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Municipal Services
Garner, N.C.

Engineering Company, P.A.
Boone, N.C.

Carmen Johnson
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Design Hydrogeologic Study, Phase 2
White Oak Subtitle D Landfill
Haywood County, North Carolina

Project No. G 98010.6

NCDENR

North Carolina Department of
Environment and Natural Resources

Division of Waste Management

James B. Hunt Jr.
Governor

Bill Holman
Secretary

William L. Meyer
Director

July 12, 2000

MEMORANDUM

To: Bill Sessoms, Solid Waste Section

From: James M. Gamble, P.G. , Solid Waste Section JMG

Re: Design Hydrogeologic Study
White Oak Landfill
Haywood County

The Solid Waste Section has completed its review of the Design Hydrogeologic Study for the above referenced site. With amendments and additional evaluation submitted by Municipal Engineering Services Company, P.A., the site now appears to meet the minimum requirements of Title 15A NCAC 13B .1623(b).

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OPERATION/CONSTRUCTION MANAGERS
CIVIL/SANITARY ENGINEERS
Municipal Services Engineering Company, P.A.
PO Box 97, Garner, North Carolina 27529 (919) 772-5393
PO Box 349, Boone, North Carolina 28607 (828) 262-1767

June 26, 2000

Mr. James M. Gamble, P.G.
Solid Waste Section
Division of Waste Management
North Carolina Department of Environment and Natural Resources
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Design Hydrogeologic Study, Phase 2
White Oak Subtitle D Landfill, Haywood County, North Carolina
MESCO Project No. G98010.6

Dear Mr. Gamble:

The following are responses to your letter dated June 16, 2000 pertaining to the Phase 2 Design Hydrogeologic Report for the White Oak Subtitle D Landfill in Haywood County, North Carolina.

> Section Comment
> The Section recommends that the application be revised to remove assertions that groundwater movement in the bedrock can be represented as an equivalent porous media. The assertion rests on limited site data and the lack of an observed fault on the property. This is too little information to support such a conclusion. Attempts to represent bedrock as an equivalent porous media have rarely been successful in North Carolina.

The application has been revised to accommodate the change recommended in the above comment of yours.

> Section Comment
> The Sampling and Analysis Plan states that sampling of groundwater to establish background water quality will commence after a Permit to Operate is issued. Please note that it is the long-standing policy of the Section not to issue the Permit to Operate until after at least one sampling event has occurred. Also, the plan refers to an attached copy of the North Carolina Groundwater Monitoring Guidance document but no copy is included. The application should be amended to address these issues.

The Sampling and Analysis Plan has been revised to incorporate the change mentioned in the above comment of yours. A copy of the North Carolina Groundwater Monitoring Guidance document is also included in Appendix F. As stated in this revised submittal, we will ensure that, following the issuance of the Permit to Construct, at least one sampling event will be placed prior to issuance of the Permit to Operate.

Please contact me at 919.772.5393 should you have any further questions or comments regarding the content of this submittal.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., P.A.

Kohei Yoshida
Hydrogeologist

Enclosures

cc: Mr. Rick Honeycutt, Assistant County Manager, Haywood County
Mr. Joe Walker, Solid Waste Director, Haywood County
Dr. Edward S. Custer, Jr., P.G.

OPERATION/CONSTRUCTION MANAGERS
CIVIL/SANITARY ENGINEERS

Municipal Services Engineering Company, P.A.

PO Box 97, Garner, North Carolina 27529 (919) 772-5393
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April 10, 2000

Mr. James M. Gamble, P.G.
Solid Waste Section
Division of Waste Management
North Carolina Department of Environment and Natural Resources
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Design Hydrogeologic Study, Phase 2
White Oak Subtitle D Landfill, Haywood County, North Carolina
MESCO Project No. G98010.6

Dear Mr. Gamble:

Enclosed you will find three copies of the Design Hydrogeologic Study for the Phase 2, Haywood County Subtitle D White Oak Landfill. This report has been completed to meet the requirements as described in *15A NCAC 13B Rule .1623(b)*.

Please contact me at 919.772.5393 should you have any questions or comments regarding this report.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., P.A.

Kohei Yoshida
Hydrogeologist

Enclosures

cc: Mr. Rick Honeycutt, Assistant County Manager
Dr. Edward S. Custer, Jr., P.G.

Municipal Services Engineering Company, P.A.
Garner, N.C.
Boone, N.C.

Design Hydrogeologic Study, Phase 2
White Oak Subtitle D Landfill
Haywood County, North Carolina

Project No. G98010.6

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1 PURPOSE AND SCOPE OF STUDY

This study was undertaken to define, with borings, piezometers and laboratory testing, the soil and rock types, conditions, and the uppermost aquifer regime at the Phase 2 part of the White Oak Landfill, Haywood County. Field information collected for this study was used to determine hydrogeologic and engineering properties of subsurface soils and rocks with appropriate field and laboratory tests, and perform evaluations of hydrogeologic and geologic conditions, and engineering analyses. Data, conclusions, and recommendations for hydrologic and geologic conditions are provided to fulfill the requirements for the Design Hydrogeologic Study as described in the North Carolina Department of Environment, Health, and Natural Resources, Division of Waste Management, Solid Waste Management Rules 15A NCAC 13B, .1623(b).

2 SITE DESCRIPTION

The proposed Phase 2 site of the Haywood County MSWLF is located on a portion of 268 acres that includes the existing White Oak Landfill (Plate 1). The Phase 2 site will occupy 10.26 acres west and adjacent to the existing Phase 1 part of the Landfill. The site is located 12 miles north of Waynesville at the Fines Creek Exit (Exit 15) of Interstate 40.

The site lies within the Blue Ridge physiographic province characterized by mountainous topography. The overall property has a relief of approximately 450 feet. However, the Phase 2 part has a relief of approximately 110 feet. On site slopes average 20% with grades ranging from 38% along the boundary ridges to less than 10% along the central drainage feature. As shown on Plate 1, the site is bounded: on the south and west by ridges; on the east by the Phase 1 part of the landfill; and the north boundary is an arbitrary boundary that cuts across the topography and marks the southern boundary of the proposed Phase 3 portion of the landfill. An ephemeral to intermittent stream flows through the center of the site. Some wetlands are located adjacent to this drainage feature. The water from this drainage feature flows northward to the Pigeon River.

The immediate subsurface of the Phase 2 site is primarily composed of saprolite of sandy silts and silty sands. The site has historically been used for pasture and farmland with more recent use being for a soil and cover borrow area for the Phase 1 part of the landfill. Access to the site for light vehicles can be obtained by either way of trails or existing roads.

3 FIELD INVESTIGATION

MESCO installed thirteen borings for the Phase 2 Design Hydrogeologic Study in March and April 1999. This is in addition to the thirty borings installed for the site study. Piezometers were installed in all borings that intersected the water table and their locations were surveyed by MESCO in accordance with 15A NCAC 13B .1632. The borings were drilled to provide subsurface and extended groundwater level data necessary for site and design characterization. Elevations from both the piezometers and existing Groundwater Monitoring wells are utilized to define the potentiometric surface and groundwater flow characteristics. The locations of all borings and monitoring wells that lie within and/or immediately adjacent to the Phase 2 site are shown on Plate 1. Water elevations and pertinent bore-hole and monitoring well depths are presented on Table 1.

Under the supervision of a MESCO geologist, Engineering Tectonics installed 13 temporary piezometers (P1-1S through P1-8D) in the borings using 2 inch diameter screens. The borings were air rotaried with either a 5 7/8 or 7 7/8 inch tricone bit to refusal. Those borings extending below refusal were installed with a 4 inch casing for support of overburden soils during either coring and/or air hammering. Coring of the rock was undertaken using a 2 inch diameter core barrel in borings P1-1D, P1-2D, P1-3, P1-4, P1-5S/5D, and P1-8D. These borings were subsequently enlarged using a 3 1/2 inch air hammer prior to installation of the 2 inch diameter PVC screens. Standard split-barrel samples of subsurface soils were taken at five foot intervals. Standard penetration tests were conducted in conjunction with the split-barrel sampling in accordance with ASTM Test Procedure D 1586-84 using a 2 inch OD split-barrel sampler.

Borings were logged in the field by a MESCO geologist and/or engineer according to the Unified Soil Classification System and sealed in containers for laboratory testing. Water levels were determined while drilling and taken periodically after the piezometers were installed. Appendix A contains the relevant boring logs and construction records from both the site and design investigations. The soil depths on the boring logs and depths of materials on the construction records are referenced by depth below existing ground surface.

4 GEOLOGIC CONSIDERATIONS

The stratigraphy and structure of the southern Appalachian region have been the topic of many investigations and professional papers. In addition to previous observations by Law Engineering and Hatcher, MESCO personnel documented rock types and structure within the vicinity of the proposed landfill site. These observations were used in conjunction with extensive field reconnaissance performed by Hadley and Goldsmith to construct a geologic map outlining structures and lithologies within and surrounding the proposed site.[6] The derived geologic map and accompanying field notes are presented in Plate 2.

4.1 Regional Geology

Regionally the site lies near Ocoee series rocks that include both the older Snowbird Group and younger Great Smoky Group. The site itself overlies the Precambrian age basement complex that consists of metamorphosed plutonic rocks and the Carolina Gneiss.[6] Both units have experienced various degrees of polymetamorphism in both the Precambrian and Paleozoic where the original structure of the rocks was massively deformed, if not completely destroyed. The plutonic rocks, as described by Hadley and Goldsmith, stratigraphically overlie the Carolina Gneiss and are described as massive, often coarse textured rocks with varying textures and compositions. The composition of these meta-crystalline plutonic rocks (orthogneisses) suggests the parent materials were felsic igneous intrusions, namely granite and granodiorite. Though the underlying Carolina Gneiss is similar in texture and appearance, its composition suggests it was derived from very old meta-sedimentary units.[6] A non-conformity exists between the plutonic rocks of the basement complex and the overlying Thunderhead Sandstone that crops out to the west and south of the site.

Structurally, the site is located very near the Cataloochee Divide Syncline between the kyanite and staurolite isograds. The degree of metamorphism increases to the south-southeast.[6] The Cataloochee Anticlinorium, located to the northwest of the site, is bounded by the Greenbrier Fault and bisected by the Cold Springs Fault. Located north-northwest of the site are small, high angle reverse faults that roughly parallel the Cold Springs Fault. However, the lateral continuity of these faults is not established across the Pigeon River. Ridgeline orientation typically parallels structural features which trend northeast/southwest.

A stream trace analysis was performed within a 1 mile radius of the site. Structurally controlled features were traced from USGS 7.5 min Cove Creek Gap and Fines Creek Quadrangles. Dominant stream trends in the region are N5W to N25W and N35W to N45W, and minor trends are N5E to N30E and N75E to N85E. Field reconnaissance reveals major foliations trend N5W to N20W paralleling one of the dominant stream traces. Major joints trend N20W to N40W paralleling major stream traces. Other major foliation orientations (N9E to N20E) and joint orientations (N10E to N20E) parallel the minor stream traces. Stream traces do not appear to vary greatly between rock types, however, east of the Pigeon River stream traces trend N75W to east/west to N75E. This indicates a difference in fracturing on the opposite side of the Pigeon River which is likely following a major fracture system. Stream traces are presented on Plate 3. The Rose diagram on Plate 3B summarized the orientations of approximate straight line stream and drainage segments.

The site lies within a seismic impact zone defined as an area having greater than 10 percent probability that the maximum expected horizontal acceleration expressed as a percentage of the earth's gravitational pull (g) will exceed 0.10 g in 250 years.[1] There are no Holocene faults present within 200 feet of the landfill site.[9]

4.2 Site Specific Geology

Rock outcrop and core samples on the overall property support the boundaries outlined by Hadley and Goldsmith.[6] Most of the core samples are layered. coarse-grained gneiss with varied degrees of fracturing and weathering. Some samples display granitic texture and good relict crystalline structure with only slight secondary orientation. Other samples show a typically gneissic texture that is massively foliated with interlayers of biotite mica and coarse-grained plagioclase and quartz. A summary of the rock coring is presented in Table 2. Although changes in texture and composition are observed, the rocks underlying and outcropping within and directly adjacent to the overall property are classified as Precambrian plutonic basement rocks.

No rock outcrops were located within the Phase 2 site. The most abundant locations of rock outcrops are outside the site on the steep slopes that rise from the Pigeon River along the eastern and northern boundary of the overall property. Outcrop locations observed by Hatcher and Law Engineering were confirmed in the field by MESCO personnel. These outcrops consist of Precambrian basement granitoid gneiss with varying degrees of foliation. No faults are evident on the Phase 2 site and overall property.

5 SUBSURFACE CONDITIONS

The soils encountered in the borings ranged from clay in the upper two to four feet of the boring that is generally underlain by silt that grades downward to silty sand and/or sand. Relict mineralogical layering, foliation and fractures, indicative of saprolite, could be recognized in the silts and sands. Partially weathered rock (PWR), defined by the blow counts per foot exceeding 100, was sometimes encountered both directly above the fractured bedrock and as zones within the saprolite.

Textural distinctions that occur throughout the saprolite are indicated on the boring logs. The boring logs are divided into different soil lithologies to add insight to the type and gradation of soils to be encountered. Divisions on the logs are made based on expected hydrogeologic implications and how such variations are expected to influence the vertical and/or horizontal migration of groundwater.

The subsurface conditions at this particular site can be divided into three potential hydrogeologic units. Boundaries for these units are made based on field inspection during installation of the boring, visual and laboratory sample analysis, and surrounding subsurface conditions. The uppermost portion of the site consists of saprolite defined as *in situ* chemically weathered crystalline rock. In this zone, a dense soil is found that grades slightly in composition, size, and degree of weathering depending on zonal variations in parent bedrock. Small scale structures are found in the saprolite that, upon visual inspection, are similar to underlying gneissic bedrock. Relict structures include foliations, thin fractures with iron-stains and clay replacement, broken quartz intrusions, phyllitic texture, and weathered crystals. Because the extent of chemical weathering of a rock depends largely upon the ease of access of water to the rock, a thick overburden (saprolite) layer can be an indication that the rock from which it is derived is abundantly fractured or has interstices of some type through which water can flow. A thick saprolite unit which is generally porous although not necessarily very permeable, serves as a reservoir to feed water into fractures.[11]

The second unit is a zone of partially weathered rock (PWR). The PWR is highly fractured and stained with a large amount of soil filled fractures. This unit is often expected directly above bedrock as a transition zone between the overlying saprolite and underlying bedrock. In addition, however, the PWR unit in the mid-slope area is often found suspended in saprolite as a result of fracturing and weathering differences in the parent material. The presence of this material is indicated by slow advancement of the auger, abundant rock fragments in split spoon samples and auger cuttings, and blow counts approaching refusal. PWR produces low recovery (REC) and rock quality designation values (RQD) in core samples when coring is attempted. In some instances, soil directly above zones of partially weathered rock becomes moist which may indicate the ability of PWR to inhibit vertical migration of groundwater and create a small, localized perched water table.

The third unit is the underlying fractured gneissic bedrock. This unit, as previously described, is composed of meta-crystalline plutonic rocks. These orthogneisses vary in composition, texture, and structure. Fractures commonly parallel gneissic foliation at approximately 45 to 70° in the core samples. The abundance of fractures within bedrock is often dependent on rock type. Strongly metamorphosed rock, such as that underlying the Haywood County site, develops planes of cleavage owing to the growth of micaceous minerals. Cleavage planes provide openings along which water may enter and flow.[11] Degree of fracturing is evident in an examination of core recovery (REC) and rock quality designation (RQD) values. The relationship between topography and degree of fracturing observed in the site study is not as obvious from the borings obtained for this study. The borings on ridgelines and toward the top of slopes (P1-1D, P1-2D, P1-4 and P1-5D) show higher average REC and RQD values. P1-1D, located on a ridgeline, has REC of 94% and RQD of 28%. This low RQD is probably the result of only the upper 3.5 feet of rock being cored. The REC values for the other borings vary from 75 to 100%, while the RQD values range from 70 to 92%. These high REC's and RQD's are an indication of intact and moderately fractured rock. These high values also suggest the reason for the existence of ridgelines and steep topography on the property. Conversely, borings located in valleys and toward the bottom of shallow slopes (P1-3, P1-8 and P2-1) display a slight decrease in REC and RQD values. REC and RQD values from P2-1, which was located midslope (before previous grading), are 84% and 48% respectively. P1-8D is located very near a drainage feature. The average REC is 87% and the average RQD is 60%. The REC value for P1-3 is 64%, while the RQD value is 24%. This boring was located midslope near the head of a draw (Table 2).

Along with supplying soil samples, standard penetration tests (SPT's) provide information to determine the relative *in situ* density of the saprolite unit. This information, when viewed in conjunction with other subsurface data, can help define weathering patterns and the presence of the various hydrogeologic units. A review of blows per foot (bpf) versus depth in the borings indicates blow counts increase only slightly from ground surface through the majority of the boring. Average standard penetration values of saprolite fall between 10 and 40 bpf. However, toward refusal (80% to 100% depth), the standard penetration values increase rapidly. This sudden rise in *in situ* densities indicate an extensively and uniformly weathered overburden soil. Variations in the blows per foot for the saprolite interval are the result of zones of resistance such as partially weathered rock and broken quartz veins.

Groundwater was initially encountered in all three units. Due to the general absence of subsurface structure that might influence groundwater movement (horizontal displacement, unweathered intrusions *etc.*), water elevations are largely a function of overlying topography. Water was initially encountered in saprolite in borings P1-2S/D, P1-4, P1-6, P1-8S/D, P-10, and P-12/12D; initially in partially weathered rock in P1-1S/D, P1-3, and P1-5S/D; and initial water elevations occurred in rock in the remaining borings (P1-7S/7D, P2-1 and P2-2). Of these, water in P2-1 and P2-2 was found just below the soil/rock interface as defined by auger refusal. Once allowed to stabilize after piezometer installation, the head in P-10, P-12, P1-2S/D, and P1-7S/D increased. The head in P1-1S/D, P1-5D and P1-6 fell after stabilization. The remaining borings (P-12D, P1-3, P1-4, P1-5S, P1-8 and P1-8D) stabilized to levels comparable to those recorded while drilling.

A top of rock contour map was constructed and is presented on Plate 4. Bedrock data were not available from all borings, therefore the bedrock surface under and between certain boreholes is interpretive. Cross-sections are presented on Plates 5A and 5B. These sections display subsurface soil, rock, and groundwater conditions. The cross-sections and top of rock contours show a somewhat uniform rock surface that generally follows the topography. PWR occurs directly over the bedrock surface in some areas. It is most abundant on ridges and hills where it can be found in thick units on top of the rock surface as well as suspended in the saprolite unit. This is a result of reduced joints and fractures on the resistant hills and ridges. The saprolite remains thick, with larger zones of PWR. In the valleys and draws, saprolite tends to be thin, while the PWR unit often pinches out on either side of the draw.

The estimated long term seasonal high water table is presented on all cross-sections. The seasonal high surface generally occurs in the saprolite or PWR and tends to follow topographic and bedrock surface contours. Proposed subgrade elevations are also included on the cross-sections to show at least a four foot separation between subgrade elevations, the seasonal high water table elevations, and top of rock elevations.

Hydraulic conductivities were determined using the Bouwer and Rice[2] or Hvorslev method.[10] These slug test methods were developed as bail-down tests; that is, the water level is lowered by bailing so that the water flows from the aquifer into the well. The Bouwer and Rice method can also be used when water is added to the well and heads in the casing fall, provided that the static level is above the well screen or open borehole.[4] It should be noted that Bouwer mentioned the occurrence of so-called "double straight line effect" when the water level is lowered below the top of the open section.[3] In case of such occurrence, two or more lines were drawn to fit the drawdown curve, and the line that best represents the aquifer characteristics in the vicinity of the piezometer was determined and used to compute the hydraulic conductivity. In some piezometers, the water level was initially above the top of the open section, and was lowered so far that it crossed the upper boundary of the open section. For those piezometers, multiple lines were expected, and the appropriate line was selected for the determination of hydraulic conductivity. A total of nine slug tests provided data to determine the hydraulic conductivities of the three distinct lithologic units comprising the uppermost aquifer.

Slug tests were performed on P-10, P-12, P-13, P1-2S, P1-6 and P1-8S which are screened in the saprolite/PWR portion of the upper aquifer. The average hydraulic conductivity for these wells is 2.64×10^{-4} cm/sec. Piezometers P1-2D, P1-4 and P1-8D are screened in fractured gneissic bedrock. The average for this unit is 7.24×10^{-5} cm/sec. A summary of the hydrologic properties of the lithologic units comprising the aquifer are presented on Table 4, while the calculations are included in Appendix B.

6 LABORATORY RESULTS

Selected soil samples were tested in the laboratory in accordance with ASTM Standards to assist in classification and the estimation of engineering parameters. Laboratory tests included analysis of specific gravity, particle size through sieve analysis and hydrometer, and Atterberg limits. Particle size plotted on textual classification triangles determined effective porosities for the overburden soils. Total and effective porosity values used in calculating flow rates are presented in Table 4. Table 3 summarizes the laboratory results and Appendix B includes all related documentations.

Atterberg limits (ASTM D-4318) were determined for twelve samples representative of variations within the saprolite unit. Liquid Limits ranged from 37% to 55% with an average of 44%. Plastic Limits ranged from 27% to 48% with an average of 35%. Plasticity Index ranged from 0 to 26% with an average of 20%. Test results for natural moisture content indicate an average of 23.6% with a range from 14.4% to 32.3%. By Unified Soil Classification System parameters, these soils are low plasticity inorganic silts and fine sands to slightly plastic clayey silts.

7 GROUNDWATER CONSIDERATIONS

Regionally, the upper aquifer occurs in regolith overlying fractured crystalline bedrock. Regolith is inclusive of all unconsolidated material that overlies intact bedrock. Most groundwater storage is located in the regolith because it has a higher porosity than fractured bedrock.[8] The approximate range in porosity for the saprolite and bedrock is shown in the following table.

Rock type	n_e (%)[a]	K (ft/day)[b]
Saprolite	20–30	1–20
Bedrock	0.1–1	1–20

[a] n_e denotes effective porosity.

[b] K denotes hydraulic conductivity.

The above values suggest that the principal difference between saprolite and bedrock is in water-storage capacity.[7]

Infiltration occurs when precipitation reaches the land surface and penetrates the unsaturated soil. Water then moves laterally and downward through a temporary saturated zone. Ultimately, water will move into bedrock and be transported along interconnected fractures to points of discharge.[8]

On-site groundwater generally occurs within 10 feet of the highly fractured bedrock surface, except where the topography is underlain by thick saprolite such as on the crests of ridges and/or in draws. Where the saprolite unit is thick, the water table may lie up to 40 feet above the top of rock surface. Groundwater flow is generally northward toward the regional discharge feature, the Pigeon River. However, the central drainage feature also appears to be an intermittent local discharge feature in the vicinity of proposed Phases 3 and 4. This local discharge feature could influence groundwater flow direction during those high groundwater level times when discharge to the intermittent stream occurs. This influence probably results in some east or westward flow component toward the discharge feature. A groundwater divide is located south of the Phase 2 site and this same area is also part of the recharge area. The Site Hydrogeologic Study and the data collected for this study indicated that this divide does not move significantly regardless of groundwater level time of year, and that groundwater flow in the Phase 2 site should always be northward from this divide toward the Pigeon River and/or the local discharge feature. There are two other divides present near the Phase 2 site. A smaller divide is located along the western boundary of the Phase 2 site and the other is located northwest of the site in the vicinity of the Phase 3 , 4 and 6 area. These two divides tend to redirect the general northward groundwater flow eastward and southeastward toward the central drainage feature. Plate 6 provides a single day potentiometric map generated from water level elevations obtained on March 14, 2000.

Activities on or adjacent to the Phase 2 site that could influence groundwater flow, besides normal recharge from precipitation, include the following: spring relief drains installed under the existing landfill and seasonal adjustments to the normal pool level in the Pigeon River reservoir.

There are several spring relief drains located underneath the existing landfill. As discussed in the Site Hydrogeologic Study, the effect of these spring relief drains on water table levels appears to be marginal and should not impact the water levels underneath the Phase 2 site. Seasonal adjustments in pool levels in the Pigeon River reservoir should not have an effect on groundwater levels in the Phase 2 site, based on the analysis discussed in the Site Hydrogeologic Study.

As discussed in the Site Hydrogeologic Study and the results from this study indicate that the hydraulic conductivities for the three lithologic units comprising the aquifer are comparable. This is evidenced by the fact that the groundwater flow does not appear to be greatly affected by the change from silty sand saprolite to PWR to highly fractured rock. Consequently, groundwater is probably preferentially flowing along relict fractures and foliation in the saprolite and PWR as it does in the highly fractured gneiss. Flow in the saprolite and PWR is also occurring between the fractures in the interstices between the soil grains. This would result in the slightly higher hydraulic conductivity observed for these two units as compared to the fractured gneiss. The apparent partial control on flow by fractures and foliation means that zones of preferential flow can be identified by the presence of major stream traces, since these major traces also follow foliation and fracture orientations observed in outcrop.

Horizontal groundwater flow rates for the upper saprolite unit were calculated using hydraulic conductivity and effective porosity data presented in Table 4, and the horizontal hydraulic gradients determined from the single-day potentiometric map (Plate 6). The average effective porosity value of 16.8% was used for all boring locations. For wells on which the slug test was performed, the derived hydraulic conductivity value was used for the calculation of flow rates. For all other wells, the average hydraulic conductivity value was used. Flow rate is primarily controlled by two factors: effective porosity and hydraulic conductivity. As evident in the flow rate equation, hydraulic conductivity and effective porosity are proportional, and inversely proportional to flow rate, respectively.* The highest flow rate is 275 ft/yr, which occurs at P1-8S location in the draw, while the lowest is 15 ft/yr at P1-2S on the slope immediately west of the draw. Although the map suggests the head difference at P1-8S location is greater than that at P1-2S, the flow rate is greater at P1-8S due to hydraulic conductivity at this location greater than that at P1-2 by a factor of 10.

The nearest supply wells are individual house water wells located just south of the property. The wells are across a groundwater divide which occurs from P-1S to G-11S/D, P-4S, between P-6S/D

*Flow rate, *a.k.a.* average linear velocity, is defined by the equation

$$v_x = \frac{K}{n_e}\frac{dh}{dl}$$

where

v_x = average linear velocity (L/T)
K = hydraulic conductivity (L/T)
n_e = effective porosity
dh/dl = hydraulic gradient (L/L)[5]

and TWD-10. All the groundwater under proposed Phase 2 will flow north toward the Pigeon River and discharge into the River or local streams which feed the river. It is anticipated that no groundwater flow in Phase 2 will be toward the supply wells south of the property. There is also a group of wells west of the site. Based on topography and the location of local streams, groundwater will flow north to northeast in the area of these wells, that is, groundwater will be flowing from these wells toward the landfill. Supply wells are also located north of the property, however, these wells are north of the Pigeon River and will not be affected by groundwater originating in the landfill area.†

7.1 Groundwater Flow in Fractured Bedrock

Vertical flow rates were calculated at ten nested piezometers/monitoring wells locations within, and in the vicinity of the proposed Phase 2 site. The results are summarized in Table 5. All measured locations show indications of downward flow, with the exception of P-6S/D nest, which suggests a slight upward migration of groundwater over two measurement periods. The two highest flow rates were recorded at P1-2S/D and P1-7S/D nest locations both of which are located on slopes. The lowest is recorded at TWD-10/10D. At this location, the groundwater rarely shows any vertical migration throughout the measurement period. Relatively low vertical flow rates were recorded at P1-1S/D, P1-8S/D and P-12/12D nest locations. P1-1S/D are located on hilltop on the west end of the proposed Phase 2 site. Both P1-8S/D and P-12/12D are located in the draw. At P1-1S/D location, both horizontal and vertical flow are shown to be marginal. At P1-8S/D location, on the other hand, the majority of flow seems to occur laterally rather than vertically. This may be attributed to the facts that groundwater migrating from two different hydraulic domains converge at this location, resulting in greater momentum of flow, and that part of the water discharges to the surface thereby reducing the downward momentum of flow.

Since each of the well nests consists of one well screened in the overburden saprolite and another screened in the bedrock, the presence of vertical flow between these depths suggests that those two

†The Site Hydrogeologic Study found that the effect of the river level changes on the water table elevations at the site is marginal. In addition, even the lowest recorded level at the site is higher than the highest river elevation by at least 100 feet. This difference should be sufficient to encompass any future elevation changes.

lithologically distinct units are hydraulically connected. For each well nest, heads in the shallow well were plotted against those in the deep well to visualize the linear relationship between the trends of head changes at these two depth levels (Appendix B). Each plot was accompanied by a linear fit curve and the corresponding R^2 values are provided in the table below.

Well Nest	R^2 Value
P-12/12D	0.9786
P1-1S/D	0.8981
P1-2S/D	0.9927
P1-5S/D	0.9795
P1-7S/D	0.1418
P1-8S/D	0.7366
GWM-7/7D	0.7013
TWD-10/10D	0.9701

These large R^2 values indicate the similarities of head behaviors, which typically occurs when the compared measurement points are in the same hydraulic domain. Given that this trend is present over the entire property, it is apparent that the hydraulic systems both in the saprolite and the bedrock are mutually dependent; changes in hydraulic potential in one system will likely affect the other.

The aquifer in the Haywood landfill site consists of three major lithologic units. The upper most aquifer occurs in the saprolite unit, which sits on top of a zone of highly fractured crystalline bedrock. A zone of partially weathered rock (PWR) may exist between these two units as a transition zone. The overburden saprolite is typically derived from the underlying parent bedrock by weathering, and has mineral compositions similar to those of the bedrock. As mentioned earlier, a thick overburden saprolite layer may well indicate the presence of abundant fractures in the parent rock from which it is derived. In fact, boring logs for all installed piezometers suggest moderate to high degrees of fractures present in the bedrock. Since the occurrence of single, isolated fractures is mainly associated with faults, and no faults have been observed within the property, it is highly probable that the bedrock unit underneath the property contain moderate to high degrees of fracture networks.

Based on the discussion and evidence presented in the site study and the confirming results obtained from this study, it is concluded that the layers of upper saprolite unit and underlying highly fractured bedrock unit are hydraulically connected, and that the average hydraulic gradients in both units follow the overall trend of head distribution.

7.2 Local Precipitation

Precipitation data from stations 319147 in Waynesville and 311564 in Cataloochee were evaluated in order to infer expected precipitation amounts at the site. Both stations showed the same 5 year and 30 year trend though the Cataloochee station showed slightly more abundant rainfall. Averages for a 30 year period from 1961 to 1990 are included as well as monthly data for the years 1993–1998. The 5-year data set closely follows the thirty year trend except for increased June precipitation amounts in the short term for both stations.

From 1961 through 1990, both areas experienced the highest average precipitation in March with the second highest in August. Lowest average precipitation occurred in October. All data were made available by the National Climatic Data Center and is expressed in tabular and graphical format in Appendix D.

7.3 Observation Well Data

Data from local USGS observation wells were used to track natural fluctuations in the regional water table. NC-40 is the closest currently maintained observation well. It is located approximately 20 miles to the southeast of the site along US 276. The well is 18-feet deep and is screened in saprolite of Precambrian gneiss. This is similar to the saprolite at the White Oak Landfill. The highest water level recorded during the 1998 water year was 2.13 feet below land surface in February. The low occurred in September, 1997 at 6.45 feet below land surface for a difference of 4.32 feet. Observation well NC-40 is a climatic effects well located in a valley. The maximum fluctuation recorded in this well is approximately 4 feet. A review of this observation well data does not indicate any significant upward or downward trend for either the high or low elevations. This suggests that the seasonal fluctuation, although variable, remains relatively constant. The observation well location and data are provided in Appendix D.

Data available for groundwater fluctuations at the landfill site from the temporary piezometers were obtained for a varying period, but elevations were taken during a sufficient time span to cover the normal temporal high and low periods of time according to the USGS observation well data. The temporal highs and lows for each piezometer were determined. The fluctuation data was then compiled according to the topographic location of the piezometer (Ridge, Slope and Draw). An average fluctuation for each topographic location group was determined and rounded up to the nearest foot. In order to determine a conservative estimate for the seasonal high, the rounded average fluctuation for each topographic setting was added to the highest recorded elevation for a piezometer based on its topographic location. These rounded averages are: ridge—4 feet, slope—3 feet, and draw—2 feet. The seasonal high estimation is summarized in Table 6, and potentiometric contours are shown on Plate 7. All calculations and documentation are included in Appendix D.

8 WATER QUALITY MONITORING PLAN

Groundwater in the Phase 2 area generally flows north along the central draw. Nested piezometers indicate that groundwater flow is downward throughout the site.

Two monitoring well locations and one surface water location, in conjunction with the use of the existing background groundwater monitoring wells GWM-11S and GWM-11D, are proposed to monitor the ground and surface water quality in the Phase 2 area. Monitoring wells will be designated GWM-12, GWM-13S and GWM-13D. In addition to the proposed groundwater monitoring wells, it also proposed that all the piezometers installed on the property outside the foot print of the Phase 2 site be retained along with installing one nested piezometer set to assist in determining water level elevations. The new piezometer set will be designated PZ-1S and PZ-1D. The previously installed piezometers will retain their original boring numbers. The ground and surface water monitoring and piezometer locations are presented on Plate A.

The existing background monitoring wells GWM-11S and GWM-11D will be utilized as background wells for the Phase 2 site as well as the existing landfill. Monitoring wells GWM-12, GWM-13S and GWM-13D will be installed down gradient from the Phase 2 site, but within 150 feet of the waste boundary.

Monitoring well GWM-12 is proposed as a down-gradient well located on the east side of the central draw area. It is proposed to replace GWM-6A that will have to be abandoned due to its close proximity to the Phase 2 waste boundary. The purpose of GWM-12 is to monitor groundwater quality from the water flowing on the east side of and under Phase 2 and from the west side of the existing landfill. A 15 foot screen will be installed in the saprolite part of the upper aquifer, because it is anticipated that groundwater will be present in this portion of the upper aquifer during both estimated seasonal high and low periods.

Monitoring wells GWM-13S and 13D are proposed as a nested well pair to be installed on the west side of the central draw and down-gradient of the Phase 2 site. Although it is anticipated that groundwater will be present in the saprolite portion of the upper aquifer during both estimated seasonal high and low periods at this site, a nested pair is proposed to properly monitor the groundwater flowing from under the Phase 2 Lined Landfill. GWM-13S will be installed with a 15 foot screen in the saprolite part of the upper aquifer.

