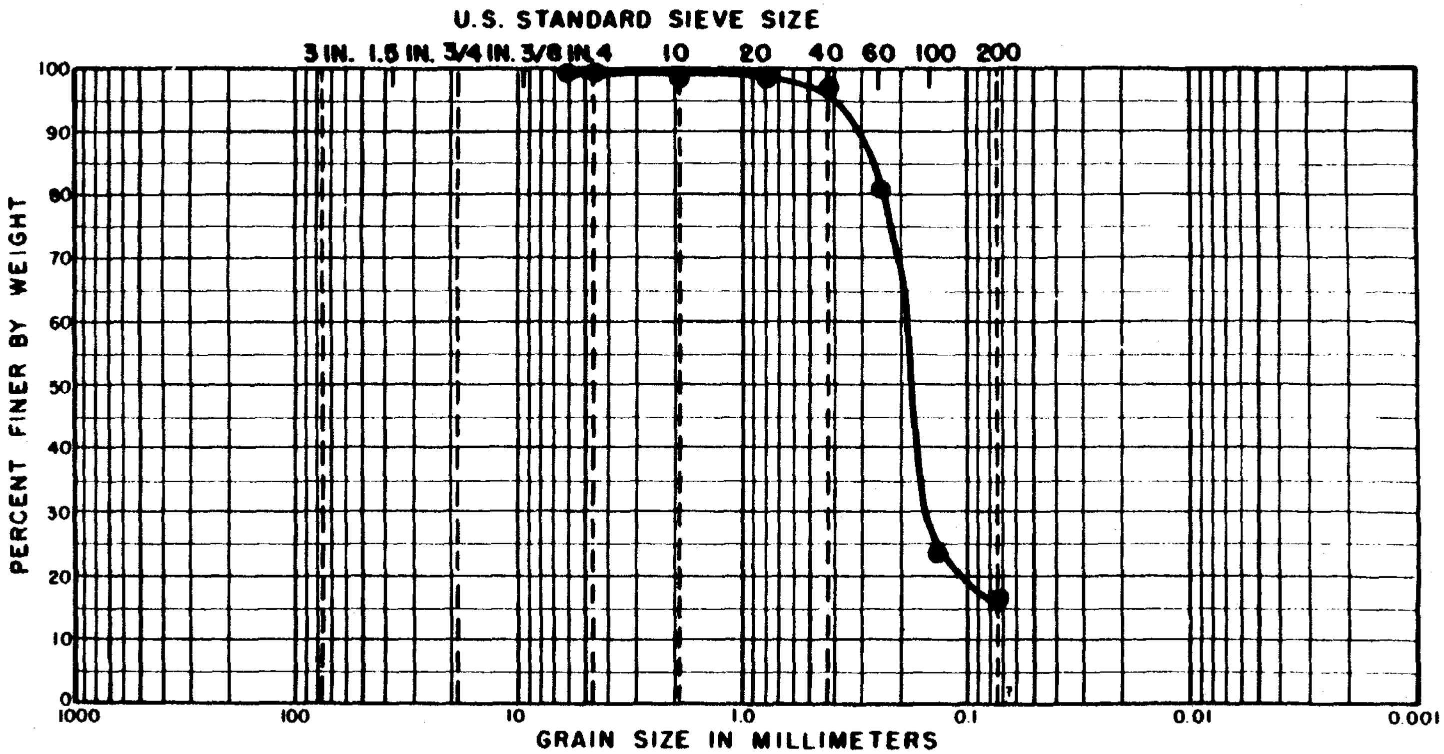
REVISIONS
BY DATE
BY DATE
PLATE OF



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-2	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-18	25.5-27.0'							

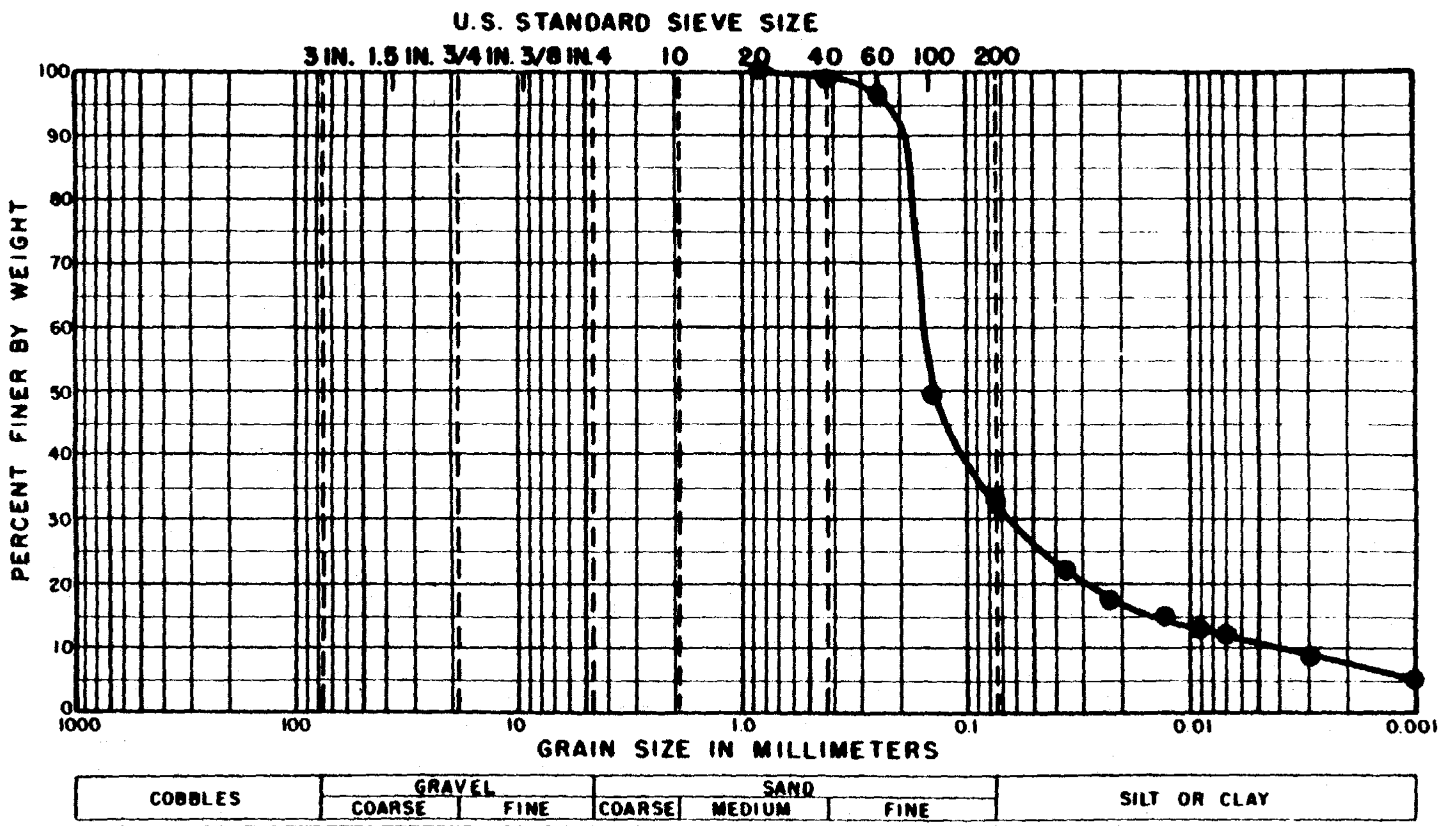
DR 000620

Dames & Moore

GRADATION CURVE

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF



SB-3	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-31	60.5-62.5'							

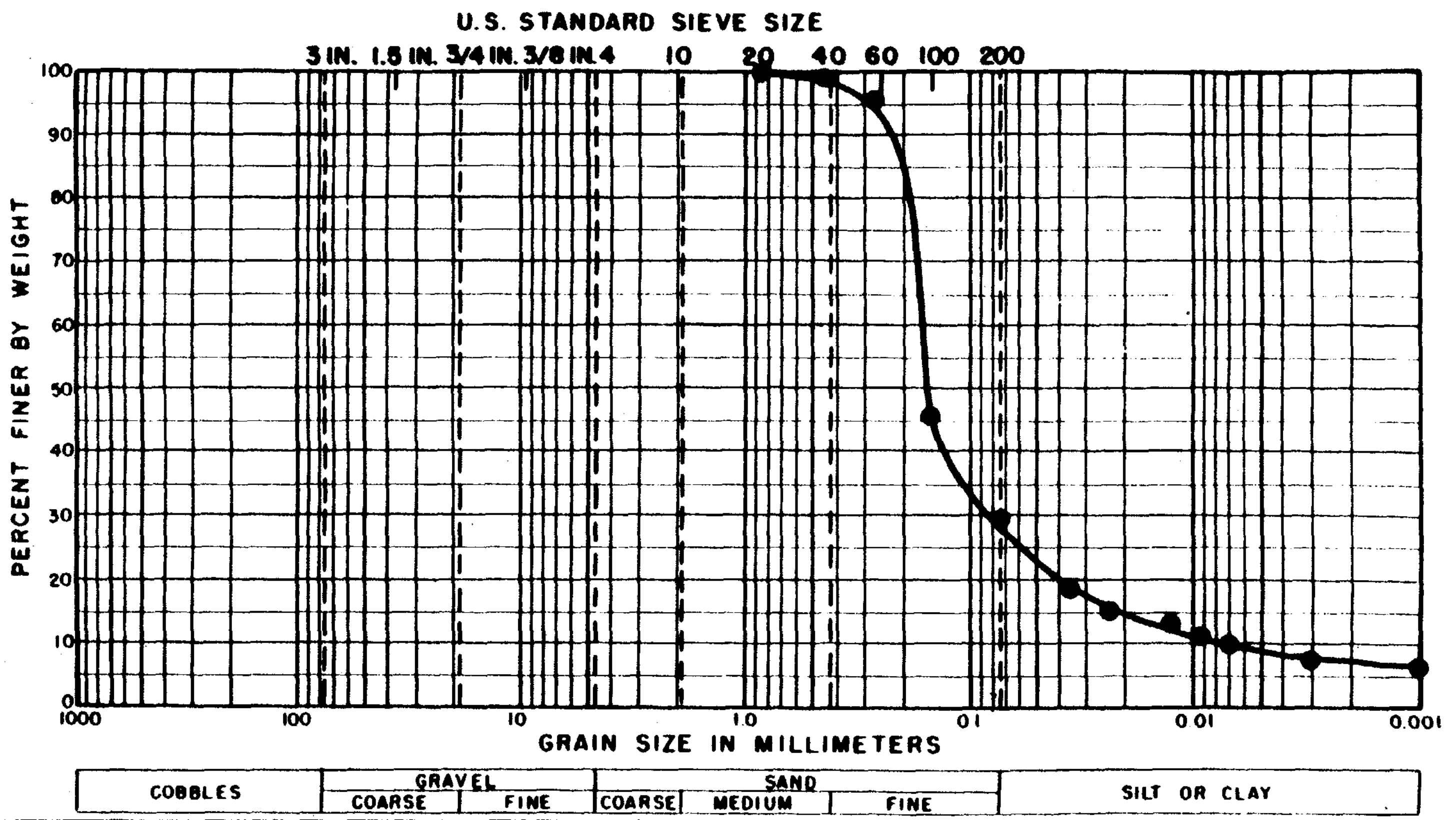
DR 000621

Dames & Moore

GRADATION CURVE

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF



SB-3	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-30	58.5-60.5'							

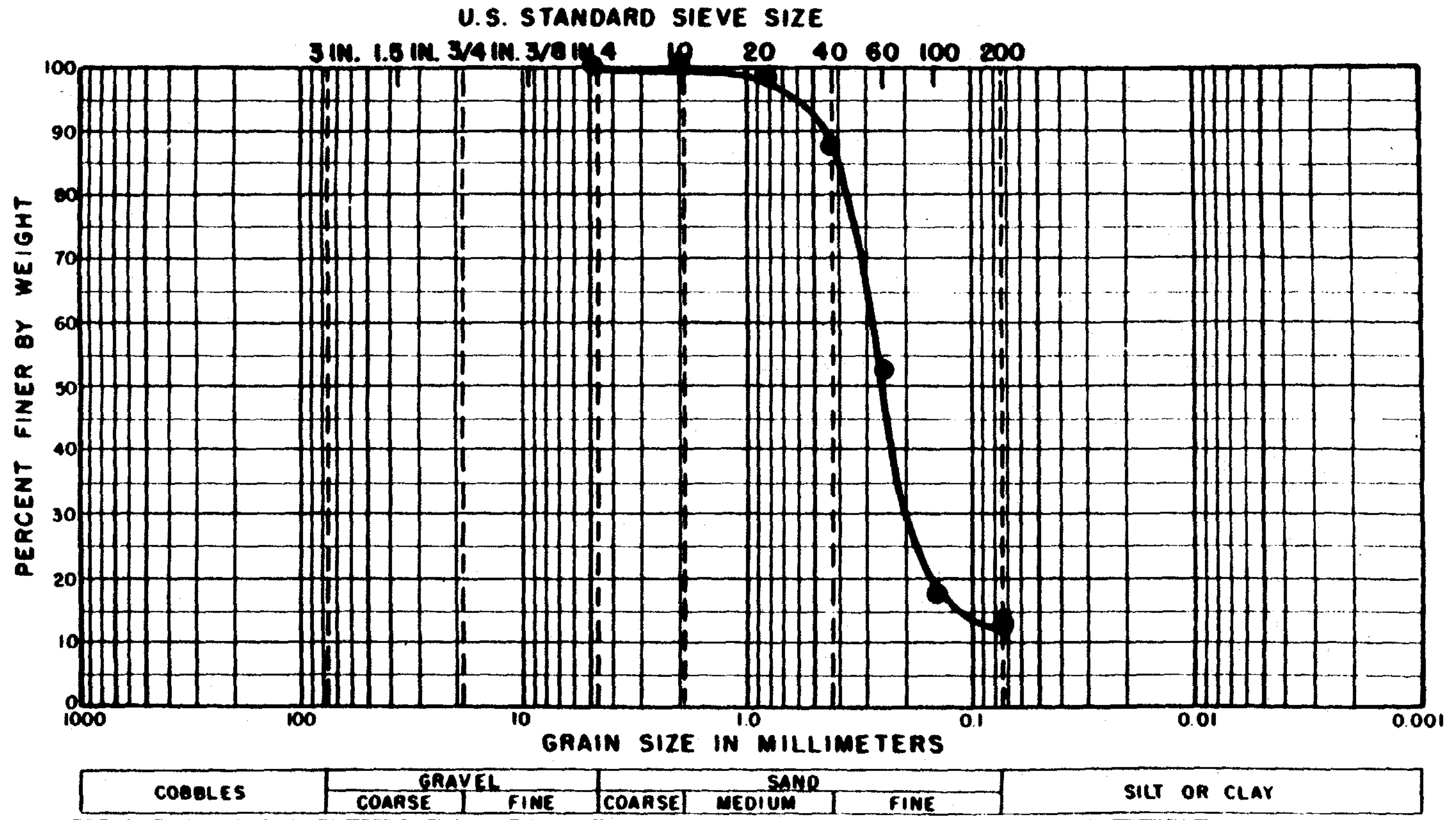
DR 000622

Dames & Moore

GRADATION CURVE

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF



SB-3	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-21	35-36.5'							

DR 000623

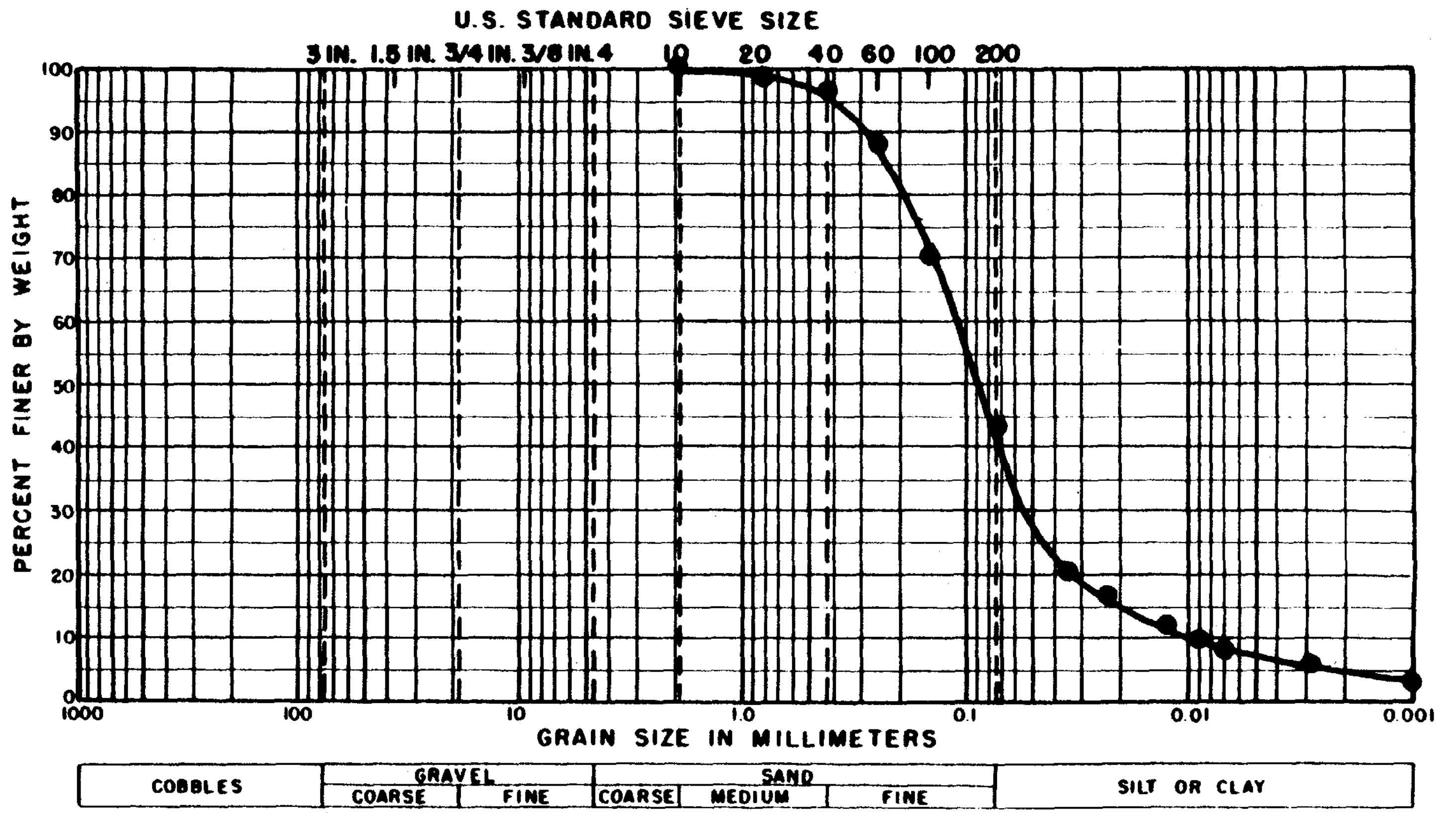
Dames & Moore

GRADATION CURVE

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF

757-2 REV 4-62



DR 000624

SB-4	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-43	69.5-71.0'							

Dames & Moore

GRADATION CURVE

FILE

BY DATE

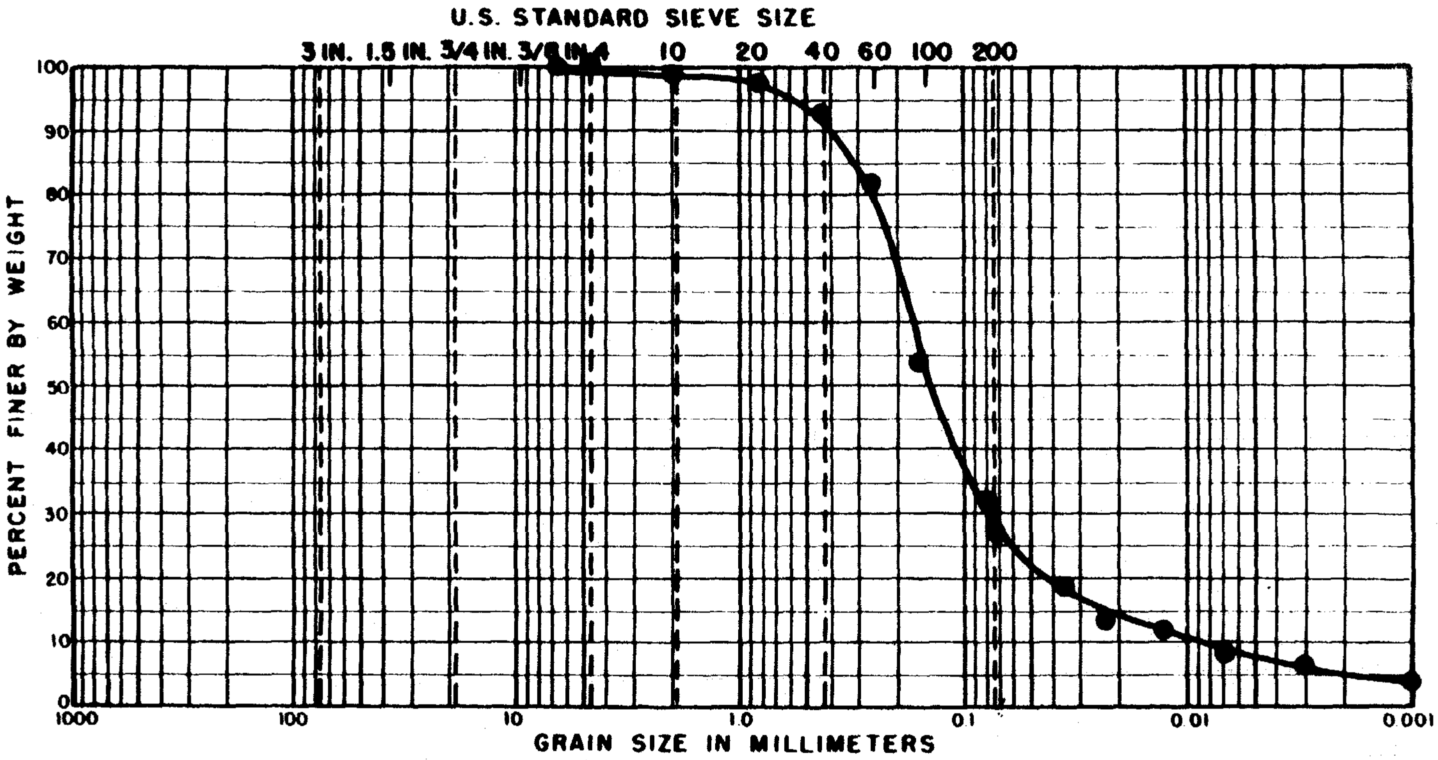
CHECKED BY DATE

REVISIONS

BY DATE

BY DATE

PLATE OF



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-4	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-49	81.5-83.5'							