GWM-13D will be installed with a 10 foot screen in the highly fractured rock part of the upper aquifer. Estimated flow paths and current groundwater data suggest a downward gradient throughout the Phase 2 area toward the central draw. This deeper well is designed to detect potential contaminants that might result from a leak in the central or up-gradient part of the Phase 2 area. These potential contaminants might migrate downward and northward along the central draw so that they might not be detected in proposed GWM-13S.

The wells should be installed according to regulations. Plate B shows a typical monitoring well schematic as recommended by the State of North Carolina. The groundwater monitoring wells and piezometers should be constructed approximately to the elevations and conditions listed in Table 7. These estimated depths are based on the seasonal high groundwater potentiometric map (Plate 7) and the boring logs. The actual depths for screen installation in these wells is dependent on the actual depth at which water is first encountered or rock is encountered and how this level compares to seasonal groundwater cycle. The screen should be installed at completion depth if possible, however hole conditions may preclude this. One surface water monitoring site SW-5 is proposed to be located downstream from the Phase 2 and Phase 1 sites. This location will replace SW-4 which is currently located within the footprint of the Phase 2 site.

All groundwater monitoring wells and piezometers must be tagged, labeled, locked, have vent caps, and their locations surveyed. A permanent mark should be placed at the location where the surface water sample should be taken. Testing of the ground and surface water should be performed in accordance with and using the methods set forth in North Carolina regulations for subtitle D landfills.

Wells are planned to be installed in areas not subject to flooding. These monitoring wells GWM-12, GWM-13S and 13D will have to be abandoned prior to construction of Phase 3.

Monitoring wells, new and existing, surface water locations, and the leachate from the lagoon should be tested semi-annually for Appendix I chemical constituents. The leachate should also be tested for biochemical oxygen demand (BOD), chemical oxygen demand (COD), phosphorus, sulfate, nitrate, nitrite, and pH. The sampling and analysis plan is included in Appendix E.

In summary, it is proposed that the following be undertaken to provide groundwater, surface water and leachate monitoring:

1. Utilize the existing background monitoring wells GWM-11S and -11D as background wells.
2. Install three downgradient compliance monitoring wells (GWM-12, GWM-13S, and GWM-13D)
3. Use the existing monitoring wells GWM-4A and GWM-8 as the upgradient wells and GWM-3 and GWM-3D as the downgradient wells for the leachate lagoon.
4. Surface water SW-5 will be taken at the location shown on Plate A.
5. Leachate will be sampled from the inflow pipe at the lagoon.

9 CLOSURE

This report completes the requirements for the geological and hydrological features for the Design Hydrogeologic Report as described in Rule .1623(b). Geological and hydrological data, information, and conclusions contained herein and in reports of adjacent studies indicate no hindrance to the development and monitoring of the described Phase 2. The ground and surface water monitoring plan is designed to be effective in the early detection of any possible release of hazardous constituents from the White Oak Landfill Phase 2 MSWLF unit or leachate surface impoundment to the uppermost aquifer.

All temporary piezometers installed during subsurface exploration and not converted to permanent monitoring wells or piezometers will be abandoned in accordance with the procedures for permanent abandonment of wells as described in 15A NCAC 2C Rule .0113(a)(2).

Respectfully submitted,
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Long-Term Precipitation Data, Waynesville Station
Haywood County White Oak Landfill

Station: (319147) WAYNESVILLE_EXP_STN
Element: Precipitation (in)

	1961-1990*	1991	1992	1993	1994	1995	1996	1997	1998	1991-1997*
January	3.88	2.89	2.22	5.04	5.39	6.19	9.46	5.05	10.02	5.18
February	4.39	5.37	3.59	2.98	5.75	5.99	3.27	4.78	7.31	4.53
March	5.28	9.04	3.14	4.39	9.12	3.61	4.67	8.36	2.98	6.05
April	3.61	3.96	2.06	2.70	6.46	2.04	4.03	4.02	8.54	3.61
May	4.25	2.92	6.14	2.83	2.30	3.43	3.36	3.24	-	3.46
June	3.55	7.21	4.52	3.03	6.08	4.78	3.30	6.63	-	5.08
July	3.98	5.06	1.66	1.60	5.08	3.60	3.56	2.94	-	3.36
August	4.15	7.67	6.63	5.36	6.89	8.20	3.82	0.85	-	5.63
September	3.39	2.94	3.84	3.40	3.78	2.86	7.38	6.53	-	4.39
October	2.97	0.31	3.96	1.45	3.79	8.24	1.67	4.01	-	3.35
November	3.55	4.22	5.93	3.77	2.98	4.37	3.56	1.71	-	3.79
December	4.13	4.55	5.60	4.58	3.05	1.64	5.01	3.67	-	4.01
Total	**47.13**	**56.14**	**49.29**	**41.13**	**60.67**	**54.95**	**53.09**	**51.79**	**28.85**	**52.44**

* Average data over specified measurement period.

Monthly Precipitation 1991-1997, Waynesville Station

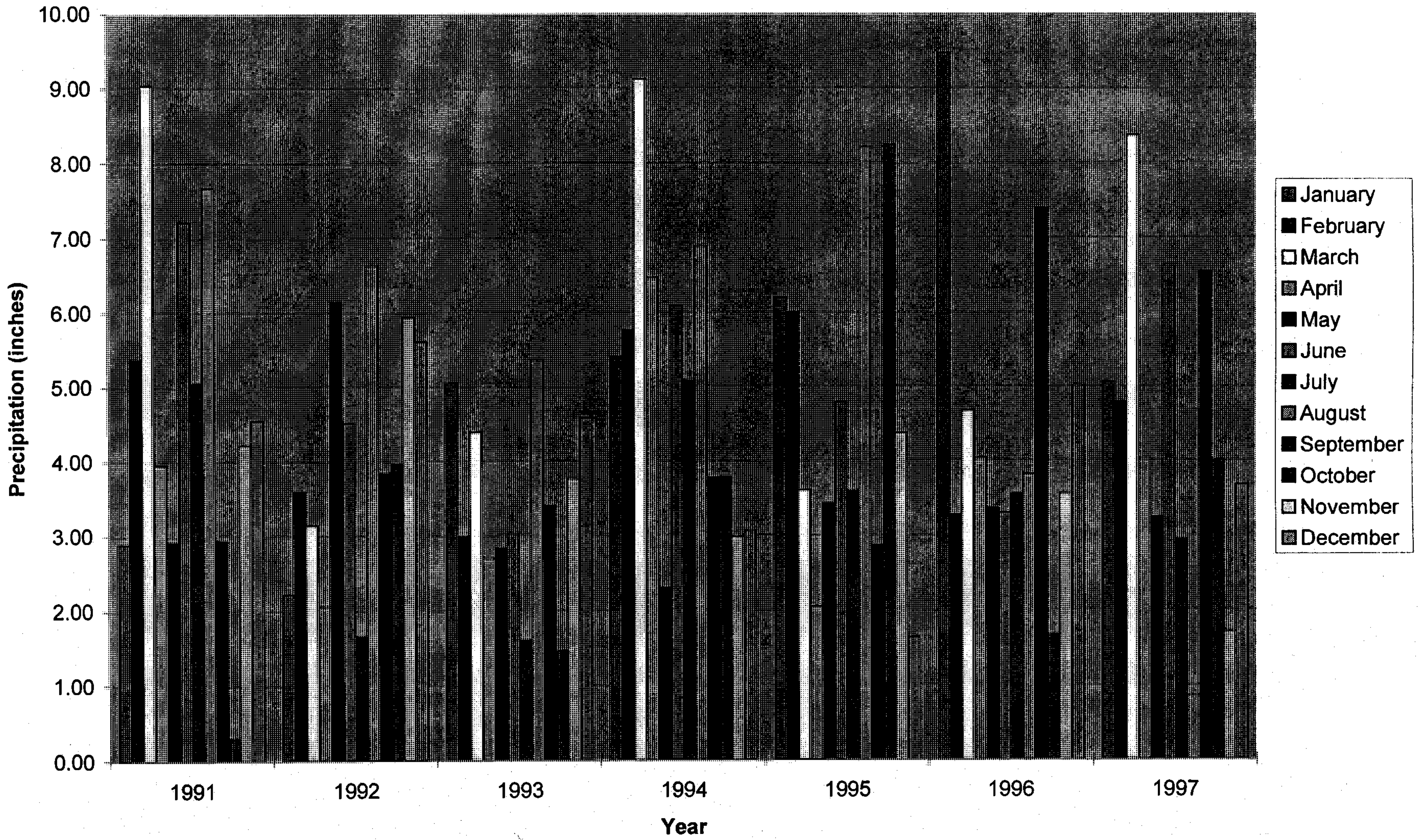


Table 1. Groundwater Elevation Summary - Haywood County Lined Landfill, Waynesville, North Carolina

Piezometer Number	Date Installed	Ground Elevation	Casing Top Elevation	Completion Depth	Top of Rock	While Drilling	After Drilling	24 Hours After	7 Days After	6/9/98	7/7/98
P-10	03/19/98	2579.49	2581.86	2506.49	-	2527.49	2529.99	2530.16	2531.40	2534.05	2533.82
P-11	03/18/98	2551.87	2553.87	2526.87	2526.87	2534.37	2538.37	2537.75	2537.67	2536.07	2536.09
P-12	03/13/98	2555.38	2557.62	2537.38	2537.38	2547.38	2548.38	2550.20	2548.42	2549.47	2549.27
P-12D	04/06/99	2554.58	2555.83	2519.58	2537.58	2546.58	2545.48	2546.75	2546.56	-	-
P-13/GMW-11S	04/21/98	2671.66	2675.69	2575.66	-	2587.66	2589.56	2600.21	2598.97	2599.34	2599.82
P1-1S	03/30/99	2626.20	2628.07	2558.20	-	2576.20	-	2560.72	2559.76	-	-
P1-1D	03/31/99	2625.52	2627.68	2525.52	2555.52	2575.52	-	2560.68	2560.97	-	-
P1-2S	04/07/99	2602.48	2604.01	2553.98	-	2562.48	2565.14	2569.99	2569.86	-	-
P1-2D	04/07/99	2603.09	2604.98	2523.84	2533.84	2563.09	2564.61	2566.18	2565.93	-	-
P1-3	04/13/99	2609.67	2612.35	2562.17	2573.67	2585.67	2585.89	-	-	-	-
P1-4	04/12/99	2610.78	2613.42	2538.78	2548.78	2571.78	2571.68	-	-	-	-
P1-5S	03/25/99	2633.21	2636.07	2575.21	2582.21	2584.21	-	-	2583.19	-	-
P1-5D	03/24/99	2633.21	2635.45	2554.71	2582.21	2584.21	-	-	2581.46	-	-
P1-6	04/09/99	2589.77	2592.18	2544.77	-	2555.27	-	2554.17	2554.13	-	-
P1-7S	04/05/99	2575.00	2576.76	2531.00	2562.00	2534.00	-	-	2544.82	-	-
P1-7D	03/31/99	2575.00	2575.97	2521.00	2562.00	2534.00	-	2542.75	-	-	-
P1-8S	04/05/99	2534.02	2536.11	2519.02	-	2531.52	2530.33	2532.31	2532.16	-	-
P1-8D	04/06/99	2533.52	2534.65	2481.52	2491.52	2531.02	-	2530.98	2530.90	-	-
GWM-6A	09/24/93	2527.88	2530.52	2509.38	2509.38	-	-	-	-	2523.90	2522.82
GWM-7	07/12/93	2643.56	2645.74	2560.76	2560.76	-	-	-	-	2581.50	2581.92
GWM-7D	09/30/93	2643.56	2644.82	2540.36	2558.56	-	-	-	-	2579.62	2579.80
TWD-10	02/21/97	2614.39	2617.16	2579.39	-	-	-	-	-	2588.21	2587.74
TWD-10D	02/21/97	2614.39	2617.48	2555.39	-	-	-	-	-	2588.00	2587.57
P-6	05/25/98	2594.19	2597.24	2526.69	2536.19	2535.19	2537.29	-	2538.57	2538.65	2538.80
P-6S	12/20/99	2612.40	2615.16	2557.90	2557.90	2563.30	2560.90	2564.66	2564.62	-	-
P-6D	01/06/00	2613.21	2615.72	2536.04	2556.04	2564.11	2560.32	-	2565.03	-	-
GWM-5A	09/25/93	2502.47	2504.06	2482.37	2482.37	-	-	-	-	2497.70	2497.04
GWM-5D	09/29/93	2502.47	2503.28	2466.27	2482.47	-	-	-	-	2496.62	2496.23

Table 1. Groundwater Elevation Summary - Haywood County Lined Landfill, Waynesville, North Carolina

Piezometer Number	8/17/98	9/25/98	10/27/98	12/2/98	1/13/99	2/11/99	3/23/99	4/28/99	6/21/99	7/27/99	8/10/99
P-10	2532.81	2531.65	2531.03	2530.29	2529.79	2529.76	2529.85	2529.85	2530.00	2530.11	2529.92
P-11	2535.98	2536.23	2535.88	2535.67	2536.07	2535.77	-	-	2536.15	2536.14	2536.07
P-12	2548.89	2548.81	2548.37	2548.03	2547.99	2549.52	-	2547.42	2546.85	2547.29	2546.97
P-12D	-	-	-	-	-	-	-	2546.68	2546.07	2546.53	2546.18
P-13/GMW-11S	2600.48	2600.98	2601.31	2601.11	2600.57	2599.99	2599.32	2598.69	2598.15	2597.89	2597.89
P1-1S	-	-	-	-	-	-	-	2559.27	2558.63	2558.43	2558.44
P1-1D	-	-	-	-	-	-	-	2558.69	2558.13	2557.93	2557.91
P1-2S	-	-	-	-	-	-	-	2569.86	2569.80	2569.89	2569.91
P1-2D	-	-	-	-	-	-	-	2565.73	2565.64	2565.90	2565.78
P1-3	-	-	-	-	-	-	-	2589.34	2588.95	2589.46	2589.14
P1-4	-	-	-	-	-	-	-	2575.82	2575.89	2575.72	2575.72
P1-5S	-	-	-	-	-	-	-	2583.16	2583.57	2583.76	2583.78
P1-5D	-	-	-	-	-	-	-	2581.48	2582.02	2582.30	2582.36
P1-6	-	-	-	-	-	-	-	2554.00	2553.55	2553.86	2553.54
P1-7S	-	-	-	-	-	-	-	2544.82	2544.45	2544.74	2544.45
P1-7D	-	-	-	-	-	-	-	2542.64	2542.92	2543.62	2543.30
P1-8S	-	-	-	-	-	-	-	2532.61	2532.01	2532.41	2532.41
P1-8D	-	-	-	-	-	-	-	2531.24	2530.83	2531.40	2531.13
GWM-6A	2522.27	2522.21	2521.99	2521.92	2522.47	2523.52	-	2523.16	2522.54	2522.97	2522.67
GWM-7	2581.37	2580.67	2579.18	2579.48	2578.81	2578.64	-	2578.04	2577.98	2577.96	2580.14
GWM-7D	2579.39	2578.67	2578.19	2577.50	2577.10	2576.62	-	2577.03	2578.15	2578.12	2577.12
TWD-10	2586.48	2585.17	2584.20	-	2584.74	2582.86	-	2585.15	2584.06	-	2584.06
TWD-10D	2586.33	2585.04	2584.08	2583.10	2583.41	2582.78	-	2584.91	2584.41	-	2583.93
P-6	2538.68	2538.54	2538.20	2538.06	2537.58	2537.34	-	-	2537.63	-	2538.01
P-6S	-	-	-	-	-	-	-	-	-	-	-
P-6D	-	-	-	-	-	-	-	-	-	-	-
GWM-5A	2496.76	2496.43	2496.36	2496.15	2496.09	2497.76	-	-	2496.51	-	2496.80
GWM-5D	2496.07	2495.90	2495.88	2495.68	2495.75	2496.48	-	-	2495.82	-	2495.99

Table 1. Groundwater Elevation Summary - Haywood County Lined Landfill, Waynesville, North Carolina

Piezometer Number	2/11/00	3/14/00	Temporal High	Temporal Low	Fluctuation
P-10	2528.20	2528.33	2534.05	2528.20	5.85
P-11	2535.22	2535.42	2536.23	2535.22	1.01
P-12	2547.19	2547.27	2549.52	2546.85	2.67
P-12D	2546.41	2546.43	2546.68	2546.07	0.61
P-13/GMW-11S	2596.37	2595.68	2601.31	2595.68	5.63
P1-1S	2558.22	2558.17	2559.27	2558.17	1.10
P1-1D	2557.28	2557.28	2558.69	2557.28	1.41
P1-2S	2567.66	2567.66	2569.91	2567.66	2.25
P1-2D	2564.26	2564.28	2565.90	2564.26	1.64
P1-3	2586.65	2586.87	2589.46	2586.65	2.81
P1-4	2576.13	2575.47	2576.13	2575.47	0.66
P1-5S	2581.50	2581.22	2583.78	2581.22	2.56
P1-5D	2580.45	2580.18	2582.36	2580.18	2.18
P1-6	2552.77	2551.83	2554.00	2551.83	2.17
P1-7S	2544.30	2544.41	2544.82	2544.30	0.52
P1-7D	2542.47	2542.66	2543.62	2542.47	1.15
P1-8S	2532.50	2532.81	2532.81	2532.01	0.80
P1-8D	2531.14	2531.50	2531.50	2530.83	0.67
GWM-6A	2523.02	2523.12	2523.90	2521.92	1.98
GWM-7	2577.34	2576.94	2581.92	2576.94	4.98
GWM-7D	2575.33	2574.92	2579.80	2574.92	4.88
TWD-10	2581.00	2581.26	2588.21	2581.00	7.21
TWD-10D	2580.93	2581.18	2588.00	2580.93	7.07
P-6	2536.89	2536.72	2538.80	2536.72	2.08
P-6S	2563.99	2563.47	2563.99	2563.47	0.52
P-6D	2564.92	2564.41	2564.92	2564.41	0.51
GWM-5A	2501.35	2496.71	2501.35	2496.09	5.26
GWM-5D	2500.87	2495.86	2500.87	2495.68	5.19

Table 2. Rock Core Summary

Location	Interval (ft.)	Top of Rock Elevation (ft.)	REC (%)	RQD (%)	Water Elevation while Drilling (ft.)	Rock Type	Comments
P1–1D	72.00 – 75.50	2555.52	94.0	29.0	2575.52	Gneiss	Highly fractured with iron deposits
P1–2D	69.25 – 79.25	2533.84	75.0	73.0	2563.09	Gneiss	
P1–3	36.00 – 46.00	2573.67	64.0	24.0	2585.67	Gneiss	Fractured parallel to 70 degree foliation
P1–4	62.00 – 72.00	2548.78	100.0	70.0	2571.78	Gneiss	
P1–5D	67.75 – 74.25	2582.21	45.0	42.0	2584.21	Gneiss	Weathered with 45 degree fractures
	74.25 – 77.75		100.0	74.0		Gneiss	
P1–8D	42.00 – 44.50	2491.52	88.0	34.0	2531.02	Gneiss	Highly weathered, fractures parallel to 30 degree foliation
	44.50 – 52.00		87.0	69.0		Gneiss	Fractures parallel to 60 degree foliation
P2–1	34.00 – 36.40	2538.74	92.0	79.0	2535.74	Gneiss	Fractures parallel to 30 degree foliation
	36.40 – 39.60		59.0	0.0		Gneiss	Highly weathered
	39.60 – 43.90		85.0	52.0		Gneiss	
	43.90 – 47.00		100.0	92.0		Gneiss	30 degree foliation

Table 3. Lab test results for soil samples

Boring	Depth (ft.)	USCS Soil Classification	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	% Silt	% Clay	Specific Gravity	Dry Density (lb/ft^3)	Natural Moisture Content (%)
P1–8S	13.0 – 14.0	SM	NV	NP	NP	1.5	59.7	29.0	9.8	2.69	–	32.3
P1–4	28.0 – 29.5	SM	NV	NP	NP	0.0	51.2	35.6	13.2	2.72	–	17.8
P1–1S	29.0 – 30.5	SM	NV	NP	NP	0.0	51.4	36.1	12.5	2.74	–	17.2
P1–7S	0.0 – 1.5	MH	52	31	21	2.5	38.2	17.3	42.0	2.64	–	28.9
P1–6	33.5 – 35.0	SM	NV	NP	NP	0.6	61.9	27.0	10.5	2.64	–	22.2
P1–4	13.0 – 14.5	SM	NV	NP	NP	3.4	57.0	29.6	10.0	2.78	–	14.4
P1–4	33.0 – 34.5	ML	NV	NP	NP	0.2	44.3	44.3	11.2	2.74	–	21.2
P2–1	1.0 – 5.0	CH	55	29	26	2.4	43.5	26.4	27.7	2.71	–	24.0
P2–1	6.0 – 10.0	CL	48	27	21	3.5	45.1	24.6	26.8	2.69	–	22.9
P2–1	10.0 – 12.0	SM	39	40	NP	1.6	57.0	23.5	17.9	2.71	90.4	22.1
P2–1	21.0 – 23.0	ML	37	NP	–	0.3	39.5	36.2	24.0	2.72	84.6	30.4
P2–2	3.0 – 4.0	SM	44	34	10	8.4	47.6	28.2	15.8	2.75	95.9	21.5

Table 4. Hydrologic Properties of Lithologic Units [1]

Lithologic Unit	Hydraulic Conductivity (cm/sec)	Total Porosity (%)	Effective Porosity (%)	Flow Rate (ft/yr)
Saprolite [2]	2.64E–04	50	17	106
Fractured Gneiss [3]	7.24E–05	0 – 10	1	–

1. All presented values are average values for the lithologic unit unless otherwise indicated.
2. Calculations for hydraulic conductivity, effective porosity, and flow rate are presented in Appendix B. Average total porosity value for saprolite is calculated from total porosity values for the lithologic unit determined in Appendix C.
3. Calculations for average flow rate is provided in Appendix B. Total porosity for fractured gneiss is taken from Table 2.1 in Domenico, P. A., and Schwartz, F. W., 1997, Physical and chemical hydrogeology 2nd ed.: John Wiley & Sons, Inc., New York, p. 14. Effective porosity for fractured gneiss is estimated from reported value range (Fetter, 1994) and degree of fracturing. Fetter, C. W., 1994, Applied hydrogeology 3rd ed.: Prentice–Hall Inc., New Jersey, p. 88.

Table 5. Vertical Flow Rates Summary [1]

Nest Location	dl	dh [2]	i [2]	Vz (ft/yr) [3]
P-12/12D	16.80	-0.78	-0.05	-91 ± 4
P1-1S/D	27.68	-0.66	-0.02	-44 ± 14
P1-2S/D	29.89	-3.86	-0.13	-253 ± 24
P1-5S/D	20.50	-1.37	-0.07	-130 ± 25
P1-7S/D	10.00	-1.59	-0.16	-311 ± 80
P1-8S/D	32.00	-1.25	-0.04	-64 ± 7
P-6S/D	24.36	0.93	0.04	75 ± 1
GWM-7/7D	25.40	-1.6	-0.06	-123 ± 68
TWD-10/10D	19.00	-0.2	-0.01	-17 ± 33
GWM-5A/5D	18.70	-0.71	-0.04	-113 ± 29

1. See Appendix B for all calculations.
2. Values are average over the measurement period.
3. Flow rates are expressed as mean values and standard deviations.

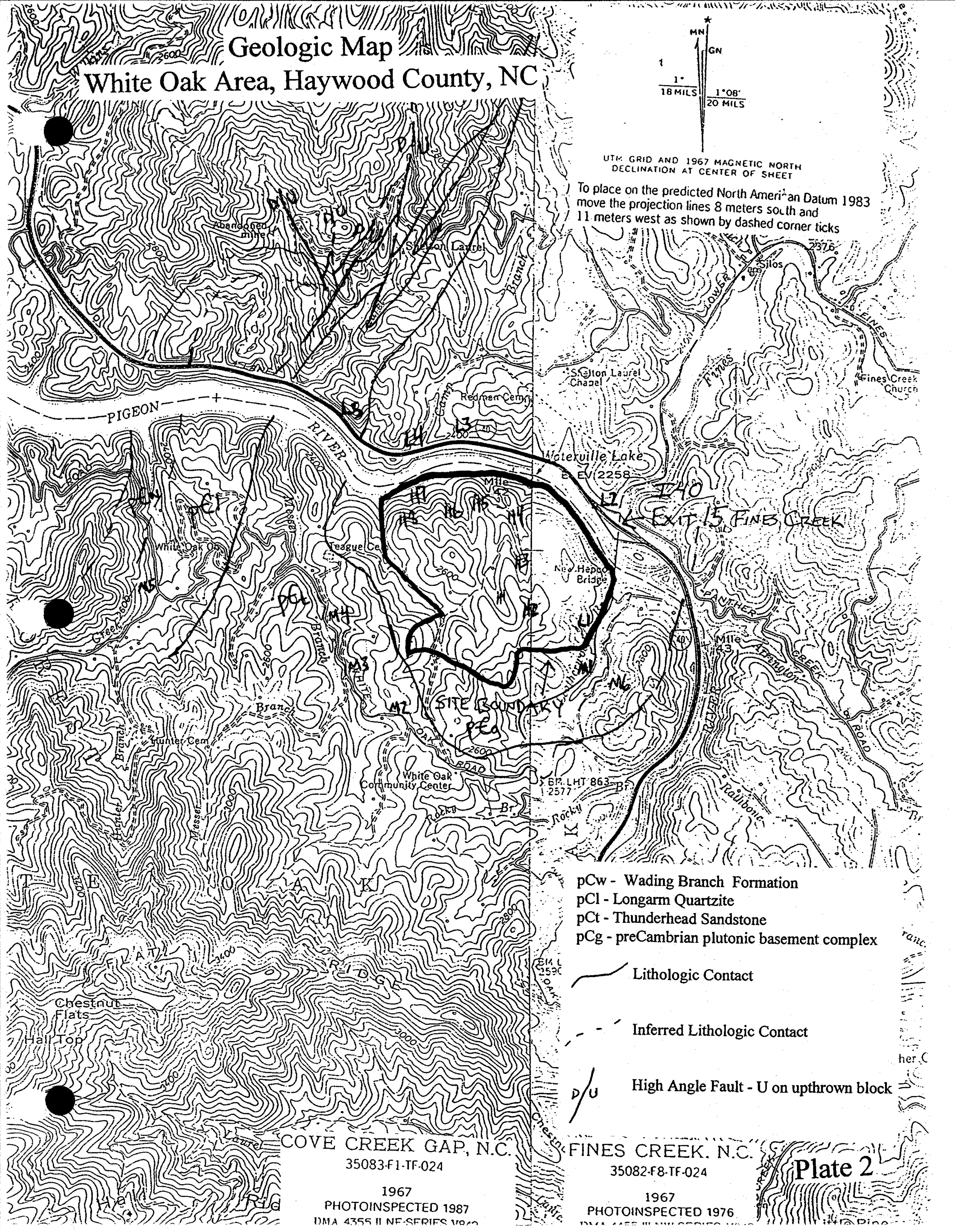
Table 6. Seasonal High Summary

Piezometer Number	Temporal High	Temporal Low	Fluctuation	Estimated Seasonal High	Topographic Setting
P-10	2534.05	2528.20	5.85	2538.05	Ridge
P-11	2536.23	2535.22	1.01	2538.23	Draw
P-12	2549.52	2546.85	2.67	2551.52	Draw
P-12D	2546.68	2546.07	0.61	2548.68	Draw
P-13/GMW-11S	2601.31	2595.68	5.63	2605.31	Ridge
P1-1S	2559.27	2558.17	1.10	2563.27	Ridge
P1-1D	2558.69	2557.28	1.41	2562.69	Ridge
P1-2S	2569.91	2567.66	2.25	2572.91	Slope
P1-2D	2565.90	2564.26	1.64	2568.90	Slope
P1-3	2589.46	2586.65	2.81	2592.46	Slope
P1-4	2576.13	2575.47	0.66	2579.13	Slope
P1-5S	2583.78	2581.22	2.56	2587.78	Ridge
P1-5D	2582.36	2580.18	2.18	2586.36	Ridge
P1-6	2554.00	2551.83	2.17	2557.00	Slope
P1-7S	2544.82	2544.30	0.52	2547.82	Slope
P1-7D	2543.62	2542.47	1.15	2546.62	Slope
P1-8S	2532.81	2532.01	0.80	2534.81	Draw
P1-8D	2531.50	2530.83	0.67	2533.50	Draw
GWM-6A	2523.90	2521.92	1.98	2525.90	Draw
GWM-7	2581.92	2576.94	4.98	2585.92	Ridge
GWM-7D	2579.80	2574.92	4.88	2583.80	Ridge
TWD-10	2588.21	2581.00	7.21	2592.21	Ridge
TWD-10D	2588.00	2580.93	7.07	2592.00	Ridge
P-6	2538.80	2536.72	2.08	2542.80	Ridge
P-6S	2563.99	2563.47	0.52	2567.99	Ridge
P-6D	2564.92	2564.41	0.51	2568.92	Ridge
GWM-5A	2501.35	2496.09	5.26	2503.35	Draw
GWM-5D	2500.87	2495.68	5.19	2502.87	Draw

Table 7. Summary of Proposed Monitoring Well Construction [1]

Well	Surface Elevation	Seasonal High Elevation	Seasonal High Depth	Depth to Screen Bottom	Top of Rock Depth	Total Depth
GWM-12	2520	2517	3	17	25	17
GWM-13S	2523	2519	4	18	23	18
GWM-13D [2]	2523	2519	4	43	23	43
PZ-1S	2605	2547	58	72	65	72
PZ-1D [2]	2605	2547	58	97	65	97

1. All numbers are expressed in feet.
2. GWM-13D and PZ-1D will be screened over a 10-foot interval. The remainder of the wells will be screened over a 15-foot interval.


Geologic Map
White Oak Area, Haywood County, NC
UTM GRID AND 1967 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
To place on the predicted North American Datum 1983 move the projection lines 8 meters south and 11 meters west as shown by dashed corner ticks
PIGEON RIVER
Waterville Lake
Abandoned mine
Shelton Laurel
Shelton Laurel Chapel
Redmen Cem
Silos
Fines Creek Church
Teague Cem
White Oak Ch
Hunter Cem
White Oak Community Center
Chestnut Flats
Hall Top
I-40
EXIT 15 FINES CREEK
SITE BOUNDARY
pCw - Wading Branch Formation
pCl - Longarm Quartzite
pCt - Thunderhead Sandstone
pCg - preCambrian plutonic basement complex
Lithologic Contact
Inferred Lithologic Contact
High Angle Fault - U on upthrown block
COVE CREEK GAP, N.C.
35083-F1-TF-024
1967
PHOTOINSPECTED 1987
FINES CREEK, N.C.
35082-F8-TF-024
1967
PHOTOINSPECTED 1976
Plate 2

OUTCROP LOCATIONS IN THE WHITE OAK AREA, HAYWOOD COUNTY

Hatcher's Observations

H1. Strongly foliated feldspar-quartz-biotite gneiss. Rocks are strongly isoclinally folded with fold axial surfaces parallel to the dominant foliation. Foliation N11E/36SE. Unfilled Joints N68W/69SW, N67E/75NW. Fracture density is low (2-3 ft spacing)

H2. Massive, coarse grained feldspar-quartz-biotite orthogneiss. Foliation N59E/32SE. Unfilled Joint N61E/32NW.

H3. Massive, exfoliated coarse-grained feldspar-quartz-biotite orthogneiss. Garnet and orthopyroxine metacrysts up to 0.5 cm in some parts of exposure, oriented parallel to compositional banding. Almost no fractures. Joint spacing 20-30 ft. Unfilled Joints N32E/79NW, N56W/77SW.

H4. Strongly foliated and lineated feldspar-quartz-biotite orthogneiss. Foliation N9E/32SE. Unfilled Joints (spacing 0.5-1 ft) N45E/76NW, N70E/80SE.

H5. Strongly fractured feldspar-quartz-biotite orthogneiss. Foliation N67E/32SE. Dominant closely spaced (1in to 3 in) fracture set (N38W/77NW) approximately parallel to valley orientation.

H6. Medium-grained annealed mylonite derived from feldspar-quartz-biotite orthogneiss. No measurements taken because is a large block, probably locally derived (within <100ft of present location) but out of place.

H7. Strongly foliated feldspar-quartz-amphibole gneiss along Walters Lake. Foliation N66E/22SE. Unfilled joint N40W/69W.

H8. Large cliff exposure of coarse grained feldspar-quartz-biotite orthogneiss. Rock mass is moderately fractured, with a zone of intense fracturing (spacing <1-2 ft) in part of the exposure. Foliation N33E/24SE. Unfilled Joints N33W/86NE, N41W/81NE, N47W/68SW, N23E/vertical, N43E/vertical.

Law Engineering Observations

L1. Foliations N60E/65SE, N70E/62SE, N70E/63SE
Joint N75W/80SW

L2. Foliations N10E/38SE, N12E/30SE, N58E/78SE
Fault N15E/90

L3. Foliation N33E/62SE
Joint N20E/26SE

L4. Foliation N38E/48SE
Joint N15E/48SE, N55W/75SW

L5. Foliation N22E/48SE, N34E/58SE
Fault N30W/7SW, N30E/90

Municipal Engineering Observations

M1. Biotite Gneiss, with quartz and plagioclase (preCambrian basement) - Fractures N15E/90, N70E/75SE

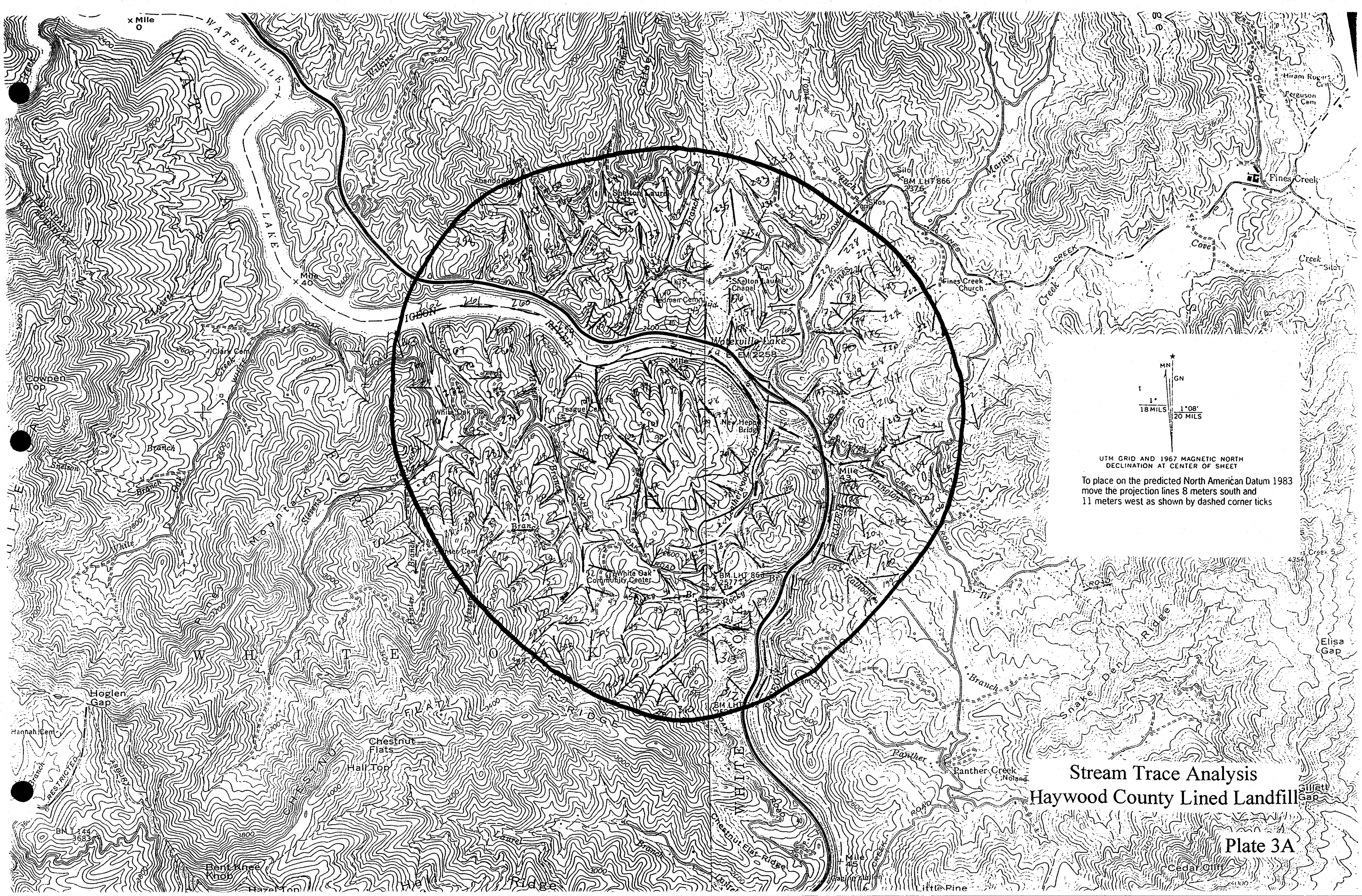
M2. Boulders of garnet schist in road cut. (Thunderhead Sandstone Unit)

M3. Garnet schist (Thunderhead Sandstone Unit), fractures parallel to foliation N20W/66NE, Fractures N75E/64NW, N38E/30SE

M4. Garnet schist Foliation N5W/85NE

M5. Pink, feldspathic quartzite,
Fractures N11E/53SE, N75E/60NW

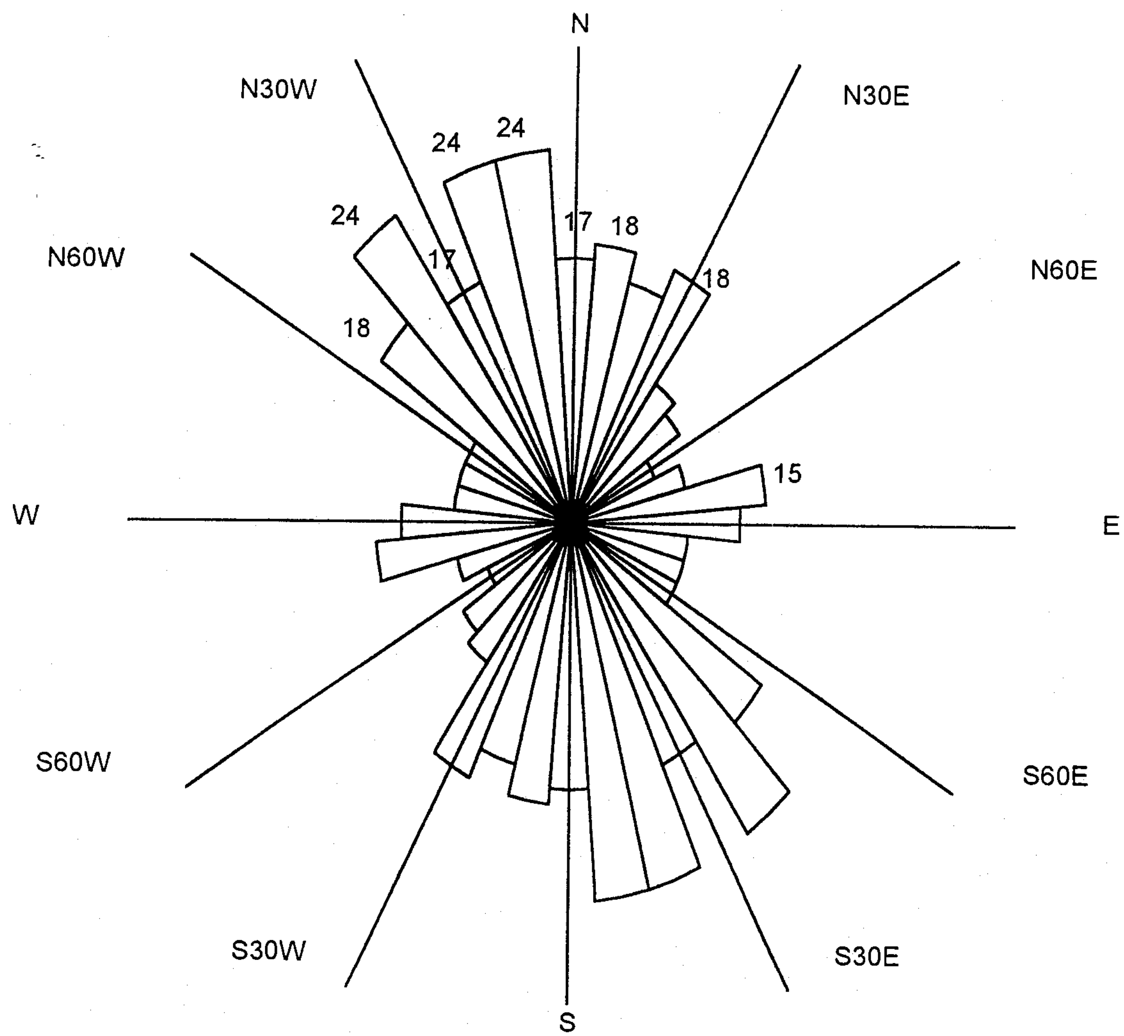
M6. Boulders of biotite gneiss with quartz and plagioclase.



Stream Trace Analysis
Haywood County Lined Landfill

Plate 3A

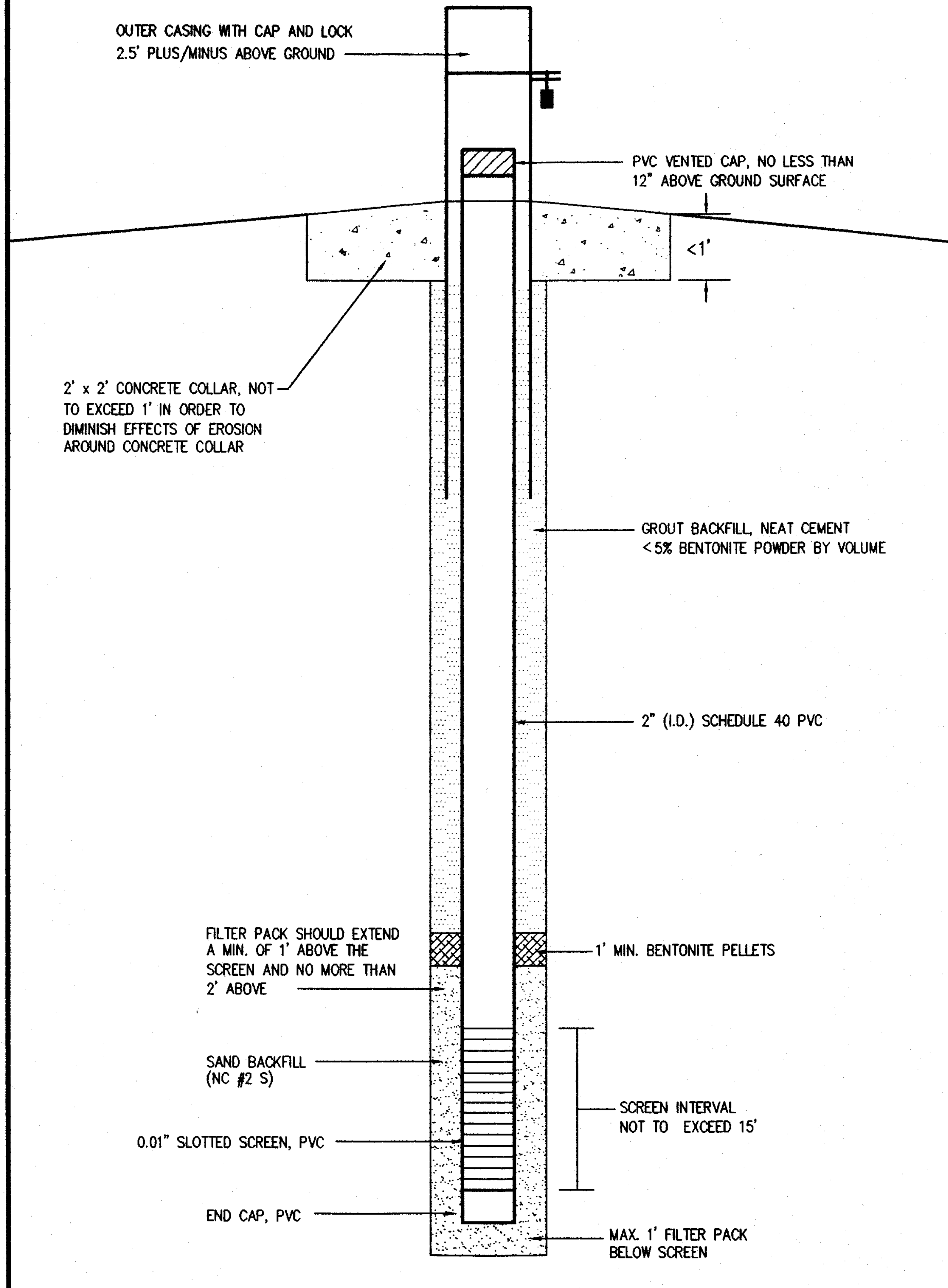
Rose Diagram of Stream Traces
Landfill Site, Haywood County, NC



10 Degree Increments

------- Total Number = 272

Plate 3B



NOTE: SHALLOW WELLS REQUIRE A MINIMUM OF 5' COMBINED THICKNESS OF GROUT AND BENTONITE.

TYPICAL MONITORING WELL
PLATE B

LOG OF BORING: P-10

Project: Haywood County
Project No. G98010.5
Type: HSA SS

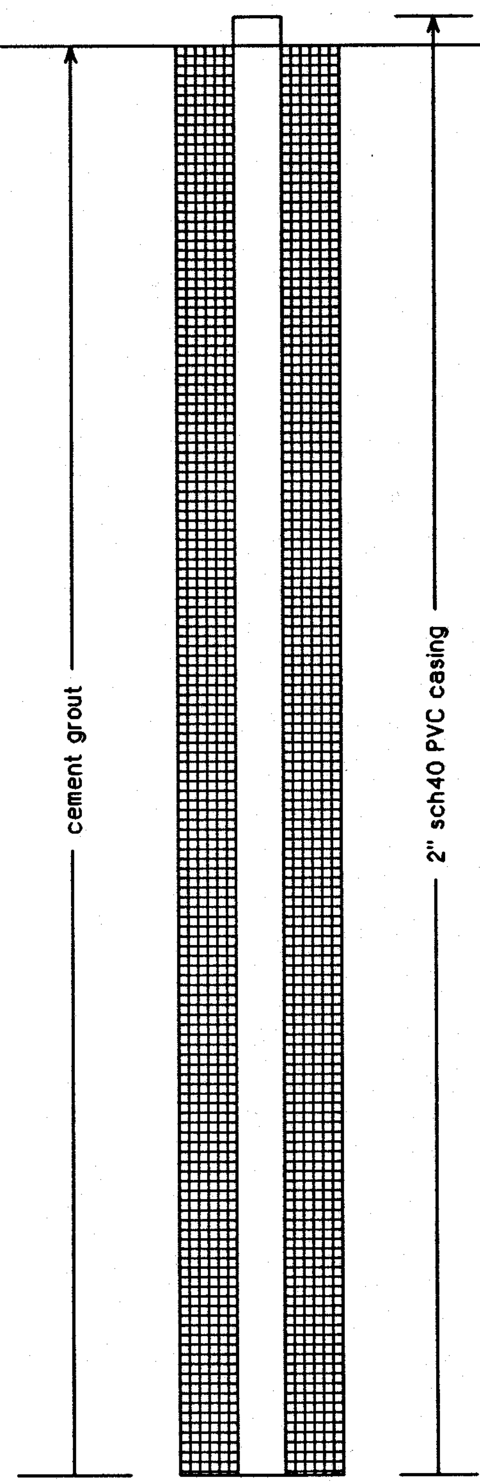
Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2579.49ft
Top of Casing: 2581.86ft

BLOWS PER FOOT	DESCRIPTION OF MATERIAL
5	SILT (ML); pink-brown, firm, with sand and clay, trace mica, relict structure
7	-grades with weathered zones of biotite
12	SANDY SILT (ML); olive green to brown, medium dense, fine to coarse sand, relict structure, weathered relict crystals, some mica
17	SILT (ML); brown to white, very stiff,trace fine sand and rock fragments, layers of mica
26	SANDY SILT (ML); red to brown, medium dense, sand medium grained, zones of muscovite
32	-grades brown, dense, fine sand, rock fragments, iron stained, relict gneissic layering
31	-grades brown to rust colored, poorly sorted sand, rock fragments relict structure
34	-grades with rock fragments
50/4	-grades very dense, relict gneissic structure, rust staining
38	-grades moist, dense, gneissic structure, trace coarse sand, some mica
18	-grades medium dense, with mica and trace clay, iron stained relict fracture

DEPTH (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

PIEZOMETER DIAGRAM



Completion Depth: 73.0 ft
DATE: 3/19/98

Depth to Water: 52 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______________
Signature of Field Agent

LOG OF BORING: P-10

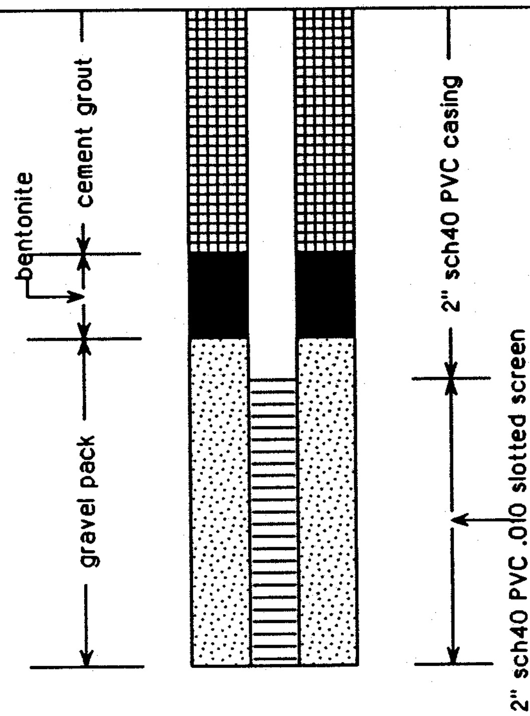
Project: Haywood County
Project No. 698010.5
Ty[illegible]SA SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2579.49ft
Top of Casing: 2581.86ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
55	27		X	-grades wet
60	25		X	-grades with more clay
65	50/4		X	-grades very dense, relict foliation near vertical
70	50/5		X	-grades with black and white relict layering
75				End of Boring at 73.0 feet
80				
85				
90				
95				
100				

PIEZOMETER DIAGRAM



Completion Depth: 73.0 ft
DATE: 3/19/98

Depth to Water: 52 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______ Signature of Field Agent

LOG OF BORING: P-11

Project: Haywood County
Project No. G98010.5
T[illegible]HSA,SS

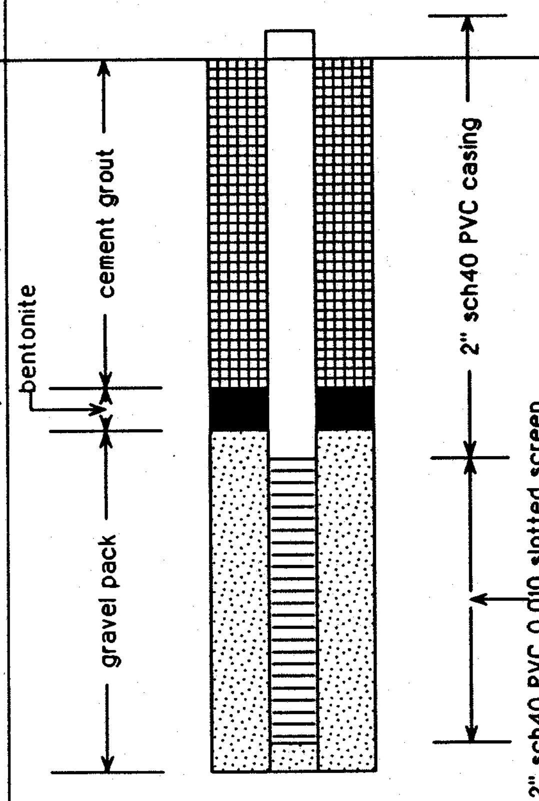
Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2551.87ft
Top of Casing: 2553.87ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	4			SILTY CLAY (CL); Medium brown, moist, soft, with medium to coarse sand
5	3			CLAYEY SILT (ML); Brown, moist, soft, some root debris, trace coarse sand and mica
10	11			SILT (ML); dark brown, stiff, saprolitic, with mica and fine sand layers, some clay, rust stained relict foliation
15	16			SANDY SILT (ML); black/white gneissic banding, moist, very stiff, saprolitic, some coarse quartz grains
20	50/1			-grades dark brown with tan and orange layers, saturated, very dense, micaceous
25	ref/3			-grades with few rock fragments, some coarse grains, trace mica
				End of Boring at Auger Refusal 25.0 feet

DEPTH (ft) scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

PIEZOMETER DIAGRAM



Completion Depth: 25.0 ft
DATE: 3/18/98

Depth to Water: 17.5 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______________________
Signature of Field Agent

LOG OF BORING: P-12

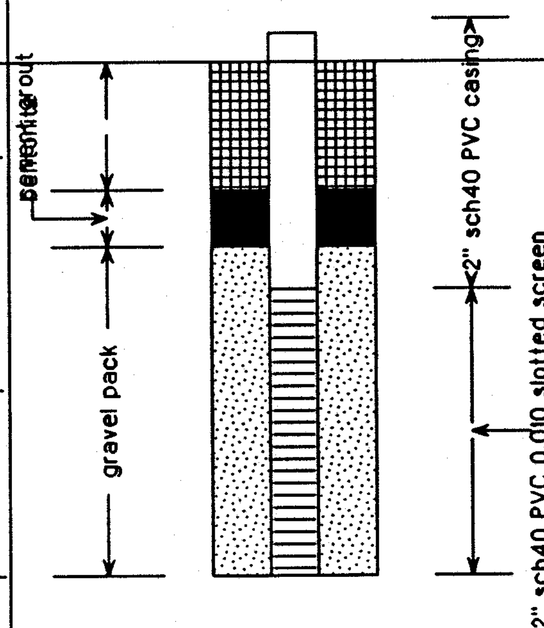
Project: Haywood County
Project No. G98010.5
Ty[illegible]HSA,SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2555.38ft
Top of Casing: 2557.62ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	7		X	SILTY CLAY (CL); Dark brown, damp, firm, some coarse sand, trace fine mica
5	12		X	SILT (ML); Tan to brown, moist, stiff, faint relict structure, some fine mica and coarse sand, trace clay
10	8		X	-grades medium to dark brown, saturated, firm, with medium and coarse sand, 1" layer of gravel at 8'
15	12		X	SILTY SAND (SM); brown with yellow-orange mottles, saturated, stiff, relict gneissic banding, coarse grained
20				End of Boring at Auger Refusal 18.0 feet
25				
30				
35				
40				
45				

PIEZOMETER DIAGRAM



Completion Depth: 18.0 ft
DATE: 3/13/98

Depth to Water: 8.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.
I acknowledge that this record is true to the best of my knowledge: ____________
Signature of Field Agent

LOG OF BORING: P-12D

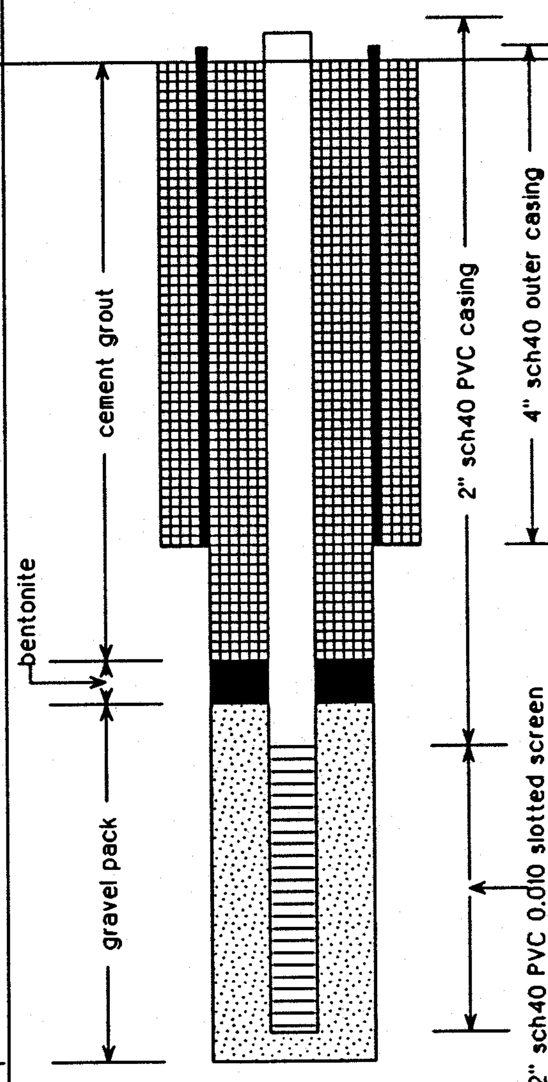
Project: Haywood County
Project No. G98010.6
Ty[illegible]A/R,A/H

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2554.58ft
Top of Casing: 2555.83ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	7		X	SILTY CLAY (CL); Dark brown, damp, firm, some coarse sand, trace fine mica
5	12		X	SILT (ML); Tan to brown, moist, stiff, faint relict structure, some fine mica and coarse sand, trace clay
10	8		X	-grades medium to dark brown, saturated, firm, with medium and coarse sand, 1" layer of gravel at 8 feet
15	12		X	SILTY SAND (SM); brown with yellow-orange mottles, saturated, stiff, relict gneissic banding, coarse grained Air Rotary Bit Refusal at 17.0 feet
20				GNEISS, meta-granitic texture, slightly weathered, some iron deposit on surface -A/H irregular, saprolite and weathered fracture zone
25				-A/H irregular, saprolite and weathered fracture zone
30				
35				End of Boring at 35.0 feet
40				
45				
50				

PIEZOMETER DIAGRAM



Completion Depth: 35.0 ft
DATE: 4/6/99

Depth to Water: 8.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________
Signature of Field Agent

LOG OF BORING: P-13

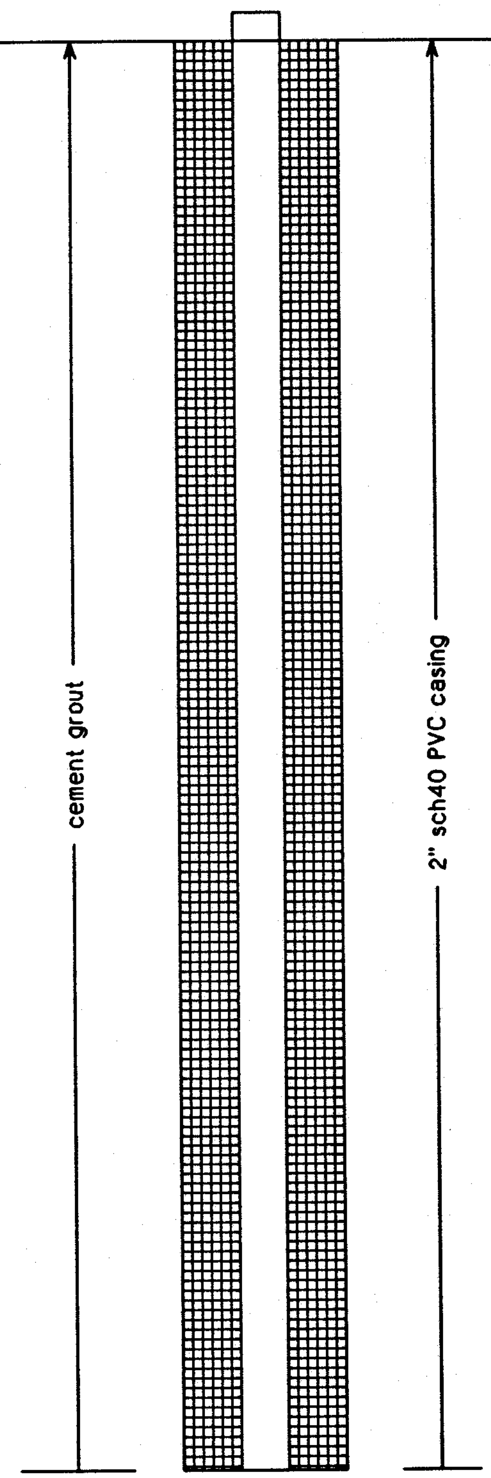
Project: Haywood County
Project No. 698010.5
T[illegible]HSA SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2671.66ft
Top of Casing: 2675.69ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	9			SILT (ML), red, stiff, with mica, relict iron mineralization
5	12			-red to purple, relict foliation, trace mica and fine to medium sand
10	13			-grades with white mottles, relict foliation
15	18			-grades with black mottles, very stiff
20	30			-grades with zones of orange coarse sand
25	26			SANDY SILT (ML); tan to pink, black and white rock fragments, medium dense
30	44			-grades dense, with coarse grains and small rock fragments
35	34			SILT (ML); purple to brownish red, hard, saprolite, some mica
40	41			SANDY SILT (ML); dark red with white and black mottles, saprolite, medium to coarse grained sand, iron mineralization on relict foliation
45	30			-grades with mica, rust staining on mica surfaces
50	51			

PIEZOMETER DIAGRAM



Completion Depth: 96.0 ft
DATE: 4/21/98

Depth to Water: 84.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______________
Signature of Field Agent

LOG OF BORING: P-13

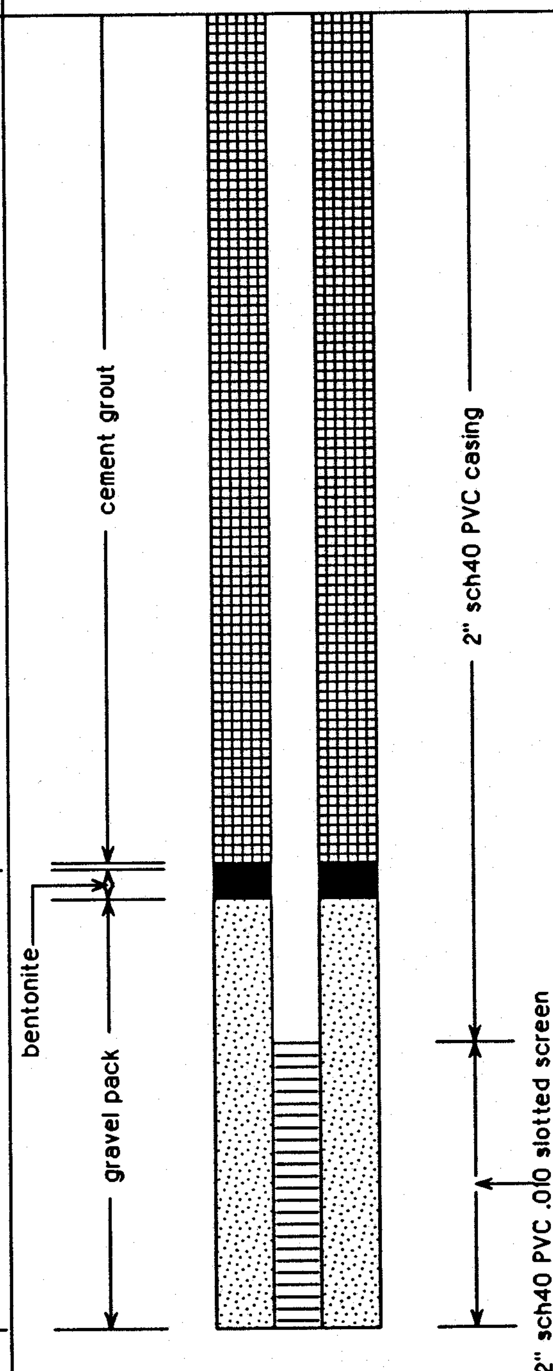
Project: Haywood County
Project No. G98010.5
Type: HSA SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2671.66ft
Top of Casing: 2675.69ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
		~~grades with quartz fragments and coarse sand~~
55	29	-grades with fine sand and rust stained schistose layers
60	68	-grades with medium grained sand and biotite, relict foliation
65	27	-grades with fine grained sand and trace coarse sand
70	29	-grades dark brown with trace clay
75	31	-grades with fine sand, less clay, lighter color, relict foliation
80	69	-grades darker with coarse sand, micaceous
85	53	-grades wet, micaceous, relict foliation
90	68	-grades to gray and black gneissic banding, wet
95	50/2	
		End of Boring at 96.0 feet
100		

PIEZOMETER DIAGRAM



Completion Depth: 96.0 ft
DATE: 4/21/98

Depth to Water: 84.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______ Signature of Field Agent

LOG OF BORING: P-6S

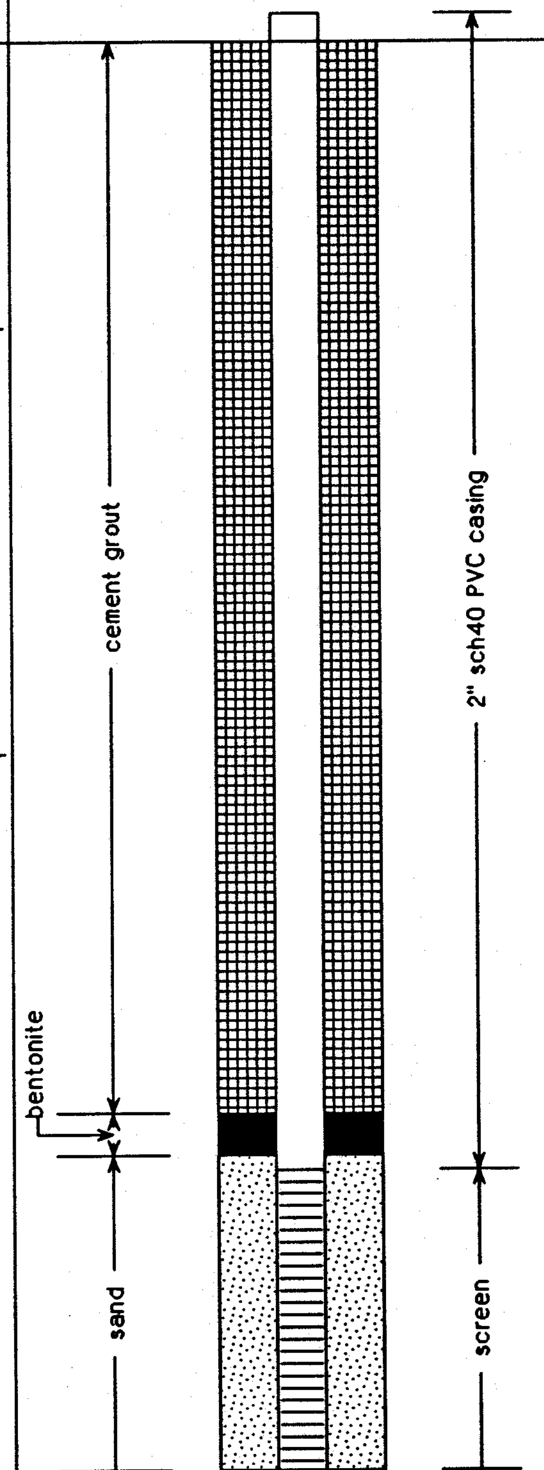
Project: Haywood County
Project No. 698010.5
T[illegible] HSA RB

Drilling Contractor: Engineering Tectonics
Registration Number:

Surface Elevation: 2612.40ft
Top of Casing: 2615.15ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
5	24	SAPROLITE; orange-red silt w/some sand, micaceous, ferrous stains. Moist.
10	23	SAPROLITE; orange-brown sandy silt, micaceous, ferrous stains. Moist.
15	85	SAPROLITE; orange-brown-gray sandy silt, micaceous, ferrous stains & PWR fragments at the bottom of the sample.
20	50/4"	SAPROLITE; orange-gray-brown sandy micaceous silt w/PWR fragments. Moist. Ferrous stains in last 6" of the sample at the angle of 45 degrees.
25	38	SAPROLITE; gray-white-brown mottled silt w/some small black stained spots & mica. Moist. Some ferrous stained material in the middle of the sample.
30	35	Same as the last sample. Bedding observed at angle of 45 degrees. Moist.
35	50/5"	SAPROLITE; brown-tan micaceous silt w/some sand, iron/ferrous stains. Moist.
40	50/3"	SAPROLITE; brown-black or gray micaceous silt w/stains. Moist. - Hard drilling starts.
45	50/6"	SAPROLITE; brown, balck, tan micaceous silt w/sand & stains. Moist. - Water first observed while drilling.
50	50/5" 25/0"	