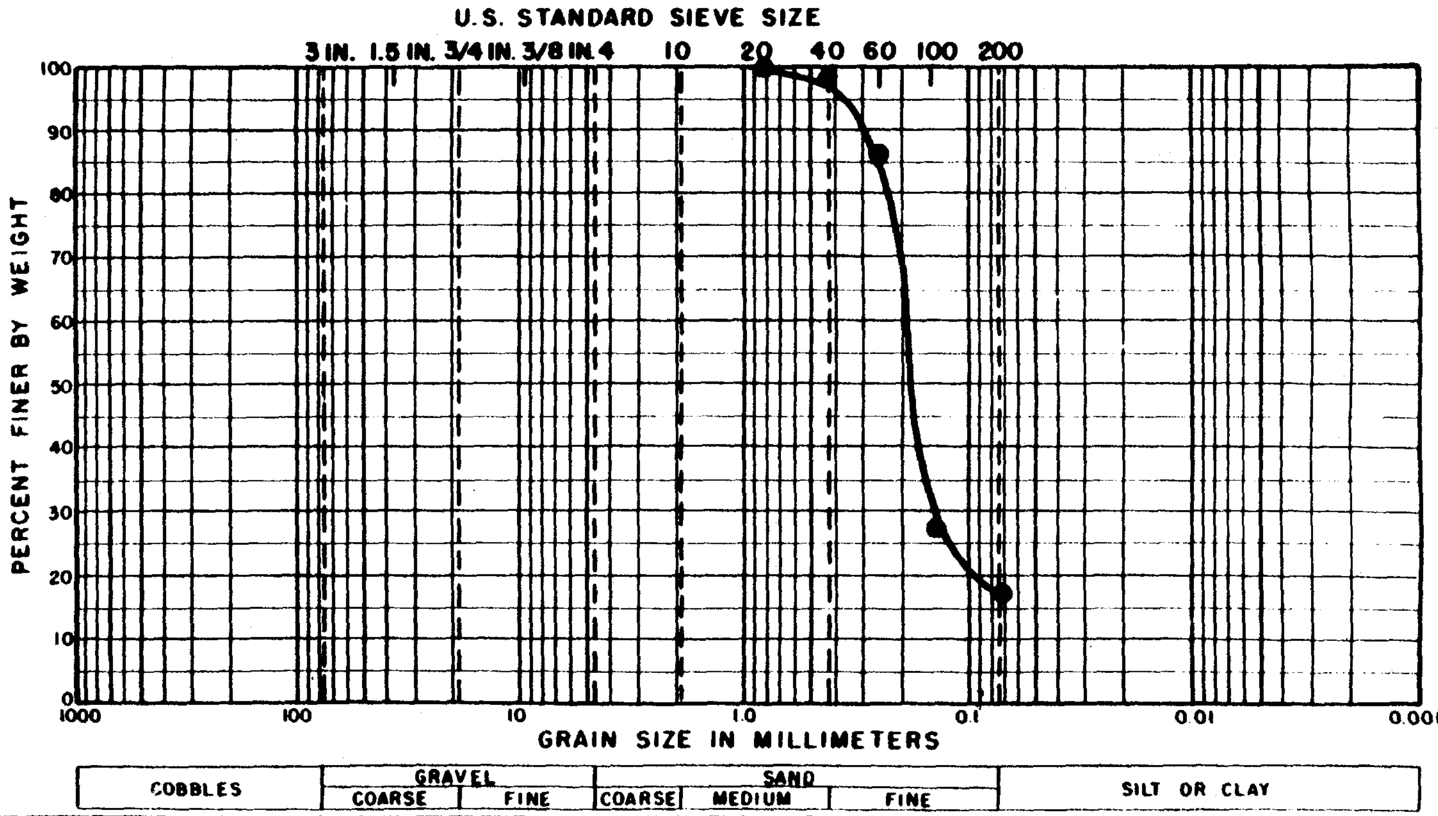
DR 000625

Dames & Moore

GRADATION CURVE

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF



SB-4	DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI	
S-33	48-49.5'						

DR 000626

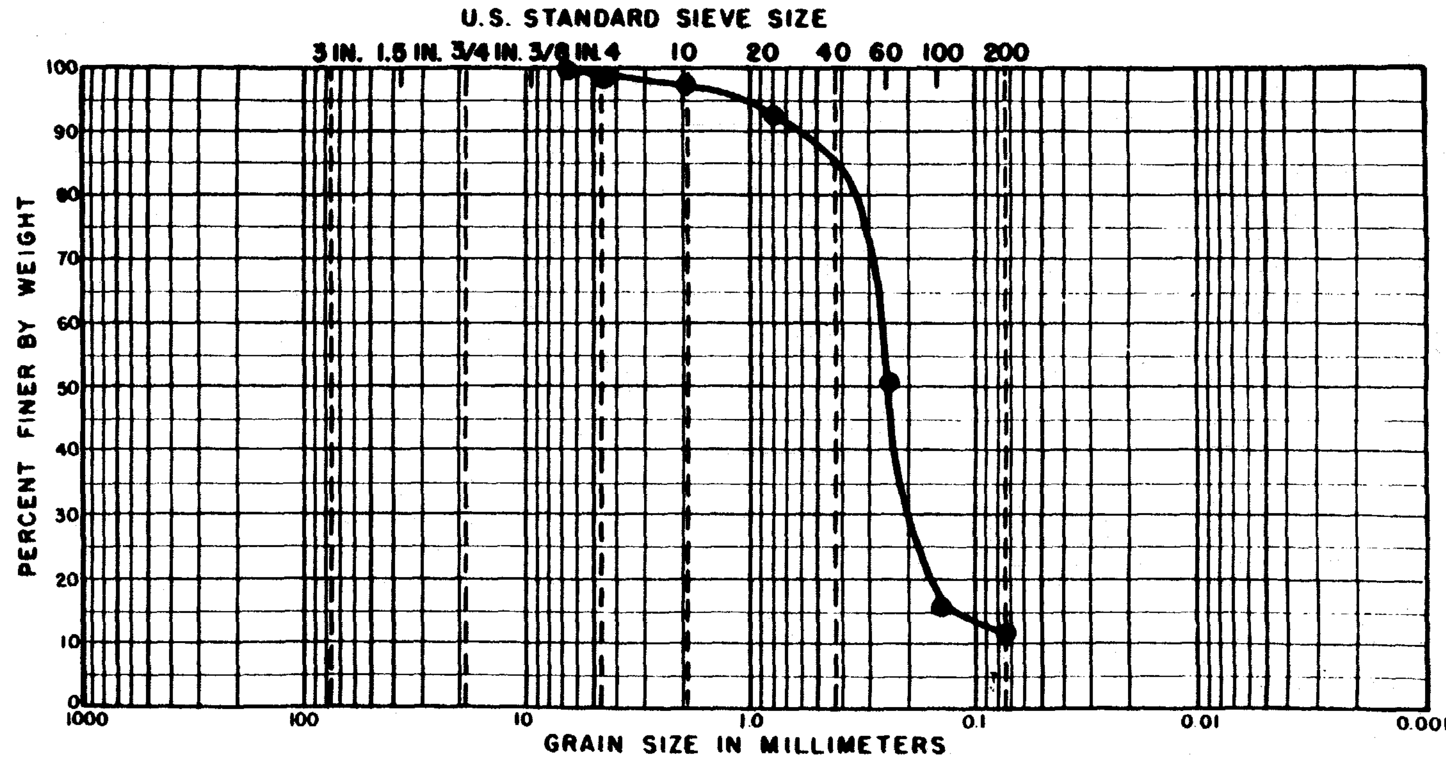
Dames & Moore

GRADATION CURVE

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF

757 2 REV 4-62)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-4	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-20	28.5-30'							

DR 0006277

Dames & Moore

GRADATION CURVE

FILE

BY DATE

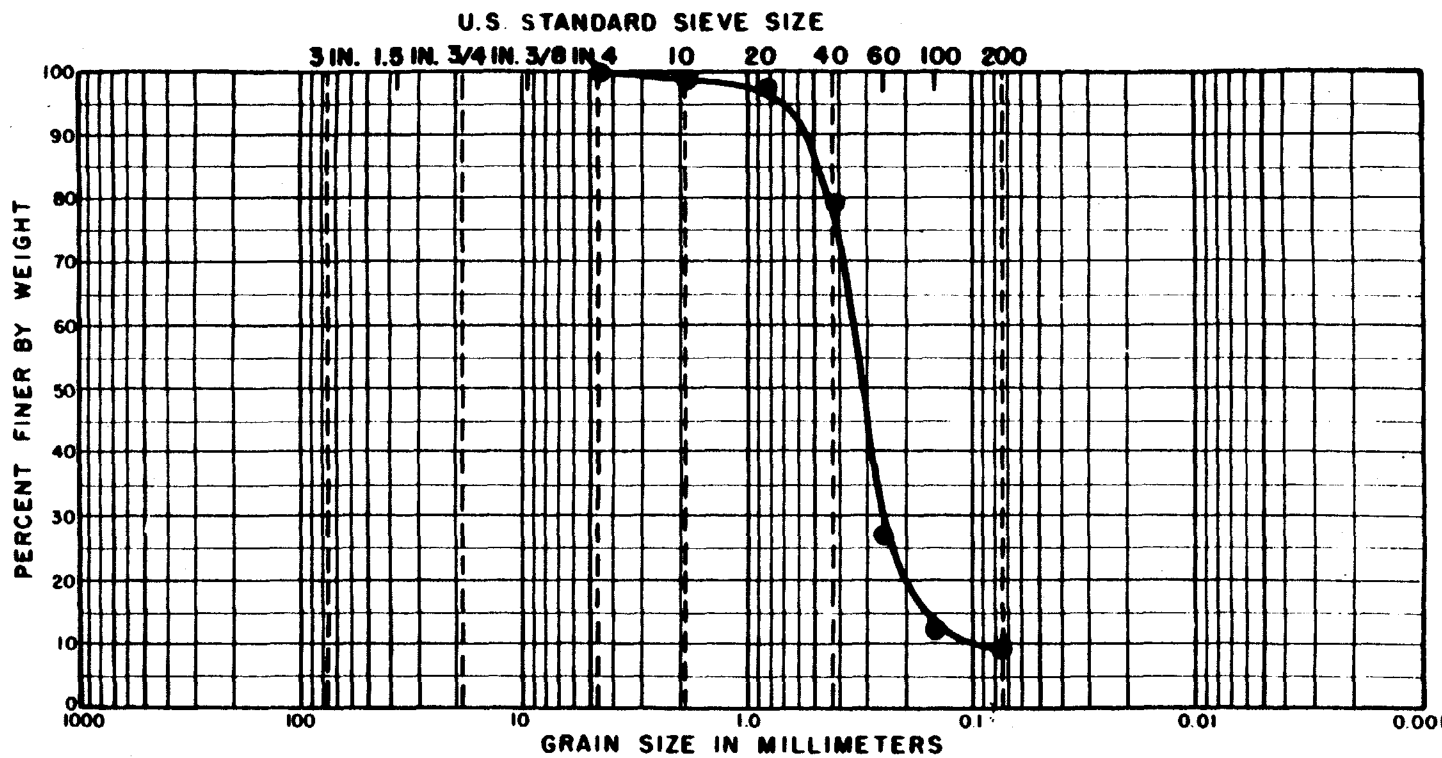
CHECKED BY DATE

REVISIONS

BY DATE

BY DATE

PLATE OF



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-4	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-5	6-7.5'							

GRADATION CURVE

DR 000628

Dames & Moore

FILE

BY DATE

CHECKED BY DATE

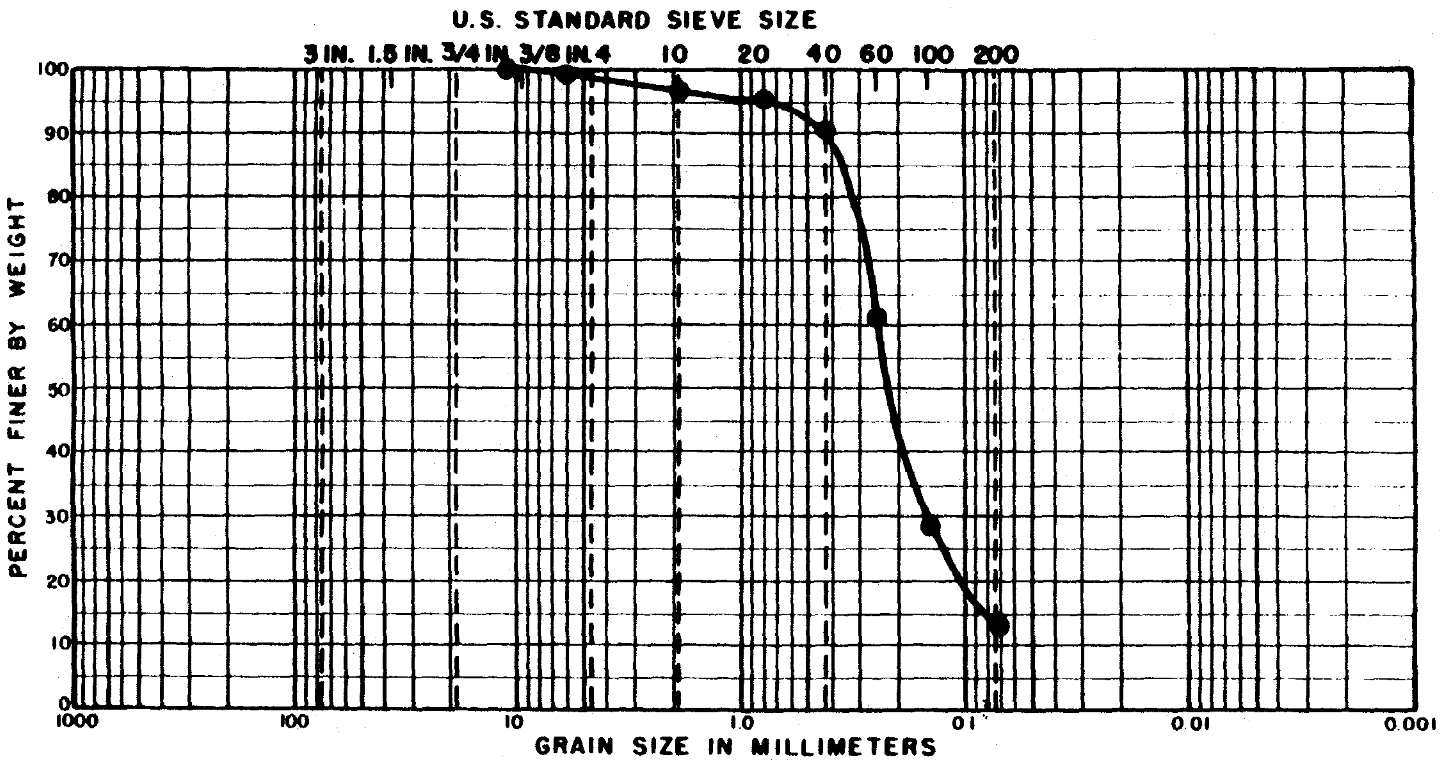
REVISIONS

BY DATE

BY DATE

PLATE OF

DR 000629



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

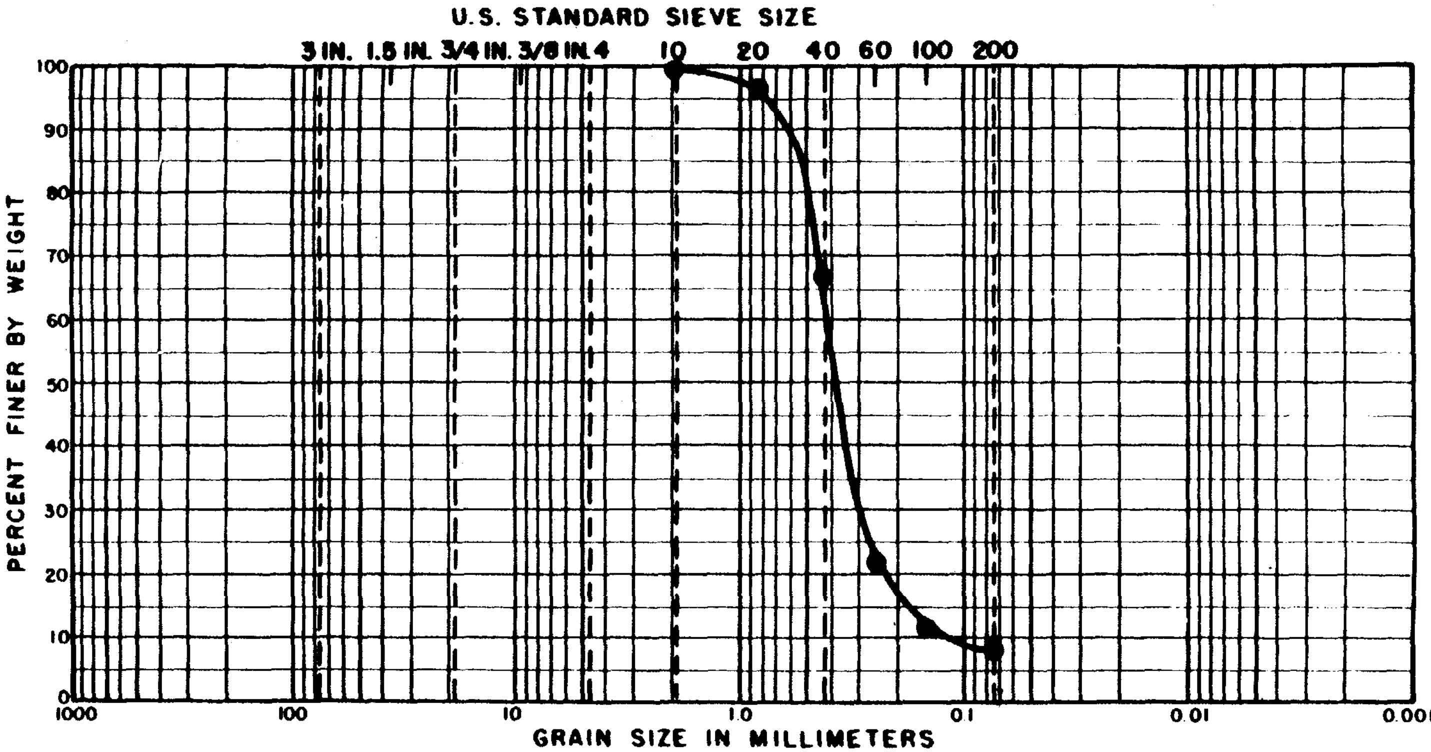
SB-5	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-20	38-40'							

Dames & Moore

GRADATION CURVE

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF



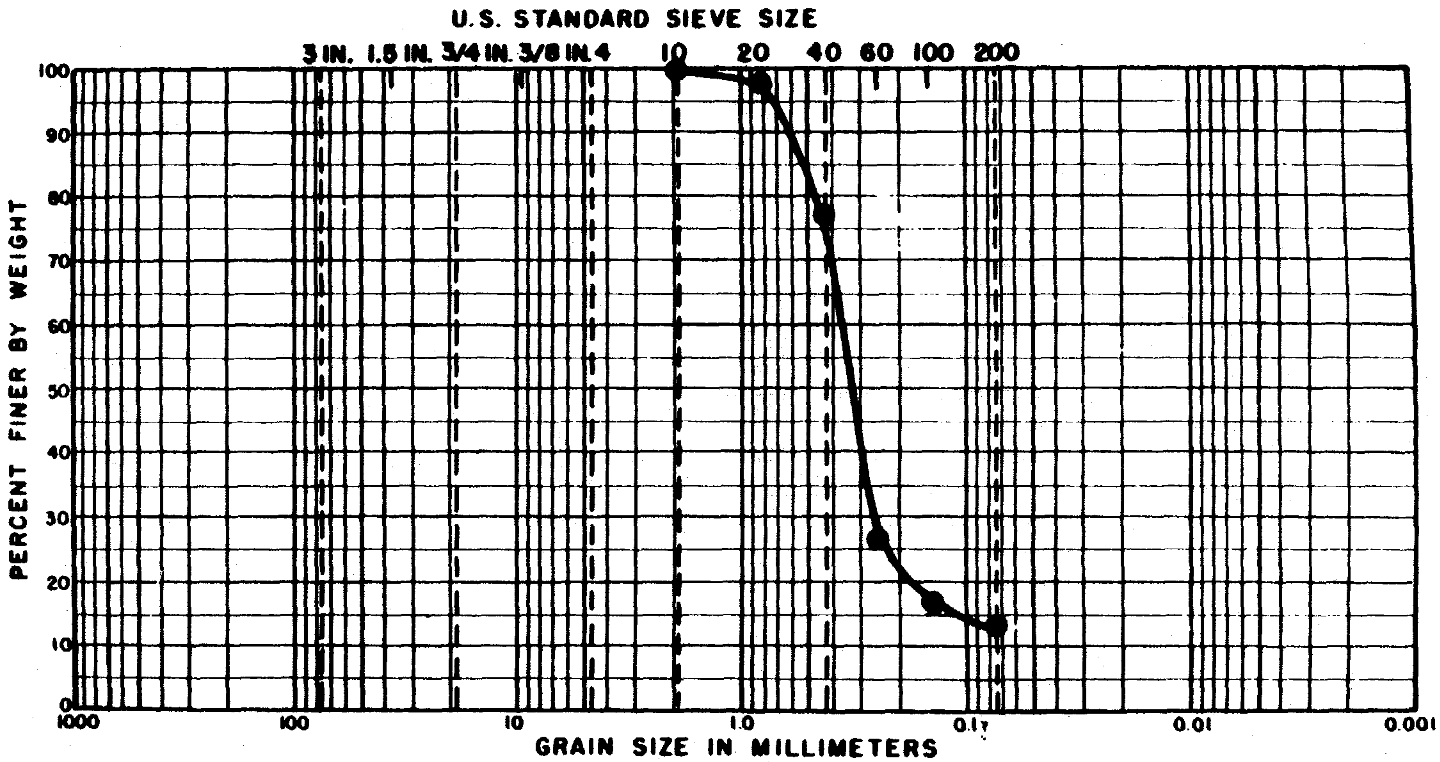
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-5	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-8	10.5-12'							

DR 000630

Dames & Moore

GRADATION CURVE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

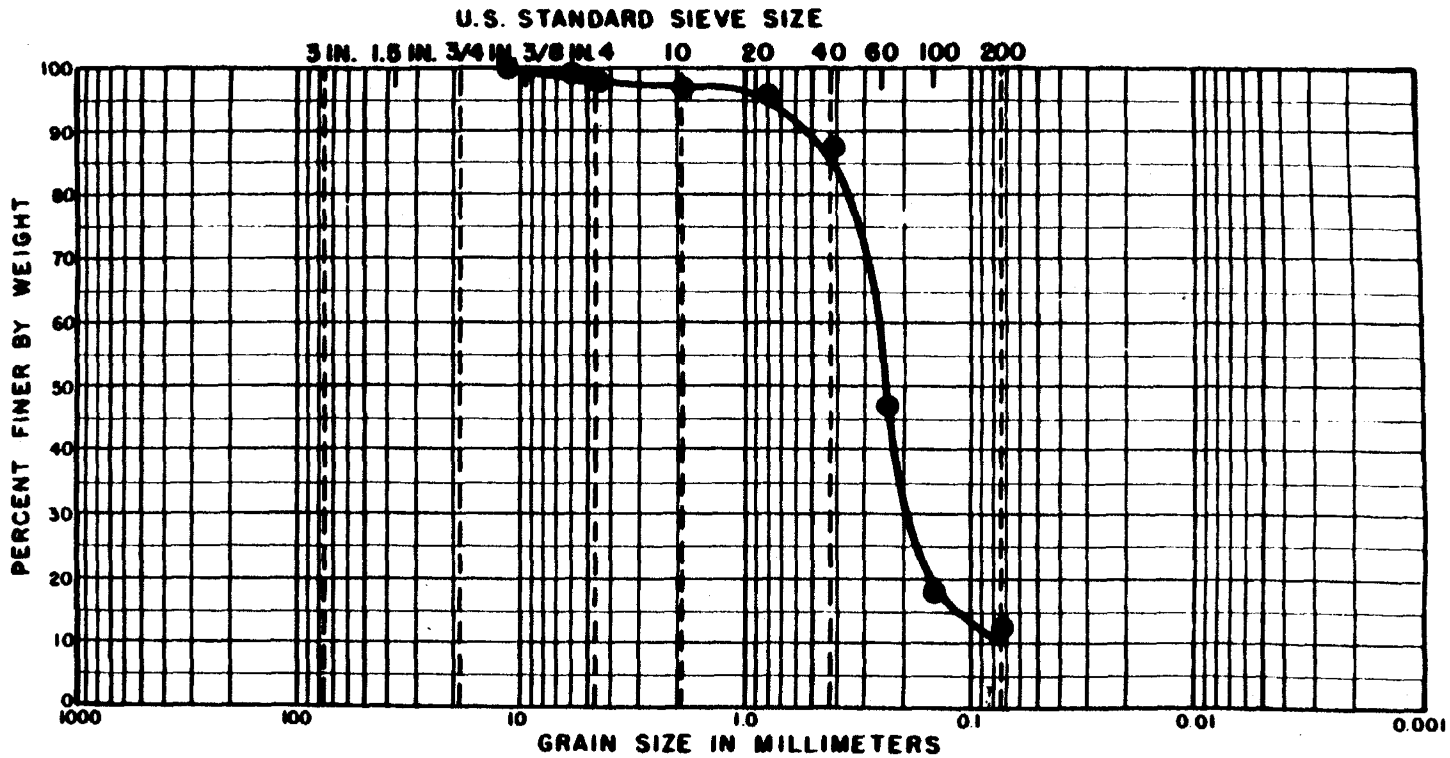
SB-6	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-8	10.5-12.0'							