PIEZOMETER DIAGRAM



Completion Depth: 54.5 ft
DATE: 12/20/1999

Depth to Water: 49.1 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

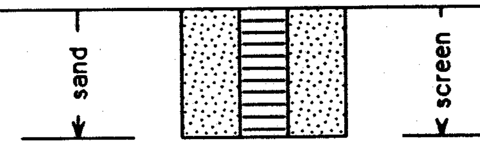
I acknowledge that this record is true to the best of my knowledge: Kohei Yoshida
Signature of Field Agent

LOG OF BORING: P-6S

Project: Haywood County
Project No. G98010.5
T[illegible] HSA RB

Drilling Contractor: Engineering Tectonics
Registration Number:

Surface Elevation: 2612.40ft
Top of Casing: 2615.15ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	PIEZOMETER DIAGRAM
				Brown, black, orange sandy silt w/mica & PWR fragments. Wet.	
55				End of Boring at Auger Refusal 54.5 feet	
60					
65					
70					
75					
80					
85					
90					
95					
100					

Completion Depth: 54.5 ft
DATE: 12/20/1999

Depth to Water: 49.1 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: Kohei Yoshida
Signature of Field Agent

LOG OF BORING: P-6D

Project: Haywood County
Project No. G98010.5
T[illegible] HSA RB

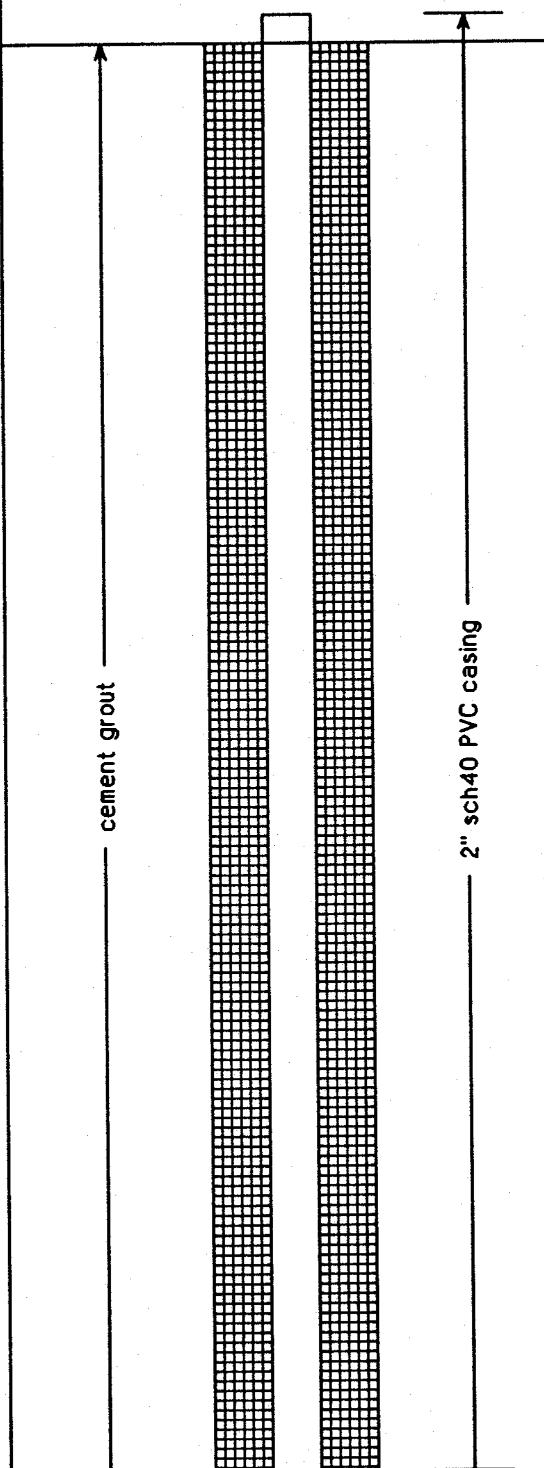
Drilling Contractor: Engineering Tectonics
Registration Number:

Surface Elevation: 2613.21ft
Top of Casing: 2615.72ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
				Air drilled w/o any sampling

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

PIEZOMETER DIAGRAM



Completion Depth: 77.17 ft
DATE: 1/6/2000

Depth to Water: 49.1 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________ Signature of Field Agent

LOG OF BORING: P-6D

Project: Haywood County
Project No. G98010.5
T[illegible]HSA RB

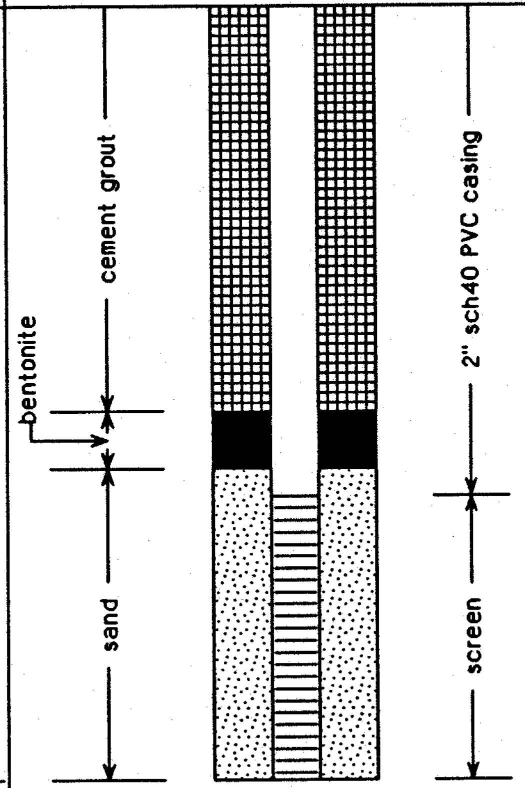
Drilling Contractor: Engineering Tectonics
Registration Number:

Surface Elevation: 2613.21ft
Top of Casing: 2615.72ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
55–57.17				Hit rock at 57.17 ft.
57.17				REC=91.875%, RQD=14.16% Gneiss, quartz, muscovite, biotite foliation. 40 degree dip increasing quartz content downward. Breaks along foliation. Iron stained.
				Slightly weathered from 57.2 to 64.7 ft.
				REC=91.875%, RQD=46.25% Gneiss, same as above.
77.17				End of Boring at 77.17 feet

Depth scale: 55, 60, 65, 70, 75, 80, 85, 90, 95, 100

PIEZOMETER DIAGRAM



Completion Depth: 77.17 ft
DATE: 1/6/2000

Depth to Water: 49.1 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.
I acknowledge that this record is true to the best of my knowledge: Kohei Yoshi[illegible]
Signature of Field Agent

LOG OF BORING: P1-1S

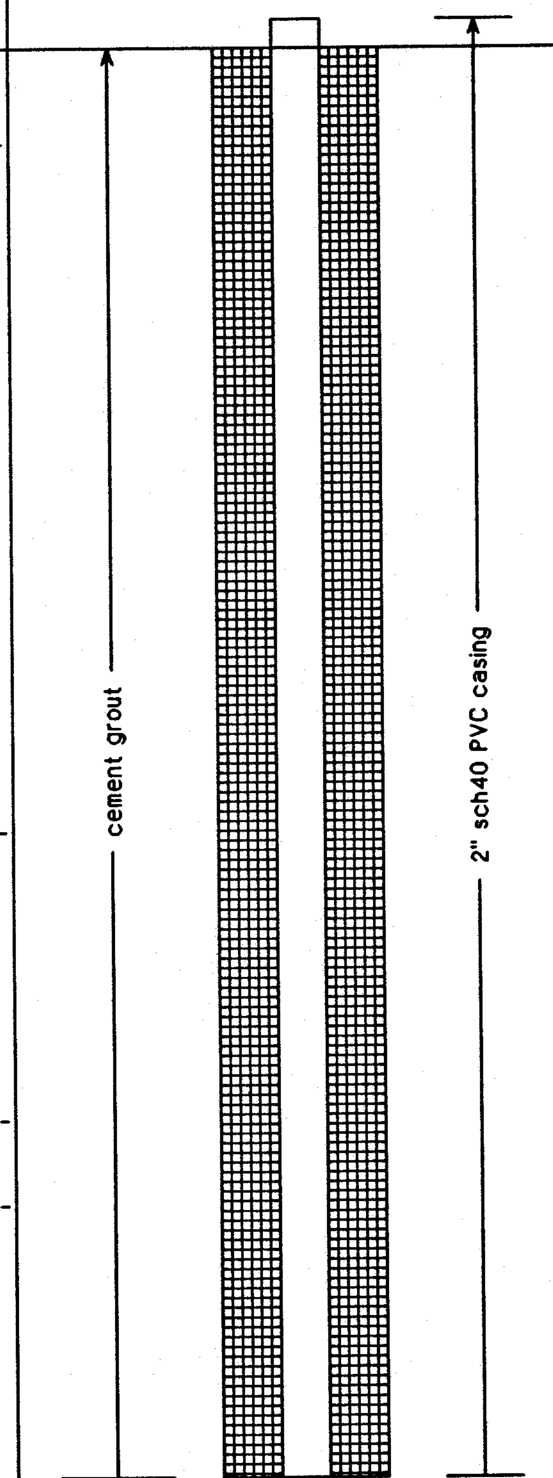
Project: Haywood County
Project No. G98010.6
Type: A/R,A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2626.20ft
Top of Casing: 2628.07ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
	6	CLAY (CL); red-brown, trace silt and sand, micaceous, some root debris and topsoil
5	11	SILT (ML); pink, with sand, relict structure, rust and iron staining, micaceous
10	16	-grades light brown to pink, relict structure, iron and rust staining on thin fractures, micaceous
15	23	-grades red, with zones of orange and yellow, some sand, trace clay, relict foliations
20	35	-grades tan to light red, weathered gneissic structure
25	18	-grades dark, trace sand, schistose structure, iron stained fracture
30	19	SILTY SAND (SM); brown to reddish orange, relict foliation at 30 degrees, white mottles
35	64	-grades dark brown with rust staining, zones of white silt, relict gneissic structure
40	77	SAND (SM); with silt, gray, relict structure
		PARTIALLY WEATHERED ROCK; relict structure, hard drilling
45	ref/5.5	-grades light tan, coarse sand and rock fragments, felsic gneiss
50	50/4	-weathered gneiss, rust stained zones, coarse sand, metacrystalline structure, wet

PIEZOMETER DIAGRAM



Completion Depth: 68.0 ft
DATE: 3/30/99

Depth to Water: 50.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________ Signature of Field Agent

LOG OF BORING: P1-1S

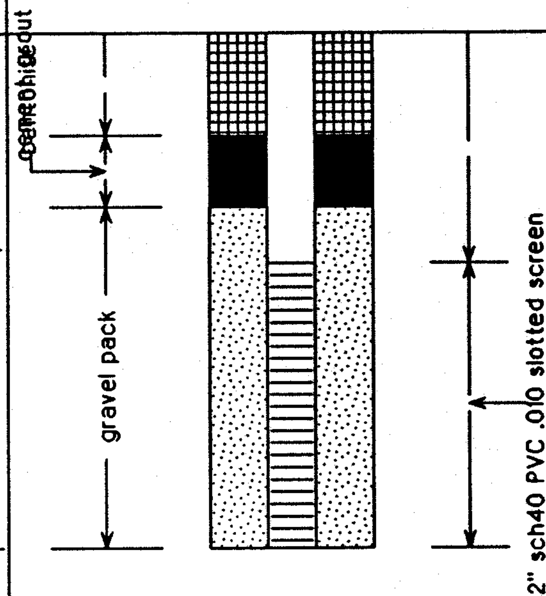
Project: Haywood County
Project No. G98010.6
T[illegible] A/R,A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2626.20ft
Top of Casing: 2628.07ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
55	50/5		X	-dark brown, heavily weathered mica zone, iron and rust staining, relict foliation
				SILTY SAND (SM); orange, white and black mottles, zones of fine mica, relict structure
60	36		X	
65	20		X	-gray and white weathered gneissic structure, quartz vein
				End of Boring at 68.0
70				
75				
80				
85				
90				
95				
100				

PIEZOMETER DIAGRAM



Completion Depth: 68.0 ft
DATE: 3/30/99

Depth to Water: 50.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.
I acknowledge that this record is true to the best of my knowledge: ______ Signature of Field Agent

LOG OF BORING: P1-1D

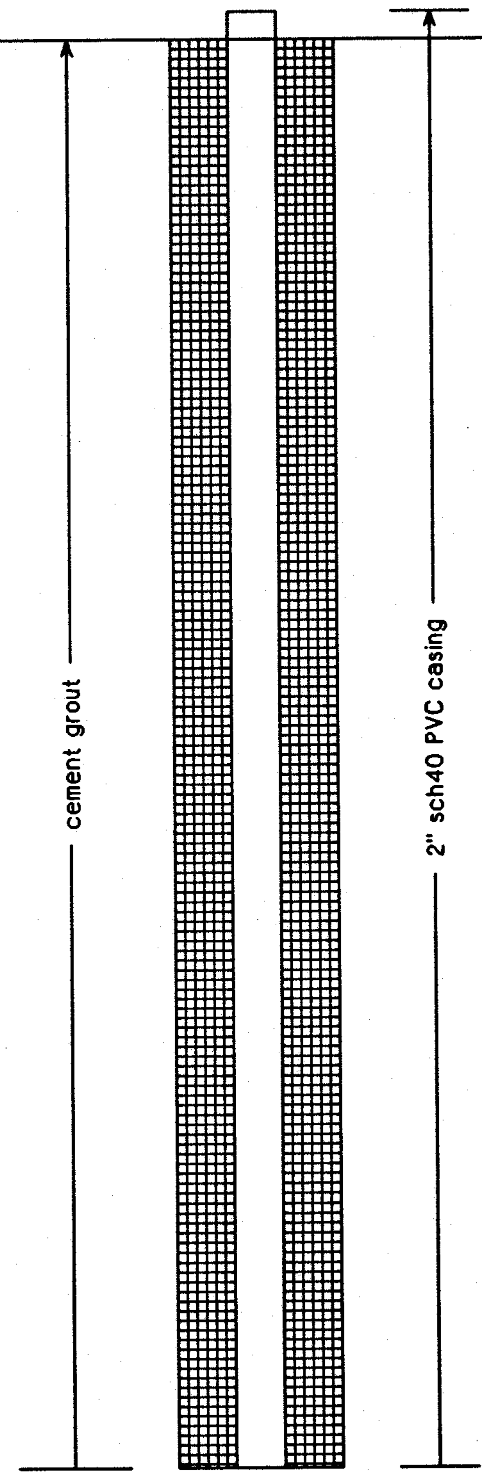
Project: Haywood County
Project No. G98010.6
T[illegible]A/R,A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2625.52ft
Top of Casing: 2627.68ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	6		X	CLAY (CL); red-brown, trace silt and sand, micaceous, some root debris and topsoil
5	11		X	SILT (ML); pink, with sand, relict structure, rust and iron staining, micaceous
10	16		X	-grades light brown to pink, relict structure, iron and rust staining on thin fractures, micaceous
15	23		X	-grades red, with zones of orange and yellow, some sand, trace clay, relict foliations
20	35		X	-grades tan to light red, weathered gneissic structure
25	18		X	-grades dark, trace sand, schistose structure, iron stained fracture
30	19		X	SILTY SAND (SM); brown to reddish orange, relict foliation at 30 degrees, white mottles
35	64		X	-grades dark brown with rust staining, zones of white silt, relict gneissic structure
40	77		X	SAND (SM); with silt, gray, relict structure
				PARTIALLY WEATHERED ROCK; relict structure, hard drilling
45	ref/5.5		X	-grades light tan, coarse sand and rock fragments, felsic gneiss
50	50/4		X	-weathered gneiss, rust stained zones, coarse sand, metacrystalline structure, wet

PIEZOMETER DIAGRAM



Completion Depth: 100.0 ft
DATE: 3/31/99

Depth to Water: 50.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______________
Signature of Field Agent

LOG OF BORING: P1-1D

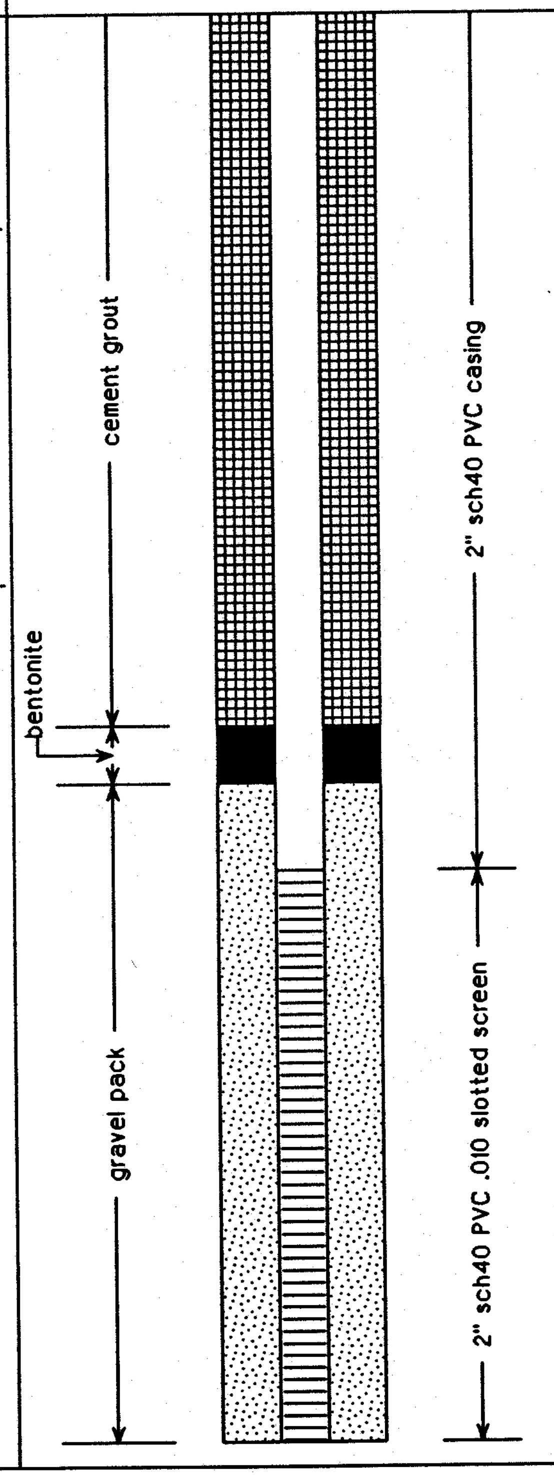
Project: Haywood County
Project No. G98010.6
T[illegible]: A/R,A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2625.52ft
Top of Casing: 2627.68ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
55	50/5	-dark brown, heavily weathered mica zone, iron and rust staining, relict foliation
60	36	SILTY SAND (SM); orange, white and black mottles, zones of fine mica, relict structure
65	20	-gray and white weathered gneissic structure, quartz vein
		Air Rotary Bit Refusal at 70 feet
70		REC=94.3% RQD=28.8%, Gneiss, light-colored, foliated meta-granitic structure, zonal variation, highly fractured w/ iron deposit
75		
80		
85		
90		
95		
100		

PIEZOMETER DIAGRAM



Completion Depth: 100.0 ft
DATE: 3/31/99

Depth to Water: 50.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: Kohi Yoshil
Signature of Field Agent

LOG OF BORING: P1-2S

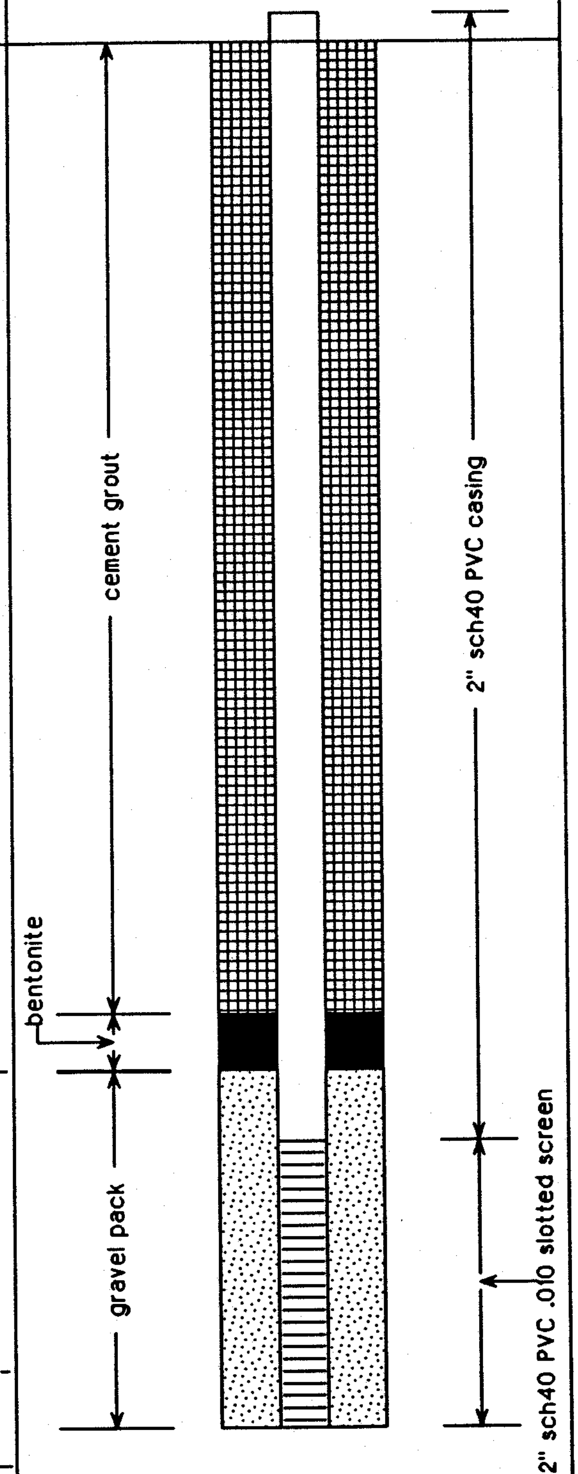
Project: Haywood County
Project No. G98010.6
T[illegible] A/R,A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2602.48ft
Top of Casing: 2604.01ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	9		X	Sandy Silt (ML); FILL MATERIAL, medium brown, no structure, few fragments
5	11		X	-FILL MATERIAL
10	15		X	-FILL MATERIAL
15	14		X	-FILL MATERIAL
20	13		X	-FILL MATERIAL
25	11		X	-FILL MATERIAL
30	13		X	-FILL MATERIAL
35	10		X	-FILL MATERIAL
				SILT (ML), dark brown to black, some root debris, original ground elevation
40	4		X	-medium brown, little structure, wet
				-rocky zone from 40-41 feet
45	8			
				SANDY SILT (ML); brown to gray, faint structure, abundant rust staining, small vertical fracture, some dark mica, wet
50				End of Boring at 48.5 feet

PIEZOMETER DIAGRAM



Completion Depth: 48.5 ft
DATE: 4/7/99

Depth to Water: 40.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________
Signature of Field Agent

LOG OF BORING: P1-2D

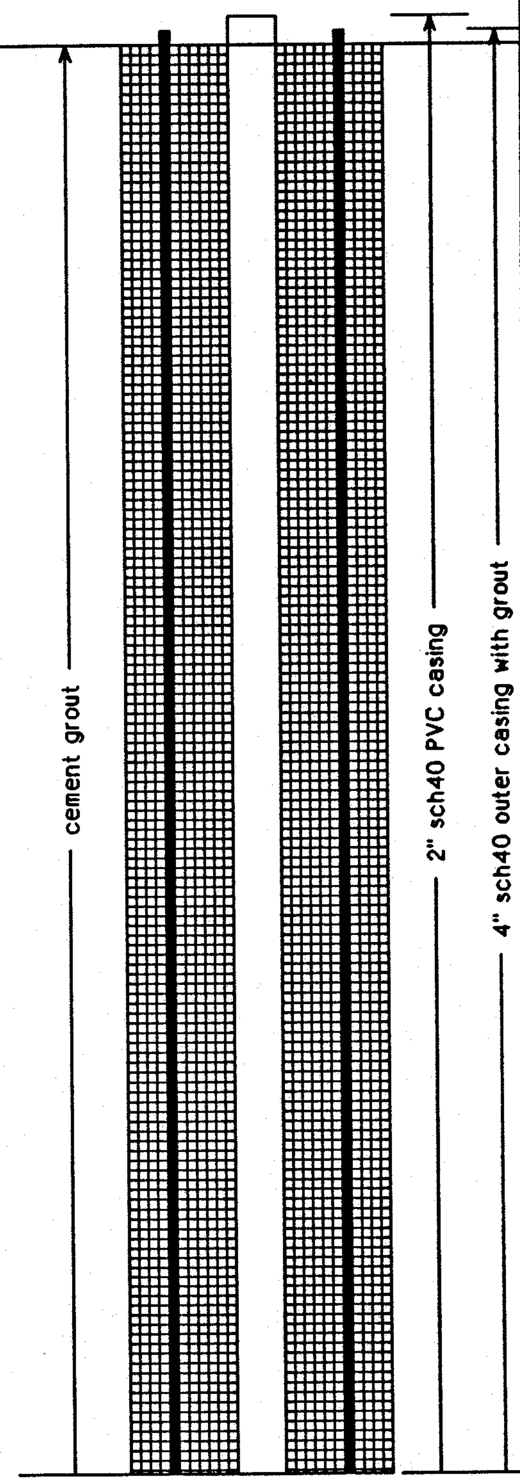
Project: Haywood County
Project No. G98010.6
T A/R,A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2603.09ft
Top of Casing: 2604.98ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	9		X	Sandy Silt (ML); FILL MATERIAL, medium brown, no structure, few fragments
5	11		X	-FILL MATERIAL
10	15		X	-FILL MATERIAL
15	14		X	-FILL MATERIAL
20	13		X	-FILL MATERIAL
25	11		X	-FILL MATERIAL
30	13		X	-FILL MATERIAL, moist
35	10		X	-FILL MATERIAL
				SILT (ML), dark brown to black, some root debris, original ground elevation
40	4		X	-medium brown, little structure, wet
45	8		X	
				SANDY SILT (ML); brown to gray, faint structure, abundant rust staining, small vertical fracture, some dark mica, wet
50	12		X	

PIEZOMETER DIAGRAM



Completion Depth: 79.25 ft
DATE: 4/7/99

Depth to Water: 39.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________
Signature of Field Agent

LOG OF BORING: P1-2D

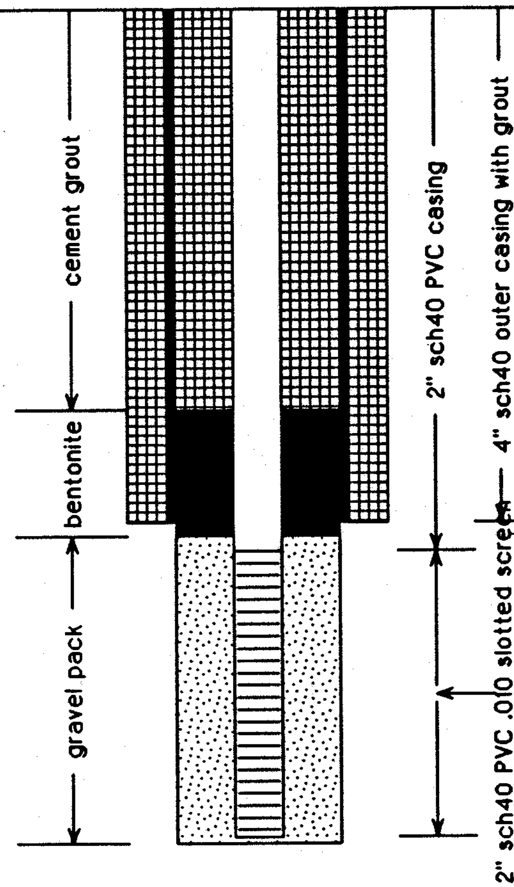
Project: Haywood County
Project No. G98010.6
T[illegible] A/R,A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2603.09ft
Top of Casing: 2604.98ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
55	24	-red-brown to gray, thinly layered weathered gneiss, some heavy rust staining, fine mica foliations
		-rocky zone
60	13	
65	17	
		Air Rotary Bit Refusal at 69.25 feet
70		REC=75.0% RQD=73.0% Gneiss; white, meta-granitic structure, weathered toward top, angled foliation
75		-zone of weathered saprolite, brown to yellow
80		End of Boring at 79.25 feet
85		
90		
95		
100		

PIEZOMETER DIAGRAM



Completion Depth: 79.25 ft
DATE: 4/7/99

Depth to Water: 39.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______________
Signature of Field Agent

LOG OF BORING: P1-3

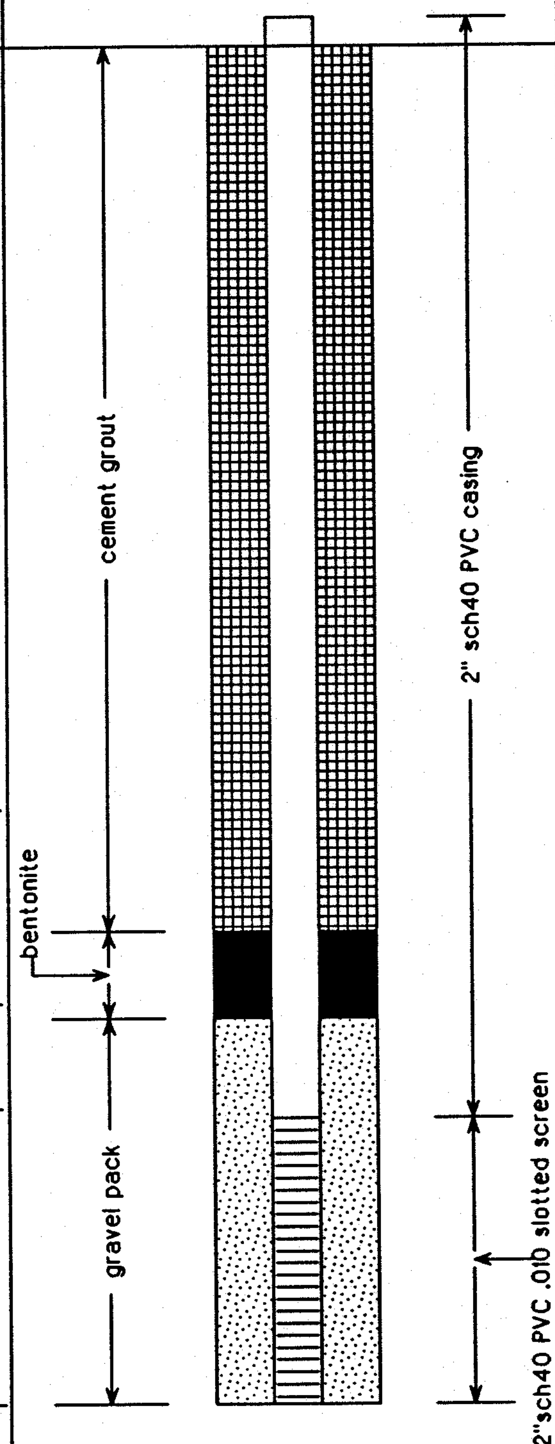
Project: Haywood County
Project No. G98010.6
T[illegible] A/R,A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2609.67ft
Top of Casing: 2612.35ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
	4	CLAYEY SILT (ML); medium brown-red, relict structure, some root debris and mica, few rock fragments
5	22	SANDY SILT (SM); tan and pink, zones of medium-grained mica, thinly layered, saprolite of metacrystalline parent material
10	18	-thickly layered mica and white sand-silt, heavy iron staining, some rust staining
15	18	-faint layering, trace mica, relict fractures with good iron staining, rust staining abundant
20	50/5.5"	PARTIALLY WEATHERED ROCK; dark gray-green weathered schist, red clay and iron staining on relict foliations and fractures
25	50/2"	-layered mica, saturated
30	29	SANDY SILT (SM); medium brown, faint relict structure, wet
35	ref/0	PARTIALLY WEATHERED ROCK
		Air Rotary Bit Refusal at 36.0 feet
40		REC=64.0% RQD=24.0%, Gneiss, 10 degree foliation and fractures, grades to massive green w/gray meta-crystalline.
		—noticeable weathering
45		-fracture perpendicular to foliation w/iron staining
50		End of Boring at 47.5 feet

PIEZOMETER DIAGRAM



Completion Depth: 47.5 ft
DATE: 4/13/99

Depth to Water: 24 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: Kohei Yoshida
Signature of Field Agent

LOG OF BORING: P1-4

Project: Haywood County
Project No. G98010.6
T[illegible] A/R,A/H,NX/NQ,SS

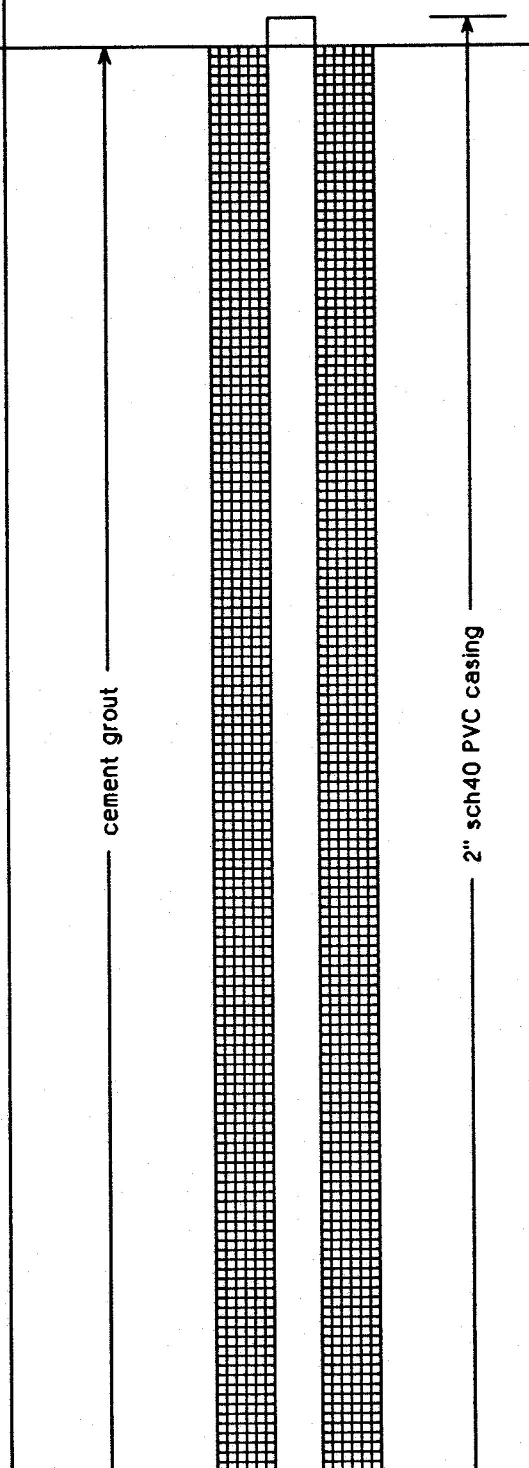
Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2610.78ft
Top of Casing: 2613.42ft

BLOWS PER FOOT	SAMPLES	DESCRIPTION OF MATERIAL
4	X	SILT (ML); medium to dark brown, some medium and coarse sand, faint gneissic structure
11	X	SANDY SILT (SM); tan to gray, some coarse sand, banded with white silt and fine sand, faint relict structure
40	X	-tan to white, thin fracture with iron staining, zones of weathered mica schist
49	X	-dark brown, fine to medium sand, near vertical relict fractures with rust staining, weathered schist texture
28	X	-weathered massive metacrystalline, faint layering
46	X	-thick layered schist with iron and rust stains, zones of white medium sand and silt, moist
60	X	-some coarse sand, trace clay, moist
54	X	-less layering, moist
27	X	
		-rocky zone from 40-41 feet
ref/4"	X	-few fragments, weathered gneiss

DEPTH (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

PIEZOMETER DIAGRAM



Completion Depth: 72.0 ft
DATE: 4/12/99

Depth to Water: 39.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.
I acknowledge that this record is true to the best of my knowledge: ____________
Signature of Field Agent

LOG OF BORING: P1-4

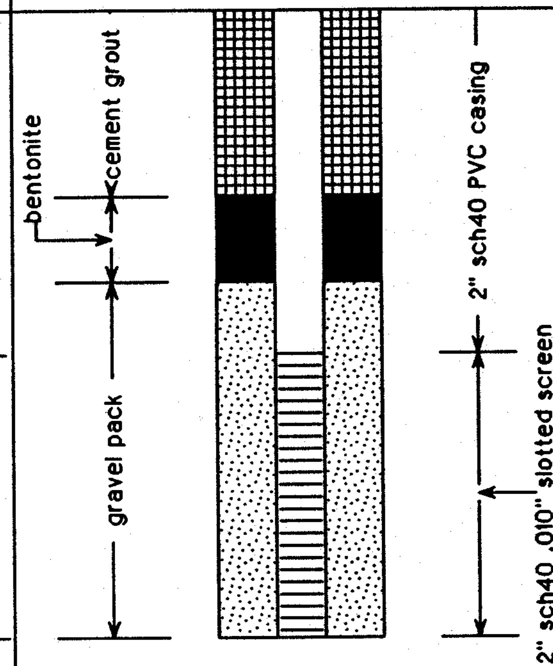
Project: Haywood County
Project No. 698010.6
T[illegible] A/R,A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2610.78ft
Top of Casing: 2613.42ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
55				
60				Air Rotary Bit Refusal at 62.0 feet
65				REC=100% RQD=70.0% gneiss; light-colored meta-granitic structure, 45 degree micaceous foliation, mixture of lateral and angled fractures
				weathering w/trace amount of iron staining
70				high-angled fracture w/iron staining
75				End of Boring at 72.0 feet
80				
85				
90				
95				
100				

PIEZOMETER DIAGRAM



Completion Depth: 72.0 ft
DATE: 4/12/99

Depth to Water: 39.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______________
Signature of Field Agent

LOG OF BORING: P1-5S

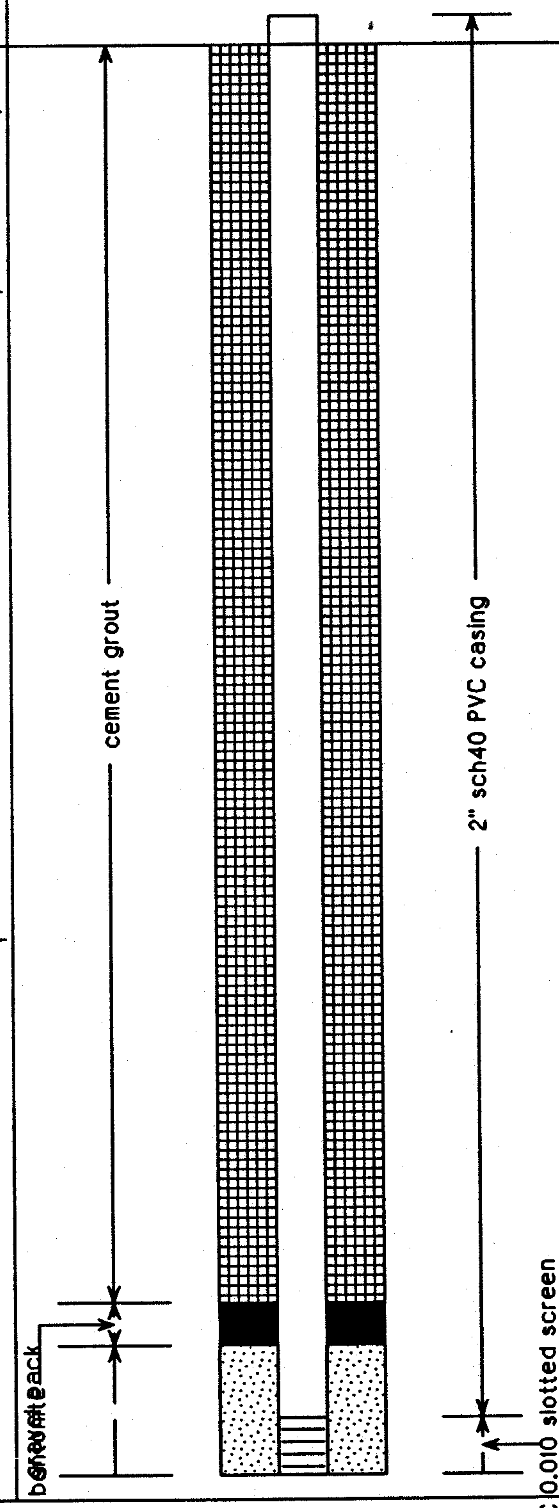
Project: Haywood County
Project No. G98010.6
[illegible]: A/R,A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2633.21ft
Top of Casing: 2636.07ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
	5	CLAY (CL); red, with silt, some root debris, no structure
	9	SILT (ML); pink and white, with fine sand, trace clay, very faint relict structure
5		-hard drilling, rock fragments of metacrystalline and white quartz
	10	SAND (SM);white and gray, fine to medium grained, trace coarse, rust stained pits, faint gneissic structure
10		
	20	-grades with white sand, relict vein apparent, no structure
15		
		-hard drilling from 18-20 feet, rock fragments of metacrystalline and thick, fractured quartz
20		
	26	-white-yellow, medium to coarse grained, with trace rock fragments, grades to brown sand and silt with relict schistosity
25		
	91	-relict foliations at 30 to 45 degrees
30		
	19	SILT (ML); dark brown to yellow, rust staining throughout, faint relict structure, relcit fracture at 45 degrees with iron and rust staining
35		
	71	-quartz vein from 39-41 feet
40		
	27	
45		
	50/5"	-white to gray, dense, trace mica and fine sand, faint structure, wet
50		-Air Rotary Bit Refusal at 51.0 feet

PIEZOMETER DIAGRAM



Completion Depth: 58.0 ft
DATE: 3/25/99

Depth to Water: 49.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

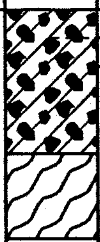
I acknowledge that this record is true to the best of my knowledge: [signature]
Signature of Field Agent

LOG OF BORING: P1-5S

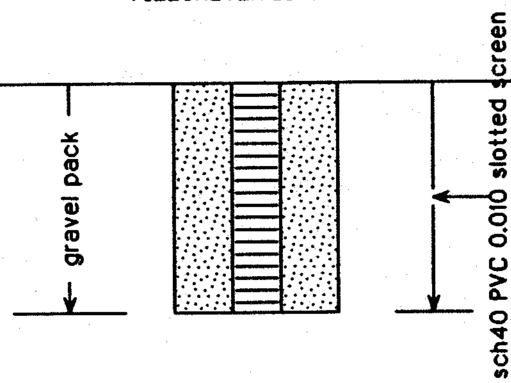
Project: Haywood County
Project No. G98010.6
T[illegible] A/R,A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2633.21ft
Top of Casing: 2636.07ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
				-PWR, A/H irregular
55				-competent rock, A/H constant
				End of Boring at 58.0 feet
60				
65				
70				
75				
80				
85				
90				
95				

PIEZOMETER DIAGRAM



Completion Depth: 58.0 ft
DATE: 3/25/99

Depth to Water: 49.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______ Signature of Field Agent

LOG OF BORING: P1-5D

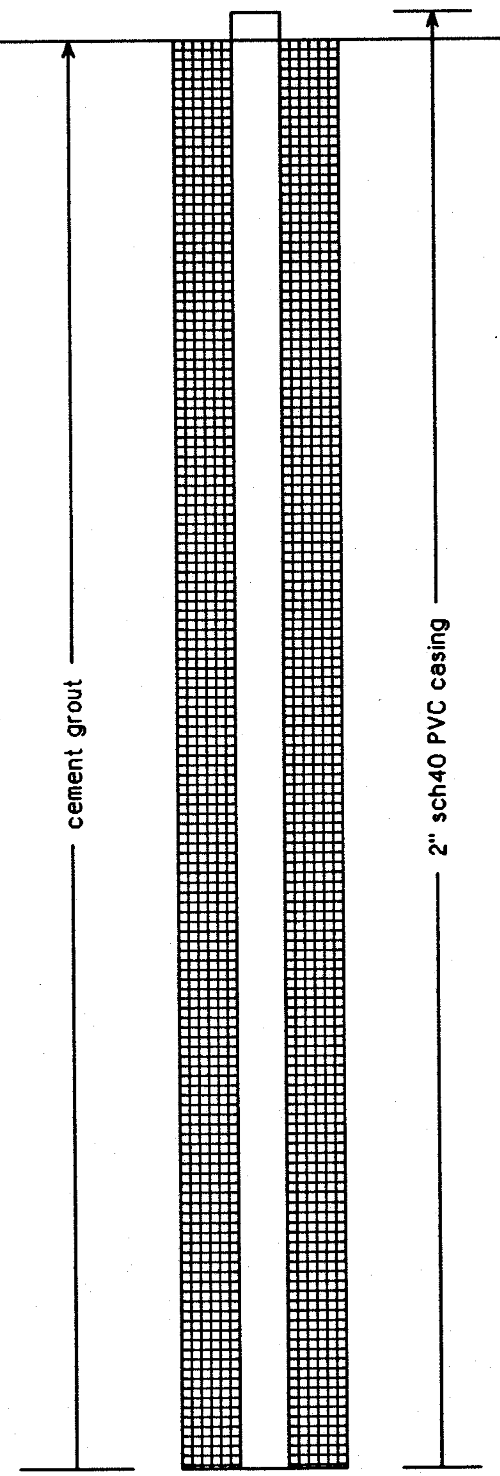
Project: Haywood County
Project No. G98010.6
T[illegible] A/R,A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2633.21ft
Top of Casing: 2635.45ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	5		X	CLAY (CL); red, with silt, some root debris, no structure
5	9		X	SILT (ML); pink and white, with fine sand, trace clay, very faint relict structure
10	10		X	SAND (SM); white and gray, fine to medium grained, trace coarse, rust stained pits, faint gneissic structure
15	20		X	-grades with white sand, relict vein apparent, no structure
20				-hard drilling from 18-20 feet, rock fragments of metacrystalline and thick, fractured quartz
25	26		X	-white to yellow, medium to coarse grained, with trace rock fragments, grades to brown sand and silt with relict schistosity
30	91		X	-relict foliations at 30 to 45 degrees
35	19		X	SILT (ML); dark brown to yellow, rust staining throughout, faint relict structure, relict fracture at 45 degrees with iron and rust staining
40	71		X	-quartz vein from 39-41 feet
45	27		X	
	50/5"		X	-white to gray, dense, trace mica and fine sand, faint structure, wet

PIEZOMETER DIAGRAM



Completion Depth: 78.5 ft
DATE: 3/24/99

Depth to Water: 49.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______________ Signature of Field Agent

LOG OF BORING: P1-5D

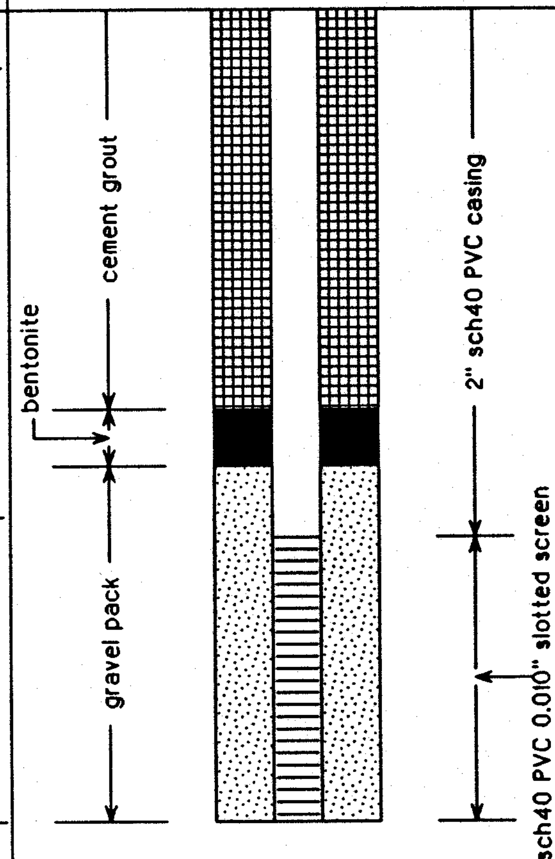
Project: Haywood County
Project No. G98010.6
T[illegible]A/R,A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2633.21ft
Top of Casing: 2635.45ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
				Air Rotary Bit Refusal at 51.0 feet
				-PWR, A/H irregular
55				-compentent rock, A/H constant
				-PWR, A/H irregular, with rust stained quart fragments
60				-competent rock, A/H constant
65				-quartz vein with rust staining
70				REC=45.0% RQD=42.0% Gneiss; white and black mica layers, 45 degree fractures.
				—dark-colored, zone of schist and gneiss w/thin foliation
75				REC=100.0% RQD=74.0% grades to more massive with few white layers.
80				End of Boring at 78.50 feet
85				
90				
95				

PIEZOMETER DIAGRAM



Completion Depth: 78.5 ft
DATE: 3/24/99

Depth to Water: 49.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.
I acknowledge that this record is true to the best of my knowledge: Kohei Yoshida
Signature of Field Agent

LOG OF BORING: P1-6

Project: Haywood County
Project No. 698010.6
Type: A/R,A/H,SS

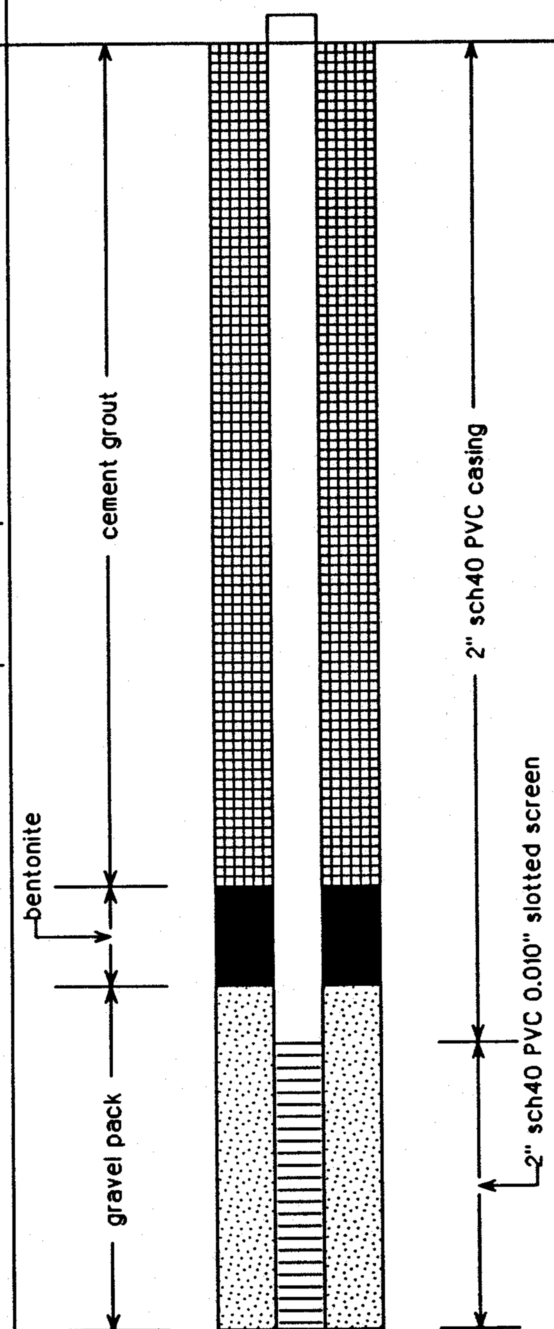
Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2589.77ft
Top of Casing: 2592.18ft

BLOWS PER FOOT	DESCRIPTION OF MATERIAL
7	SANDY SILT (SM); medium brown, some coarse grains, trace clay, no apparent structure, FILL MATERIAL
10	-FILL MATERIAL
10	-FILL MATERIAL
15	-dark brown to black, no structure, root debris apparent, original land surface
13	SILT (ML); red-brown, with sand, medium and fine-grained mica, weathered massive texture, relict foliations, abundant rust staining
11	SILTY SAND (SM); brown, some fine mica, metacrystalline texture, zone of white silt and coarse quartz sand, relict crystals, rust staining
11	-more zonal variation, gneissic texture
11	-weathered crystals replaced with fine, brown mica, wet
25	
	End of Boring at 45.0 feet

DEPTH (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

PIEZOMETER DIAGRAM



Completion Depth: 45.0 ft
DATE: 4/9/99

Depth to Water: 34.5 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: Kohei Yoshida
Signature of Field Agent

LOG OF BORING: P1-7S

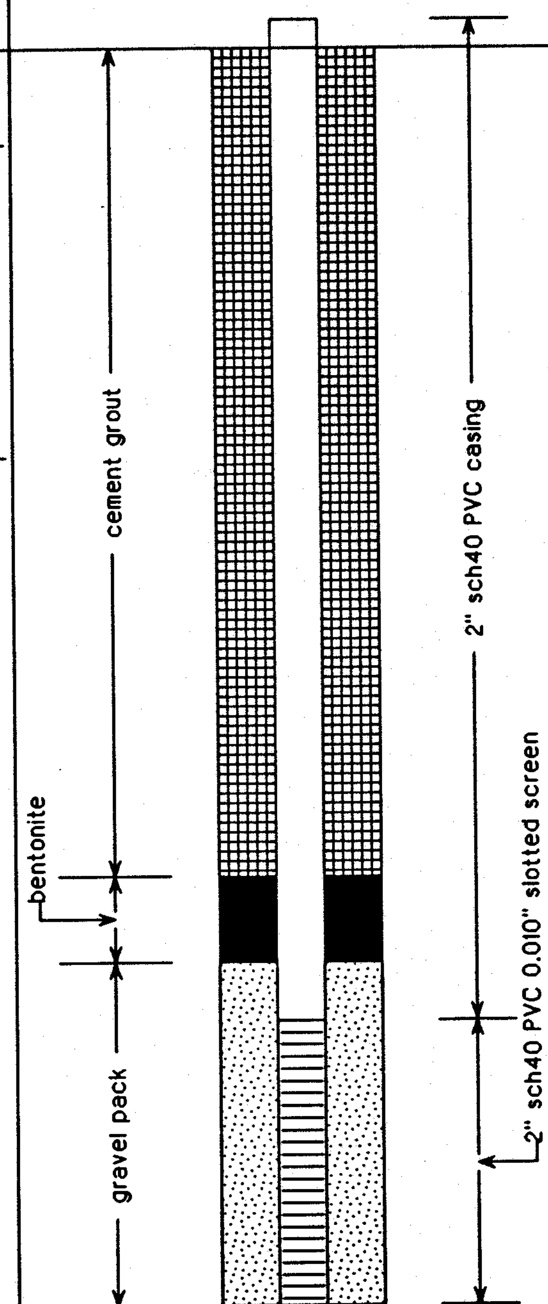
Project: Haywood County
Project No. G98010.6
Ty[illegible]/R,A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2575.00ft
Top of Casing: 2576.76ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
0–2.5	6	CLAY (CL); red-brown clay, with silt and fine sand, very faint relict structure, trace root debris
2.5–13	10	SANDY SILT (SM); medium brown to orange, micaceous, relict crstals, good relict structure, saprolite of layered schist and gneiss
		-hard drilling 7.5 to 8.5 feet
	9	-weathered metacrystalline texture, some rust and iron staining
		-Air Rotary Bit Refusal at 13.0 feet
13–44		GNEISS, A/H constant, fractured gniessic boulder
		-A/H irregular, brown soil and rock fragments
		-A/H constant
		-A/H irregular
		-A/H constant
25	50/4"	
		-fracture
		-fracture
		-water bearing fracture set
44		End of Boring at 44.0 feet

PIEZOMETER DIAGRAM



Completion Depth: 44.0 ft
DATE: 3/31/99

Depth to Water: 41.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.
I acknowledge that this record is true to the best of my knowledge: Kohei Yoshida
Signature of Field Agent

LOG OF BORING: P1-7D

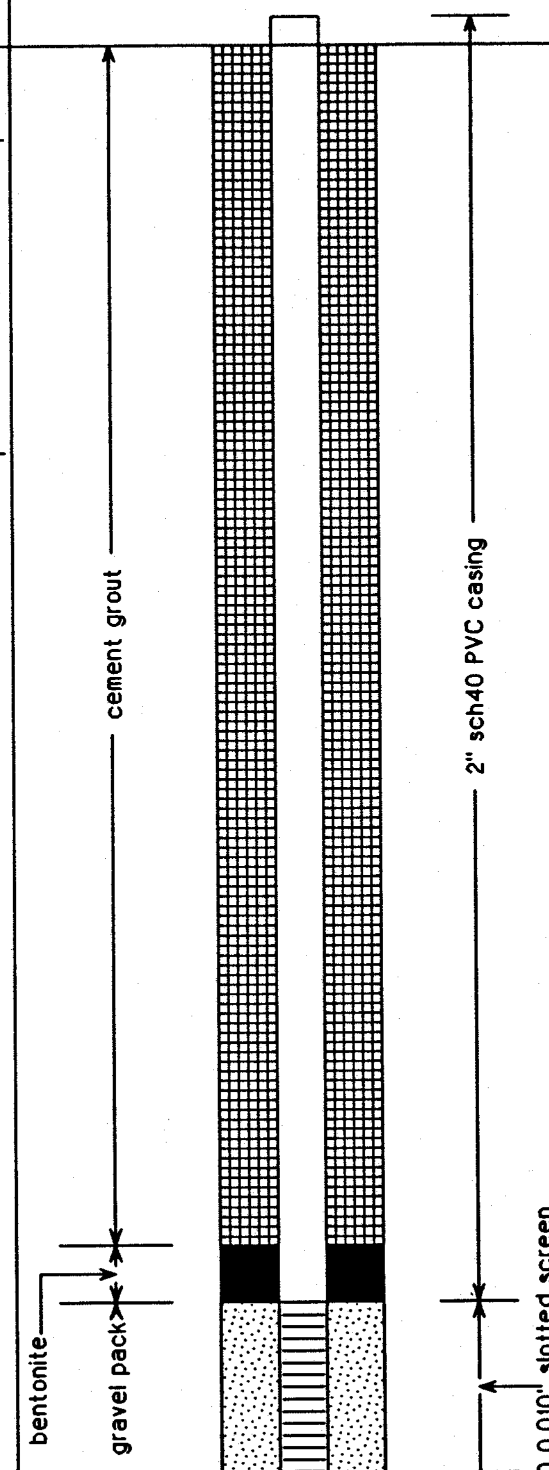
Project: Haywood County
Project No. G98010.6
Type: A/R,A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2575.00ft
Top of Casing: 2575.97ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
	6	CLAY (CL); red-brown clay, with silt and fine sand, very faint relict structure, trace root debris
5	10	SANDY SILT (SM); medium brown to orange, micaceous, relict crstals, good relict structure, saprolite of layered schist and gneiss
		-hard drilling 7.5 to 8.5 feet
10	9	-weathered metacrystalline texture, some rust and iron staining
		-Air Rotary Bit Refusal at 13.0 feet
15		GNEISS, A/H constant, fractured gneissic boulder
		-A/H irregular, brown soil and rock fragments
		-A/H constant
20		-A/H irregular
25	50/4"	-A/H constant
30		-fracture
35		
		-fracture
40		-water bearing fracture set
		-fracture set
45		-fracture

PIEZOMETER DIAGRAM



Completion Depth: 54.0 ft
DATE: 4/5/99

Depth to Water: 41.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: Kohei Yoshida
Signature of Field Agent

LOG OF BORING: P1-7D

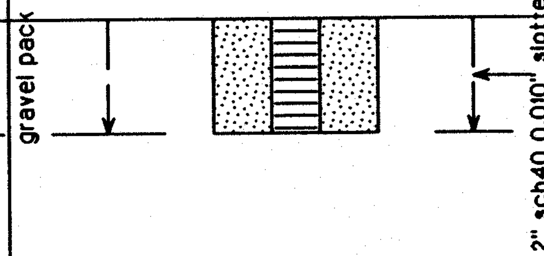
Project: Haywood County
Project No. G98010.6
Ty[illegible]/R,A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2575.00ft
Top of Casing: 2575.97ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
55				End of Boring at 54.0 feet
60				
65				
70				
75				
80				
85				
90				
95				

PIEZOMETER DIAGRAM



Completion Depth: 54.0 ft
DATE: 4/5/99

Depth to Water: 41.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________
Signature of Field Agent

LOG OF BORING: P1-8S

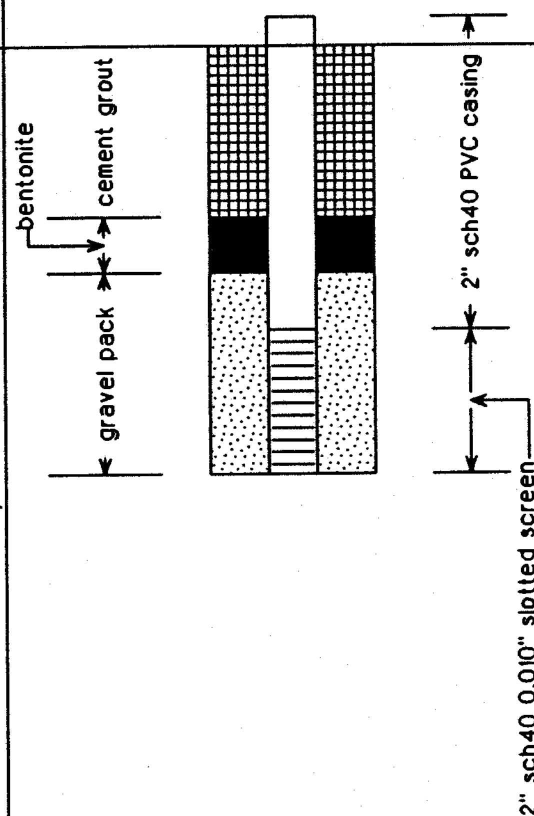
Project: Haywood County
Project No. G98010.6
T[illegible]A/R.A/H,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2534.02ft
Top of Casing: 2536.11ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	5			SILT (ML); dark brown, some organics, with sand, few fragments of weathered metagranite
5	3			SANDY SILT (SM); orange to gray, weathered metacrystalline rock, wet
10	4			-good relict metacrystalline structure, abundant rust staining, trace fine mica
15	6			-yellow-white with gray micaceous weathered crystals, iron and rust staining throughout, saturated
				End of Boring at 15.0 feet
20				
25				
30				
35				
40				
45				

PIEZOMETER DIAGRAM



Completion Depth: 15.0 ft
DATE: 4/5/99

Depth to Water: 2.5 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.
I acknowledge that this record is true to the best of my knowledge: ____________ Signature of Field Agent

LOG OF BORING: P1-8D

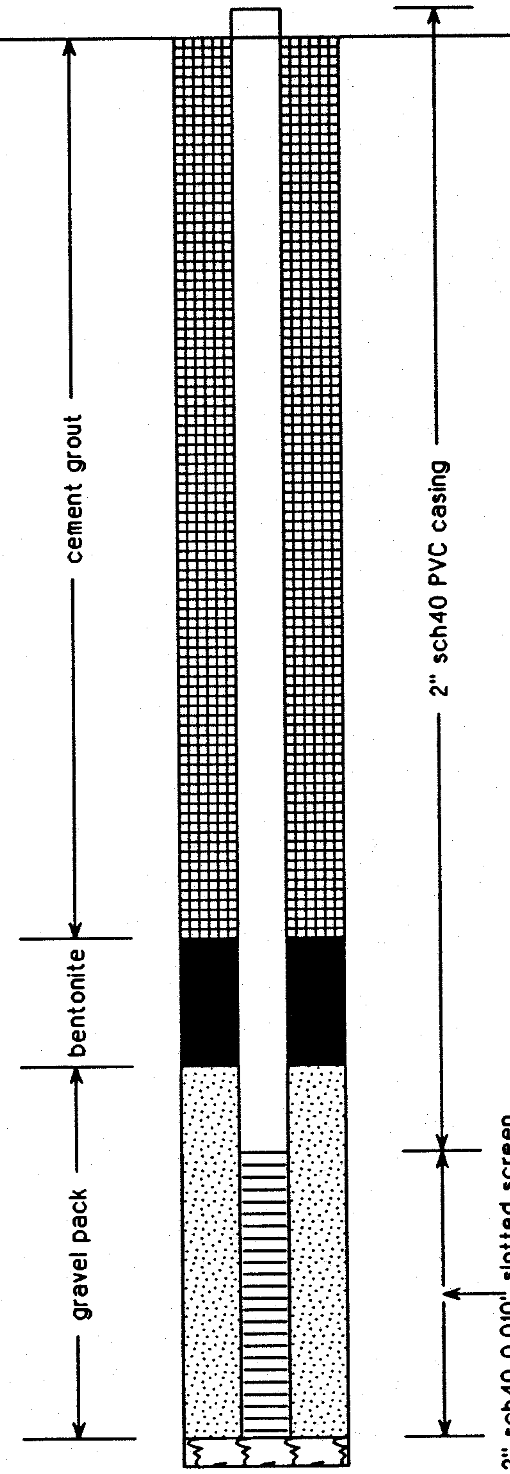
Project: Haywood County
Project No. G98010.6
T A/R.A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2533.52ft
Top of Casing: 2534.65ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	5		X	SILT (ML); dark brown, some organics, with sand, few fragments of weathered metagranite
	3		X	SANDY SILT (SM); orange to gray, weathered metacrystalline rock, wet
5				
	4		X	-good relict metacrystalline structure, abundant rust staining, trace fine mica
10				
	6		X	-yellow to white with gray micaceous weathered crystals, iron and rust staining throughout, saturated
15				
	13		X	-dark brown and black, relict structure highly weathered gneiss and schist, zones of weathered quartz, saturated
20				
	11		X	-tan to gray, micaceous, zones of white weathered quartz, medium sand, trace coarse, faint relict foliation,
25				
	18		X	-little recovery, quartz with rust staining
30				
				-no sample taken due to collapsing annular
35				
40				Air Rotary Bit Refusal at 42.0 feet
				REC=88.0% RQD=34.0%, Gneiss, highly weathered, 30 degree iron stained fractures with foliation.
45				REC=87.0% RQD=69.0%, Gneiss, 60 degree foliation and fractures, grades to less gneissic structure and more meta-crystalline.
50				-brown to yellow, weathered saprolite to heavily fractured gneiss w/iron deposit

PIEZOMETER DIAGRAM



Completion Depth: 52.0 ft
DATE: 4/6/99

Annular space collapsed up to 49.0 feet

Depth to Water: 2.5 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________ Signature of Field Agent

LOG OF BORING: P1-8D

Project: Haywood County
Project No. G98010.6
T[illegible]A/R.A/H,NX/NQ,SS

Drilling Contractor: Engineering Tectonics
Registration Number: 835

Surface Elevation: 2533.52ft
Top of Casing: 2534.65ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	PIEZOMETER DIAGRAM
				-yellowish heavily weathered saprolite	
				End of Boring at 52 feet	
55					
60					
65					
70					
75					
80					
85					
90					
95					

Completion Depth: 52.0 ft
DATE: 4/6/99

Depth to Water: 2.5 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________ Signature of Field Agent