DR 000631

Dames & Moore

GRADATION CURVE

DR 000632

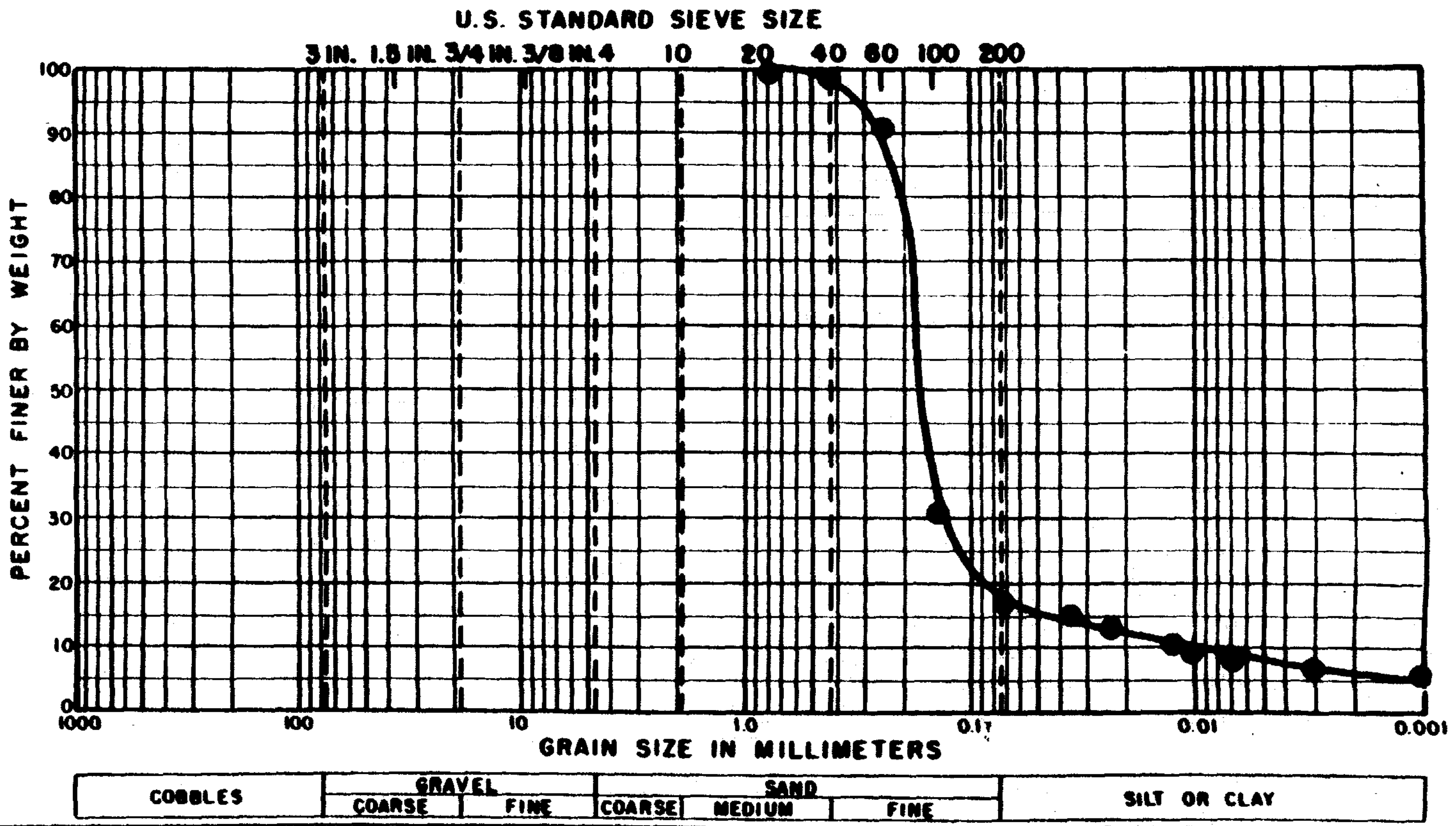


COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-6	DEPTH	CLASSIFICATION		NAT WC	LL	PL	PI	
S-24	48.5-50'							

Dames & Moore

GRADATION CURVE

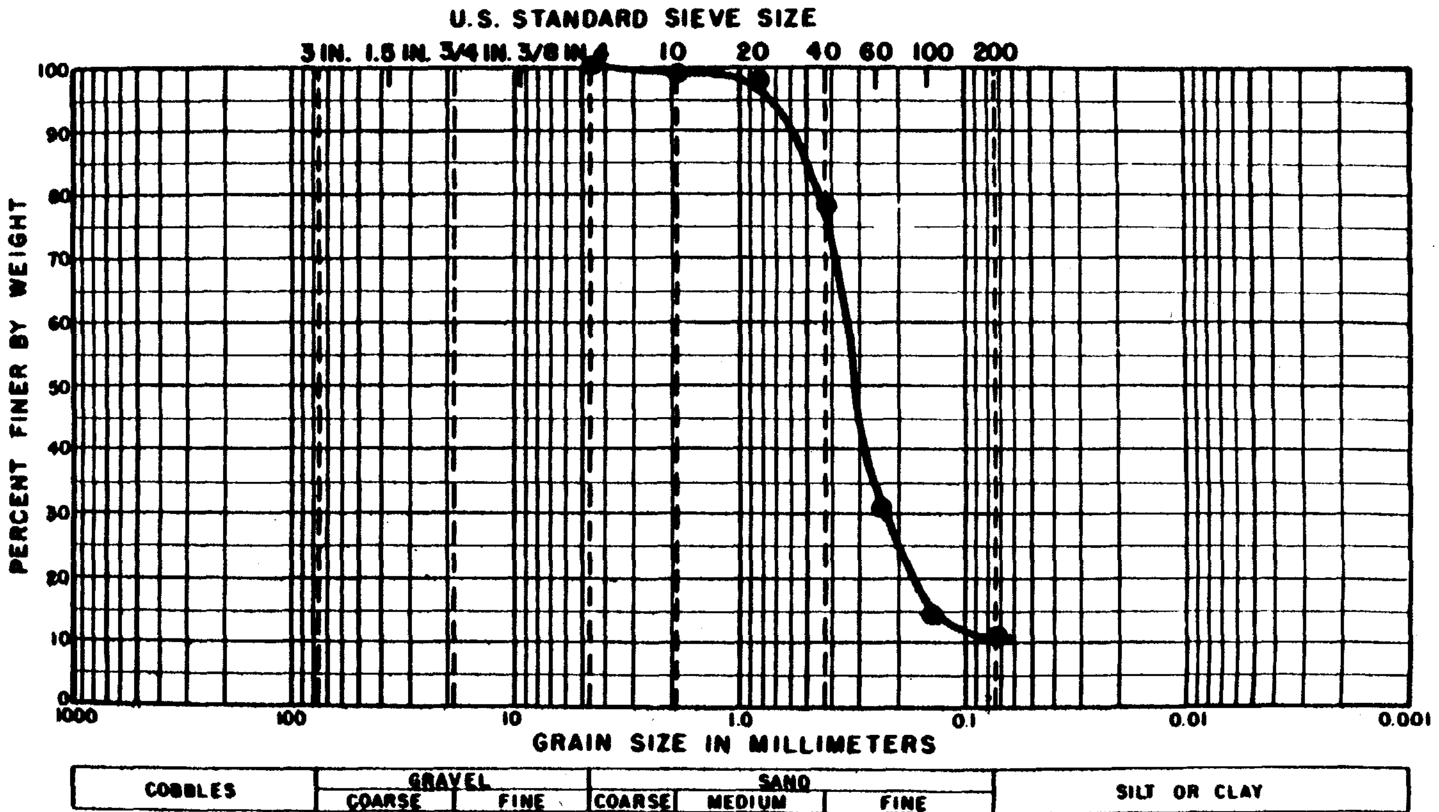


SB-6	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-37	74-76'							

GRADATION CURVE

DR 000633

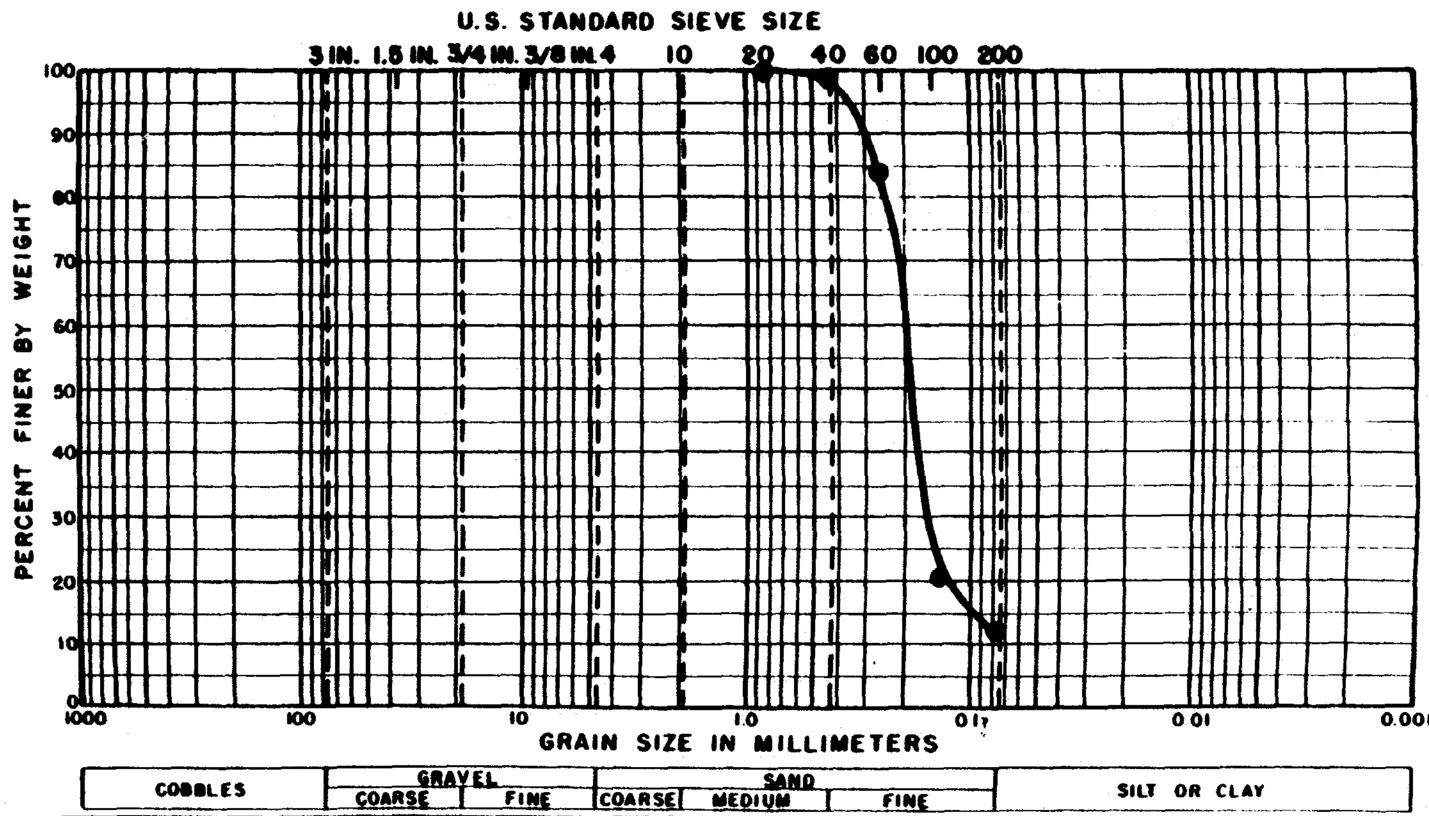
Dames & Moore



SB-8	DEPTH	CLASSIFICATION		NAT WC	LL	PL	PI	
S-20	28.5'-30'							

GRADATION CURVE

Dames & Moore



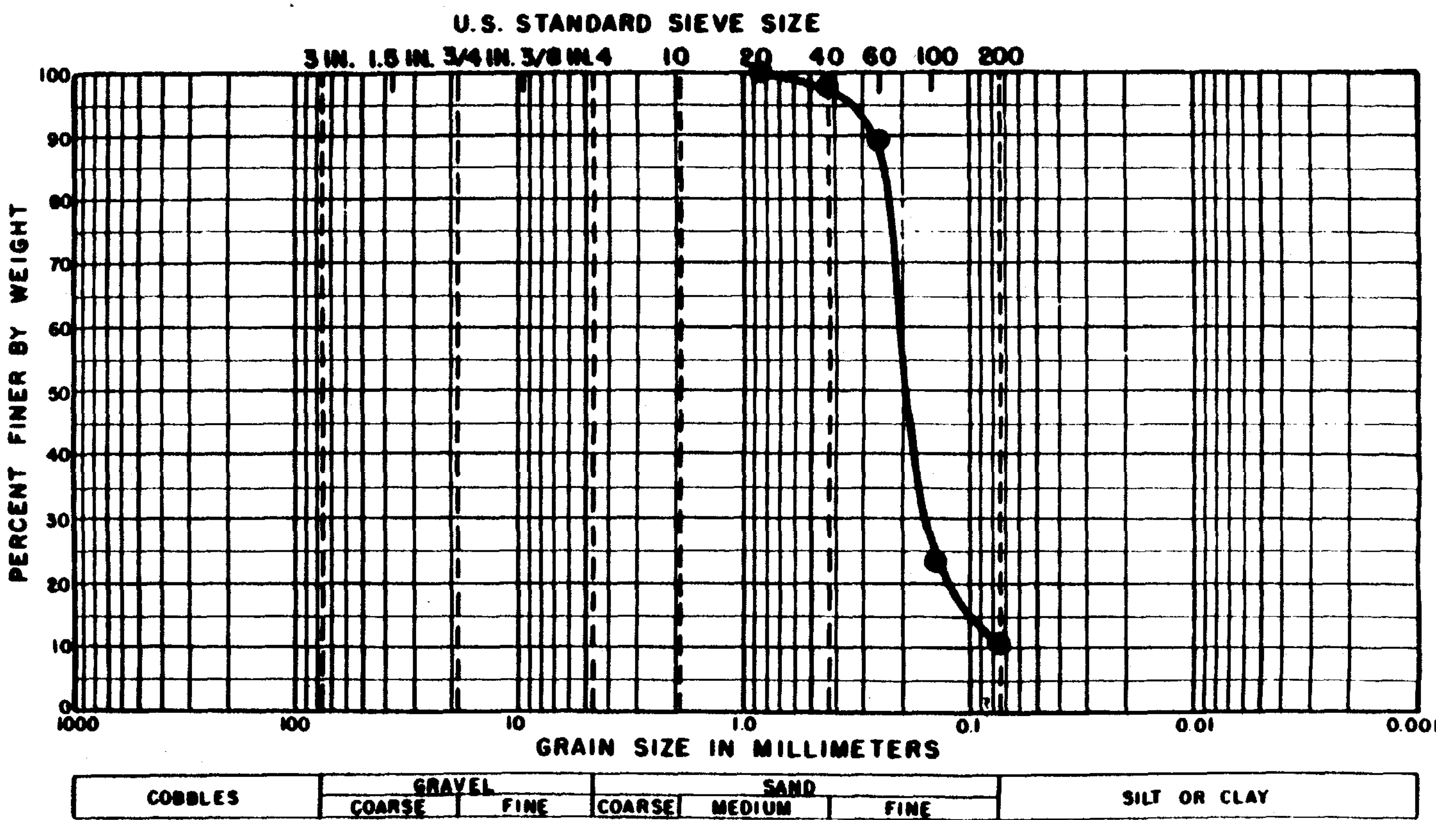
SB-8	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-31	62.5'-64.0'							

GRADATION CURVE

DR 000635

Dames & Moore

DR 000636

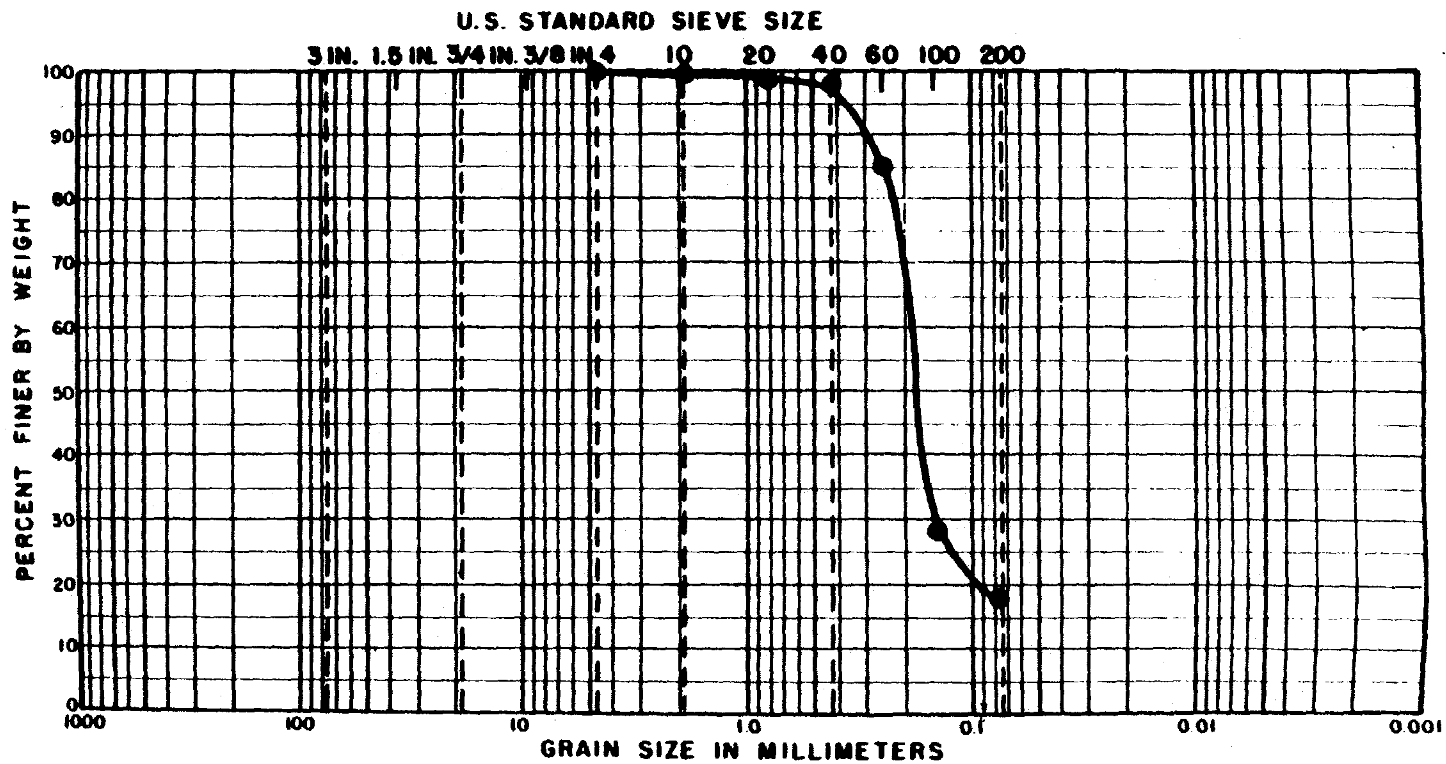


SB-9	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-13	18-19.5'							

Dames & Moore

GRADATION CURVE

REV 4-62

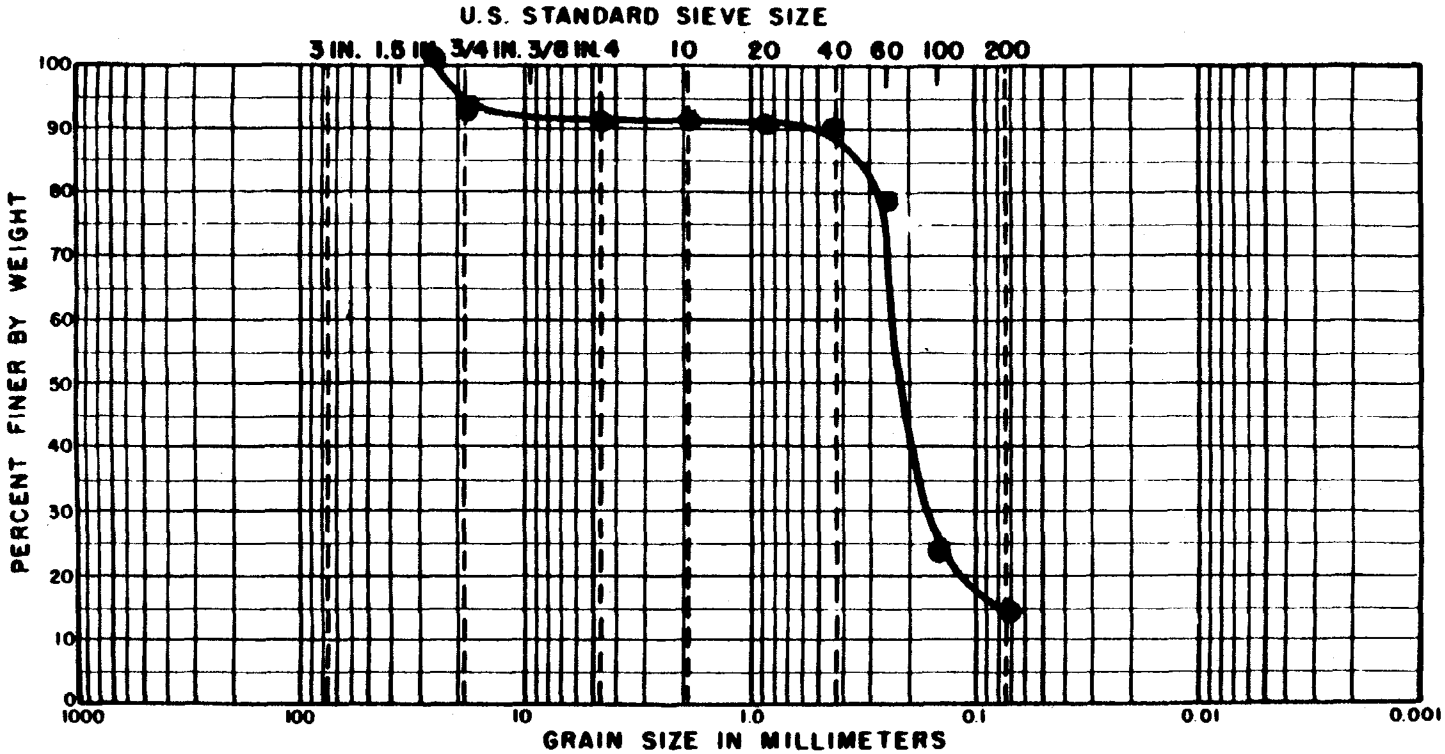


SB-10	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-6	7.5'-9.0'							

DR 0000637

Dames & Moore

GRADATION CURVE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-12	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-6	7.5-9.0'							