LOG OF BORING: P2-1

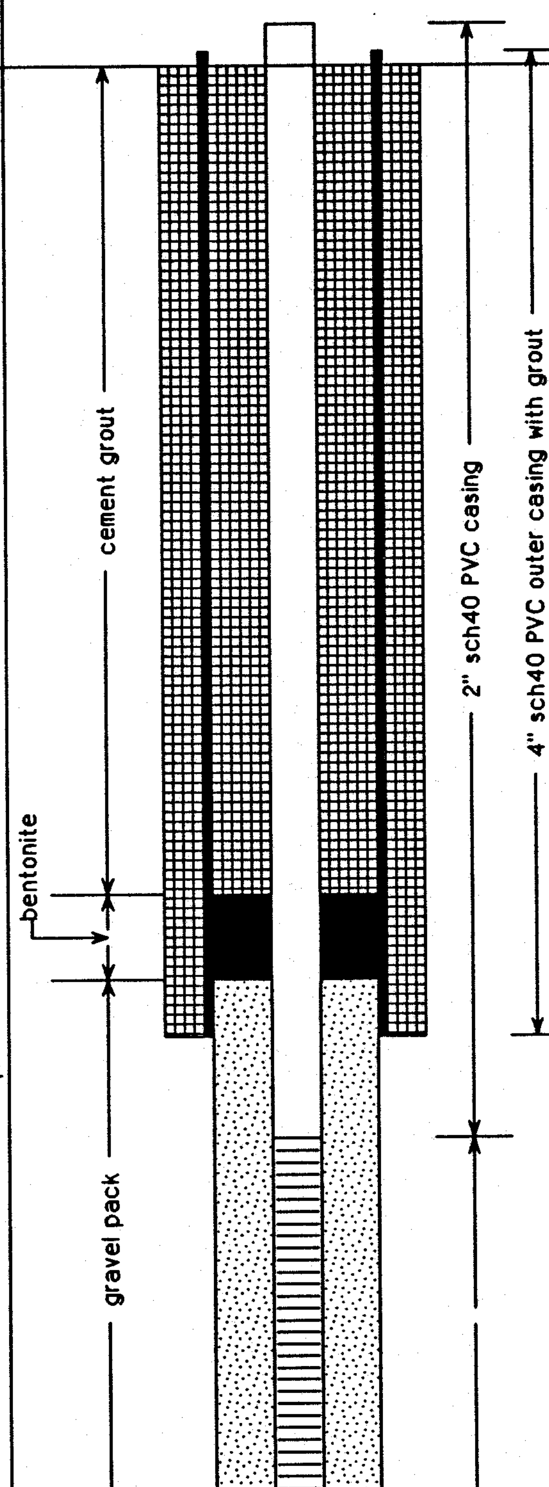
Project: Haywood County
Project No. G98010.5
T[illegible]HSA SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2572.74ft
Top of Casing: 2575.93ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
	6	SILTY SAND (SM); brown to dark brown, some clay, root debris
5	7	-brown, with medium grained sand, some mica and trace clay, some root debris
10	11	-grades stiff, with medium to coarse grained sand and mica
15	24	-red to brown, very stiff, grades with more coarse grained sand, relict foliations, zones of clayey sand
20	26	-grades with less sand, trace clay
		-grades olive brown, silty, some clay
25	39	-salt and pepper color, dense, medium to coarse grained, some gravel, near vertical clay-filled fracture, saprolite
30	57	-grades very dense, rock fragments, gneissic structure, grades to orange weathered rock, quartz grains with sand and silt, biotite layer
35		-Auger Refusal at 34.0 feet
		GNEISS; quartz, plagioclase, and mafic minerals, faint banding fractures at 30 degrees, REC=92%, RQD=79%
		-highly weathered zone, REC=59%, RQD=0%
40		-REC=85%, RQD=52%
45		-slightly weathered, fractures parallel to banding at 30 degrees REC=100%, RQD=92%

PIEZOMETER DIAGRAM



Completion Depth: 52.5 ft
DATE: 5/21/98

Depth to Water: 37 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

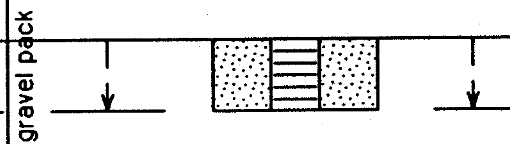
I acknowledge that this record is true to the best of my knowledge: ______________________
Signature of Field Agent

LOG OF BORING: P2-1

Project: Haywood County
Project No. G98010.5
T[illegible] HSA SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2572.74ft
Top of Casing: 2575.93ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	PIEZOMETER DIAGRAM
				End of Boring at 52.5 feet	
55					
60					
65					
70					
75					
80					
85					
90					
95					

Completion Depth: 52.5 ft
DATE: 5/21/98

Depth to Water: 37 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______ Signature of Field Agent

LOG OF BORING: P2-2

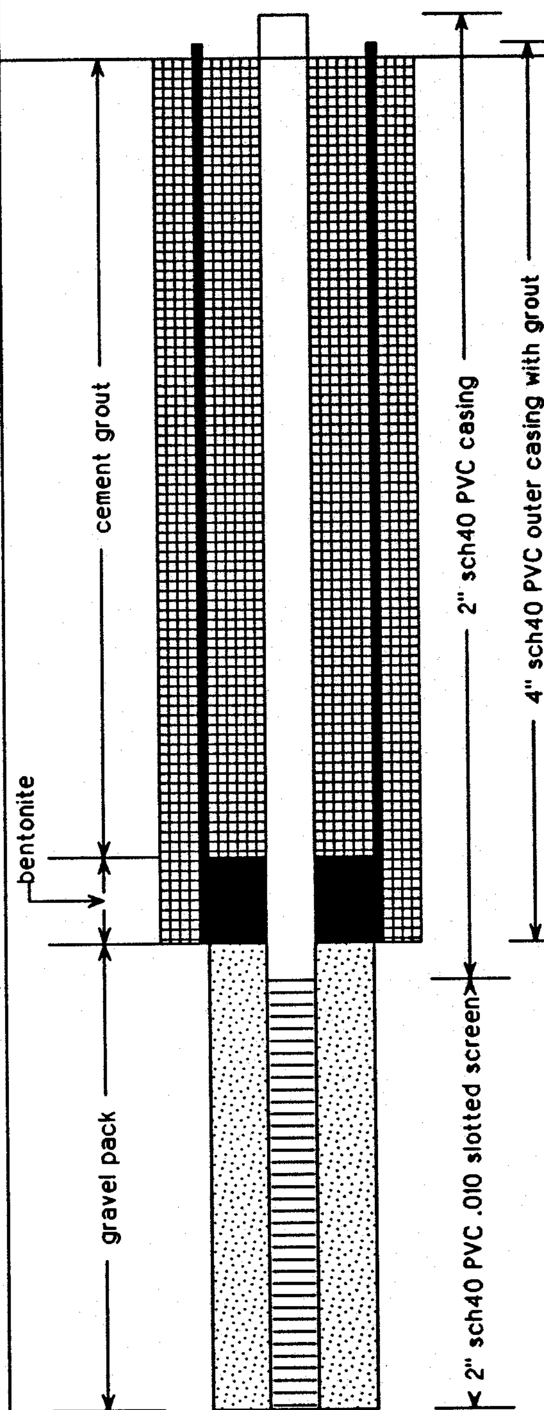
Project: Haywood County
Project No. G98010.5
Ty[illegible] HSA SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2573.66ft
Top of Casing: 2574.13ft

DEPTH (ft)	BLOWS PER FOOT	DESCRIPTION OF MATERIAL
	5	SILT (ML); tan to brown, firm, with medium to coarse grained sand, root debris
5		SILTY SAND (SM); olive brown to brown, little clay
10	10	SAND (SP); black/white, medium dense, fine to coarse grained; rock fragments, relict foliation, with quartz and biotite; iron stains
15	24	SANDY SILT (ML); tan-orange, medium dense, fine sand with some coarse grains, relict foliation, vertical fracture with iron mineralization, micaceous
20	20	SILTY SAND (SM); dark brown and black, medium dense, rust staining, highly weathered quartz grains, relict foliatioin at 45 degrees with iron staining
25	29	-grades black and white with yellow stains, coarse quartz grains, micaceous iron staining, relict foliation
30	50/5	SAND (SP); white-yellow, very dense, medium to coarse grained, with gravel, relict foliation
		Auger Refusal at 31.0 feet
35		GNEISS
40		
45		
		End of Boring at 47.3 feet

PIEZOMETER DIAGRAM



Completion Depth: 47.3 ft
DATE: 5/21/98

Depth to Water: 33 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ______ Signature of Field Agent

LOG OF BORING: GMW-11D

Project: Haywood County
Project No. G98010.5
T[illegible] HSA RB

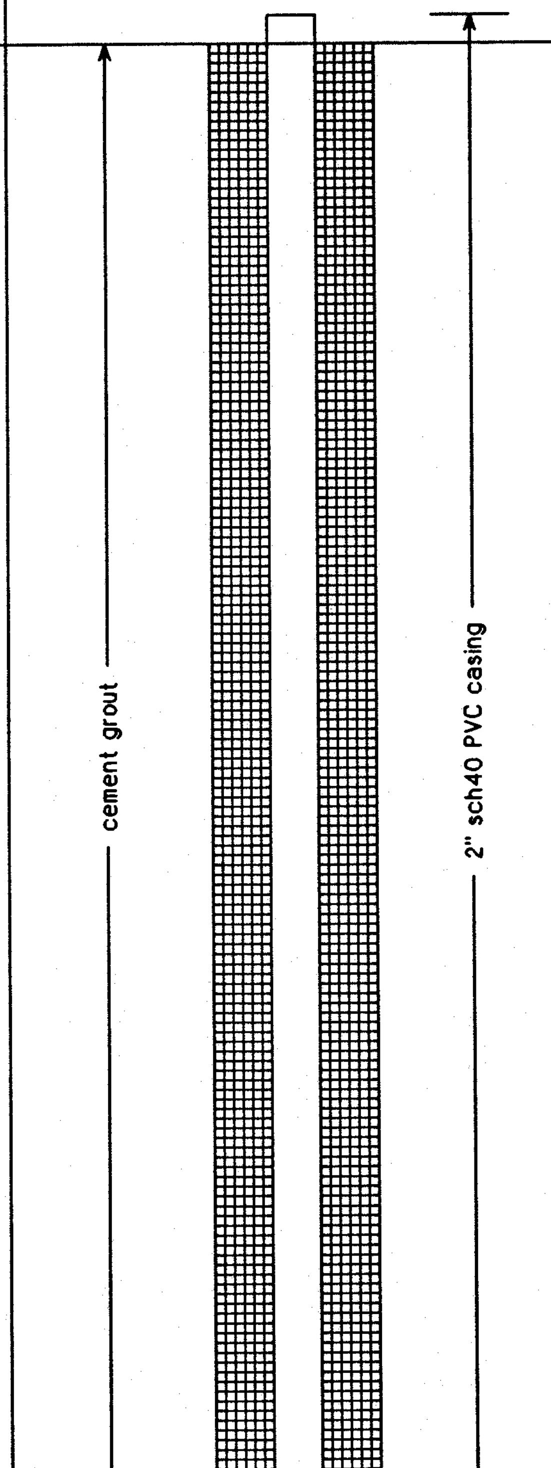
Drilling Contractor: Engineering Tectonics
Registration Number:

Surface Elevation: 2672.01ft
Top of Casing: 2675.21ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
0–50				Air drilled w/o any sampling to 98'

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

PIEZOMETER DIAGRAM



Completion Depth: 127.6 ft
DATE: 12/27/1999

Depth to Water: 98.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________
Signature of Field Agent

LOG OF BORING: GMW-11D

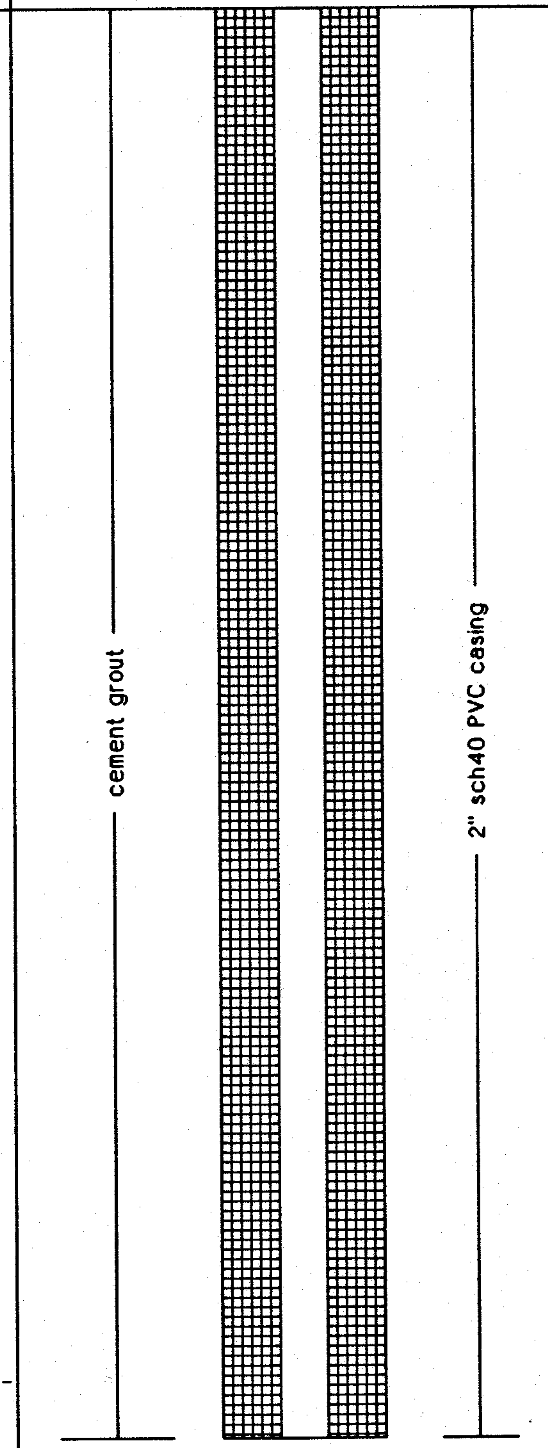
Project: Haywood County
Project No. 698010.5
Ty[illegible] HSA RB

Drilling Contractor: Engineering Tectonics
Registration Number:

Surface Elevation: 2672.01ft
Top of Casing: 2675.21ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
55				
60				
65				
70				
75				
80				
85				
90				
				- Hard drilling starts.
95				- Cuttings from borehole wet.
				Highly fractured rock
100				

PIEZOMETER DIAGRAM



Completion Depth: 127.6 ft
DATE: 12/27/1999

Depth to Water: 98.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________ Signature of Field Agent

LOG OF BORING: GMW-11D

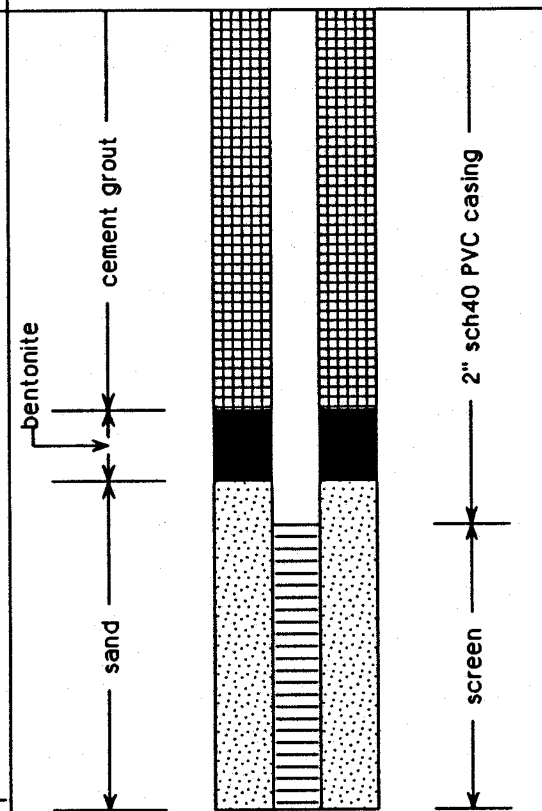
Project: Haywood County
Project No. 698010.5
T[illegible] HSA RB

Drilling Contractor: Engineering Tectonics
Registration Number:

Surface Elevation: 2672.01ft
Top of Casing: 2675.21ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
105				
110				REC=97.1%, RQD=20.8% Gneiss, quartz, muscovite, biotite foliation. 40 to 50 degree dip of foliation. Breaks along foliation.
115				- 70 degree iron stained fracture that crosses foliation from 114.1 to 114.4 ft.
				REC=100%, RQD=63.8% Gneiss, same as above.
120				
125				
130				End of Boring at 127.6 feet
135				
140				
145				
150				

PIEZOMETER DIAGRAM



Completion Depth: 127.6 ft
DATE: 12/27/1999

Depth to Water: 98.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

I acknowledge that this record is true to the best of my knowledge: ____________ Signature of Field Agent

Slug Test Results Summary
Haywood County White Oak Landfill

Well	Initial Head Change (ft)	K (ft/sec)	K (cm/sec)	Mathematical Method	Field Method	Lithology	Topography
P1–2S	7.77	7.94E–07	2.42E–05	Bouwer & Rice	Bailout	Saprolite – Silt	Slope
P1–2D	9.91	2.79E–06	8.50E–05	Hvorslev	Bailout	Gneiss	Slope
P1–4	8.73	9.25E–07	2.82E–05	Hvorslev	Bailout	Gneiss	Slope
P1–6	2.34	1.71E–06	5.21E–05	Bouwer & Rice	Bailout	Saprolite – Silty Sand	Slope
P1–8S	1.80	3.23E–05	9.85E–04	Bouwer & Rice	Bailout	Saprolite – Sandy Silt	Draw
P1–8D	12.05	3.41E–06	1.04E–04	Hvorslev	Bailout	Gneiss	Draw
P–10 *	2.41	9.25E–06	2.82E–04	Bouwer & Rice	Bailout	Saprolite – Sandy Silt	Ridge
P–12 *	3.65	7.71E–06	2.35E–04	Bouwer & Rice	Bailout	Saprolite – Silty Sand	Draw
P–13 * (GWM–11S)	8.13	2.34E–07	7.12E–06	Bouwer & Rice	Bailout	Saprolite – Sandy Silt	Ridge

* K values for P–10, P–12, and P–13 (GWM–13S) were taken from the site hydrogeologic study. (MESCO, 1999)

Flow Rate Calculations
Haywood County White Oak Landfill

Boring	K (cm/sec)[1]	n_e[2]	h_1 (ft)	h_2 (ft)	dh (ft)[3]	dl (ft)	Flow Rate[4] Q (cm/sec)	Q (ft/yr)	Flow Direction
P-6	2.64E-04	16.8%	2536.72	2530	6.72	65.69	1.61E-04	166	N73E
P-6S	2.64E-04	16.8%	2563.47	2580	16.53	116.36	2.23E-04	231	S72E
P-10	2.64E-04	16.8%	2528.33	2525	3.33	156.61	3.34E-05	35	N41E
P-11	2.64E-04	16.8%	2535.42	2535	0.42	24.04	2.75E-05	28	N84W
P-12	2.64E-04	16.8%	2547.27	2545	2.27	45.19	7.89E-05	82	N08W
P1-1S	2.64E-04	16.8%	2558.17	2555	3.17	77.38	6.44E-05	67	N25W
P1-2S	2.42E-05	16.8%	2567.66	2560	7.66	75.81	1.46E-05	15	N40W
P1-3	2.64E-04	16.8%	2586.87	2580	6.87	57.28	1.88E-04	195	N22W
P1-5S	2.64E-04	16.8%	2581.22	2575	6.22	88.91	1.10E-04	114	N25W
P1-6	5.21E-05	16.8%	2551.83	2545	6.83	104.63	2.02E-05	21	N66W
P1-7S	2.64E-04	16.8%	2544.41	2540	4.41	65.82	1.05E-04	109	N20W
P1-8S	9.85E-04	16.8%	2532.81	2530	2.81	61.95	2.66E-04	275	N14W
GWM-5A	2.64E-04	16.8%	2496.71	2500	3.29	65.35	7.91E-05	82	N22E
GWM-6A	2.64E-04	16.8%	2523.12	2520	3.12	43.45	1.13E-04	117	N24W
GWM-7	2.64E-04	16.8%	2576.94	2570	6.94	94.07	1.16E-04	120	N00W
TWD-10	2.64E-04	16.8%	2581.26	2575	6.26	77.02	1.28E-04	132	N33W
P1-4	2.82E-05	16.8%	2575.47	2565	10.47	94.22	1.87E-05	19	N45W

1. K denotes hydraulic conductivity. Underlined values are the average value for saprolite determined in Appendix B.
2. n_e denotes effective porosity. The average value for saprolite was used for all borings.
3. dh denotes the absolute head difference between h_1 and h_2.
4. Flow rates are defined by the equation:

$$Q = -\frac{K}{n_e}\frac{dh}{dl}$$

Average Flow Rates and Effective Porosities for Lithologies Units
Haywood County White Oak Landfill

Effective Porosity (%)

Saprolite		Fractured Gneiss	
P1-8S	20.1	Default	1.0
P1-1S	17.8		
P1-6	20.0		
P1-4 (1)	21.0		
P1-4 (2)	16.8		
P1-4 (3)	18.4		
P2-1 (1)	14.0		
P2-1 (2)	8.0		
P2-2	15.4		
Mean:	16.8	**Mean:**	1.0
Std. Dev.:	4.0	**Std. Dev.:**	–

Hydraulic Conductivity (cm/sec)

Saprolite		Fractured Gneiss	
P1-2S	2.42E-05	P1-2D	8.50E-05
P1-6	5.21E-05	P1-4	2.82E-05
P1-8S	9.85E-04	P1-8D	1.04E-04
P-10	2.82E-04		
P-12	2.35E-04		
P-13 (GWM-11S)	7.12E-06		
Mean:	2.64E-04	**Mean:**	7.24E-05
Std. Dev.:	3.71E-04	**Std. Dev.:**	3.94E-05

Drawdown Test for P1-2S
Haywood County White Oak Landfill

Initial depth to water table (ft.) 34.23
Initial head change (ft.) 7.77

Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	Log of dh
15:07:58	54478	0	42.00	7.77	0.890421019
15:08:05	54485	7	41.95	7.72	0.8876173
15:08:13	54493	15	41.90	7.67	0.884795364
15:08:21	54501	23	41.85	7.62	0.881954971
15:08:27	54507	29	41.80	7.57	0.87909588
15:08:34	54514	36	41.75	7.52	0.876217841
15:08:41	54521	43	41.70	7.47	0.873320602
15:08:48	54528	50	41.65	7.42	0.870403905
15:08:55	54535	57	41.60	7.37	0.867467488
15:09:03	54543	65	41.55	7.32	0.864511081
15:09:10	54550	72	41.50	7.27	0.861534411
15:09:17	54557	79	41.45	7.22	0.858537198
15:09:24	54564	86	41.40	7.17	0.855519156
15:09:31	54571	93	41.35	7.12	0.852479994
15:09:39	54579	101	41.30	7.07	0.849419414
15:09:48	54588	110	41.25	7.02	0.846337112
15:09:56	54596	118	41.20	6.97	0.843232778
15:10:04	54604	126	41.15	6.92	0.840106094
15:10:13	54613	135	41.10	6.87	0.836956737
15:10:22	54622	144	41.05	6.82	0.833784375
15:10:31	54631	153	41.00	6.77	0.830588669
15:10:39	54639	161	40.95	6.72	0.827369273
15:10:46	54646	168	40.90	6.67	0.824125834
15:10:55	54655	177	40.85	6.62	0.820857989
15:11:03	54663	185	40.80	6.57	0.81756537
15:11:13	54673	195	40.75	6.52	0.814247596
15:11:23	54683	205	40.70	6.47	0.810904281
15:11:34	54694	216	40.65	6.42	0.807535028
15:11:44	54704	226	40.60	6.37	0.804139432
15:11:55	54715	237	40.55	6.32	0.800717078
15:12:07	54727	249	40.50	6.27	0.797267541
15:12:21	54741	263	40.45	6.22	0.793790385
15:12:35	54755	277	40.40	6.17	0.790285164
15:12:49	54769	291	40.35	6.12	0.786751422
15:12:57	54777	299	40.30	6.07	0.783188691
15:13:47	54827	349	39.75	5.52	0.741939078
15:13:52	54832	354	39.70	5.47	0.737987326
15:13:58	54838	360	39.65	5.42	0.733999287
15:14:25	54865	387	39.40	5.17	0.713490543
15:14:31	54871	393	39.35	5.12	0.709269961
15:14:37	54877	399	39.30	5.07	0.705007959
15:14:43	54883	405	39.25	5.02	0.700703717
15:14:49	54889	411	39.20	4.97	0.696356389
15:14:55	54895	417	39.15	4.92	0.691965103
15:15:01	54901	423	39.10	4.87	0.687528961
15:15:14	54914	436	39.00	4.77	0.678518379

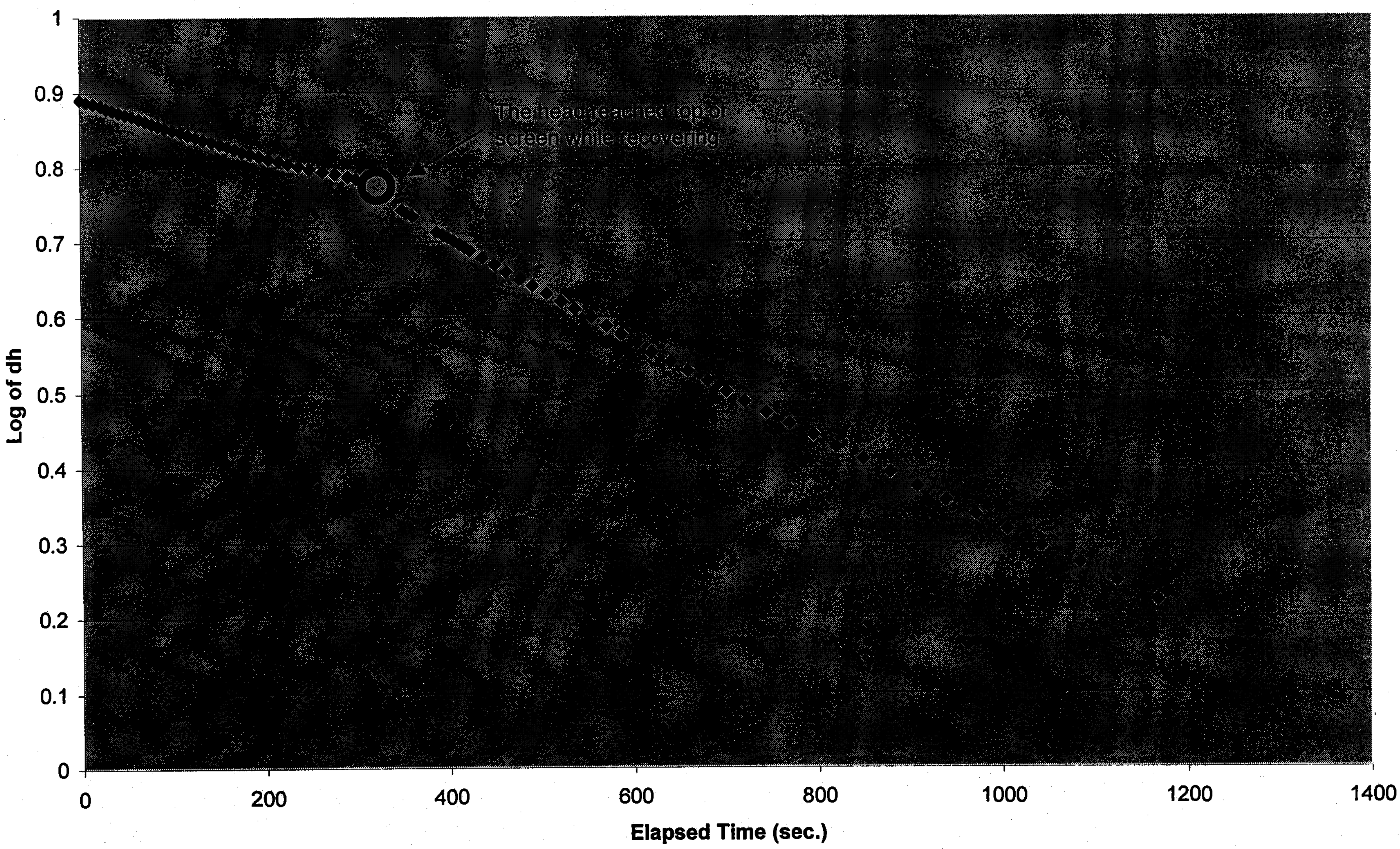
Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	Log of dh
15:15:27	54927	449	38.90	4.67	0.669316881
15:15:40	54940	462	38.80	4.57	0.6599162
15:15:55	54955	477	38.70	4.47	0.650307523
15:16:08	54968	490	38.60	4.37	0.640481437
15:16:23	54983	505	38.50	4.27	0.630427875
15:16:39	54999	521	38.40	4.17	0.620136055
15:16:54	55014	536	38.30	4.07	0.609594409
15:17:11	55031	553	38.20	3.97	0.598790507
15:17:28	55048	570	38.10	3.87	0.587710965
15:17:44	55064	586	38.00	3.77	0.57634135
15:18:01	55081	603	37.90	3.67	0.564666064
15:18:17	55097	619	37.80	3.57	0.552668216
15:18:38	55118	640	37.70	3.47	0.540329475
15:18:57	55137	659	37.60	3.37	0.527629901
15:19:18	55158	680	37.50	3.27	0.514547753
15:19:39	55179	701	37.40	3.17	0.501059262
15:19:59	55199	721	37.30	3.07	0.487138375
15:20:22	55222	744	37.20	2.97	0.472756449
15:20:48	55248	770	37.10	2.87	0.457881897
15:21:13	55273	795	37.00	2.77	0.442479769
15:21:38	55298	820	36.90	2.67	0.426511261
15:22:06	55326	848	36.80	2.57	0.409933123
15:22:35	55355	877	36.70	2.47	0.392696953
15:23:05	55385	907	36.60	2.37	0.374748346
15:23:36	55416	938	36.50	2.27	0.356025857
15:24:09	55449	971	36.40	2.17	0.336459734
15:24:43	55483	1005	36.30	2.07	0.315970345
15:25:20	55520	1042	36.20	1.97	0.294466226
15:26:01	55561	1083	36.10	1.87	0.271841607
15:26:41	55601	1123	36.00	1.77	0.247973266
15:27:25	55645	1167	35.90	1.67	0.222716471

Drawdown Test for P1-2S
Haywood County White Oak Landfill

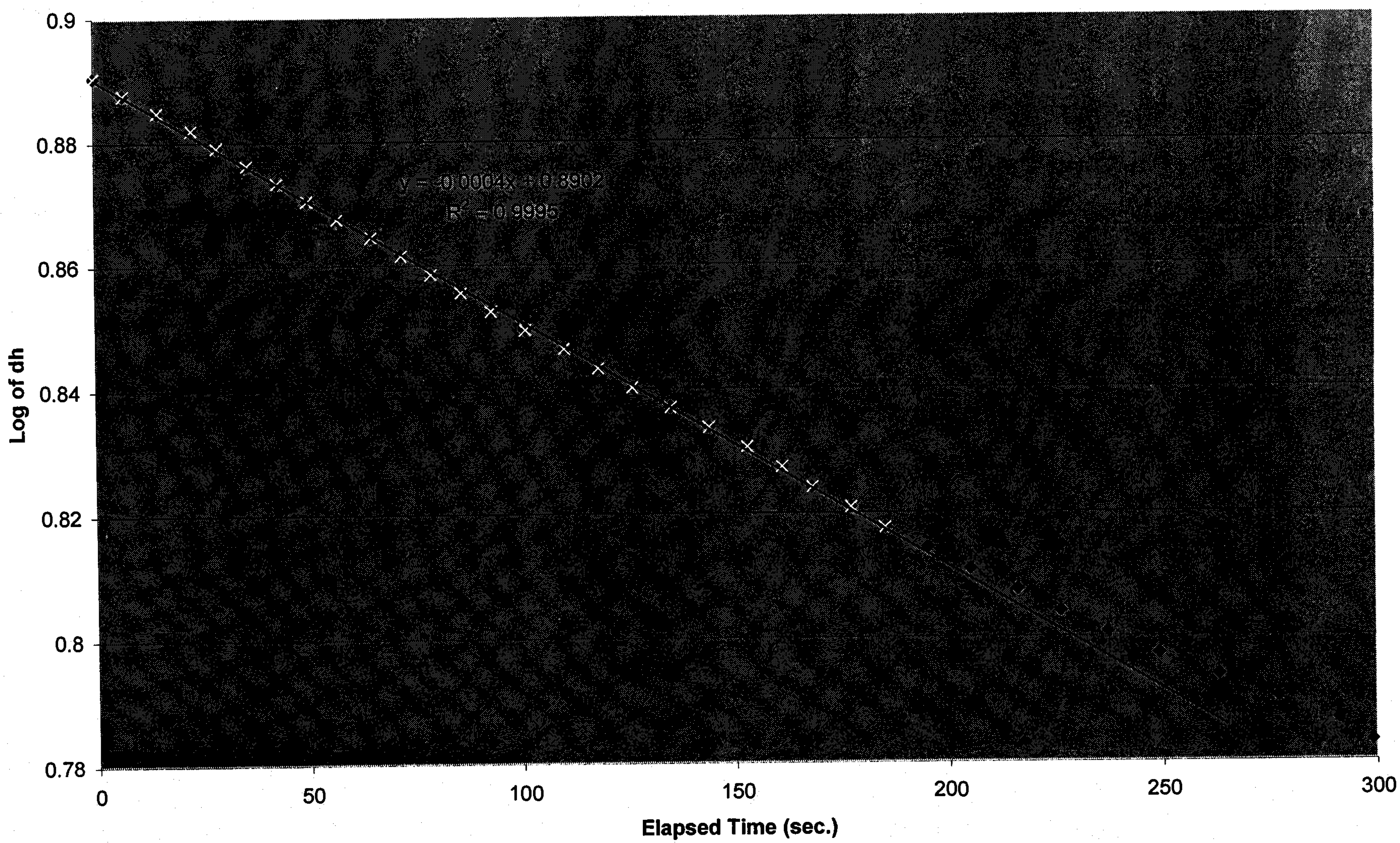
Slug Test by Bouwer and Rice

Initial depth to water table from top of pipe:	34.23	ft.
Initial Drawdown:	7.77	ft.
Total well length:	50.03	ft.
Radius of well casing (r_c):	0.0833	ft.
Radius of gravel pack (r_w):	0.2448	ft.
Length of open section (L_e):	10	ft.
Drawdown at time = 0 (y_0):	7.77	ft.
Drawdown at time = t (y_t):	6.57	ft.
Elapsed Time between y_0 and y_t (t):	185	sec.
A (dimentionless):	2.78	
B (dimentionless):	0.44	
Initial water column in well (L_w):	15.80	ft.
$\ln(R_e/r_w)$ =	2.52	
K =	7.94E-07	ft./sec.
	25.03	ft./yr.