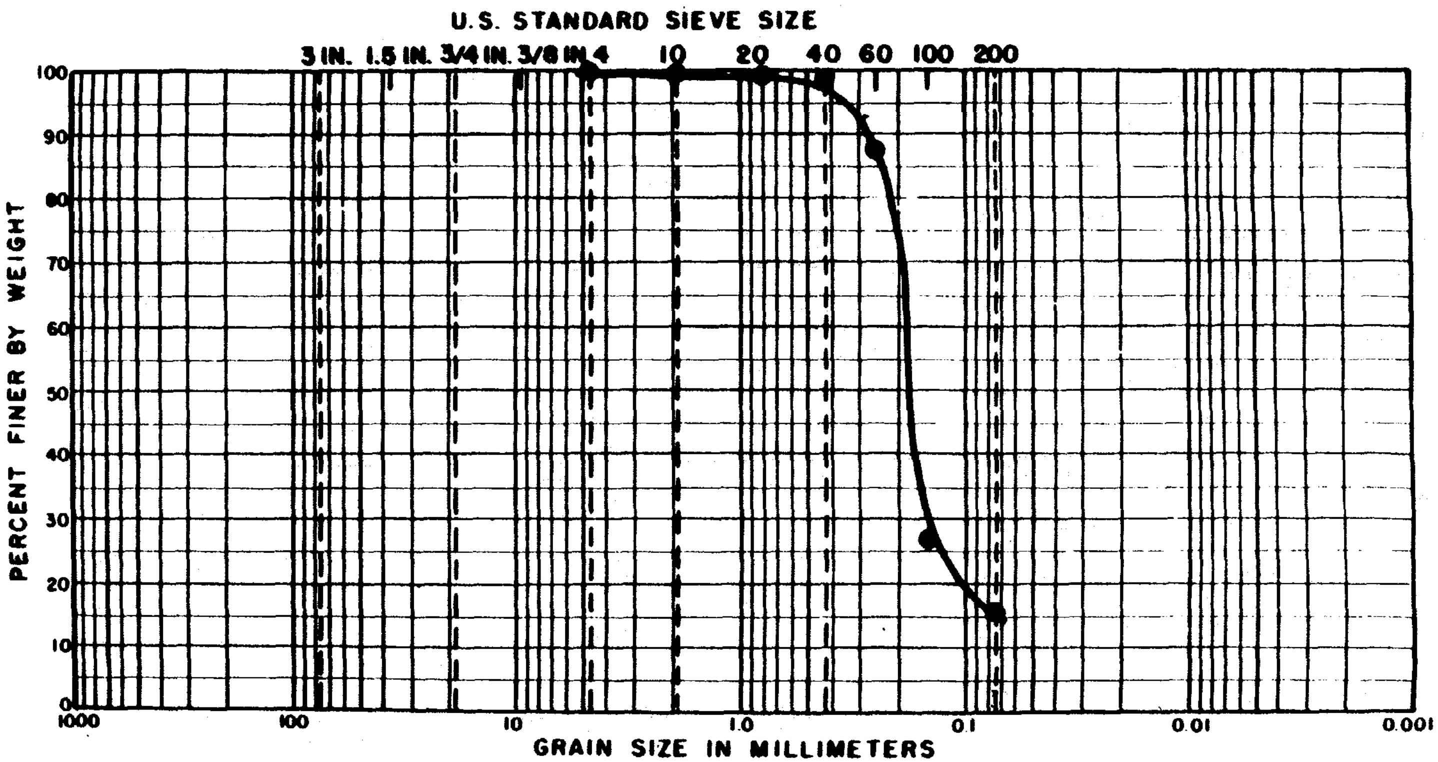
Dames & Moore

GRADATION CURVE

DR 000638

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF



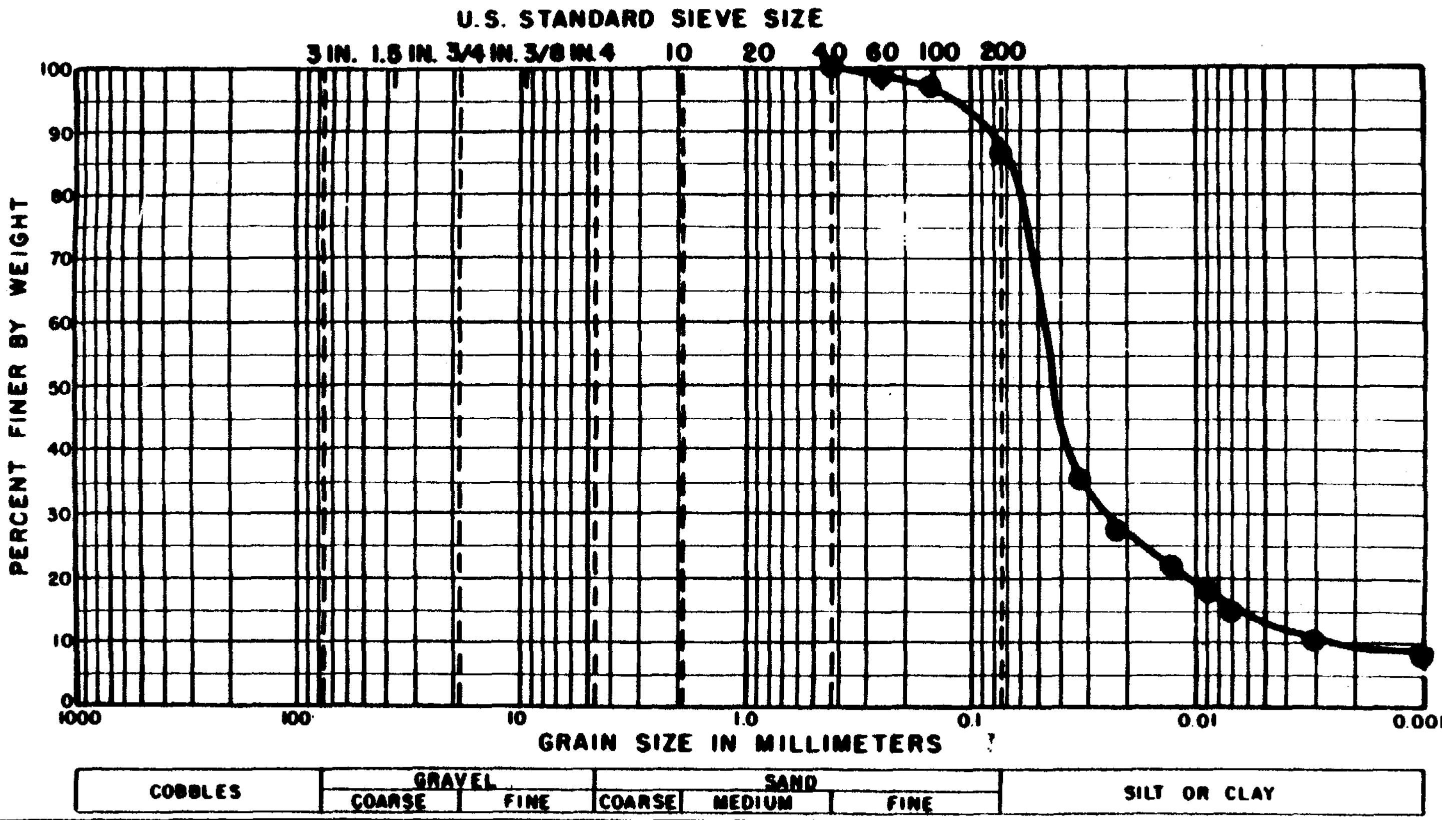
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SB-12	DEPTH	CLASSIFICATION		NAT WC	LL	PL	PI	
S-7	9'-10'							

DR 000639

Dames & Moore

GRADATION CURVE

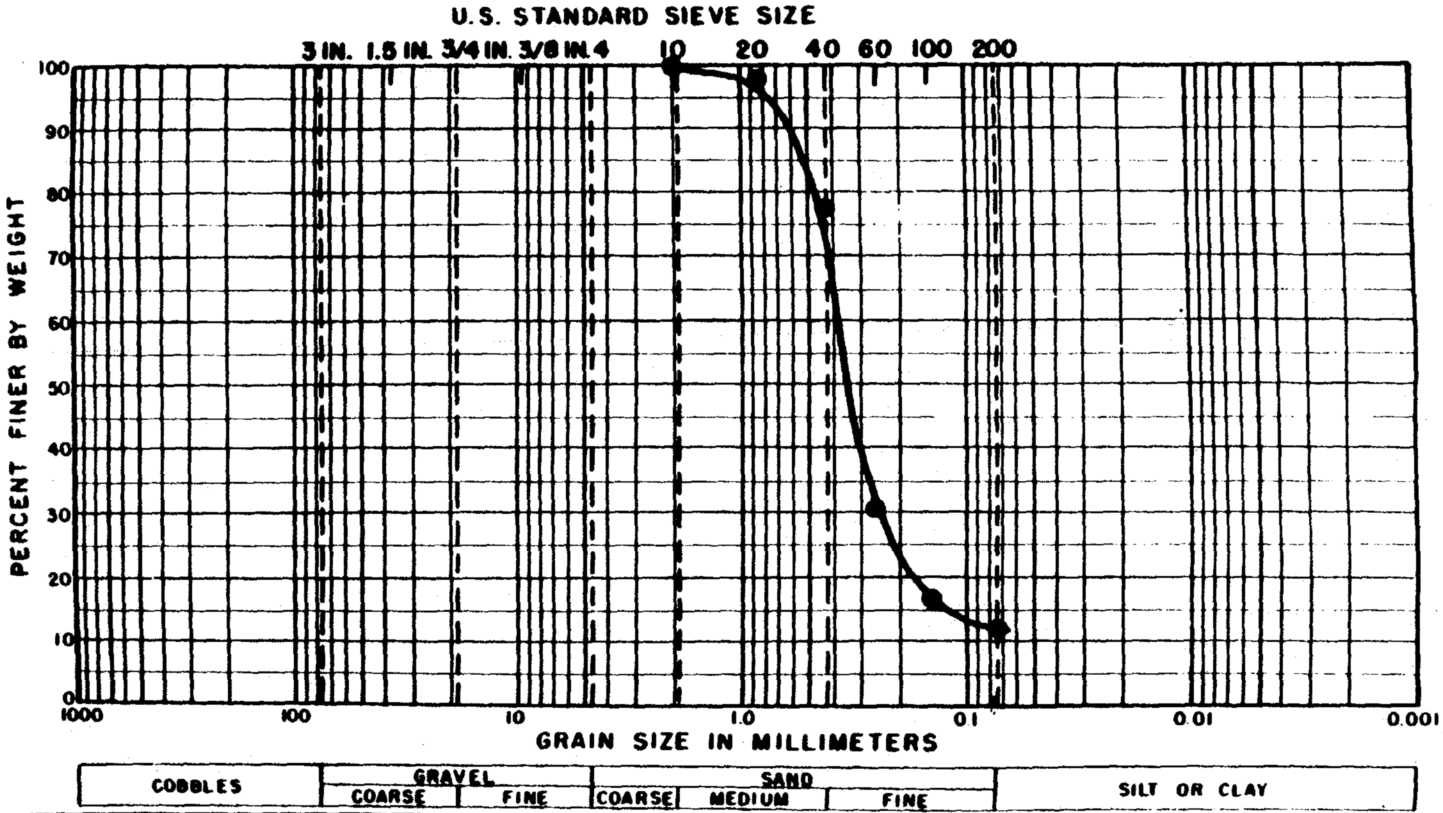


SB-12	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-30	49.5-50.5'							

DR 000640

Dames & Moore

GRADATION CURVE



DR 000641

SB-15	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-19	27'-28.5'							

Dames & Moore

GRADATION CURVE

FILE

BY DATE

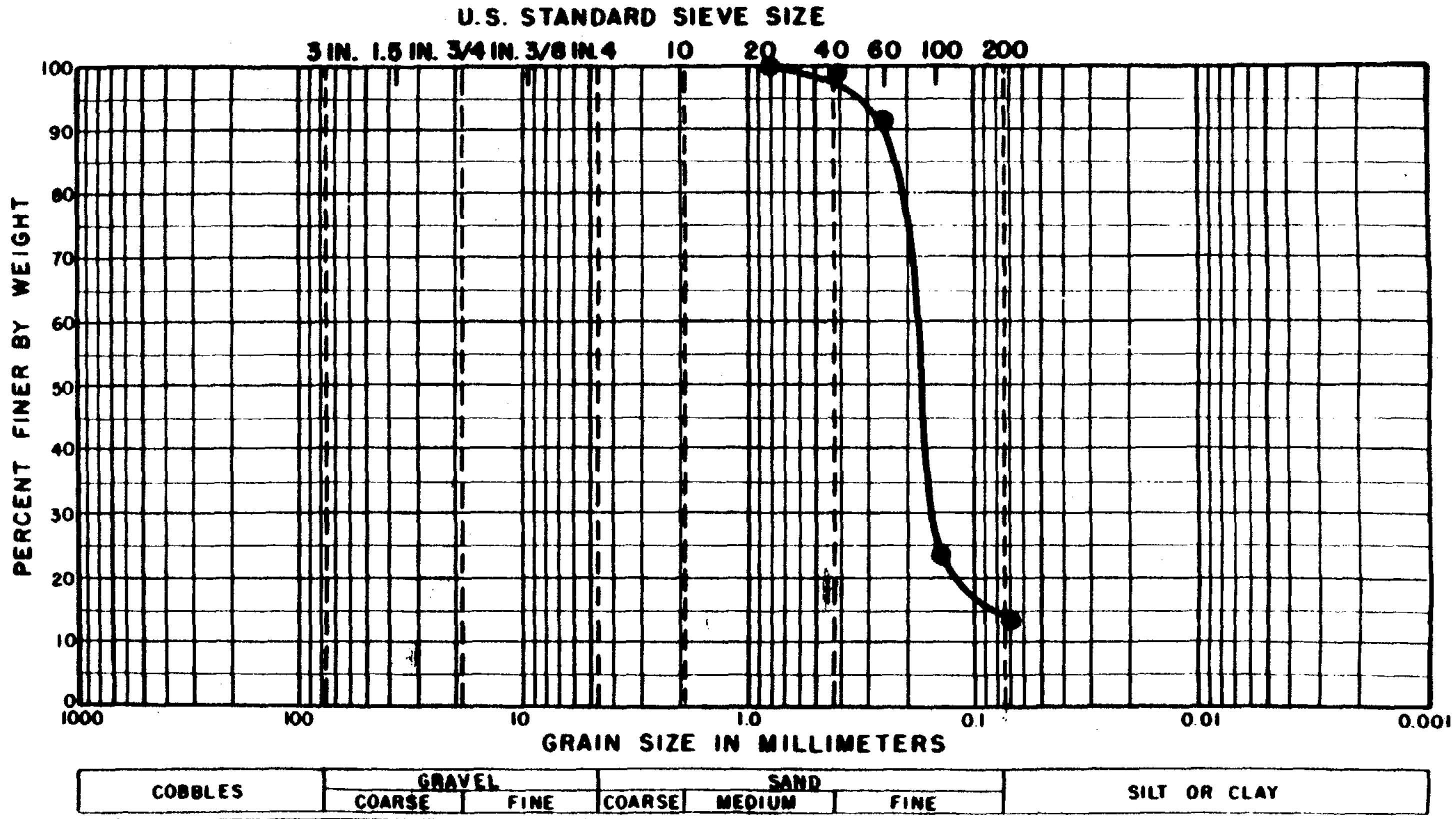
CHECKED BY DATE

REVISIONS

BY DATE

BY DATE

PLATE OF

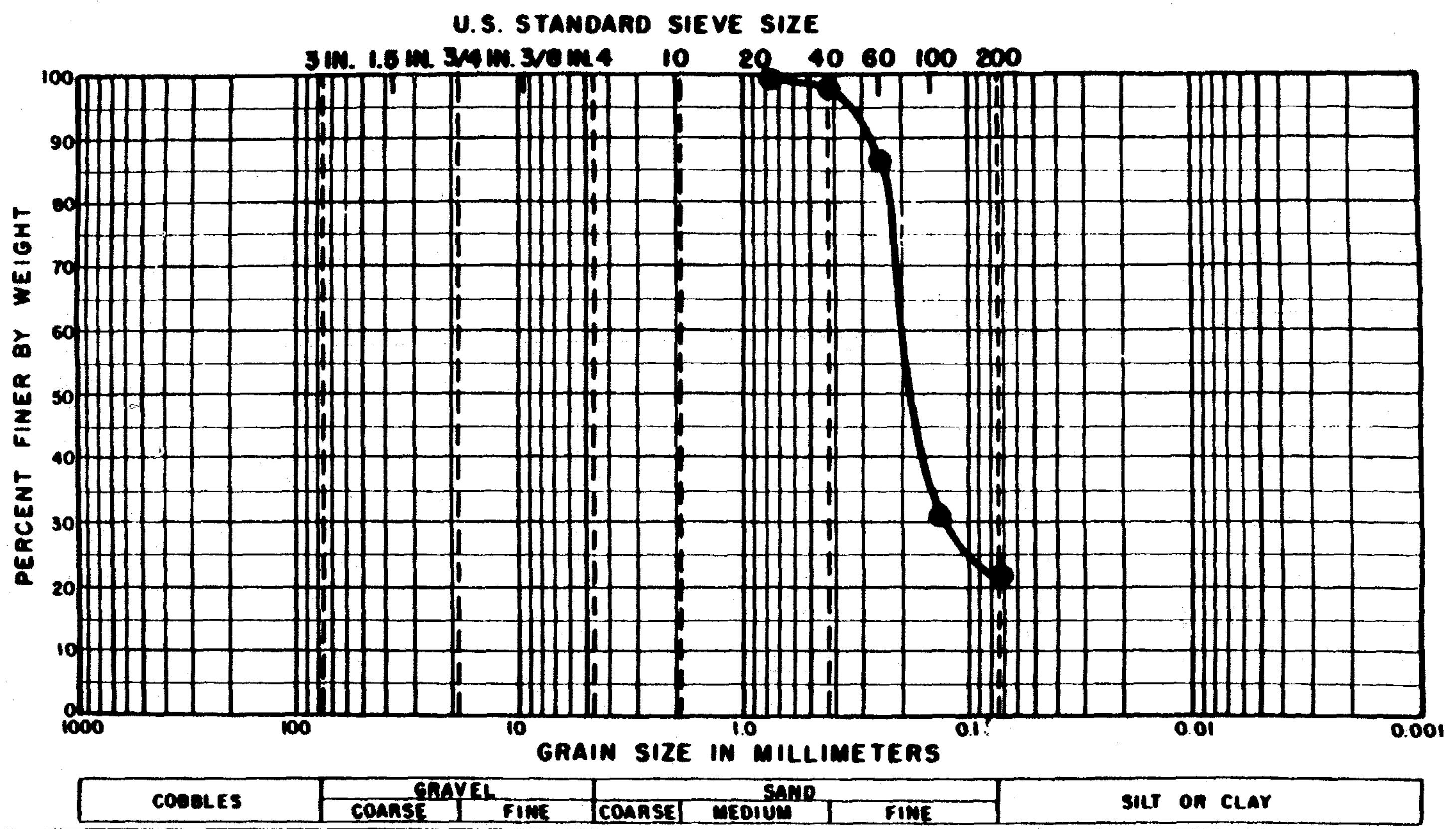


SB-15	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-32	60.5'-62'							

GRADATION CURVE

DR 000642

Dames & Moore

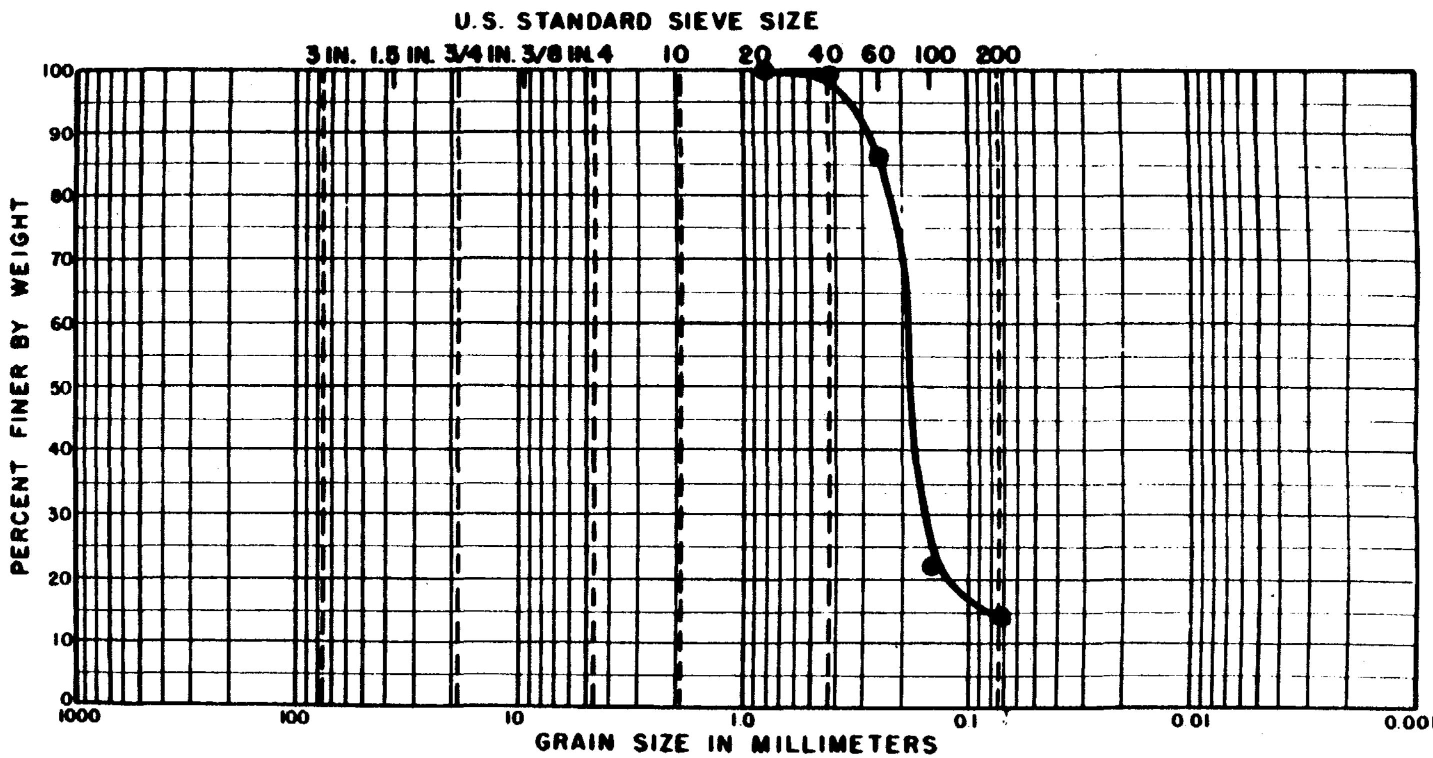


SB-15	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-38	70.5-72.5'							

GRADATION CURVE

DR 000643

Dames & Moore



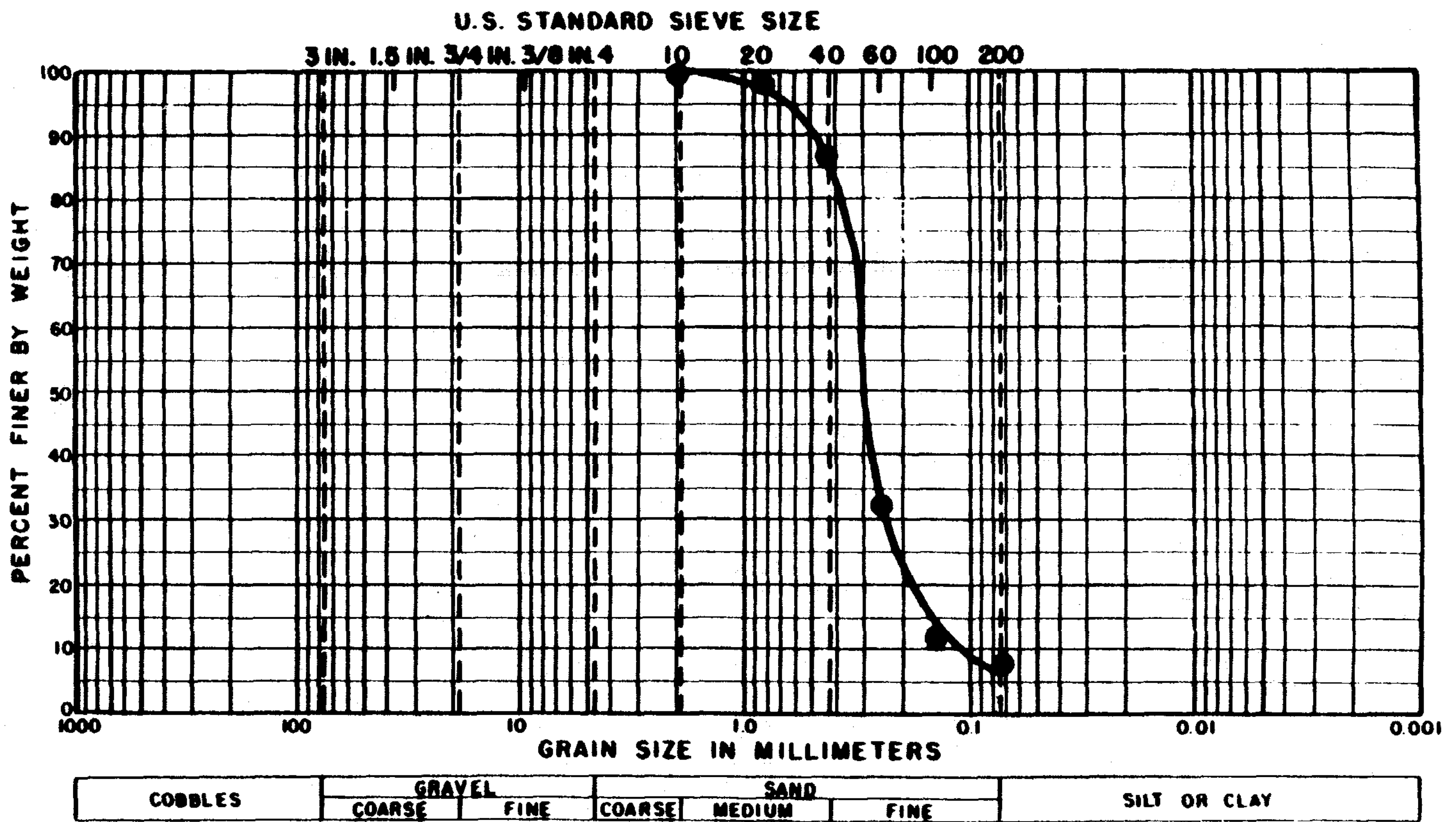
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SMW-1	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-19	27-28.5'							

GRADATION CURVE

DR 000644

Dames & Moore



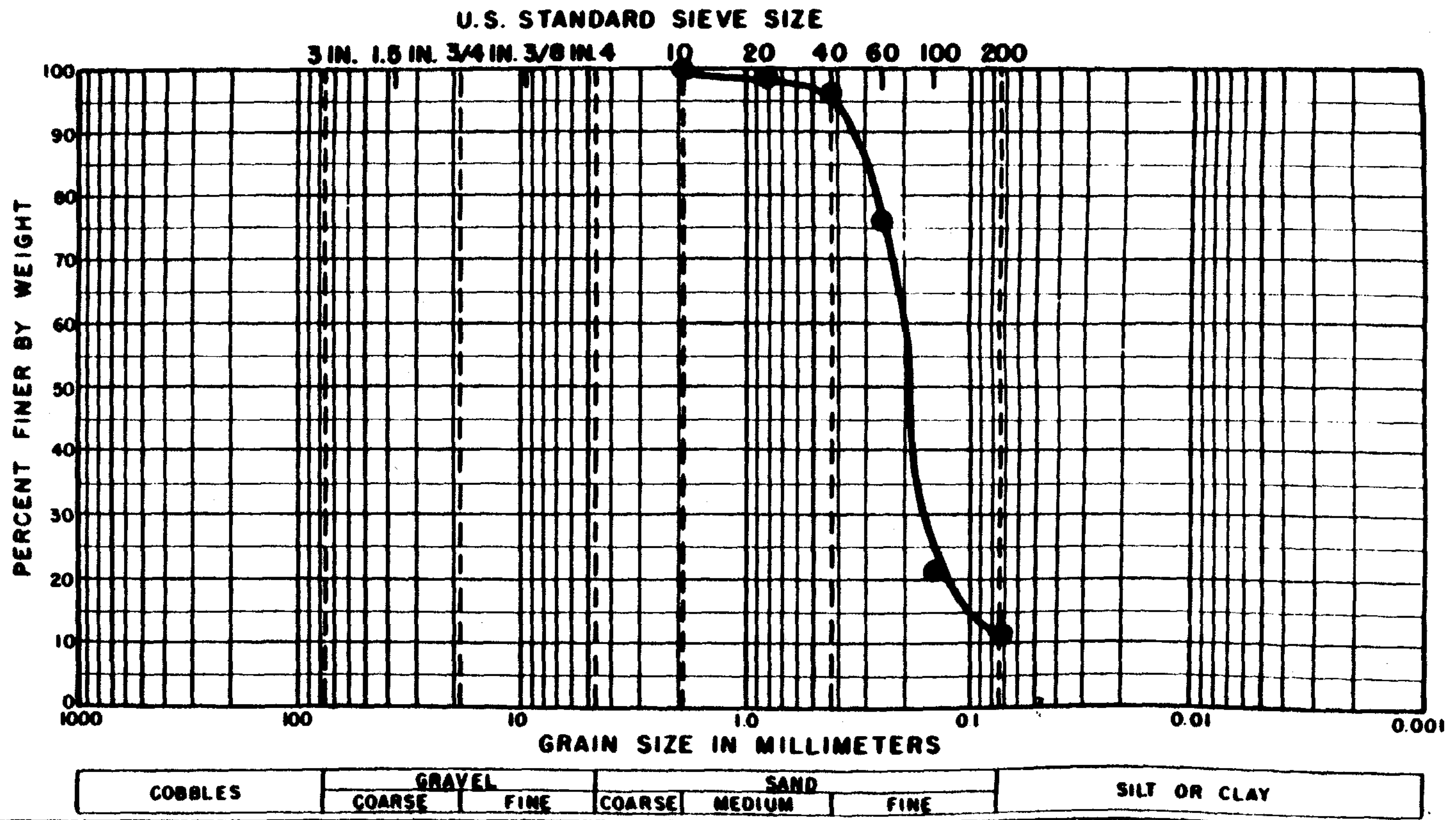
DR 000645

SMW-2	DEPTH	CLASSIFICATION		NAT WC	LL	PL	PI	
S-10	13.5-15.0'							

Dames & Moore

GRADATION CURVE

DR 000646



SMW-2	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-21	34-35.5'							

Dames & Moore

GRADATION CURVE

APPENDIX 7-1

SCHEPPS BORROW PIT LABORATORY DATA

DR 000647

L. J. Rusciani Associates Inc.
CONSULTING ENGINEERS • MATERIALS ENGINEERING & TESTING SERVICES
State Highway 73 & Chestnut Avenue, Berlin, New Jersey 08009 (609) 767-2323

CLIENT: Bill Magaha DATE: November 22, 1982

SAMPLE OF: Clay
Delivered to lab by client on 11/22/82

SOURCE: Building Site, Mannington Township

TEST REQUIRED: (1) Wash Gradation
(2) Proctor
(3) Atterburg Limits
(4) Moisture-Permeameter Test Specimen
(5) Permeability Test

LJR #11616
Rpt.#1

Wash Gradation:
LABORATORY NO. SG-1000

SIEVES	% PASSING
#4	100.0
#6	100.0
#8	99.8
#14	99.2
#16	98.7
#20	98.1
#30	96.0
#40	92.9
#50	87.9
#100	80.0
#200	76.0

LABORATORY NO.	PROCTOR Max. Dens. (#/cf)	PROCTOR Opt. Moist. (%)	MOISTURE DURING PERMEABILITY TEST (%)	PERMEABILITY (cm/sec.)	ATTERBURG LIMITS L.L.	ATTERBURG LIMITS P.L.	ATTERBURG LIMITS P.I.
PT-1040	103.0	20.6	21.5	1.28×10^{-7}	43.6	22.8	20.8

Respectfully submitted,
LEONARD J. RUSCIANI ASSOCIATES, INC.

Leonard J. Rusciani

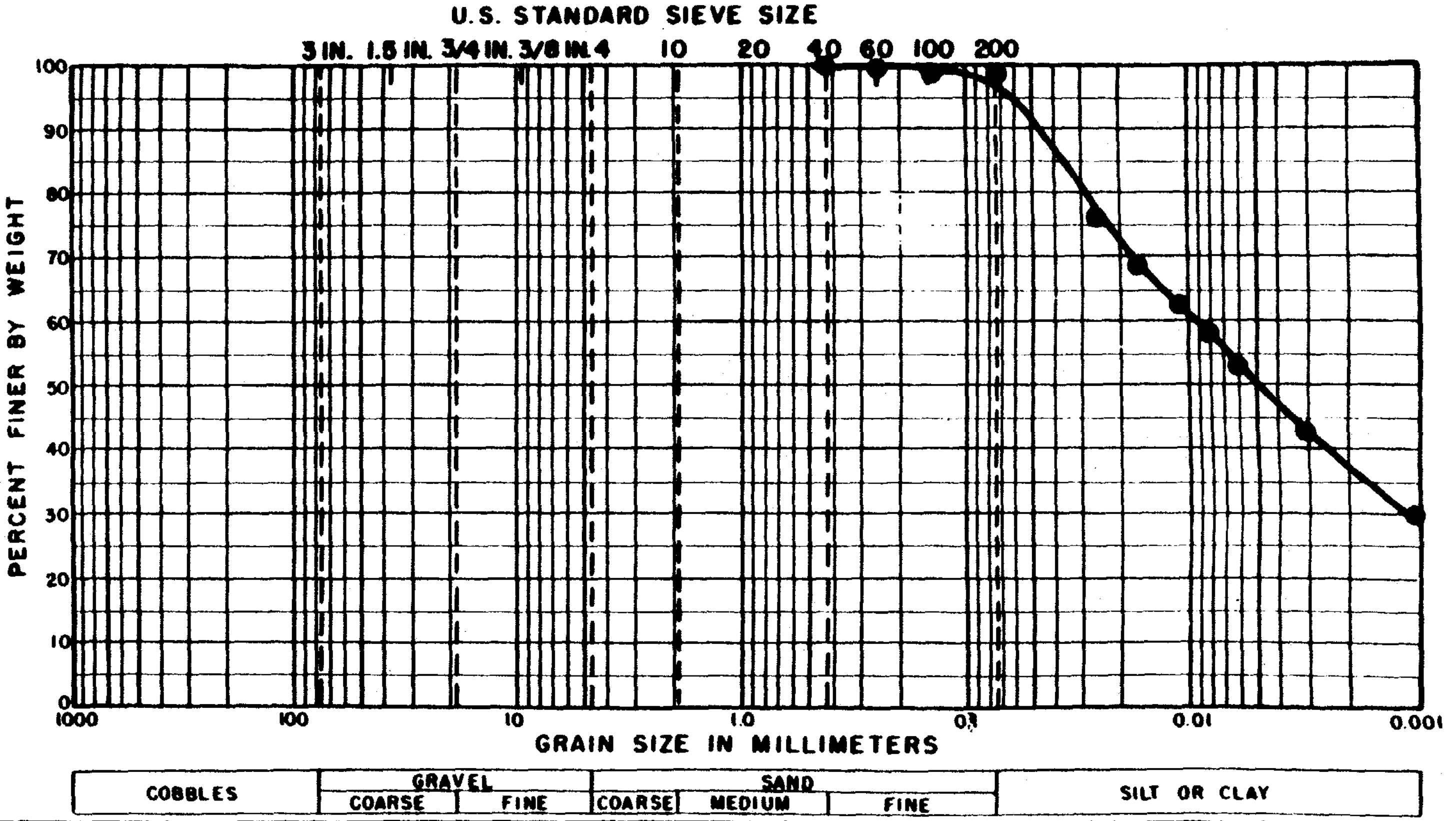
Leonard J. Rusciani, P.E.

LJR/mb
cc: Client (2)

DR 000648

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF



	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

BILL MAGAHA PIT

GRADATION CURVE

DR 000649

Dames & Moore

BILL MAGAHA PIT

SAMPLE NO.________ DEPTH________ ELEVATION________

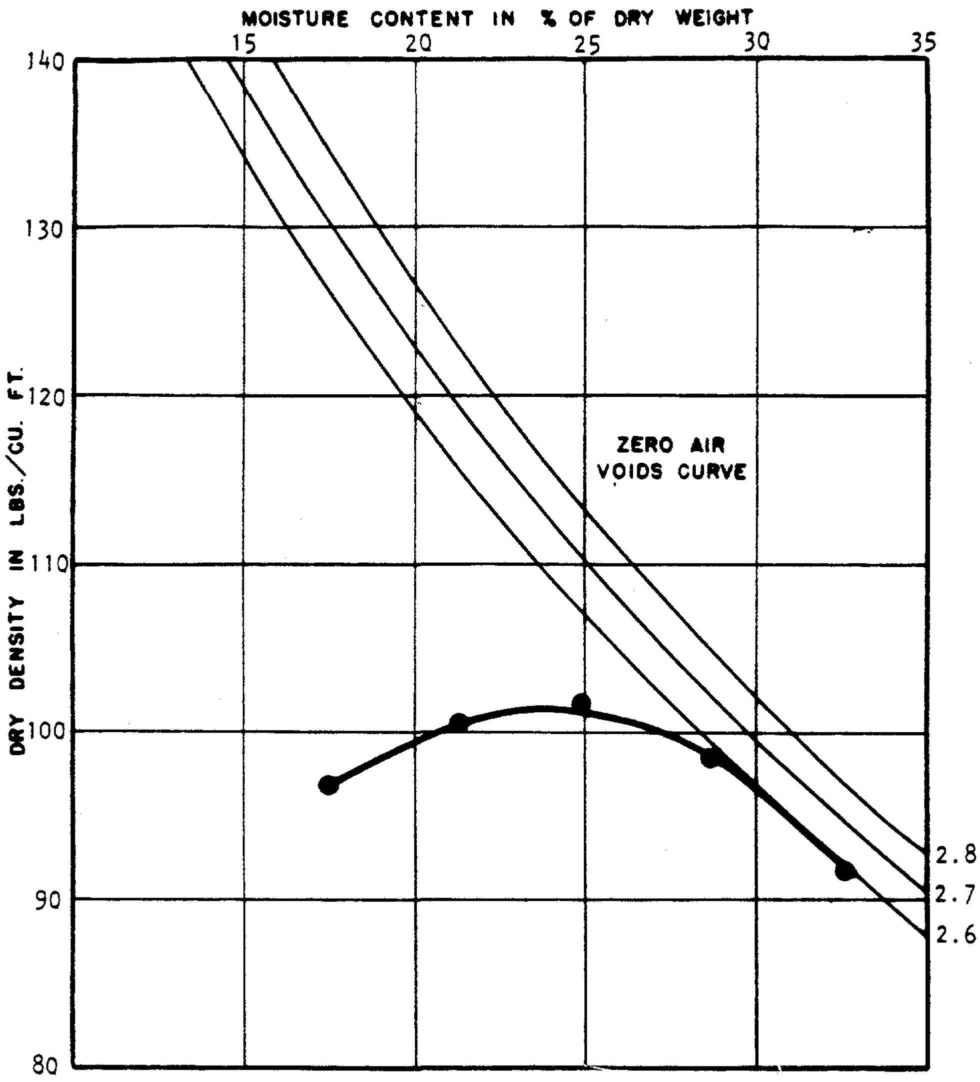
SOIL MOTTLED LIGHT -DARK BROWN

LOCATION N.J.

OPTIMUM MOISTURE CONTENT 24.9%

MAXIMUM DRY DENSITY 101.8 LBS. CU.FT.

METHOD OF COMPACTION ASTMD-1557 "A"



COMPACTION TEST DATA

DR 000650

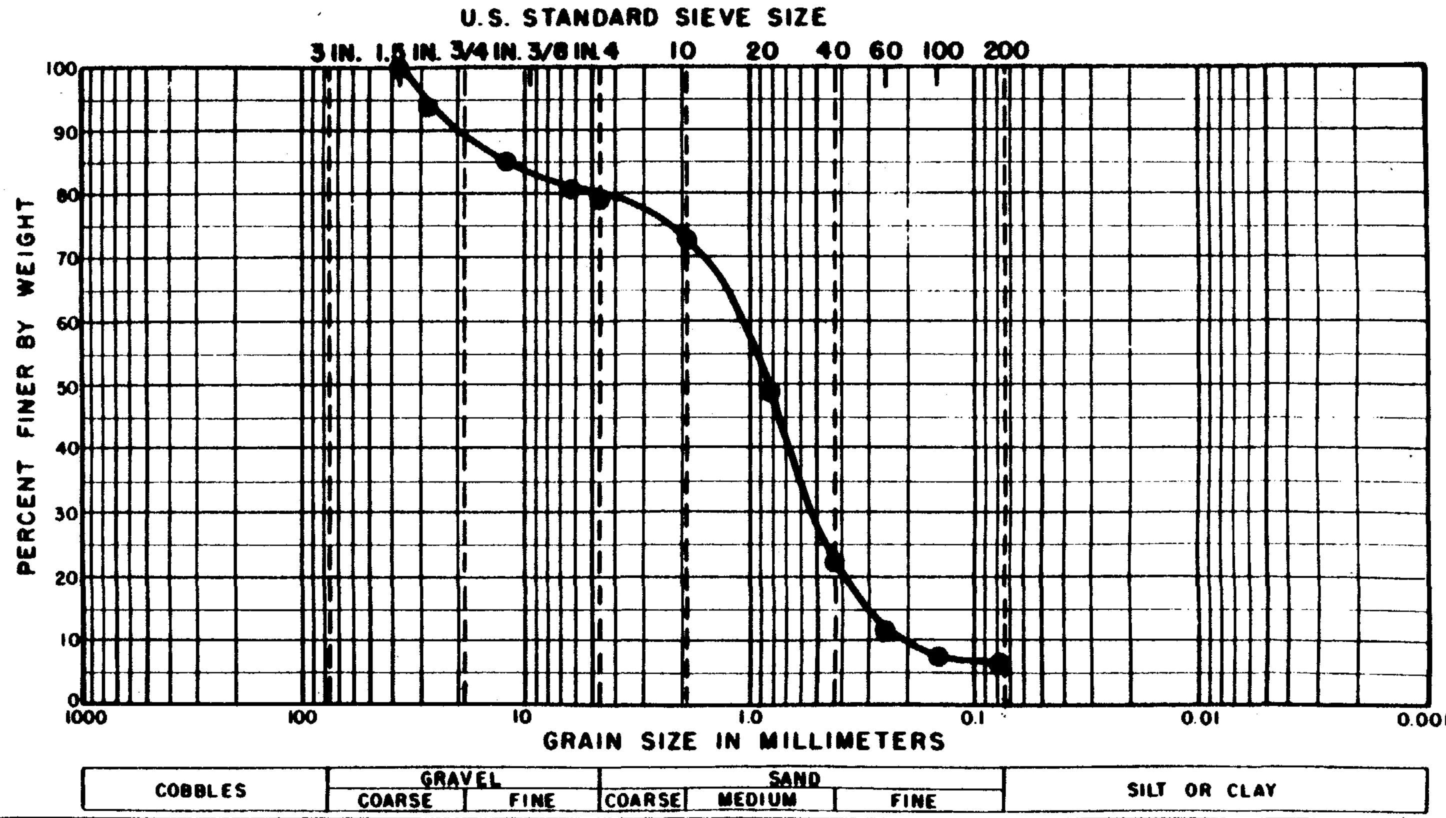
Dames & Moore

APPENDIX 7-3

GASKILL CONSTRUCTION AND WILLIAM WYNNE BORROW PITS LABORATORY DATA

FILE
BY DATE
CHECKED BY DATE

REVISIONS
BY DATE
BY DATE
PLATE OF



	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

WILLIAM WYANE BORROW PIT

GRADATION CURVE

DR 000652

Dames & Moore

CLIENT: Gaskill Construction Co.

TEST REQUIRED: Washed Gradation

DATE TESTED: 7/16/84

U.F.& S. REF. NO.: 5015

SIEVE SIZE	PERCENT PASSING						SPECIFICATIONS					
	SAMPLE #1	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE	1-2	1-5	1-8	1-9	1-10	1-11
2"	100						100	100	--	80-100	80-100	80-100
3/4"	100						65-100	70-100	--	60-100	60-100	60-100
#4	100						40-75	30-80	95-100	--	--	---
#16	98.7						--	--	45-70	20-60	20-70	--
#50	69.1						5-30	10-35	5-25	10-30	5-40	0-75
#100	13.0						--	--	--	0-20	0-30	--
#200	8.8						0-7	5-12	0-5	0-8	0-20	0-9

LOCATION:

Zone 2 from Rt. 47 Pit (I-11)

UNDERWOOD, FURMAN & SNYDER TESTING LABORATORIES, INC.

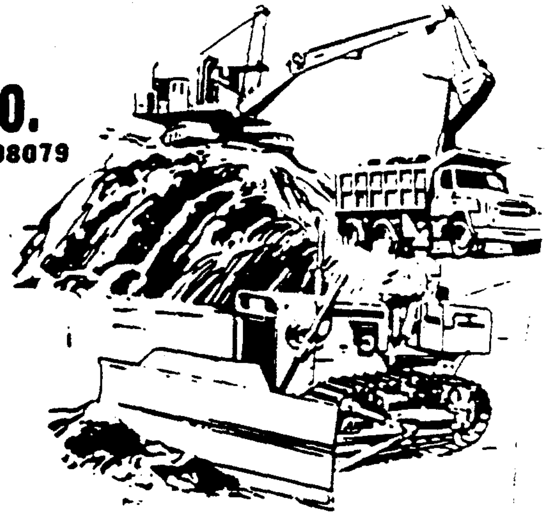
William R. Underwood, P.E.

DR 000653

VALLEY SAND & GRAVEL CO.

SCHEPPS VALLEY SALEM, N.J. 08079

(609) 455-SHEP — 455-4825



ENVIRONMENTAL CLAY

Dear Sirs,

We are pleased to receive your inquiry relative to our Schepps Environmental Clay.

The results of certified tests on the material exceeds the state's requirements for landfill and lagoon liners.

Attached are copies of the test results.

When you use Schepps Environmental Clay (10^{-8}) to line or cap your landfill, you will be using a material which meets strict environmental standards and you may save money over the cost of synthetic liner systems. Schepps Environmental Clay is available from our licensed excavation in Salem County, N.J. near the Delaware Bay and will be shipped by either truck or barge. We have large quantities available. Municipal customers may trade bonds or notes for the material instead of cash. We will sell the clay either delivered or loaded in pit

We would be pleased to furnish a quotation on the clay material necessary for your contemplated project.

Just return the coupon and we will have an installation contractor contact you.

Sincerely,

Roberta Schepps

COUPON

Valley Sand & Gravel Co.
Schepps Valley, Salem, N.J. 08079

Dear Sirs: Please have a contractor contact me to quote on my contemplated job.

Name

Munic. or Firm

Address

DR 000651

CABLE ADDRESS: "AMTEST" - PHILADELPHIA

AMBRIC TESTING ASSOCIATES OF NEW JERSEY, INC.

TESTING LABORATORIES • CHEMISTS • | REGISTERED ENGINEERS • INSPECTORS •

4041 RIDGE AVENUE, BUILDING 11
PHILADELPHIA, PENNA. 19129
GErmantown 8-2689

Re: County Landfill
County, NJ

Gentlemen:

We report our tests of soils, sampled by our representative at the site of the above project, 10-13-86

Project No. TNJ-1765

SAMPLE NO:	Prototype I			
VISUAL DESCRIPTION		PERMABILITY:	4.48 X10 -9 cm sec 2 -10 cm/sec2 minimum(4.48X10 -9 cm/sec 2)	
SIEVE ANALYSIS: SIEVE SIZE:	PERCENT PASSING:	ORGANIC MATTER: SAND SILT	1.55% 2.1% 75.5%	
GRADING: 1½ 3/4	-	CLAY	22.4%	
No. 4 No. 10 No. 40	100.0 99.9 99.5			
No. 80 No. 200	99.1 97.9 5.0minimum			
LL PL PI	46.0 35-60 21.0 25.0 15.0minimum			
CLASSIFICATION: MAXIMUM DENSITY: OPTIMUM MOISTURE:	CL 106.9 PCF 17.6			
Tested in accordance with ASTM D-1557.				

Respectfully submitted,

D.D. Meisel, P.E.