Drawdown Test for P1-2S



Drawdown Test for P1-2S (t = 0 to 300)



Drawdown Test for P1-2D
Haywood County White Oak Landfill

Initial depth to water table (ft.) 39.29
Initial head change (ft.) 9.91

Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	h/h0	Log of h/h0
14:42:52	52972	0	49.20	9.91	1.00	0.00000
14:42:59	52979	7	49.10	9.81	0.99	-0.00440
14:43:04	52984	12	49.00	9.71	0.98	-0.00885
14:43:10	52990	18	48.90	9.61	0.97	-0.01335
14:43:16	52996	24	48.80	9.51	0.96	-0.01789
14:43:23	53003	31	48.70	9.41	0.95	-0.02248
14:43:29	53009	37	48.60	9.31	0.94	-0.02712
14:43:35	53015	43	48.50	9.21	0.93	-0.03181
14:43:42	53022	50	48.40	9.11	0.92	-0.03656
14:43:48	53028	56	48.30	9.01	0.91	-0.04135
14:43:54	53034	62	48.20	8.91	0.90	-0.04620
14:44:01	53041	69	48.10	8.81	0.89	-0.05110
14:44:07	53047	75	48.00	8.71	0.88	-0.05606
14:44:14	53054	82	47.90	8.61	0.87	-0.06107
14:44:20	53060	88	47.80	8.51	0.86	-0.06614
14:44:27	53067	95	47.70	8.41	0.85	-0.07128
14:44:34	53074	102	47.60	8.31	0.84	-0.07647
14:44:41	53081	109	47.50	8.21	0.83	-0.08173
14:44:48	53088	116	47.40	8.11	0.82	-0.08705
14:44:55	53095	123	47.30	8.01	0.81	-0.09244
14:45:02	53102	130	47.20	7.91	0.80	-0.09790
14:45:09	53109	137	47.10	7.81	0.79	-0.10342
14:45:17	53117	145	47.00	7.71	0.78	-0.10902
14:45:24	53124	152	46.90	7.61	0.77	-0.11469
14:45:31	53131	159	46.80	7.51	0.76	-0.12043
14:45:39	53139	167	46.70	7.41	0.75	-0.12626
14:45:47	53147	175	46.60	7.31	0.74	-0.13216
14:45:55	53155	183	46.50	7.21	0.73	-0.13814
14:46:02	53162	190	46.40	7.11	0.72	-0.14420
14:46:10	53170	198	46.30	7.01	0.71	-0.15036
14:46:18	53178	206	46.20	6.91	0.70	-0.15660
14:46:26	53186	214	46.10	6.81	0.69	-0.16293
14:46:34	53194	222	46.00	6.71	0.68	-0.16935
14:46:42	53202	230	45.90	6.61	0.67	-0.17587
14:46:51	53211	239	45.80	6.51	0.66	-0.18249
14:47:00	53220	248	45.70	6.41	0.65	-0.18922
14:47:08	53228	256	45.60	6.31	0.64	-0.19604
14:47:16	53236	264	45.50	6.21	0.63	-0.20298
14:47:26	53246	274	45.40	6.11	0.62	-0.21003
14:47:34	53254	282	45.30	6.01	0.61	-0.21720
14:47:43	53263	291	45.20	5.91	0.60	-0.22449
14:47:52	53272	300	45.10	5.81	0.59	-0.23190
14:48:02	53282	310	45.00	5.71	0.58	-0.23944
14:48:10	53290	318	44.90	5.61	0.57	-0.24711
14:48:20	53300	328	44.80	5.51	0.56	-0.25492
14:48:30	53310	338	44.70	5.41	0.55	-0.26288

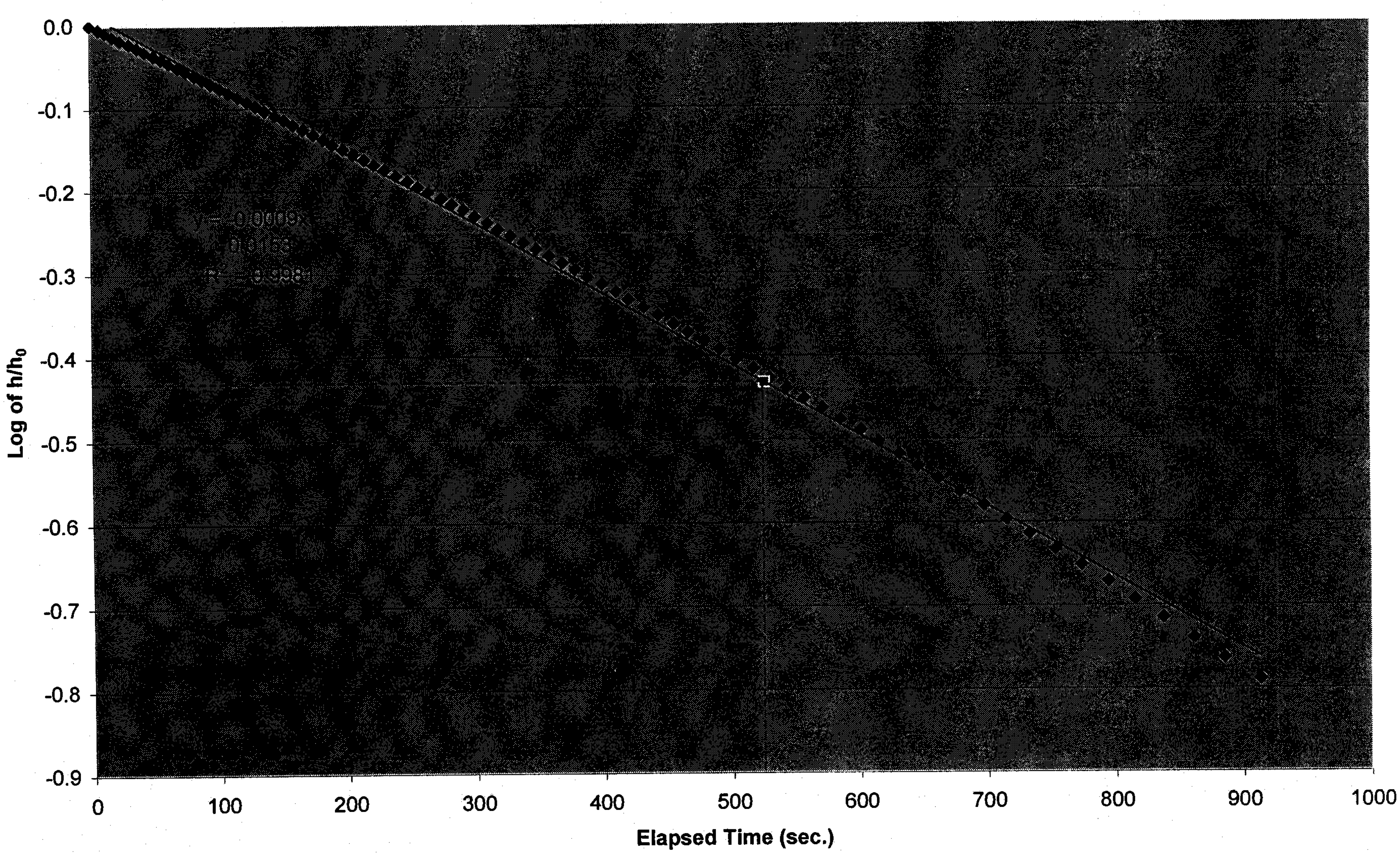
Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	h/h0	Log of h/h0
14:48:40	53320	348	44.60	5.31	0.54	-0.27098
14:48:50	53330	358	44.50	5.21	0.53	-0.27924
14:49:00	53340	368	44.40	5.11	0.52	-0.28765
14:49:10	53350	378	44.30	5.01	0.51	-0.29624
14:49:20	53360	388	44.20	4.91	0.50	-0.30499
14:49:31	53371	399	44.10	4.81	0.49	-0.31393
14:49:42	53382	410	44.00	4.71	0.48	-0.32305
14:49:52	53392	420	43.90	4.61	0.47	-0.33237
14:50:04	53404	432	43.80	4.51	0.46	-0.34190
14:50:15	53415	443	43.70	4.41	0.45	-0.35164
14:50:27	53427	455	43.60	4.31	0.43	-0.36160
14:50:38	53438	466	43.50	4.21	0.42	-0.37179
14:50:51	53451	479	43.40	4.11	0.41	-0.38223
14:51:03	53463	491	43.30	4.01	0.40	-0.39293
14:51:16	53476	504	43.20	3.91	0.39	-0.40390
14:51:29	53489	517	43.10	3.81	0.38	-0.41515
-	-	525.46	-	-	-	-0.43180
14:51:42	53502	530	43.00	3.71	0.37	-0.42670
14:51:55	53515	543	42.90	3.61	0.36	-0.43857
14:52:09	53529	557	42.80	3.51	0.35	-0.45077
14:52:23	53543	571	42.70	3.41	0.34	-0.46332
14:52:37	53557	585	42.60	3.31	0.33	-0.47625
14:52:53	53573	601	42.50	3.21	0.32	-0.48957
14:53:07	53587	615	42.40	3.11	0.31	-0.50331
14:53:23	53603	631	42.30	3.01	0.30	-0.51751
14:53:38	53618	646	42.20	2.91	0.29	-0.53218
14:53:54	53634	662	42.10	2.81	0.28	-0.54737
14:54:11	53651	679	42.00	2.71	0.27	-0.56310
14:54:29	53669	697	41.90	2.61	0.26	-0.57943
14:54:47	53687	715	41.80	2.51	0.25	-0.59640
14:55:05	53705	733	41.70	2.41	0.24	-0.61406
14:55:25	53725	753	41.60	2.31	0.23	-0.63246
14:55:45	53745	773	41.50	2.21	0.22	-0.65168
14:56:06	53766	794	41.40	2.11	0.21	-0.67179
14:56:27	53787	815	41.30	2.01	0.20	-0.69288
14:56:49	53809	837	41.20	1.91	0.19	-0.71504
14:57:13	53833	861	41.10	1.81	0.18	-0.73840
14:57:37	53857	885	41.00	1.71	0.17	-0.76308
14:58:05	53885	913	40.90	1.61	0.16	-0.78925

Drawdown Test for P1-2D
Haywood County White Oak Landfill

Slug Test by Hvorslev

Initial depth to water table from top of pipe:	39.29	ft.
Initial Drawdown:	9.91	ft.
Total well length:	81.14	ft.
Radius of the well casing (r):	0.0833	ft.
Radius of the gravel pack (R):	0.1458	ft.
Length of the well screen (L_e):	10.0	ft.
Time it takes for the water level to rise or fall to 37% of the initial change (T_0):	525.46	sec.
K =	2.79E-06	ft./sec.
	88.10	ft./yr.

Drawdown Test for P1-2D



Design Hydrogeologic Study - Haywood County White Oak Landfill

Drawdown Test for P1-4
Haywood County White Oak Landfill

Initial depth to water table (ft.) 37.67
Initial head change (ft.) 8.73

Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	h/h0	Log of h/h0
13:47:36	49656	0	46.40	8.73	1.00	0.00000
13:47:43	49663	7	46.35	8.68	0.99	-0.00249
13:47:56	49676	20	46.30	8.63	0.99	-0.00500
13:48:04	49684	28	46.25	8.58	0.98	-0.00753
13:48:12	49692	36	46.20	8.53	0.98	-0.01007
13:48:20	49700	44	46.15	8.48	0.97	-0.01262
13:48:28	49708	52	46.10	8.43	0.97	-0.01519
13:48:36	49716	60	46.05	8.38	0.96	-0.01777
13:48:44	49724	68	46.00	8.33	0.95	-0.02037
13:48:54	49734	78	45.95	8.28	0.95	-0.02298
13:49:00	49740	84	45.90	8.23	0.94	-0.02561
13:49:09	49749	93	45.85	8.18	0.94	-0.02826
13:49:18	49758	102	45.80	8.13	0.93	-0.03092
13:49:26	49766	110	45.75	8.08	0.93	-0.03360
13:49:36	49776	120	45.70	8.03	0.92	-0.03630
13:49:45	49785	129	45.65	7.98	0.91	-0.03901
13:49:54	49794	138	45.60	7.93	0.91	-0.04174
13:50:03	49803	147	45.55	7.88	0.90	-0.04449
13:50:12	49812	156	45.50	7.83	0.90	-0.04725
13:50:21	49821	165	45.45	7.78	0.89	-0.05003
13:50:31	49831	175	45.40	7.73	0.89	-0.05283
13:50:42	49842	186	45.35	7.68	0.88	-0.05565
13:50:51	49851	195	45.30	7.63	0.87	-0.05849
13:51:01	49861	205	45.25	7.58	0.87	-0.06135
13:51:10	49870	214	45.20	7.53	0.86	-0.06422
13:51:20	49880	224	45.15	7.48	0.86	-0.06711
13:51:29	49889	233	45.10	7.43	0.85	-0.07003
13:51:40	49900	244	45.05	7.38	0.85	-0.07296
13:51:51	49911	255	45.00	7.33	0.84	-0.07591
13:51:59	49919	263	44.95	7.28	0.83	-0.07888
13:52:11	49931	275	44.90	7.23	0.83	-0.08188
13:52:20	49940	284	44.85	7.18	0.82	-0.08489
13:52:30	49950	294	44.80	7.13	0.82	-0.08792
13:52:43	49963	307	44.75	7.08	0.81	-0.09098
13:52:54	49974	318	44.70	7.03	0.81	-0.09406
13:53:04	49984	328	44.65	6.98	0.80	-0.09716
13:53:16	49996	340	44.60	6.93	0.79	-0.10028
13:53:27	50007	351	44.55	6.88	0.79	-0.10343
13:53:38	50018	362	44.50	6.83	0.78	-0.10659
13:53:49	50029	373	44.45	6.78	0.78	-0.10978
13:54:00	50040	384	44.40	6.73	0.77	-0.11300
13:54:12	50052	396	44.35	6.68	0.77	-0.11624
13:54:23	50063	407	44.30	6.63	0.76	-0.11950
13:54:36	50076	420	44.25	6.58	0.75	-0.12279
13:54:47	50087	431	44.20	6.53	0.75	-0.12610
13:55:00	50100	444	44.15	6.48	0.74	-0.12944

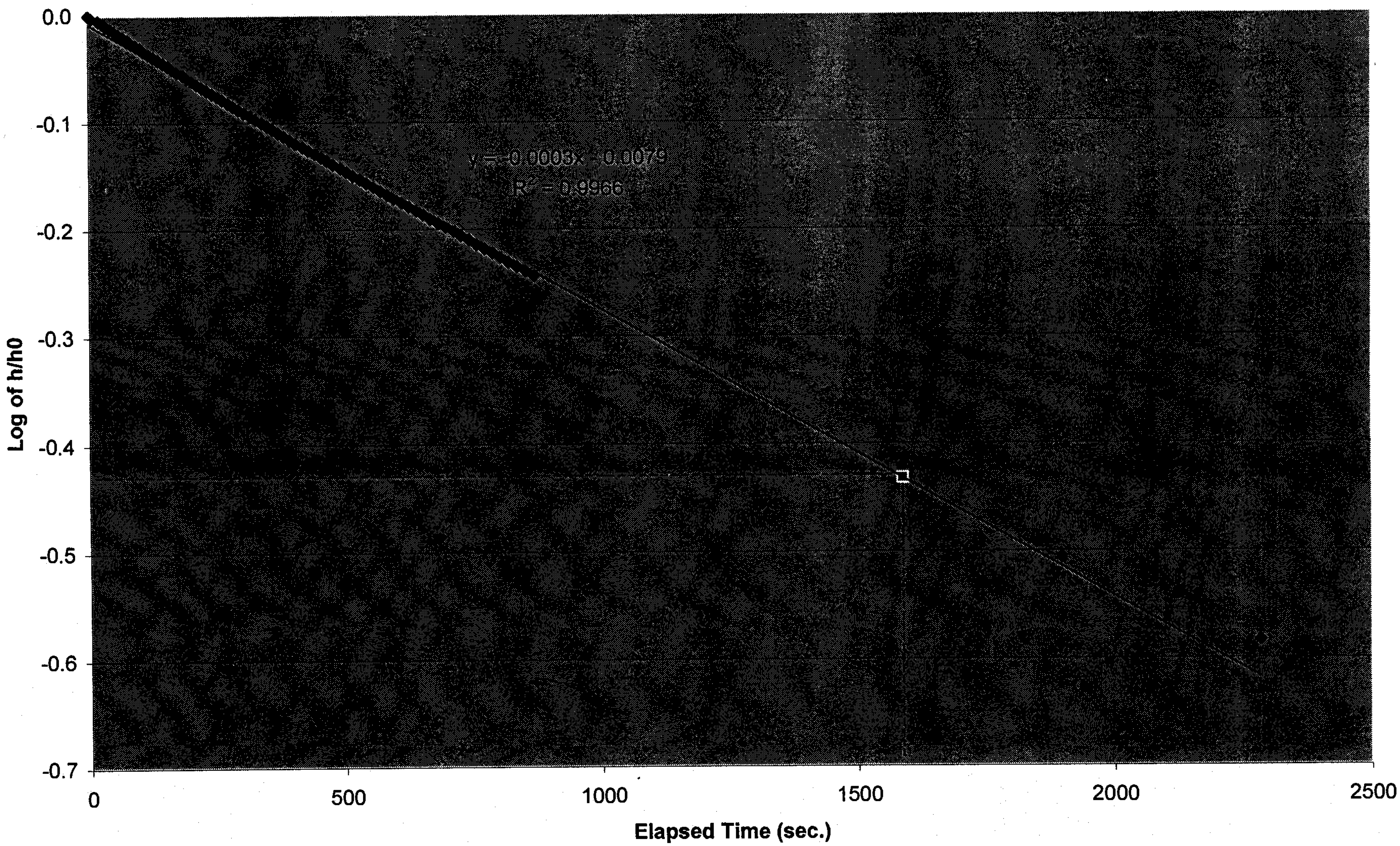
Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	h/h0	Log of h/h0
13:55:12	50112	456	44.10	6.43	0.74	-0.13280
13:55:23	50123	467	44.05	6.38	0.73	-0.13619
13:55:35	50135	479	44.00	6.33	0.73	-0.13961
13:55:50	50150	494	43.95	6.28	0.72	-0.14305
13:56:01	50161	505	43.90	6.23	0.71	-0.14653
13:56:14	50174	518	43.85	6.18	0.71	-0.15003
13:56:27	50187	531	43.80	6.13	0.70	-0.15355
13:56:40	50200	544	43.75	6.08	0.70	-0.15711
13:56:54	50214	558	43.70	6.03	0.69	-0.16070
13:57:07	50227	571	43.65	5.98	0.68	-0.16431
13:57:21	50241	585	43.60	5.93	0.68	-0.16796
13:57:33	50253	597	43.55	5.88	0.67	-0.17164
13:57:48	50268	612	43.50	5.83	0.67	-0.17535
13:58:02	50282	626	43.45	5.78	0.66	-0.17909
13:58:16	50296	640	43.40	5.73	0.66	-0.18286
13:58:30	50310	654	43.35	5.68	0.65	-0.18667
13:58:44	50324	668	43.30	5.63	0.64	-0.19051
13:58:59	50339	683	43.25	5.58	0.64	-0.19438
13:59:13	50353	697	43.20	5.53	0.63	-0.19829
13:59:29	50369	713	43.15	5.48	0.63	-0.20223
13:59:43	50383	727	43.10	5.43	0.62	-0.20621
13:59:59	50399	743	43.05	5.38	0.62	-0.21023
14:00:14	50414	758	43.00	5.33	0.61	-0.21429
14:00:30	50430	774	42.95	5.28	0.60	-0.21838
14:00:44	50444	788	42.90	5.23	0.60	-0.22251
14:01:00	50460	804	42.85	5.18	0.59	-0.22668
14:01:16	50476	820	42.80	5.13	0.59	-0.23090
14:01:32	50492	836	42.75	5.08	0.58	-0.23515
14:01:50	50510	854	42.70	5.03	0.58	-0.23945
14:02:05	50525	869	42.65	4.98	0.57	-0.24378
-	-	1587.04	-	-	-	-0.43180
14:25:39	51939	2283	39.95	2.28	0.26	-0.58308

Drawdown Test for P1-4
Haywood County White Oak Landfill

Slug Test by Hvorslev

Initial depth to water table from top of pipe:	37.67	ft.
Initial Drawdown:	8.73	ft.
Total well length:	74.64	ft.
Radius of the well casing (r):	0.0833	ft.
Radius of the gravel pack (R):	0.1458	ft.
Length of the well screen (L_e):	10.0	ft.
Time it takes for the water level to rise or fall to 37% of the initial change (T_0):	1587.04	sec.
K =	9.25E-07	ft./sec.
	29.17	ft./yr.

Drawdown Test for P1-4



Drawdown Test for P1-6
Haywood County White Oak Landfill

Initial depth to water table (ft.)	38.36
Initial head change (ft.)	2.34

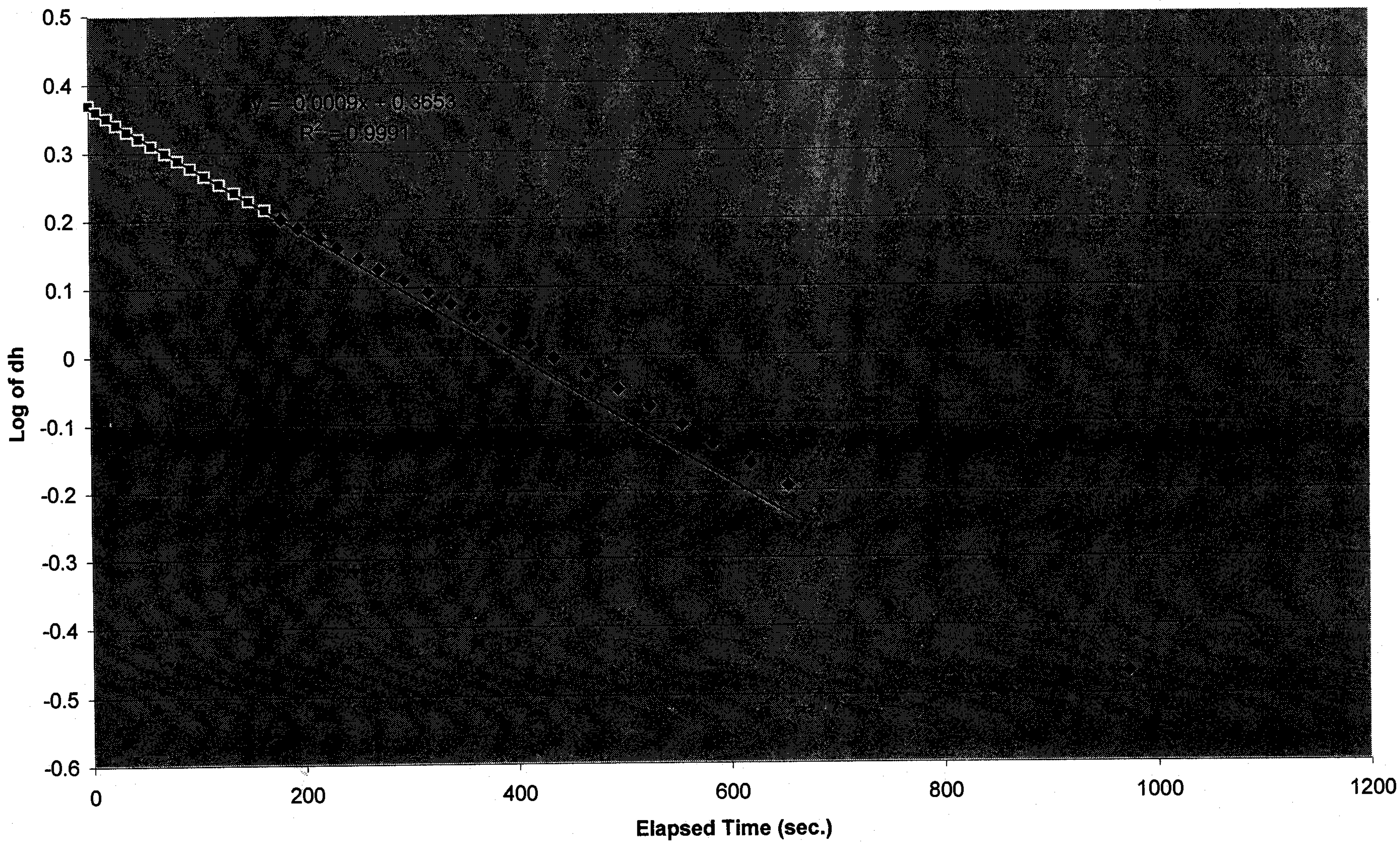
Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	Log of dh
14:11:51	51111	0	40.70	2.34	0.369215857
14:11:58	51118	7	40.65	2.29	0.359835482
14:12:08	51128	17	40.60	2.24	0.350248018
14:12:17	51137	26	40.55	2.19	0.340444115
14:12:27	51147	36	40.50	2.14	0.330413773
14:12:38	51158	47	40.45	2.09	0.320146286
14:12:50	51170	59	40.40	2.04	0.309630167
14:13:03	51183	72	40.35	1.99	0.298853076
14:13:15	51195	84	40.30	1.94	0.28780173
14:13:27	51207	96	40.25	1.89	0.276461804
14:13:40	51220	109	40.20	1.84	0.264817823
14:13:54	51234	123	40.15	1.79	0.252853031
14:14:08	51248	137	40.10	1.74	0.240549248
14:14:21	51261	150	40.05	1.69	0.227886705
14:14:36	51276	165	40.00	1.64	0.214843848
14:14:51	51291	180	39.95	1.59	0.201397124
14:15:07	51307	196	39.90	1.54	0.187520721
14:15:27	51327	216	39.85	1.49	0.173186268
14:15:44	51344	233	39.80	1.44	0.158362492
14:16:04	51364	253	39.75	1.39	0.1430148
14:16:23	51383	272	39.70	1.34	0.127104798
14:16:46	51406	295	39.65	1.29	0.11058971
14:17:09	51429	318	39.60	1.24	0.093421685
14:17:30	51450	339	39.55	1.19	0.075546961
14:17:53	51473	362	39.50	1.14	0.056904851
14:18:17	51497	386	39.45	1.09	0.037426498
14:18:43	51523	412	39.40	1.04	0.017033339
14:19:06	51546	435	39.35	0.99	-0.004364805
14:19:36	51576	465	39.30	0.94	-0.026872146
14:20:06	51606	495	39.25	0.89	-0.050609993
14:20:35	51635	524	39.20	0.84	-0.075720714
14:21:06	51666	555	39.15	0.79	-0.102372909
14:21:35	51695	584	39.10	0.74	-0.13076828
14:22:10	51730	619	39.05	0.69	-0.161150909
14:22:45	51765	654	39.00	0.64	-0.193820026
14:28:03	52083	972	38.70	0.34	-0.468521083

Drawdown Test for P1-6
Haywood County White Oak Landfill

Slug Test by Bouwer and Rice

Initial depth to water table from top of pipe:	38.36	ft.
Initial Drawdown:	2.34	ft.
Total well length:	47.41	ft.
Radius of well casing (r_c):	0.0833	ft.
Radius of gravel pack (r_w):	0.2448	ft.
Length of open section (L_e):	10	ft.
Drawdown at time = 0 (y_0):	2.34	ft.
Drawdown at time = t (y_t):	1.64	ft.
Elapsed Time between y_0 and y_t (t):	165	sec.
A (dimentionless):	2.78	
B (dimentionless):	0.44	
Initial water column in well (L_w):	9.05	ft.
$\ln(R_e/r_w)$ =	2.29	
K =	1.71E-06	ft./sec.
	53.93	ft./yr.

Drawdown Test for P1-6



Drawdown Test for P1-8S
Haywood County White Oak Landfill

Initial depth to water table (ft.) 3.70
Initial head change (ft.) 1.80

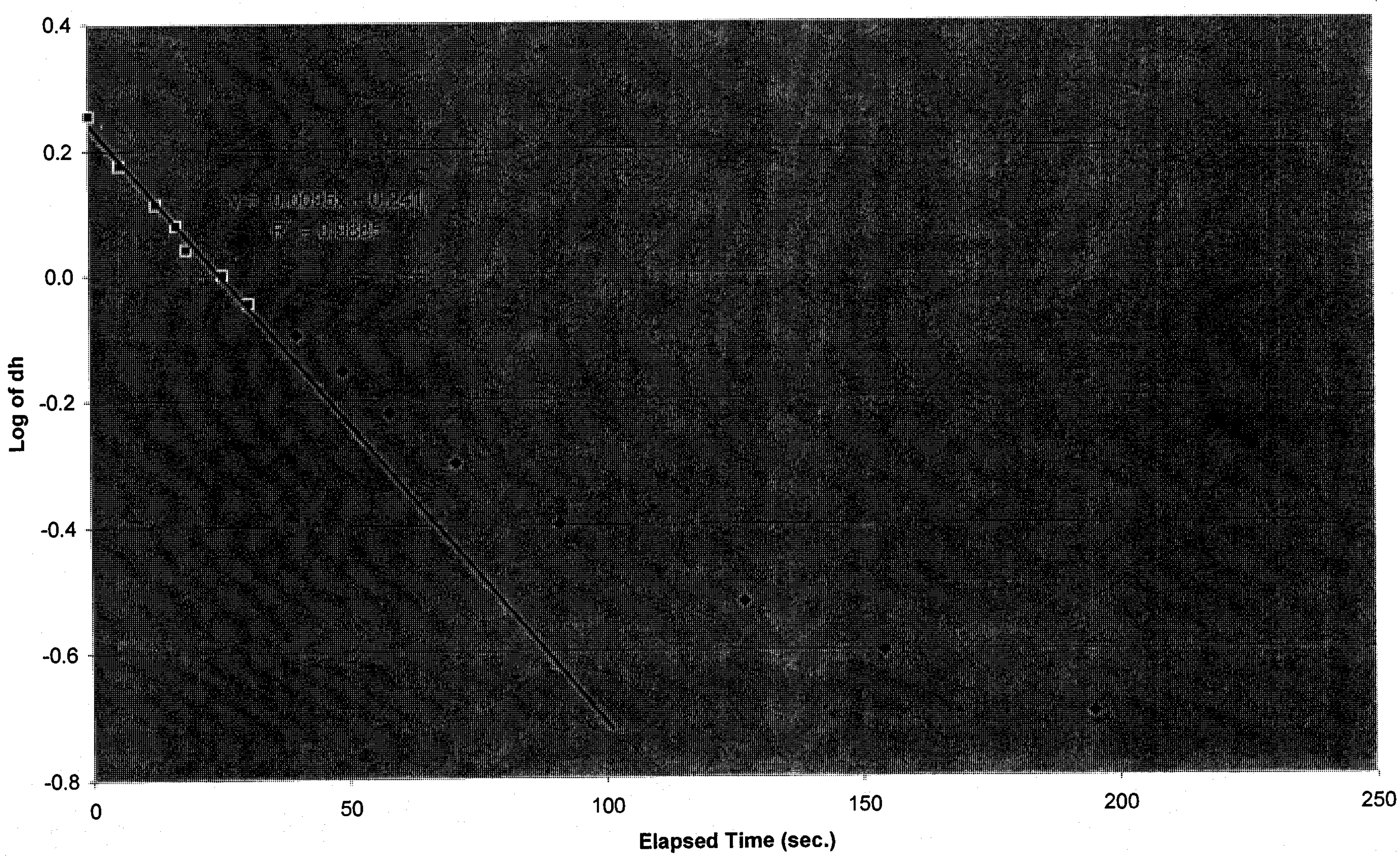
Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	Log of dh
15:22:07	55327	0	5.50	1.80	0.25527
15:22:13	55333	6	5.20	1.50	0.17609
15:22:20	55340	13	5.00	1.30	0.11394
15:22:24	55344	17	4.90	1.20	0.07918
15:22:26	55346	19	4.80	1.10	0.04139
15:22:33	55353	26	4.70	1.00	0.00000
15:22:38	55358	31	4.60	0.90	-0.04576
15:22:47	55367	40	4.50	0.80	-0.09691
15:22:56	55376	49	4.40	0.70	-0.15490
15:23:05	55385	58	4.30	0.60	-0.22185
15:23:18	55398	71	4.20	0.50	-0.30103
15:23:38	55418	91	4.10	0.40	-0.39794
15:24:14	55454	127	4.00	0.30	-0.52288
15:24:41	55481	154	3.95	0.25	-0.60206
15:25:22	55522	195	3.90	0.20	-0.69897

Drawdown Test for P1-8S
Haywood County White Oak Landfill

Slug Test by Bouwer and Rice

Initial depth to water table from top of pipe:	3.70	ft.
Initial Drawdown:	1.80	ft.
Total well length:	17.09	ft.
Radius of well casing (r_c):	0.0833	ft.
Radius of gravel pack (r_w):	0.2448	ft.
Length of open section (L_e):	5	ft.
Drawdown at time = 0 (y_0):	1.80	ft.
Drawdown at time = t (y_t):	0.90	ft.
Elapsed Time between y_0 and y_t (t):	31	sec.
A (dimentionless):	2.28	
B (dimentionless):	0.32	
Initial water column in well (L_w):	13.39	ft.
$\ln(R_e/r_w)$ =	2.08	
K =	3.23E-05	ft./sec.
	1019.10	ft./yr.