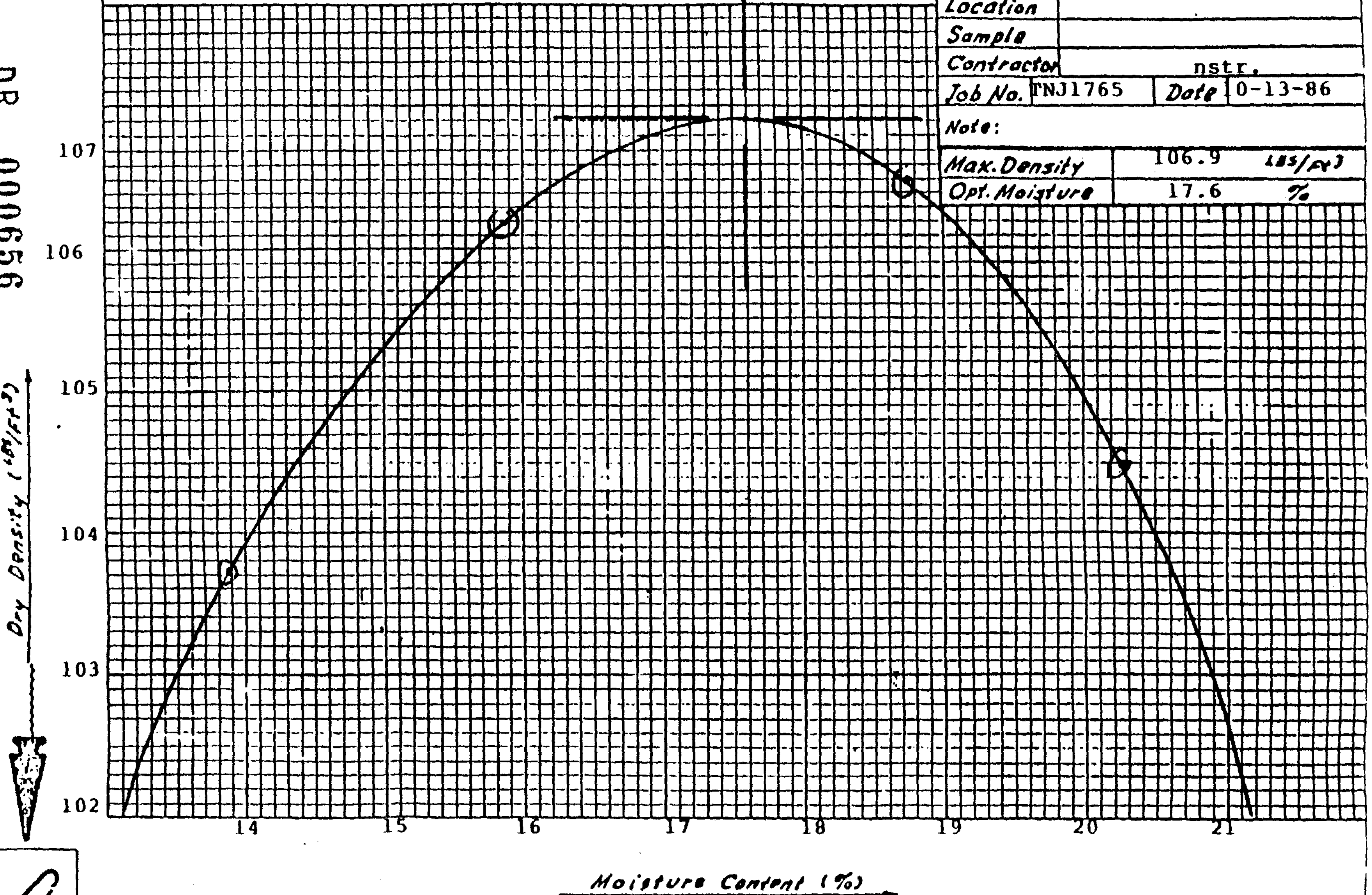
#1100

DR 000655

d

MOISTURE-DENSITY CURVE

Project	Co.Landfil
Location	
Sample	
Contractor	nstr.
Job No.	TNJ1765 — Date 0-13-86
Note:	
Max. Density	106.9 LBS/FT3
Opt. Moisture	17.6 %



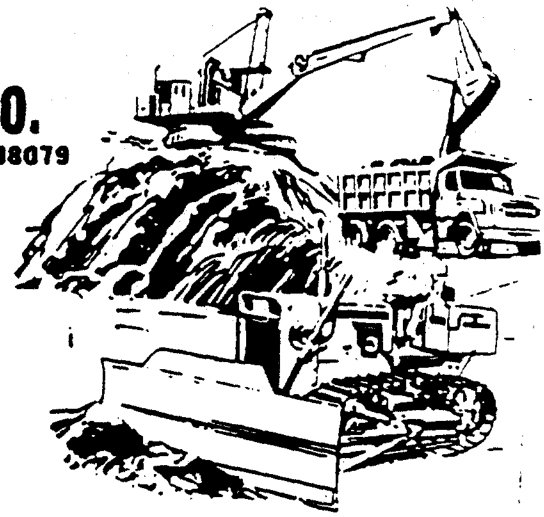
AMBRIC TESTING ASSOC. OF NEW JERSEY, INC.

4041 RIDGE AVENUE, BUILDING 11
PHILADELPHIA, PENNA. 19129

VALLEY SAND & GRAVEL CO.

SCHEPPS VALLEY SALEM, N.J. 08079

(609) 455-SHEP — 455-4825



ENVIRONMENTAL CLAY

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The results of certified tests on the material exceeds the state's requirements for landfill and lagoon liners.

Attached are copies of the test results.

When you use Schepps Environmental Clay (10^{-9}) to line or cap your landfill, you will be using a material which meets strict environmental standards and you may save money over the cost of synthetic liner systems. Schepps Environmental Clay is available from our licensed excavation in Salem County, N.J. near the Delaware Bay and will be shipped by either truck or barge. We have large quantities available. Municipal customers may trade bonds or notes for the material instead of cash. We will sell the clay either delivered or loaded in pit.

We would be pleased to furnish a quotation on the clay material necessary for your contemplated project.

Just return the coupon and we will have an installation contractor contact you.

Sincerely,

Roberta Schepps

COUPON

Valley Sand & Gravel Co.
Schepps Valley, Salem, N.J. 08079

Dear Sirs: Please have a contractor contact me to quote on my contemplated job.

Name

Munic. or Firm

Address

DR 000657

Y-2

L. J. Rusciani Associates Inc.

CONSULTING ENGINEERS • MATERIALS ENGINEERING & TESTING SERVICES

State Highway 73 & Chestnut Avenue, Berlin, New Jersey 08009 (609) 767-2323

DATE: March 31, 1982

CLIENT:

SAMPLE OF: Clay: Samples Delivered to Laboratory on 3/25/82

TESTS REQUIRED:
1) Moisture-Permeameter Test Specimen
2) Permeability Tests
3) Atterburg Limits

LJR #11235
Rpt #3

Laboratory No.	Identification of Sample	Proctor Max. Dens. (#/cf)	Proctor Opt. Moist. (%)	Moisture During Permeability Test (%)	Permeability (cm/sec.)	Atterburg Limits L.L.	Atterburg Limits P.L.	Atterburg Limits P.I.
PT-1034	Shepps #1	93.0	28.8	26.9	$3.93x10^{-8}$	49.5	22.5	27.0
PT-1035	Shepps #2	118.6	33.5	32.1	$1.62x10^{-8}$	56.5	30.0	26.5

Respectfully submitted,
L. J. RUSCIANI ASSOCIATES, INC.

Leonard J. Rusciani

Leonard J. Rusciani, P.E.

LJR/mac

C: Client (2)

DR 000658

UNDERWOOD, FURMAN & SNYDER TESTING LABORATORIES, INC.
3 South Black Horse Pike
Mt. Ephraim, N. J. 08059

William R. Underwood, P. E. | William M. Furman, Manag

Soil Borings - Soil Engineering - Testing - Inspection - Concrete - Steel - Asphalt - Masonry

Shep # 3

CLIENT:
PROJECT: Clay Soil, Shepps Pit, Salem County
TEST REQUIRED: Permeability Test, Atterburg Limits
DATE: 1/19/83
UFS REF. NO.: 4357

LABORATORY TEST RESULTS

1. Permeability (cm/sec)...........2.4×10^{-8}
2. Atterburg Limits
   - Liquid Limit...............51.9
   - Plastic Limit..............27.3
   - Plasticity Index...........24.6

UNDERWOOD, FURMAN & SNYDER TESTING LABORATORIES, INC.

William R. Underwood, P.E.

DR 000659

Exhibit T.

DEFINITIONS

Proctor Test - maximum dry density (#/cf) and optimum moisture (%)- The density to which a soil can be compacted is an important engineering property. In general the greater the density, the greater the strength of the material. For a given compactive effort the attainable density varies somewhat according to the moisture content, and that content at which the maximum dry density is attained is termed "the optimum moisture" content for that particular compactive effort. The data on both determinations, is expressing maximum dry density in pounds per cubic foot and optimum moisture in percent.

Moisture during Permeability Test (%) - This is the moisture (%) available in the soil while the permeability test was made. This is usually less than the optimum moisture required to complete the Proctor Test. If the permeability is determined at less than optimum moisture, the permeability will be generally slower when tested with optimum moisture present.

Permeability (cm/sec.) - Soil permeability is that quality of soil that enables it to transmit water and air. The accepted measure of this quality is the rate at which soil transmits water while saturated. That rate is the "saturated hydraulic conductivity" of soil physics. In this report, the conventional usage is expressed and indicates a "rate of flow" principally downward, as permeability. (3.93×10^{-8} cm/sec. is less that 0.5 in/yr. and 1.62×10^{-8} cm/sec. is about 0.2 in/yr.)

Atterburg Limits - L.L. (Liquid Limits); P.L. (Plastic Limits); P.I. (Plasticity Index) - Liquid limit and plasticity index relate to soil moisture and provide important clues to soil behavior. If water is added to a dry soil containing at least some clay and silt, the soil becomes plastic. The moisture content at which the soil becomes plastic is the plastic limit. This limit, routinely determined by laboratories, is needed to compute the plasticity index. If more water is added the soil becomes fluid. The moisture content at which the soil changes from a plastic to a fluid state is the liquid limit, and this limit is reported numerically. The difference between the liquid limit and the plastic limit is the plasticity index--the range over which the soil is plastic--and this index is reported numerically. Some soils, such as those that are very sandy, do not exhibit plasticity and therefore do not have a plasticity index. For such soils "NP", meaning nonplastic, is entered.

D'Agostino Well Drilling, Inc.
DOMESTIC & INDUSTRIAL - WATER SUPPLY SYSTEMS
RR #8, Box 122, Landis Avenue
Bridgeton, N. J. 08302

(609) 451-4922

May 2, 1983

David Schepps
Schepps Valley
Salem, NJ 08079

RE: Schepps Clay Pit
Boring Certifications

Dear Mr. Schepps:

On April 28, 1983, we made two test borings (#4, #5) at Schepps Valley Clay Pit at your request.

Attached hereto are the logs of both of those one hundred and sixty-five feet (165') borings.

Boring #4, revealed that the gray kirkwood clay layer you wanted measured was one hundred and eighteen feet (118') thick, starting at nine feet (9'), and ending at one hundred and twenty seven feet (127') below the surface.

On boring #5, the gray kirkwood clay layer measured one hundred and thirty-two feet (132') thick, starting at six feet (6') and ending at one hundred and forty feet (140') below the surface.

Sincerely,

D'AGOSTINO WELL DRILLING, INC.

Mario D'Agostino

Mario D'Agostino

MD/mmm

DR 000661

D'Agostino Well Drilling, Inc.

DOMESTIC & INDUSTRIAL - WATER SUPPLY SYSTEMS
RR #8, Box 122, Landis Avenue
Bridgeton, N. J. 08302

(609) 451-4922

May 2, 1983

David Schepps
Schepps Valley
Salem, NJ 08079

WELL LOG: #4

0' - 9'	Stones, gravel
9' - 15'	Clay
15' - 22'	Gray green clay (dry)
22' - 30'	Gray green clay
30' - 37'	Gray blue clay
37' - 45'	Gray blue clay
45' - 52'	Dark gray blue clay (very sticky)
52' - 60'	Dark gray blue clay
60' - 67'	Gray blue clay (sticky)
67' - 75'	Gray blue clay (sticky)
* 75' - 82'	Greenish gray clay
82' - 90'	Greenish gray clay (very sticky)
90' - 97'	Greenish gray clay
97' - 105'	Greenish gray clay
105' - 112'	Brownish gray clay (dry, sticky)
* 112' - 120'	Brownish gray clay
120' - 127'	Brownish gray clay
127' - 135'	Brownish clay - pepper - coarse sand
135' - 142'	Brownish gray clay - pepper - medium to fine sand
142' - 150'	Brownish gray clay - pepper - medium to fine sand
150' - 157'	Brownish gray clay - pepper - sand
157' - 165'	Brownish gray clay - pepper - sand

L. J. Rusciani Associates Inc.

CONSULTING ENGINEERS • MATERIALS ENGINEERING & TESTING SERVICES

State Highway 73 & Chestnut Avenue, Berlin, New Jersey 08009 (609) 767-2323

CLIENT: David Schepps DATE: April 28, 1983

SAMPLE OF: Schepps Clay: Samples Delivered to Laboratory on 4/28/83

LOCATION: (Test Boring #4)

TEST REQUIRED: 1) Moisture-Permeameter Test Specimen 2) Permeability Tests

LJR #11781
Report #2

Laboratory No.	Identification of Sample	Moisture During Permeability Test (%)	Permeability (cm/sec.)
PT-1045 Sample 1 - 80 ft.	Schepps #4	48.3	9.18×10^{-8}
PT-1046 Sample 2 - 120 ft.	Schepps #4	55.8	7.10×10^{-8}

Respectfully submitted,
L. J. RUSCIANI ASSOCIATES, INC.

[signature]

Leonard J. Rusciani, P.E.

C: Client (2)

DR 000663

D'Agostino Well Drilling, Inc.
DOMESTIC & INDUSTRIAL - WATER SUPPLY SYSTEMS
RR #8, Box 122, Landis Avenue
Bridgeton, N. J. 08302

(609) 451-4922

May 2, 1983

David Schepps
Schepps Valley
Salem, New Jersey 08079

WELL LOG: #5

0' -	6'	Sand, gravel
6' -	15'	Blackish gray clay (sticky)
15' -	30'	Dark gray clay (sticky)
30' -	37'	Brownish greenish gray clay (sticky)
37' -	50'	Brownish greenish gray clay (sticky)
* 50' -	60'	Blueish gray clay (very sticky)
60' -	67'	Greenish blue gray clay (very sticky, some dry)
67' -	75'	Greenish blue gray clay (very sticky, some dry)
75' -	85'	Darker greenish gray clay (dry to sticky)
85' -	90'	Brownish gray clay (dry to sticky)
90' -	97'	Dark greenish gray clay (dry, some sticky)
97' -	105'	Dark brownish gray clay (sticky to dry)
105' -	112'	Brownish gray clay
112' -	120'	Brownish gray clay, some greenish gray (dry to sticky)
* 120' -	127'	Brownish gray clay (sticky)
127' -	140'	Brownish gray clay (sticky)
140' -	142'	Brownish gray clay
142' -	150'	Brownish gray clay - pepper - sand
150' -	157'	Brownish gray clay - pepper - sand
157' -	165'	Gray black sand, some clay

TESTWELL CRAIG TESTING LABORATORIES, INC.

☒ South Jersey Division P.O. Box J, Mays Landing, NJ 08330 (609) 625-1700
☐ New York Division 36-20 13th Street, Long Island City, NY 11106 (212) 392-012?
☐ North Jersey Division 218 Little Falls Rd., Cedar Grove, NJ 07009 (201) 239-579?
☐ Connecticut Division 6 Lake Avenue, Danbury, Ct. 06810 (203) 743-7281
☐ Albany Division 518 Clinton Avenue, Albany, NY 12206 (518) 436-4114

Address correspondence to the above

TESTING ENGINEERS • STEEL • WATER • CONCRETE • CHEMICAL ANALYSIS • SOILS • TEST BORINGS • CORE DRILLING • ASPHALT • RESEARCH

June 16, 1983

CLIENT:	David Schepps
PROJECT:	1983 Quality Control
MATERIAL:	Clay bulk samples submitted by Clinet for laboratory analysis and identified as follows: Sample No. 1 - Test Boring #5 - 55 feet Sample No. 2 - Test Boring #5 - 120 feet
TEST REQUIRED:	Atterberg Limits
DATES TESTED:	May 31st and June 1st, 1983
REPORT NO.:	DS-1
LAB. NO.:	62286

LABORATORY ANALYSIS

Atterburg Limits

	Sample No. 1	Sample No. 2
Liquid Limit	54.2	56.6
Plastic Limit	31.5	30.5
Plasticity Index	22.7	26.1

Permeability (cm/sec.) *

Sample No. 1 ---------------- 2.4×10^{-8}
Sample No. 2 ---------------- 2.4×10^{-8}

*Permeability results dependent on moisture content of clay at time of placement and methods of placement.

Respectfully submitted,

TESTWELL CRAIG TESTING LABORATORIES, INC.

Frank C. Craig, Jr.

FCC/sms

Reported to: Client (3)

DR 000665

G-7

L. J. Rusciani Associates Inc.

CONSULTING ENGINEERS • MATERIALS ENGINEERING & TESTING SERVICES

State Highway 73 & Chestnut Avenue, Berlin, New Jersey 08009 (609) 767-2323

CLIENT: David Schepps DATE: April 28, 1983

SAMPLE OF: Schepps Clay: Samples Delivered to Laboratory on 4/28/83

LOCATION: (Test Boring #6 - Upper Pond)

TESTS REQUIRED: 1) Moisture-Permeameter Test Specimen LJR #11781
2) Permeability Tests Report #1

Laboratory No.	Identification of Sample	Moisture During Permeability Test (%)	Permeability (cm/sec.)
PT-1044 Sample #1-120 feet	Schepps #6	42.1	4.42×10^{-8}

Respectfully submitted,
L. J. RUSCIANI ASSOCIATES, INC.

[signature]

Leonard J. Rusciani, P.E.

C: Client (2)

DR 000666

(609) 933-1818

UNDERWOOD, FURMAN & SNYDER TESTING LABORATORIES, INC.
3 South Black Horse Pike
Mt. Ephraim, N. J. 08059

William R. Underwood, P. E. William M. Furman, Manager

Soil Borings - Soil Engineering - Testing - Inspection - Concrete - Steel - Asphalt - Masonry

test - [illegible] #8

CLIENT:	[illegible]
PROJECT:	Sample Submitted by Client
TEST REQUIRED:	See Below
LOCATION:	2,500'from Jerico Rd. - 2,500'from Gravely Hill Rd.
DATE TESTED:	October 18, 1984 - October 23, 1984
UF&S REF. NO.:	5145

TEST RESULTS

Permeability (cm/sec)............................6.8×10^{-8}

Atterberg Limits
- Plastic Limit.............................24.8
- Liquid Limit..............................49.0
- Plasticity Index..........................24.2

Moisture as submitted........................13.1

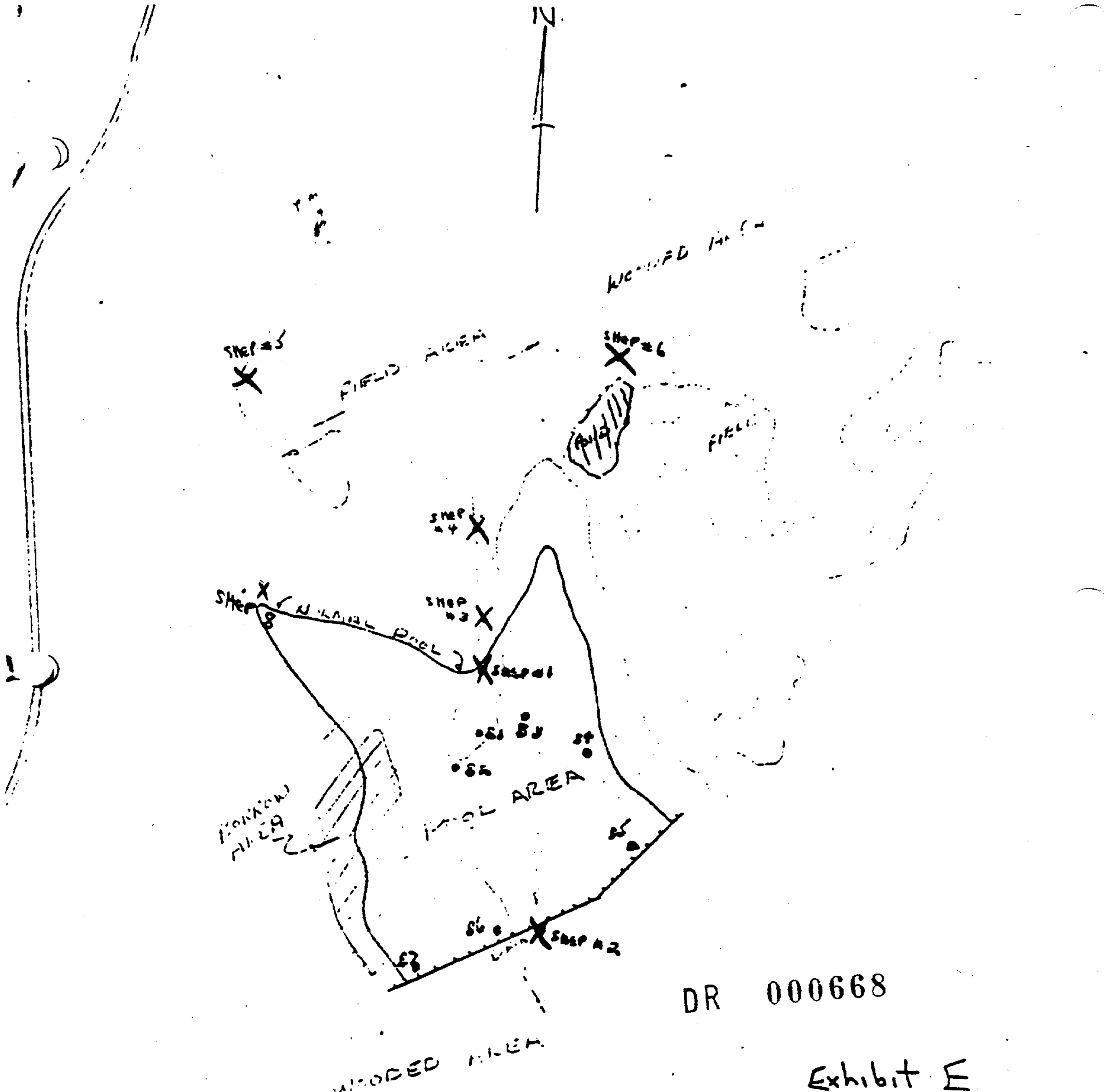
Moisture as tested...........................20.0

Proctor
- Max. Density (lbs/ft.^{3}.....................97.1
- Optimum Moisture..........................20.5
- Moisture during Permeability test..........19.5
- pH....................................... 4.8

UNDERWOOD, FURMAN & SNYDER
TESTING LABORATORIES, INC.

William R. Underwood, P.E.

DR 000667



DR 000668

Exhibit E
Flown 7/73
Borings 12/79

PLOTTED FROM AERIAL PHOTO CND 3LL 12[illegible]
SCALE 1" = 400'

(609) 933-1818

UNDERWOOD, FURMAN & SNYDER TESTING LABORATORIES, INC.
3 South Black Horse Pike
Mt. Ephraim, N. J. 08059

William R. Underwood, P. E.   William M. Furman, Manager

Soil Borings - Soil Engineering - Testing - Inspection - Concrete - Steel - Asphalt - Masonry

CLIENT:	[illegible]
PROJECT:	Sample Submitted by Client
TEST REQUIRED:	See Below
LOCATION:	2,500' from Jerico Rd. - 2,500' from Gravely Hill Rd.
DATE TESTED:	October 18, 1984 - October 23, 1984
UF&S REF. NO.:	5145

TEST RESULTS

Gradation Analysis

Percent coarser than the 200 Sieve	Specification
1.9%	Less than 15%

Classification (ASTM D2487).......................CL

This is to certify that the above material meets the specifications as outlined in the "Technical Provision Section 2D, Earthwork" for the project DACW 61-84-B-0021 and is suitable for the intended purpose.

UNDERWOOD, FURMAN & SNYDER
TESTING LABORATORIES, INC.

William R. Undewood, P.E.

Swindell Dressler
International Company
A Subsidiary of Rust International Corporation

October 25, 1982

Mr. David Schepps
Schepps Valley
Salem, NJ 08079

Dear Mr. Schepps:

Your clay sample was received at our laboratory and very basic preliminary visual inspections were made. These show the material to be a very plastic clay which fires at 2060°F to the chocolate brown which is common to clays of that area.

With the addition of non-plastic, low-shrinkage materials such as sand or grog, for reducing shrinkage and facilitate drying of this very fine-grained material, it could be made suitable for products such as brick, rooftile, or floortile.

We offer consulting and testing services on a per diem basis and will, of course, be pleased to discuss these further with you if you feel the above information warrants further interest. Please let us know how we can be of further help.

Very truly yours,

Alan J. Kinder/cb

Alan J. Kinder
Sales Engineer

AJK/cb

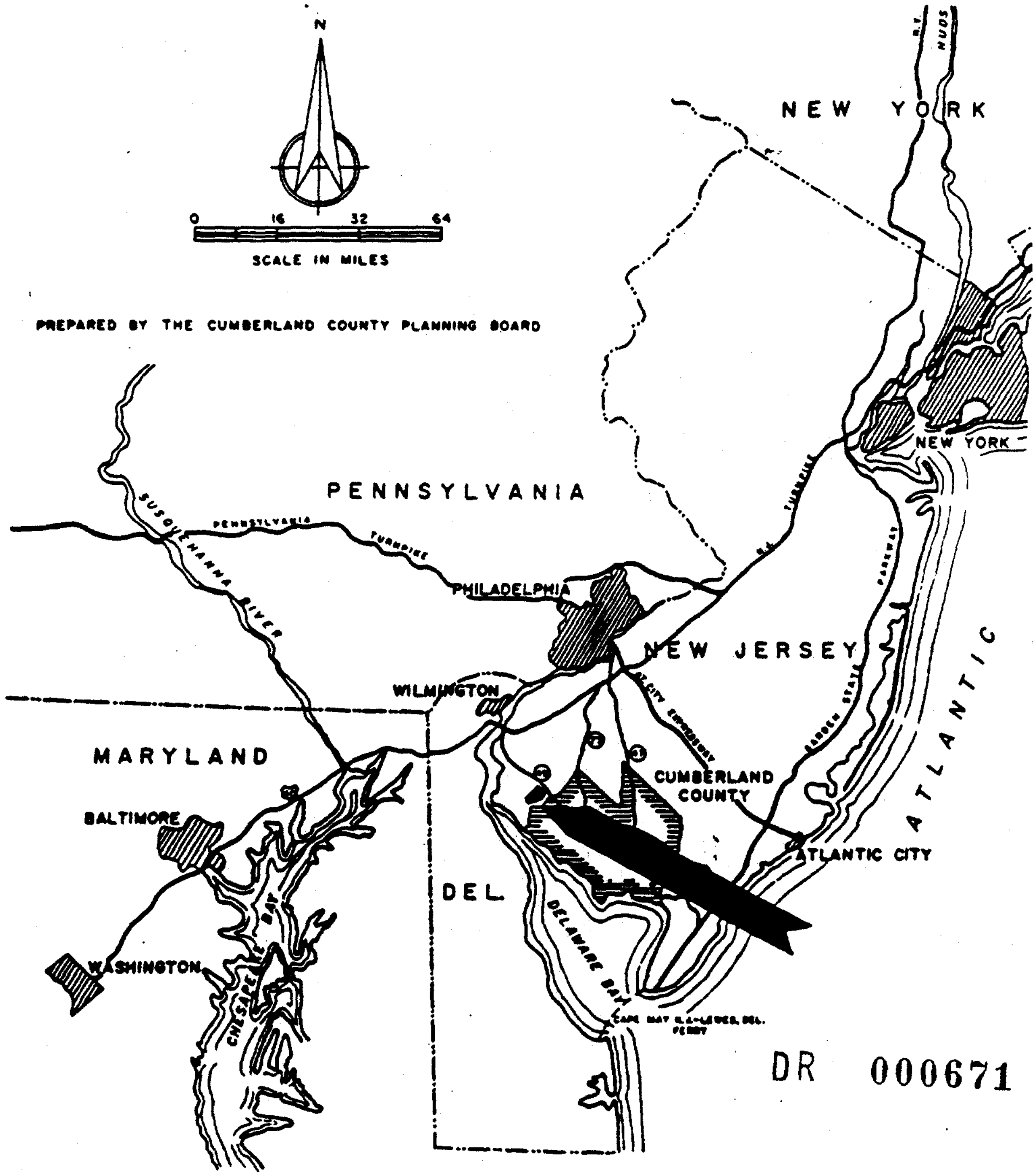
Enclosure

441 Smithfield Street, Pittsburgh, Pennsylvania 15222 (412) 562-7000
Serving the Ceramic Industry Since 1915

David D. Schepps

Distances from this site to nearby major cities:

Wilmington, Delaware	-	34 miles
Camden-Philadelphia	-	40 "
New York City, N. Y.	-	130 "
Baltimore, Maryland	-	100 "
Washington, D. C.	-	138 "
Boston, Massachusetts	-	350 "



DR 000671

Y-2

L. J. Rusciani Associates Inc.

CONSULTING ENGINEERS • MATERIALS ENGINEERING & TESTING SERVICES

State Highway 73 & Chestnut Avenue, Berlin, New Jersey 08009 (609) 767-2323

DATE: March 31, 1982

CLIENT:

SAMPLE OF: Clay: Samples Delivered to Laboratory on 3/25/82

TESTS REQUIRED: 1) Moisture-Permeameter Test Specimen — LJR #11235
2) Permeability Tests — Rpt #3
3) Atterburg Limits

Laboratory No.	Identification of Sample	Proctor Max. Dens. (#/cf)	Proctor Opt. Moist. (%)	Moisture During Permeability Test (%)	Permeability (cm/sec.)	Atterburg Limits L.L.	Atterburg Limits P.L.	Atterburg Limits P.I.
PT-1034	Shepps #1	93.0	28.8	26.9	3.93×10^{-8}	49.5	22.5	27.0
PT-1035	Shepps #2	118.6	33.5	32.1	1.62×10^{-8}	56.5	30.0	26.5

Respectfully submitted,
L. J. RUSCIANI ASSOCIATES, INC.

Leonard J. Rusciani

Leonard J. Rusciani, P.E.

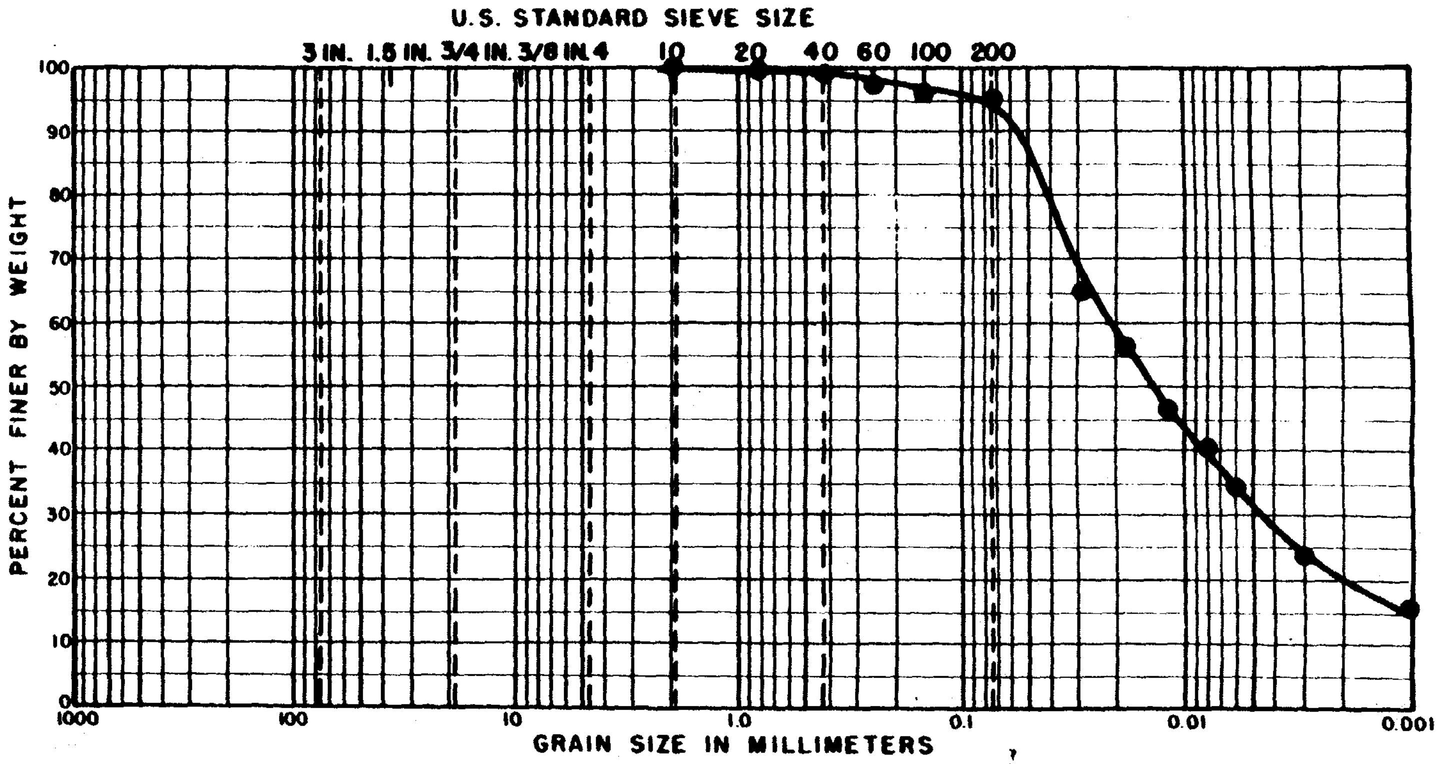
LJR/mac

C: Client (2)

DR 000672

BY DATE
CHECKED BY DATE

BY DATE
PLATE OF



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

SCHEPPS BORROW PIT

GRADATION CURVE

DR 000673

Dames & Moore

SCHEPPS

SAMPLE NO.______ DEPTH______ ELEVATION______

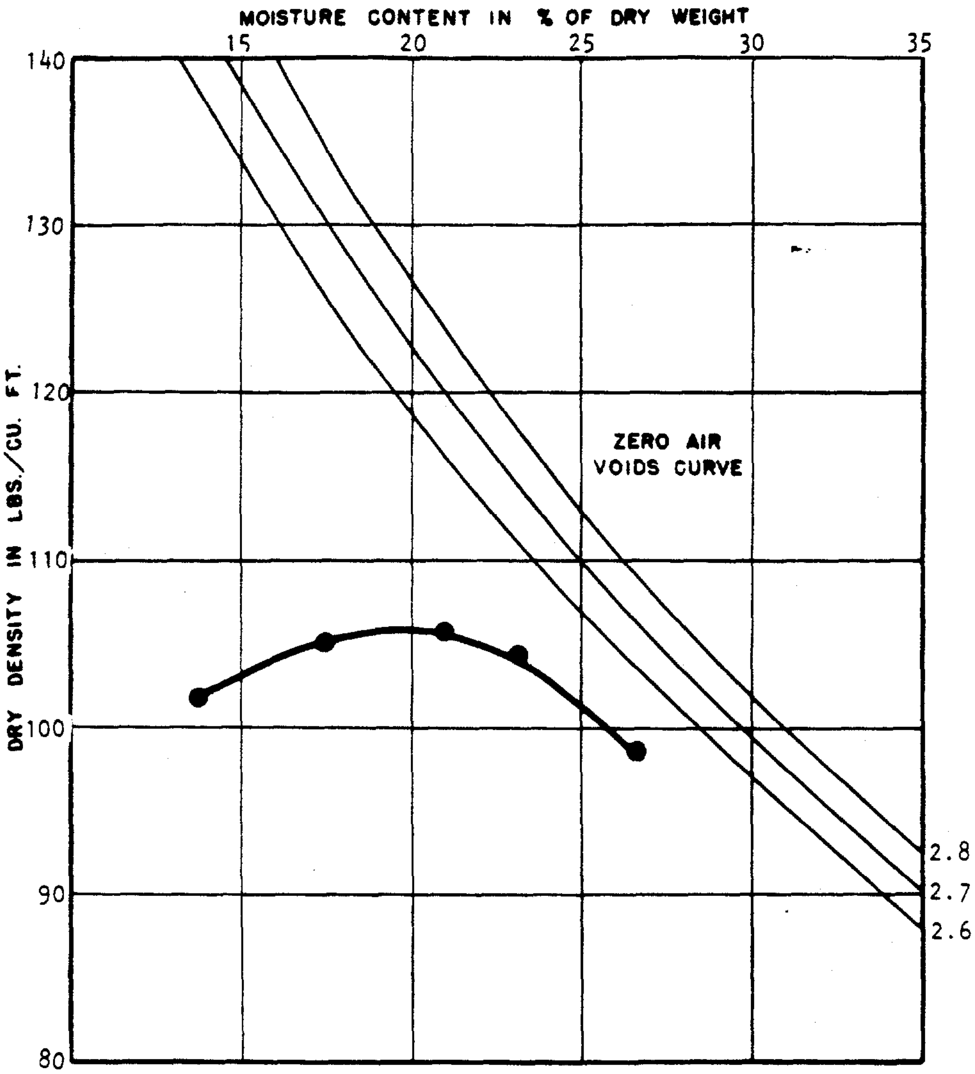
SOIL DARK GRAY SILTY CLAY

LOCATION N.J.

OPTIMUM MOISTURE CONTENT 19.5%

MAXIMUM DRY DENSITY 106.0 lbs.cu. ft.

METHOD OF COMPACTION ASTM D-1557 "A"



COMPACTION TEST DATA

DR 000674

Dames & Moore

PLATE

APPENDIX 7-2

BILL MAGAHA BORROW PIT LABORATORY DATA

CLIENT: Gaskill Construction

TEST REQUIRED: Washed Gradation DATE TESTED: 6/1/84

U.F.& S. REF. NO.: 4946

PERCENT PASSING / SPECIFICATIONS

SIEVE SIZE	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE	SAMPLE	SAMPLE	1-2	1-5	1-8	1-9	1-10	1-11
2"	100	100	100				100	100	--	80-100	80-100	80-100
3/4"	100	100	100				65-100	70-100	--	60-100	60-100	60-100
#4	99.7	100	100				40-75	30-80	95-100	--	--	---
#16	99.5	99.0	99.3				--	--	45-70	20-60	20-70	--
#50	59.6	47.2	53.5				5-30	10-35	5-25	10-30	5-40	0-75
#100	--	--	--				--	--	--	0-20	0-30	--
#200	6.3	5.0	3.7				0-7	5-12	0-5	0-8	0-20	0-9

LOCATION:

FOLLOWING INFO FROM JEFF MASON (11 JUL 84)
ABOVE SAMPLES FROM GASKILL'S ROUTE 47 PIT
SAMPLE 1 - RIGHT REAR
" 2 - CENTER "
" 3 - LEFT "

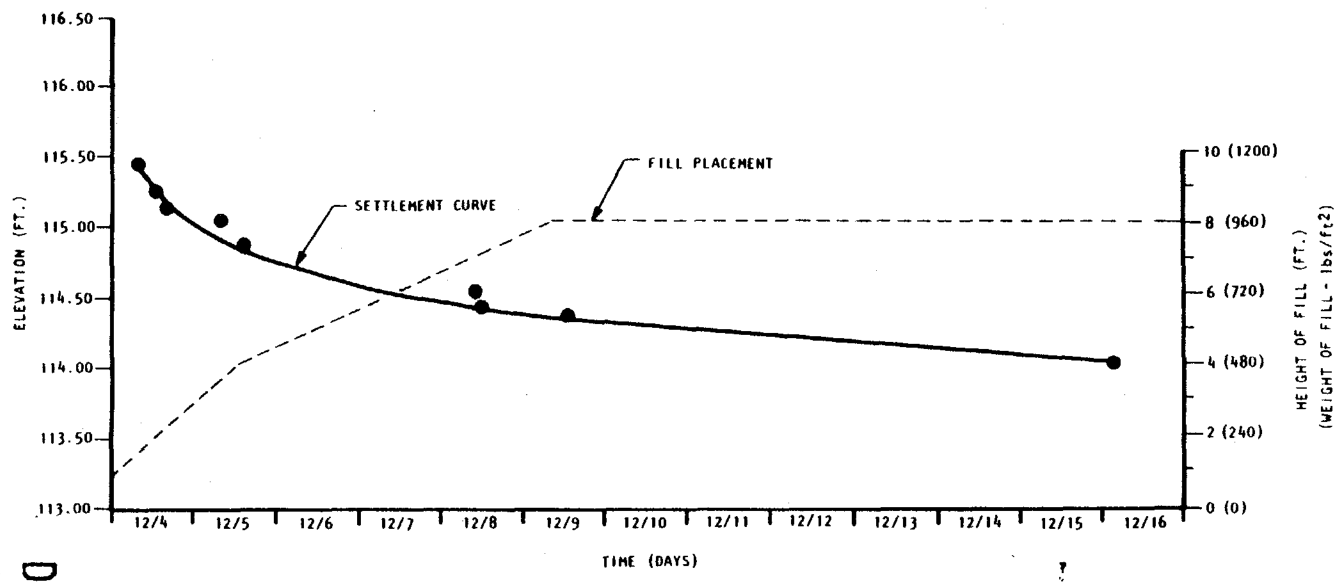
UNDERWOOD, FURMAN & SNYDER TESTING LABORATORIES, INC.

William R. Underwood, P.E.

APPENDIX 8-1

TIME/SETTLEMENT CURVES FOR SETTLEMENT MONUMENTS

DR 000677



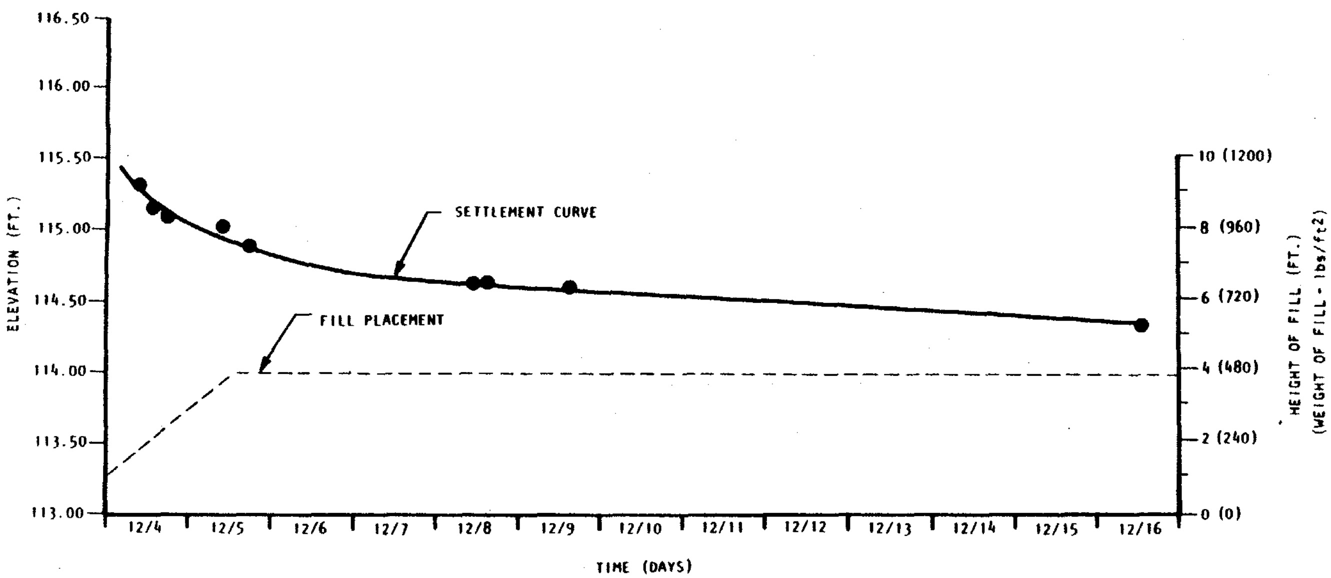
DR 000678

SETTLEMENT MONUMENT 1

TIME SETTLEMENT PLOTS

HELEN KRAMER LANDFILL

MANTUA, N.J.



SETTLEMENT MONUMENT 2

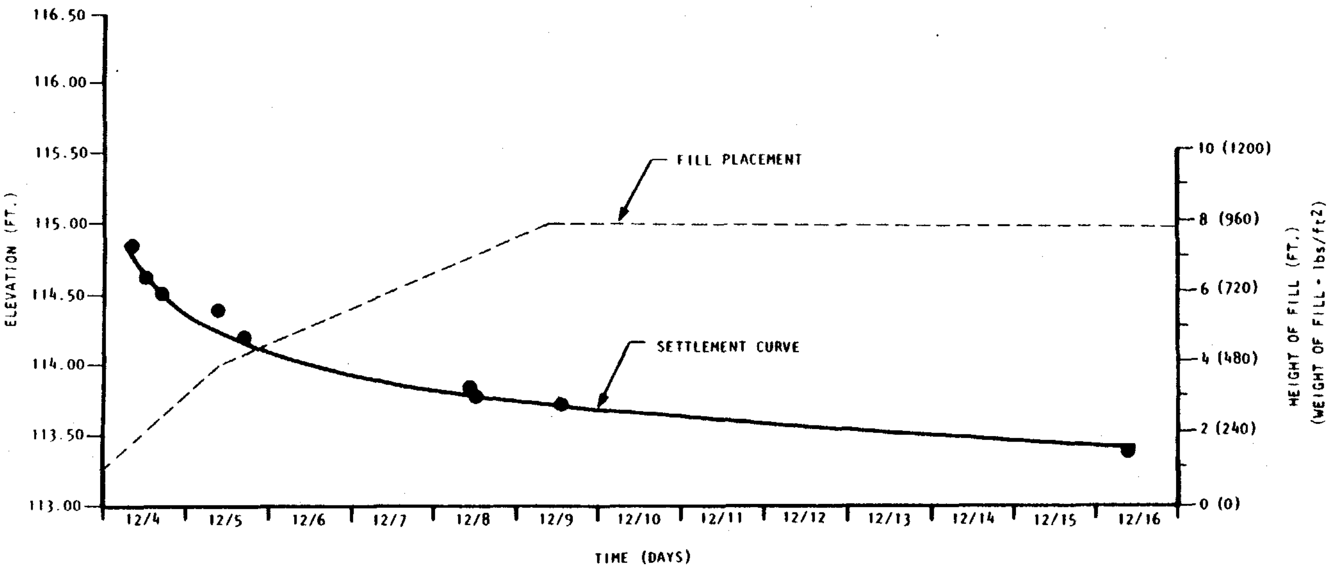
TIME SETTLEMENT PLOTS

HELEN KRAMER LANDFILL

MANTUA, N.J.

DR 000679

DAMES & MOORE



DR 000680

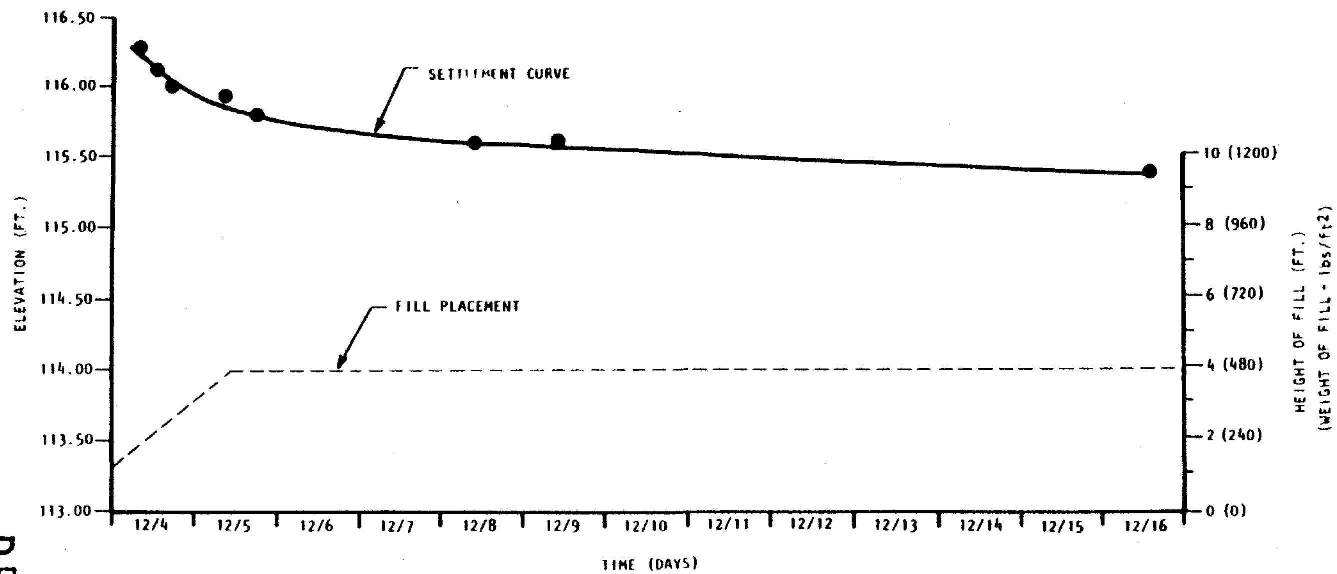
SETTLEMENT MONUMENT 3

TIME SETTLEMENT PLOTS

HELEN KRAMER LANDFILL

MANTUA, N.J.

DAMES & MOORE



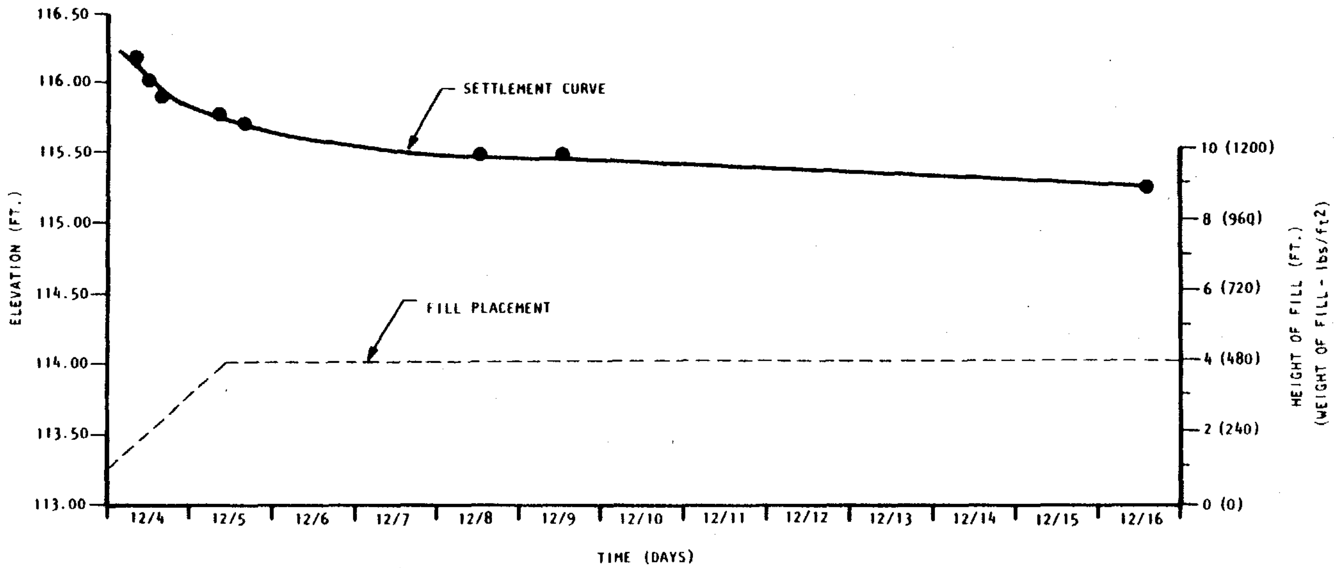
DR 000681

SETTLEMENT MONUMENT 4

TIME SETTLEMENT PLOTS

HELEN KRAMER LANDFILL

MANTUA, N.J.



DR 000682

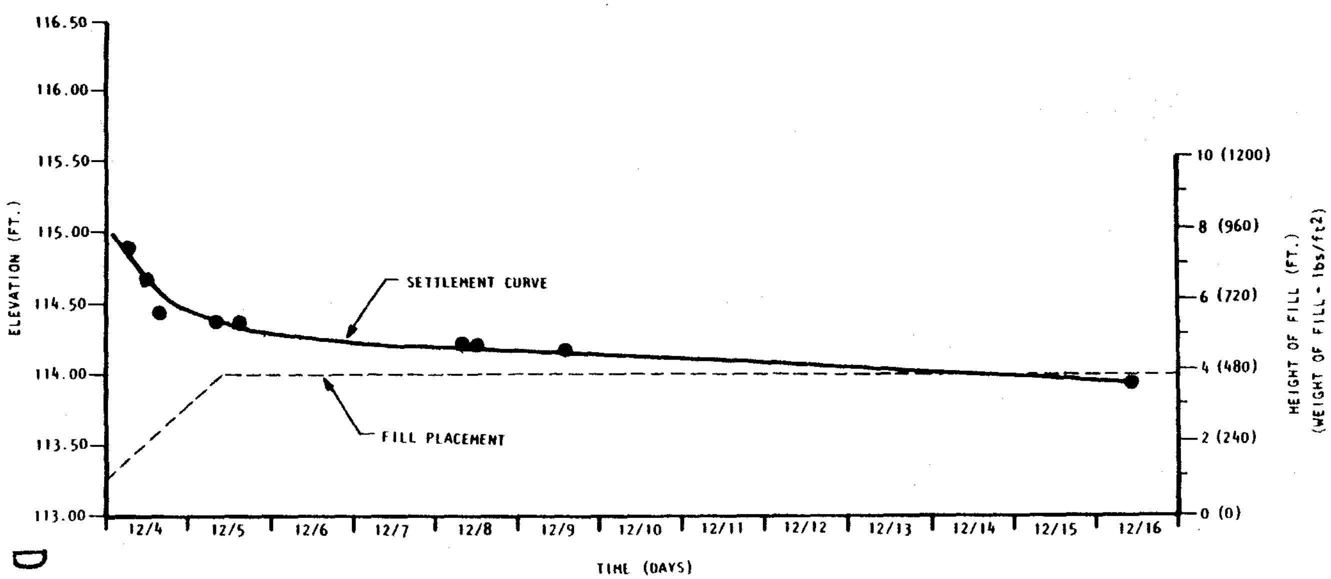
SETTLEMENT MONUMENT 5

TIME SETTLEMENT PLOTS

HELEN KRAMER LANDFILL

MANTUA, N.J.

DAMES & MOORE



DR 006683

SETTLEMENT MONUMENT 6

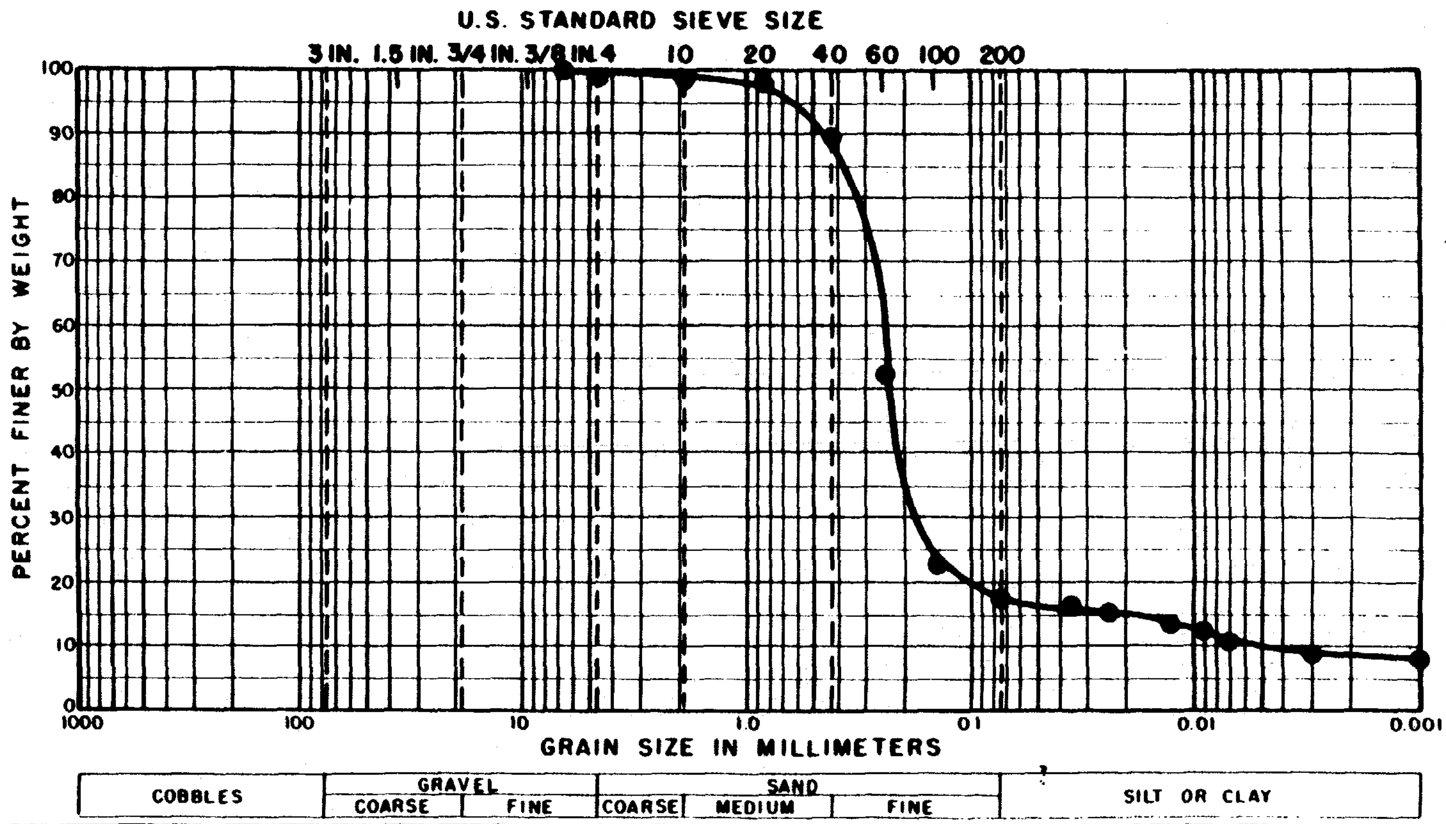
TIME SETTLEMENT PLOTS

HELEN KRAMER LANDFILL

MANTUA, N.J.

APPENDIX 12-1

GRAIN SIZE FOR SLURRY WALL BACKFILL MIXES



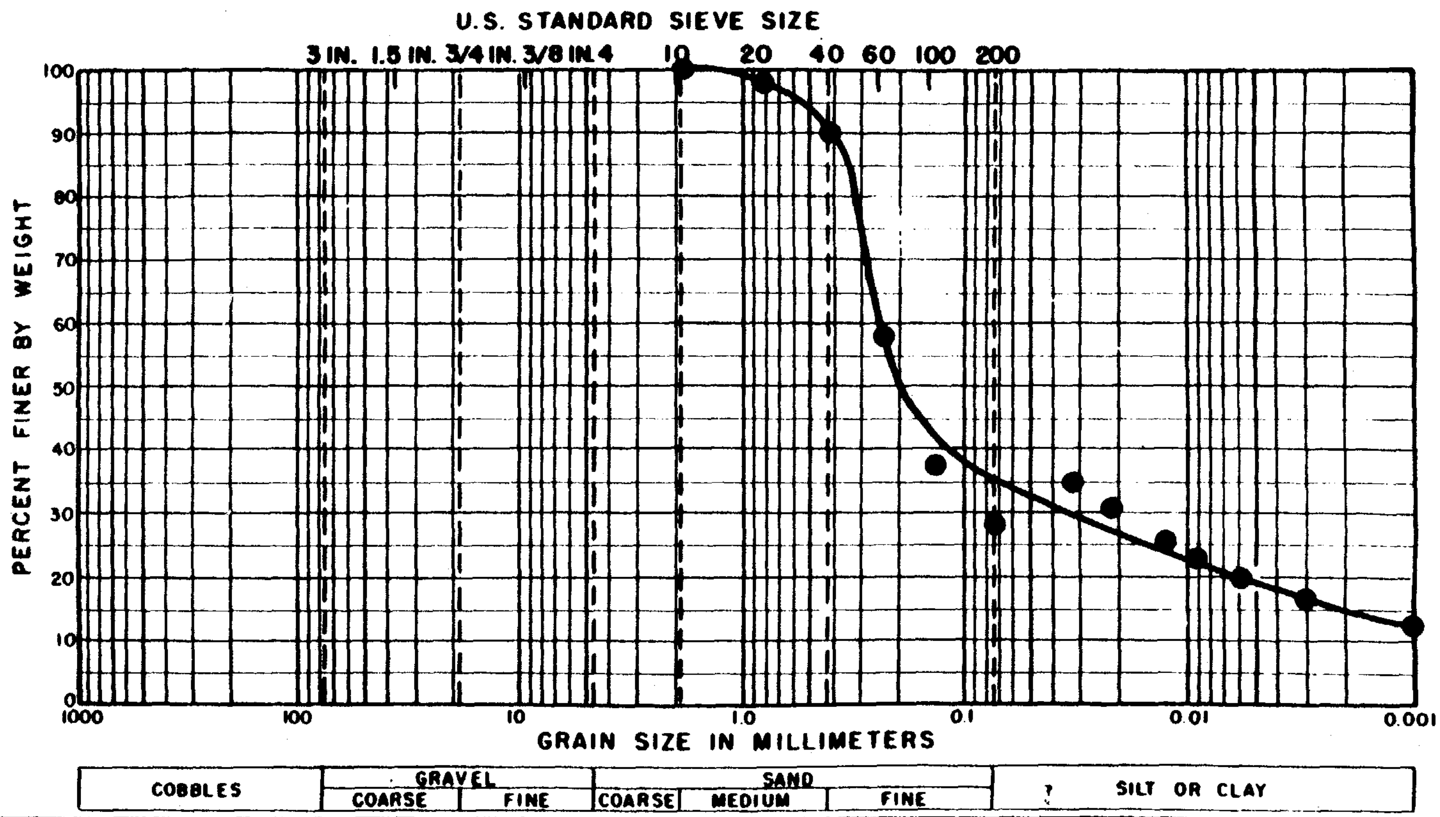
	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

BULK SOILS

GRADATION CURVE

DR 000685

Dames & Moore



	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

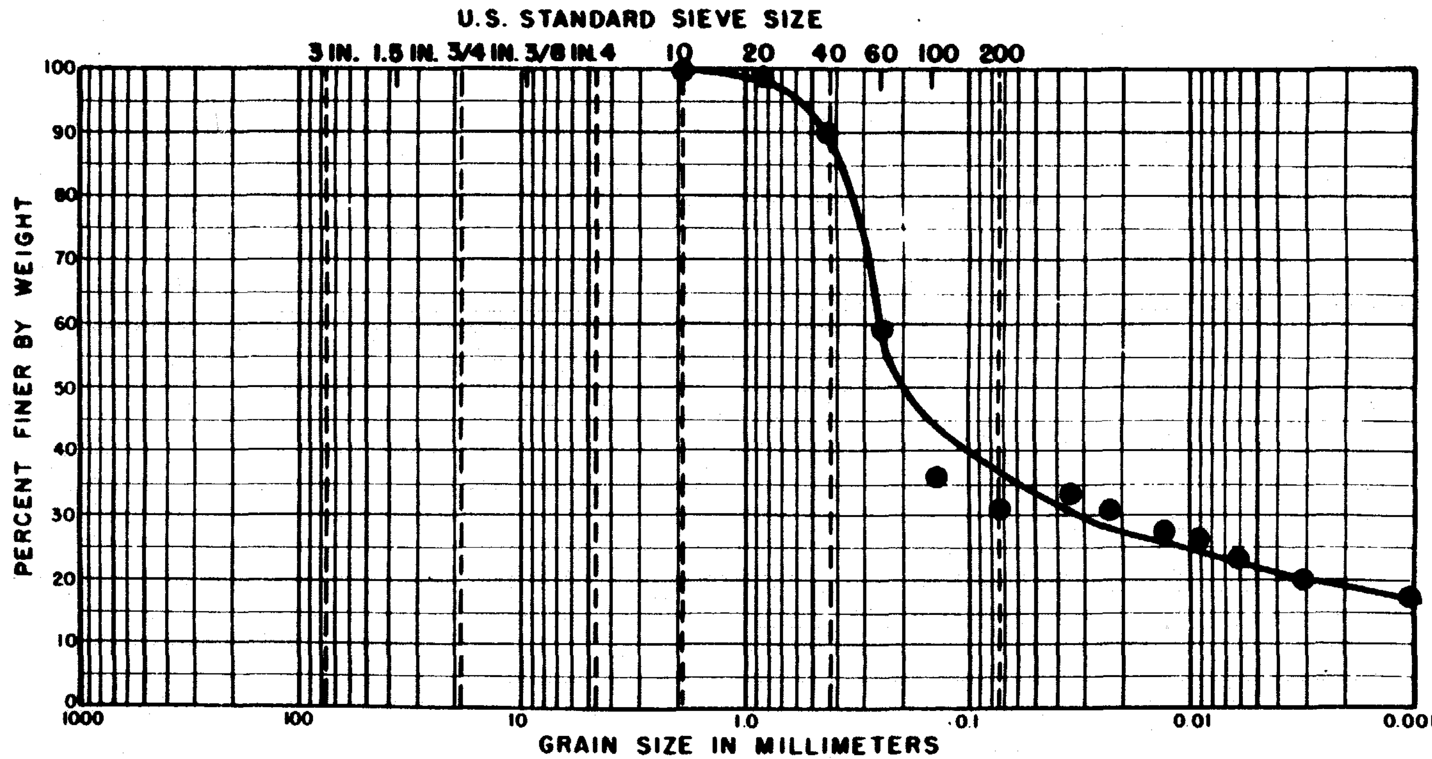
BULK SOILS WITH 20% OFFSITE FINES

GRADATION CURVE

DR 000686

Dames & Moore

DR 000687



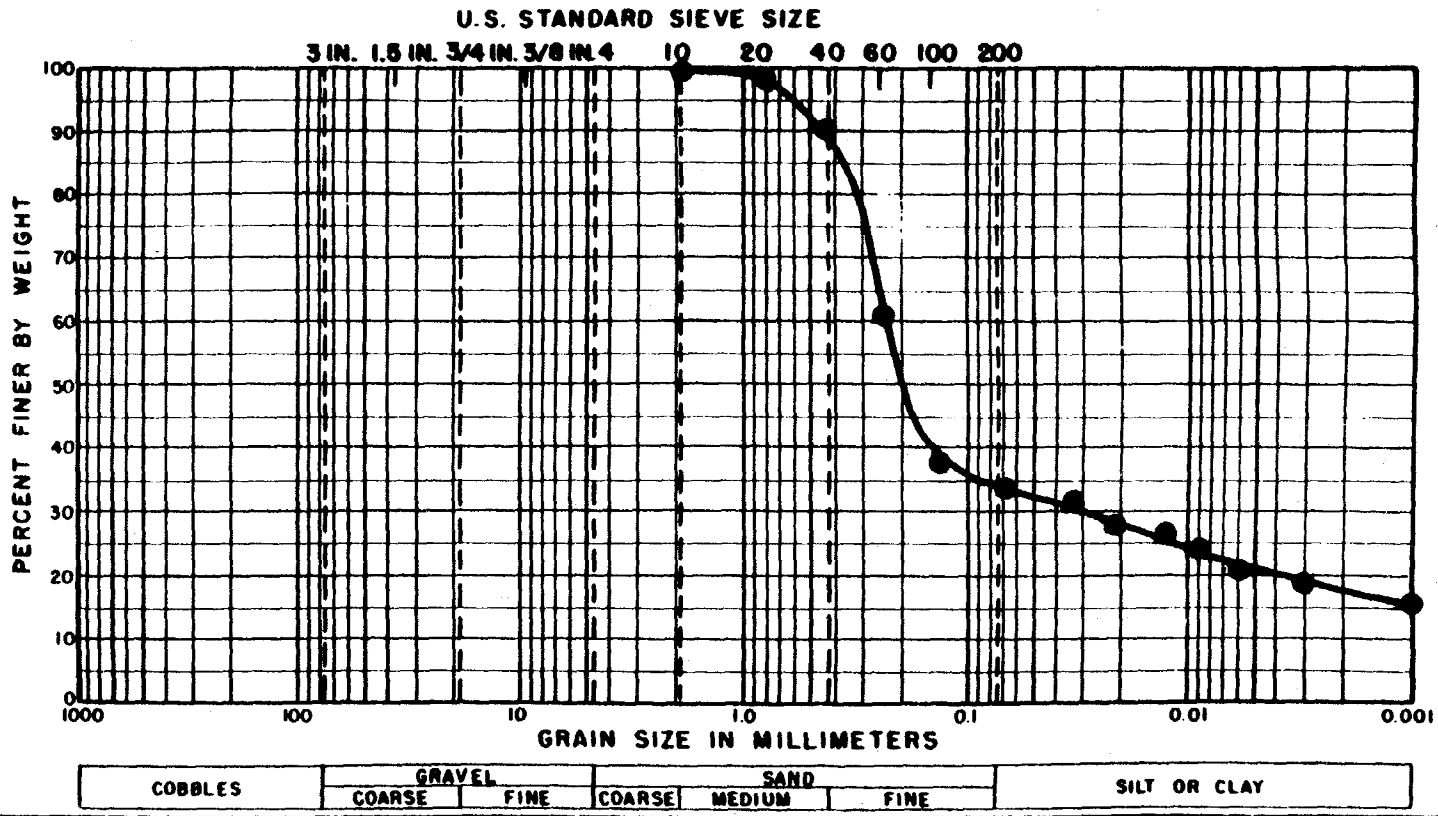
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-3								

BULK SOILS WITH 20% OFFSITE FINES AND 6% BENTONITE SLURRY

GRADATION CURVE

Dames & Moore



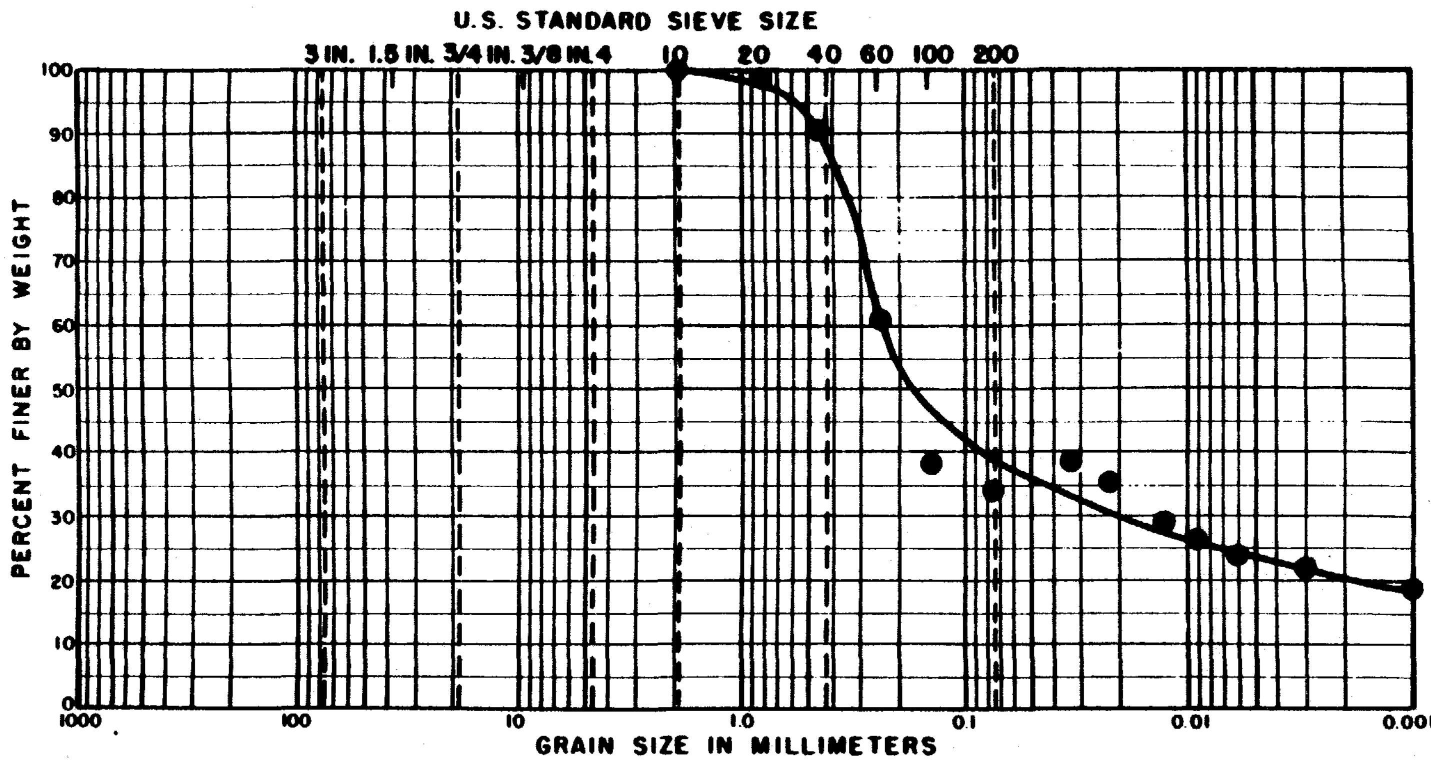
	DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI	?
S-4							

BULK SOILS WITH 20% OFFSITE FINES, 6% BENTONITE SLURRYAND 2% DRY BENTONITE

GRADATION CURVE

DR 0000688

Dames & Moore



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
S-5								

BULK SOILS WITH 20% OFFSITE FINES, 6% BENTONITE SLURRY AND 4% DRY BENTONITE

GRADATION CURVE

DR 000689

Dames & Moore