Drawdown Test for P1-8S



Drawdown Test for P1-8D
Haywood County White Oak Landfill

Initial depth to water table (ft.) 3.25
Initial head change (ft.) 12.05

Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	h/h0	Log of h/h0
14:57:55	53875	0	15.30	12.05	1.00	0.00000
14:58:02	53882	7	15.10	11.85	0.98	-0.00727
14:58:13	53893	18	14.80	11.55	0.96	-0.01841
14:58:21	53901	26	14.60	11.35	0.94	-0.02599
14:58:24	53904	29	14.50	11.25	0.93	-0.02983
14:58:29	53909	34	14.40	11.15	0.93	-0.03371
14:58:36	53916	41	14.20	10.95	0.91	-0.04157
14:58:44	53924	49	14.00	10.75	0.89	-0.04958
14:58:52	53932	57	13.80	10.55	0.88	-0.05773
14:59:00	53940	65	13.60	10.35	0.86	-0.06605
14:59:08	53948	73	13.40	10.15	0.84	-0.07452
14:59:17	53957	82	13.20	9.95	0.83	-0.08316
14:59:26	53966	91	13.00	9.75	0.81	-0.09198
14:59:35	53975	100	12.80	9.55	0.79	-0.10098
14:59:44	53984	109	12.60	9.35	0.78	-0.11018
14:59:53	53993	118	12.40	9.15	0.76	-0.11957
15:00:03	54003	128	12.20	8.95	0.74	-0.12916
15:00:12	54012	137	12.00	8.75	0.73	-0.13898
15:00:17	54017	142	11.90	8.65	0.72	-0.14397
15:00:22	54022	147	11.80	8.55	0.71	-0.14902
15:00:28	54028	153	11.70	8.45	0.70	-0.15413
15:00:32	54032	157	11.60	8.35	0.69	-0.15930
15:00:38	54038	163	11.50	8.25	0.68	-0.16453
15:00:43	54043	168	11.40	8.15	0.68	-0.16983
15:00:48	54048	173	11.30	8.05	0.67	-0.17519
15:00:53	54053	178	11.20	7.95	0.66	-0.18062
15:00:59	54059	184	11.10	7.85	0.65	-0.18612
15:01:04	54064	189	11.00	7.75	0.64	-0.19169
15:01:10	54070	195	10.90	7.65	0.63	-0.19733
15:01:16	54076	201	10.80	7.55	0.63	-0.20304
15:01:21	54081	206	10.70	7.45	0.62	-0.20883
15:01:28	54088	213	10.60	7.35	0.61	-0.21470
15:01:33	54093	218	10.50	7.25	0.60	-0.22065
15:01:39	54099	224	10.40	7.15	0.59	-0.22668
15:01:45	54105	230	10.30	7.05	0.59	-0.23280
15:01:52	54112	237	10.20	6.95	0.58	-0.23900
15:01:58	54118	243	10.10	6.85	0.57	-0.24530
15:02:04	54124	249	10.00	6.75	0.56	-0.25168
15:02:10	54130	255	9.90	6.65	0.55	-0.25817
15:02:17	54137	262	9.80	6.55	0.54	-0.26475
15:02:24	54144	269	9.70	6.45	0.54	-0.27143
15:02:30	54150	275	9.60	6.35	0.53	-0.27821
15:02:38	54158	283	9.50	6.25	0.52	-0.28511
15:02:45	54165	290	9.40	6.15	0.51	-0.29211
15:02:52	54172	297	9.30	6.05	0.50	-0.29923
15:02:59	54179	304	9.20	5.95	0.49	-0.30647

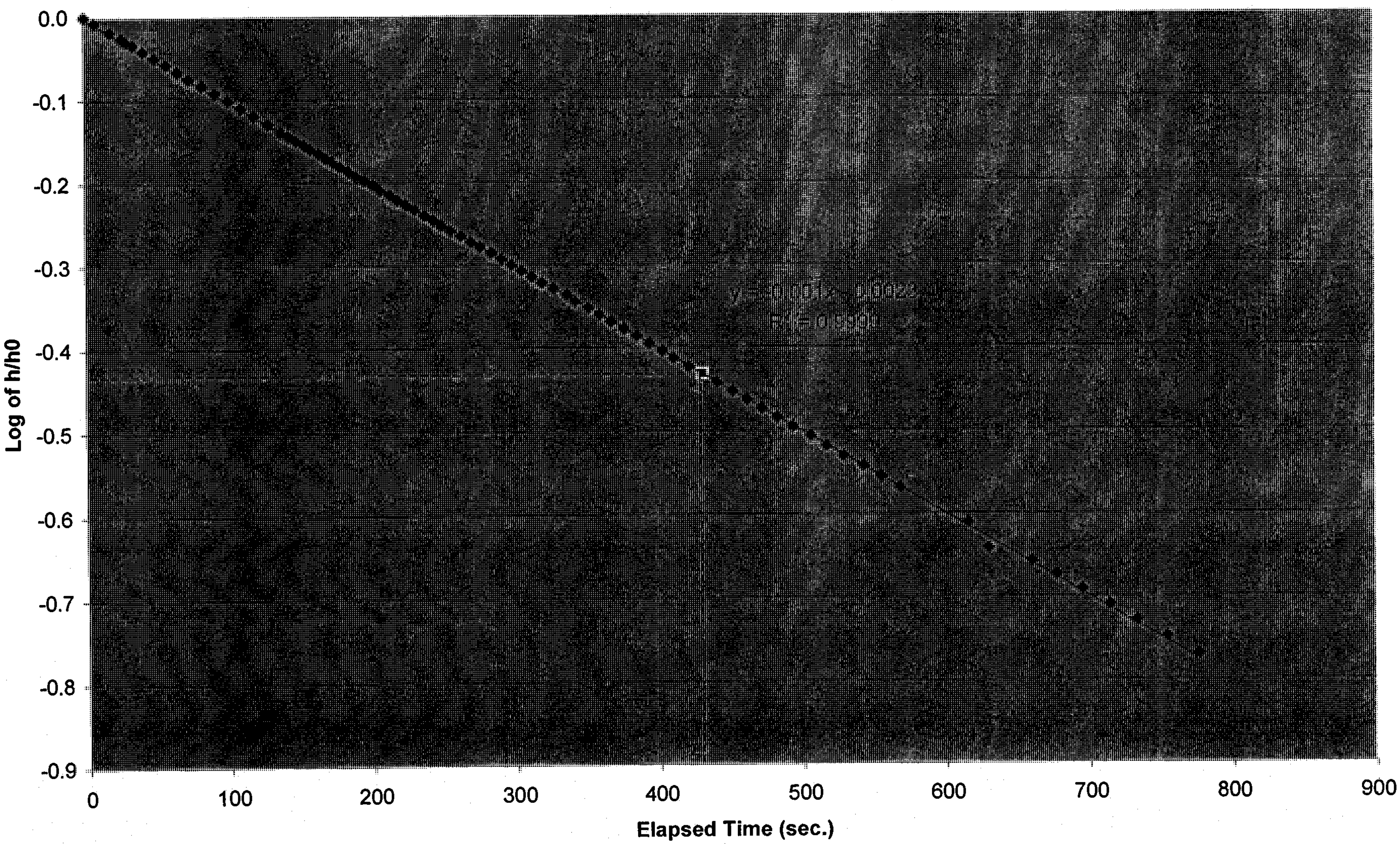
Time	Time (sec.)	Elapsed Time (sec.)	Depth to Water (ft.)	dh (ft.)	h/h0	Log of h/h0
15:03:06	54186	311	9.10	5.85	0.49	-0.31383
15:03:13	54193	318	9.00	5.75	0.48	-0.32132
15:03:21	54201	326	8.90	5.65	0.47	-0.32894
15:03:30	54210	335	8.80	5.55	0.46	-0.33669
15:03:36	54216	341	8.70	5.45	0.45	-0.34459
15:03:45	54225	350	8.60	5.35	0.44	-0.35263
15:03:53	54233	358	8.50	5.25	0.44	-0.36083
15:04:01	54241	366	8.40	5.15	0.43	-0.36918
15:04:10	54250	375	8.30	5.05	0.42	-0.37770
15:04:19	54259	384	8.20	4.95	0.41	-0.38638
15:04:28	54268	393	8.10	4.85	0.40	-0.39525
15:04:37	54277	402	8.00	4.75	0.39	-0.40429
15:04:45	54285	410	7.90	4.65	0.39	-0.41353
15:04:56	54296	421	7.80	4.55	0.38	-0.42298
15:05:05	54305	430	7.70	4.45	0.37	-0.43263
-	-	430.44	-	-	-	-0.43180
15:05:15	54315	440	7.60	4.35	0.36	-0.44250
15:05:26	54326	451	7.50	4.25	0.35	-0.45260
15:05:36	54336	461	7.40	4.15	0.34	-0.46294
15:05:46	54346	471	7.30	4.05	0.34	-0.47353
15:05:57	54357	482	7.20	3.95	0.33	-0.48439
15:06:08	54368	493	7.10	3.85	0.32	-0.49553
15:06:20	54380	505	7.00	3.75	0.31	-0.50696
15:06:31	54391	516	6.90	3.65	0.30	-0.51869
15:06:43	54403	528	6.80	3.55	0.29	-0.53076
15:06:57	54417	542	6.70	3.45	0.29	-0.54317
15:07:09	54429	554	6.60	3.35	0.28	-0.55594
15:07:22	54442	567	6.50	3.25	0.27	-0.56910
15:08:10	54490	615	6.20	2.95	0.24	-0.61117
15:08:24	54504	629	6.00	2.75	0.23	-0.64165
15:08:54	54534	659	5.90	2.65	0.22	-0.65774
15:09:11	54551	676	5.80	2.55	0.21	-0.67445
15:09:29	54569	694	5.70	2.45	0.20	-0.69182
15:09:48	54588	713	5.60	2.35	0.20	-0.70992
15:10:07	54607	732	5.50	2.25	0.19	-0.72880
15:10:28	54628	753	5.40	2.15	0.18	-0.74855
15:10:50	54650	775	5.30	2.05	0.17	-0.76923

Drawdown Test for P1-8D
Haywood County White Oak Landfill

Slug Test by Hvorslev

Initial depth to water table from top of pipe:	3.25	ft.
Initial Drawdown:	12.05	ft.
Total well length:	50.13	ft.
Radius of the well casing (r):	0.0833	ft.
Radius of the gravel pack (R):	0.1458	ft.
Length of the well screen (L_e):	10.0	ft.
Time it takes for the water level to rise or fall to 37% of the initial change (T_0):	430.44	sec.
K =	3.41E-06	ft./sec.
	107.55	ft./yr.

Drawdown Test for P1-8D



$L_e = 5.0$

$r_w = 0.2448$

$\frac{L_e}{r_w} = 20.42$

$A = 2.28$

$B = 0.32$

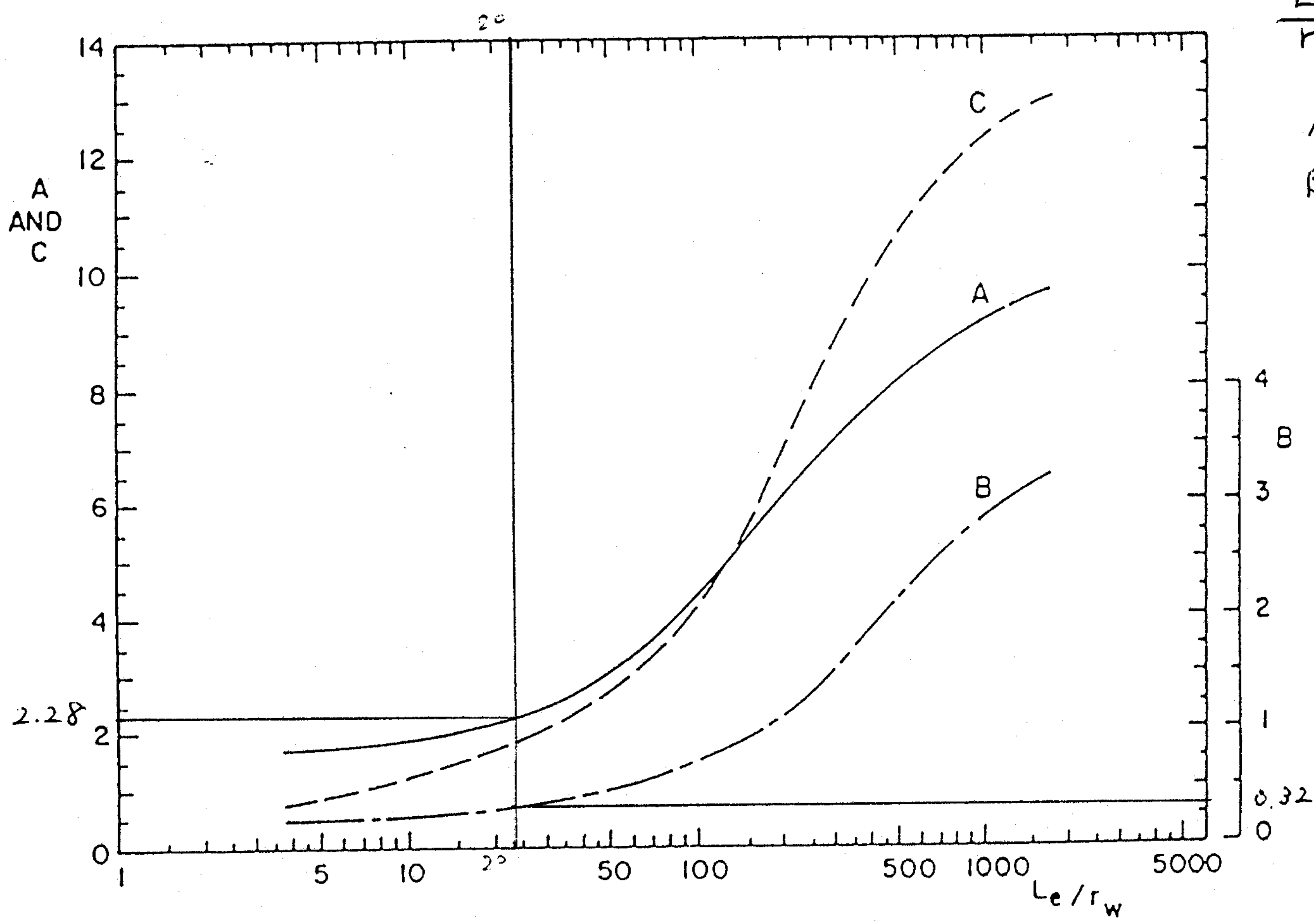


Fig. 2. Dimensionless parameters A, B, and C as a function of L_e/r_W for calculation of $\ln(R_e/r_W)$.

$L_e = 10.0$

$r_w = 0.2448$

$\frac{L_e}{r_w} = 40.85$

$A = 2.78$

$B = 0.44$

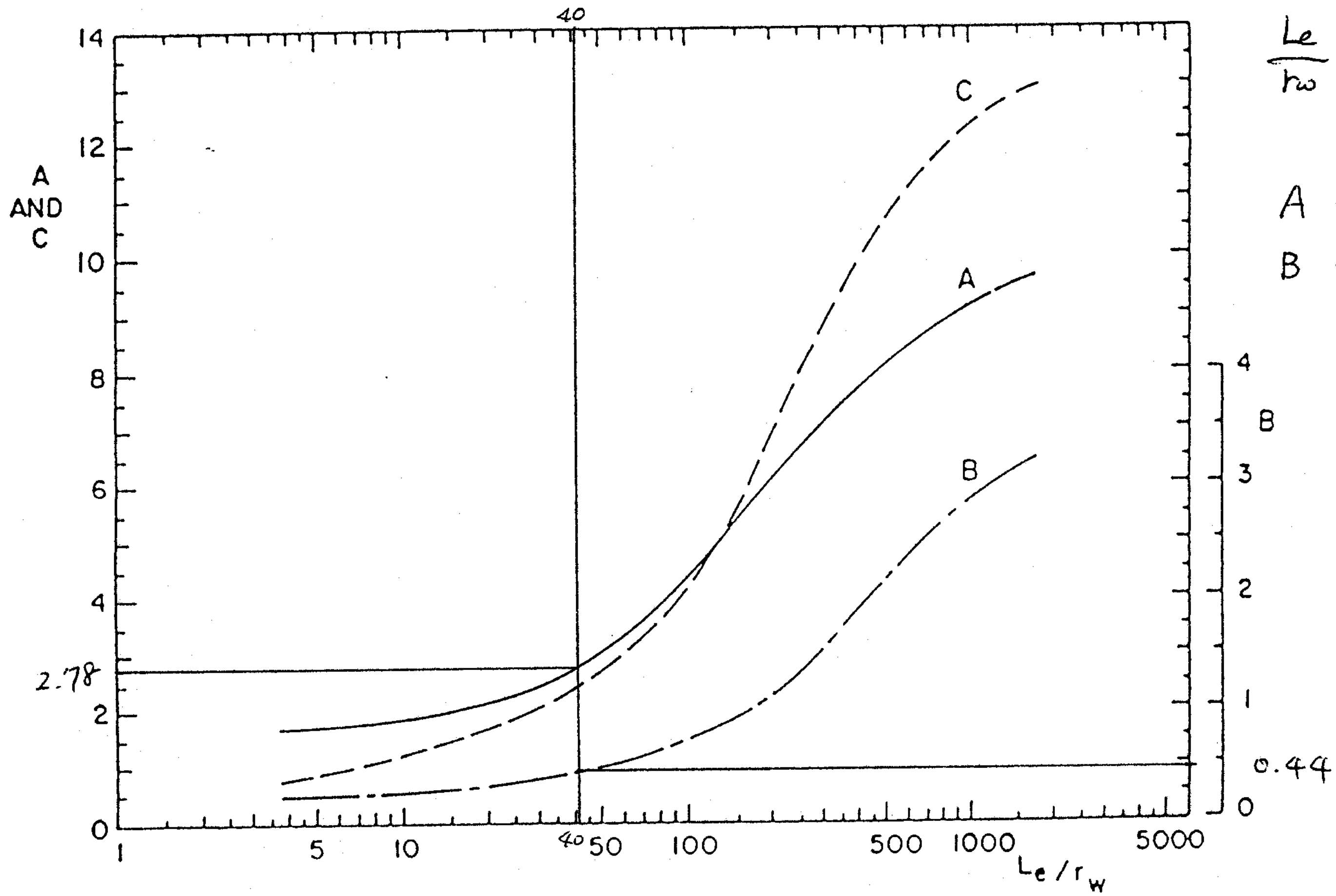


Fig. 2. Dimensionless parameters A, B, and C as a function of L_e/r_w for calculation of $\ln(R_e/r_w)$.

Calculations of Vertical Flow Rates
Haywood County White Oak Landfill

	P-12	P-12D	dh	Vz (ft/yr)
04/28/99	2547.42	2546.68	-0.74	-86.03
06/21/99	2546.85	2546.07	-0.78	-90.68
07/27/99	2547.29	2546.53	-0.76	-88.35
08/10/99	2546.97	2546.18	-0.79	-91.84
02/11/00	2547.19	2546.41	-0.78	-90.68
03/14/00	2547.27	2546.43	-0.84	-97.65

Descriptive Statistics	
Mean:	-90.87
Standard Error:	1.60
Median:	-90.68
Mode:	-90.68
Standard Deviation:	3.92
Sample Variance:	15.36
Kurtosis:	1.77843
Skewness:	-0.91246
Range:	11.63
Minimum:	-97.65
Maximum:	-86.03
Sum:	-545.22
Count:	6
dl =	16.80
average dh =	-0.78
average i =	-0.05

	P1-1S	P1-1D	dh	Vz (ft/yr)
04/28/99	2559.27	2558.69	-0.58	-38.75
06/21/99	2558.63	2558.13	-0.50	-33.40
07/27/99	2558.43	2557.93	-0.50	-33.40
08/10/99	2558.44	2557.91	-0.53	-35.41
02/11/00	2558.22	2557.28	-0.94	-62.80
03/14/00	2558.17	2557.28	-0.89	-59.46

Descriptive Statistics	
Mean:	-43.87
Standard Error:	5.53
Median:	-37.08
Mode:	-33.40
Standard Deviation:	13.55
Sample Variance:	183.63
Kurtosis:	-1.74104
Skewness:	-0.90849
Range:	29.39
Minimum:	-62.80
Maximum:	-33.40
Sum:	-263.21
Count:	6
dl =	27.68
average dh =	-0.66
average i =	-0.02

	P1-2S	P1-2D	dh	Vz (ft/yr)
04/28/99	2569.86	2565.73	-4.13	-269.86
06/21/99	2569.80	2565.64	-4.16	-271.82
07/27/99	2569.89	2565.90	-3.99	-260.71
08/10/99	2569.91	2565.78	-4.13	-269.86
02/11/00	2567.66	2564.26	-3.40	-222.16
03/14/00	2567.66	2564.28	-3.38	-220.85

Descriptive Statistics	
Mean:	-252.54
Standard Error:	9.94
Median:	-265.28
Mode:	-269.86
Standard Deviation:	24.35
Sample Variance:	593.07
Kurtosis:	-1.90530
Skewness:	0.86793
Range:	50.97
Minimum:	-271.82
Maximum:	-220.85
Sum:	-1515.26
Count:	6
dl =	29.89
average dh =	-3.86
average i =	-0.13

	P1-5S	P1-5D	dh	Vz (ft/yr)
04/28/99	2583.16	2581.48	-1.68	-160.05
06/21/99	2583.57	2582.02	-1.55	-147.67
07/27/99	2583.76	2582.30	-1.46	-139.09
08/10/99	2583.78	2582.36	-1.42	-135.28
02/11/00	2581.50	2580.45	-1.05	-100.03
03/14/00	2581.22	2580.18	-1.04	-99.08

Descriptive Statistics	
Mean:	-130.20
Standard Error:	10.30
Median:	-137.19
Mode:	#N/A
Standard Deviation:	25.22
Sample Variance:	635.95
Kurtosis:	-1.64513
Skewness:	0.46462
Range:	60.97
Minimum:	-160.05
Maximum:	-99.08
Sum:	-781.22
Count:	6
dl =	20.50
average dh =	-1.37
average i =	-0.07

	P1-7S	P1-7D	dh	Vz (ft/yr)
04/28/99	2544.82	2542.64	-2.18	-425.76
06/21/99	2544.45	2542.92	-1.53	-298.81
07/27/99	2544.74	2543.62	-1.12	-218.74
08/10/99	2544.45	2543.30	-1.15	-224.60
02/11/00	2544.30	2542.47	-1.83	-357.41
03/14/00	2544.41	2542.66	-1.75	-341.78

Descriptive Statistics	
Mean:	-311.18
Standard Error:	32.86
Median:	-320.30
Mode:	#N/A
Standard Deviation:	80.49
Sample Variance:	6479.38
Kurtosis:	-1.13028
Skewness:	-0.10962
Range:	207.02
Minimum:	-425.76
Maximum:	-218.74
Sum:	-1867.11
Count:	6
dl =	10.00
average dh =	-1.59
average i =	-0.16

	P1-8S	P1-8D	dh	Vz (ft/yr)
04/28/99	2532.61	2531.24	-1.37	-70.54
06/21/99	2532.01	2530.83	-1.18	-60.75
07/27/99	2532.41	2531.40	-1.01	-52.00
08/10/99	2532.41	2531.13	-1.28	-65.90
02/11/00	2532.50	2531.14	-1.36	-70.02
03/14/00	2532.81	2531.50	-1.31	-67.45

Descriptive Statistics	
Mean:	-64.44
Standard Error:	2.87
Median:	-66.68
Mode:	#N/A
Standard Deviation:	7.04
Sample Variance:	49.56
Kurtosis:	1.32601
Skewness:	1.32984
Range:	18.54
Minimum:	-70.54
Maximum:	-52.00
Sum:	-386.67
Count:	6
dl =	32.00
average dh =	-1.25
average i =	-0.04

	P-6S	P-6D	dh	Vz (ft/yr)
02/11/00	2563.99	2564.92	0.93	74.56
03/14/00	2563.47	2564.41	0.94	75.36

Descriptive Statistics

Mean:	74.96
Standard Error:	0.40
Median:	74.96
Mode:	#N/A
Standard Deviation:	0.57
Sample Variance:	0.32
Kurtosis:	#DIV/0!
Skewness:	#DIV/0!
Range:	0.80
Minimum:	74.56
Maximum:	75.36
Sum:	149.93
Count:	2
dl =	24.36
average dh =	0.93
average i =	0.04

	GWM-7	GWM-7D	dh	Vz (ft/yr)
06/09/98	2581.50	2579.62	-1.88	-144.56
07/07/98	2581.92	2579.80	-2.12	-163.01
08/17/98	2581.37	2579.39	-1.98	-152.24
09/25/98	2580.67	2578.67	-2.00	-153.78
10/27/98	2579.18	2578.19	-0.99	-76.12
12/02/98	2579.48	2577.50	-1.98	-152.24
01/13/99	2578.81	2577.10	-1.71	-131.48
02/11/99	2578.64	2576.62	-2.02	-155.32
04/28/99	2578.04	2577.03	-1.01	-77.66
06/21/99	2577.98	2578.15	0.17	13.07
07/27/99	2577.96	2578.12	0.16	12.30
08/10/99	2580.14	2577.12	-3.02	-232.21
02/11/00	2577.34	2575.33	-2.01	-154.55
03/14/00	2576.94	2574.92	-2.02	-155.32

Descriptive Statistics

Mean:	-123.08
Standard Error:	18.29
Median:	-152.25
Mode:	-152.25
Standard Deviation:	68.43
Sample Variance:	4683.30
Kurtosis:	0.83907
Skewness:	1.02261
Range:	245.28
Minimum:	-232.21
Maximum:	13.07
Sum:	-1723.14
Count:	14
dl =	25.40
average dh =	-1.6
average i =	-0.06

	TWD-10	TWD-10D	dh	Vz (ft/yr)
06/09/98	2588.21	2588.00	-0.21	-17.97
07/07/98	2587.74	2587.57	-0.17	-14.55
08/17/98	2586.48	2586.33	-0.15	-12.84
09/25/98	2585.17	2585.04	-0.13	-11.12
10/27/98	2584.20	2584.08	-0.12	-10.27
01/13/99	2584.74	2583.41	-1.33	-113.81
02/11/99	2582.86	2582.78	-0.08	-6.85
04/28/99	2585.15	2584.91	-0.24	-20.54
06/21/99	2584.06	2584.41	0.35	29.95
08/10/99	2584.06	2583.93	-0.13	-11.12
02/11/00	2581.00	2580.93	-0.07	-5.99
03/14/00	2581.26	2581.18	-0.08	-6.85

Descriptive Statistics	
Mean:	-16.83
Standard Error:	9.56
Median:	-11.12
Mode:	-11.12
Standard Deviation:	33.10
Sample Variance:	1095.90
Kurtosis:	8.20656
Skewness:	-2.42317
Range:	143.76
Minimum:	-113.81
Maximum:	29.95
Sum:	-201.95
Count:	12
dl =	19.00
average dh =	-0.2
average i =	-0.01

	GWM-5A	GWM-5D	dh	Vz (ft/yr)
06/09/98	2497.70	2496.62	-1.08	-112.80
07/07/98	2497.04	2496.23	-0.81	-84.60
08/17/98	2496.76	2496.07	-0.69	-72.06
09/25/98	2496.43	2495.90	-0.53	-55.35
10/27/98	2496.36	2495.88	-0.48	-50.13
12/02/98	2496.15	2495.68	-0.47	-49.09
01/13/99	2496.09	2495.75	-0.34	-35.51
02/11/99	2497.76	2496.48	-1.28	-133.68
06/21/99	2496.51	2495.82	-0.69	-72.06
08/10/99	2496.80	2495.99	-0.81	-84.60
02/11/00	2501.35	2500.87	-0.48	-50.13
03/14/00	2496.71	2495.86	-0.85	-88.77

Descriptive Statistics	
Mean:	-74.07
Standard Error:	8.31
Median:	-72.06
Mode:	-84.60
Standard Deviation:	28.77
Sample Variance:	827.90
Kurtosis:	0.18136
Skewness:	-0.77223
Range:	98.17
Minimum:	-133.68
Maximum:	-35.51
Sum:	-888.79
Count:	12
dl =	18.70
average dh =	-0.71
average i =	-0.04

Well parameters used in vertical flow rate calculations
(All parameters are expressed in feet.)

Well	Ground Elevation	Depth		Elevation			dl
		T. of Sc.	B. of Sc.	T. of Sc.	B. of Sc.	M. Pt.	
P-12	2555.38	8.00	18.00	2547.38	2537.38	2542.38	
P-12D	2554.58	24.00	34.00	2530.58	2520.58	2525.58	16.80
P1-1S	2626.20	58.00	68.00	2568.20	2558.20	2563.20	
P1-1D	2625.52	80.00	100.00	2545.52	2525.52	2535.52	27.68
P1-2S	2602.48	38.50	48.50	2563.98	2553.98	2558.98	
P1-2D	2603.09	69.00	79.00	2534.09	2524.09	2529.09	29.89
P1-5S	2633.21	48.00	58.00	2585.21	2575.21	2580.21	
P1-5D	2633.21	68.50	78.50	2564.71	2554.71	2559.71	20.50
P1-7S	2575.00	34.00	44.00	2541.00	2531.00	2536.00	
P1-7D	2575.00	44.00	54.00	2531.00	2521.00	2526.00	10.00
P1-8S	2534.02	10.00	15.00	2524.02	2519.02	2521.52	
P1-8D	2533.52	39.00	49.00	2494.52	2484.52	2489.52	32.00
P-6S	2612.40	39.50	54.50	2572.90	2557.90	2565.40	
P-6D	2613.21	67.17	77.17	2546.04	2536.04	2541.04	24.36
GWM-7	2643.56	62.30	82.30	2581.26	2561.26	2571.26	
GWM-7D	2643.56	92.70	102.70	2550.86	2540.86	2545.86	25.40
TWD-10	2614.39	25.00	35.00	2589.39	2579.39	2584.39	
TWD-10D	2614.39	39.00	59.00	2575.39	2555.39	2565.39	19.00
GWM-5A	2502.47	4.50	19.50	2497.97	2482.97	2490.47	
GWM-5D	2502.47	25.70	35.70	2476.77	2466.77	2471.77	18.70

* V_z denotes vertical flow rate, and is defined by the equation

$$V_z = \frac{K}{n_e}\frac{dh}{dl}$$

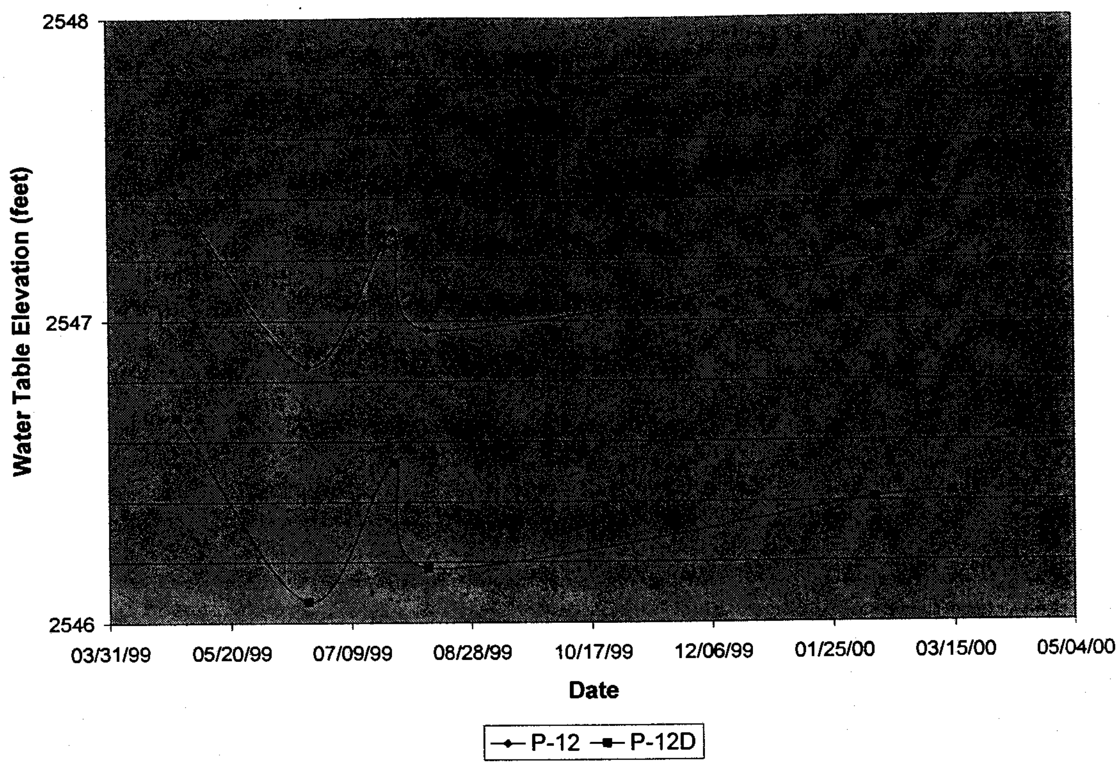
where

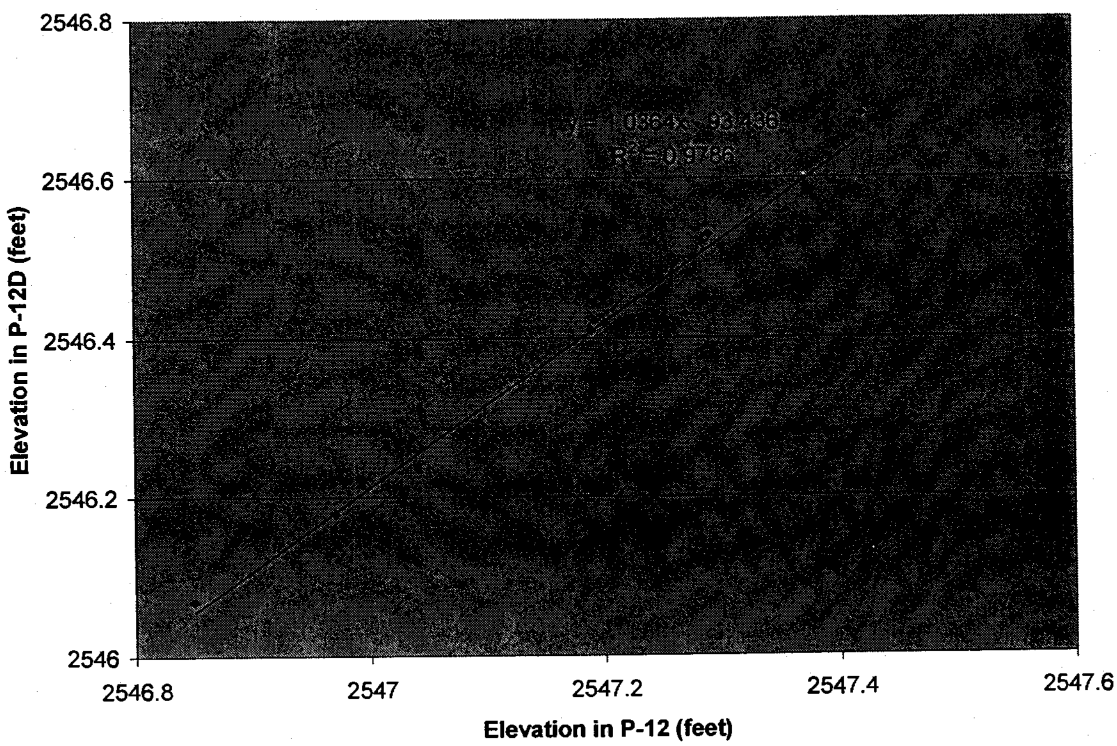
V_z = vertical flow rate (ft/yr)
K = hydraulic conductivity (cm/sec)
n_e = effective porosity (%)
dh = head difference (ft.)
dl = vertical separation (ft.)

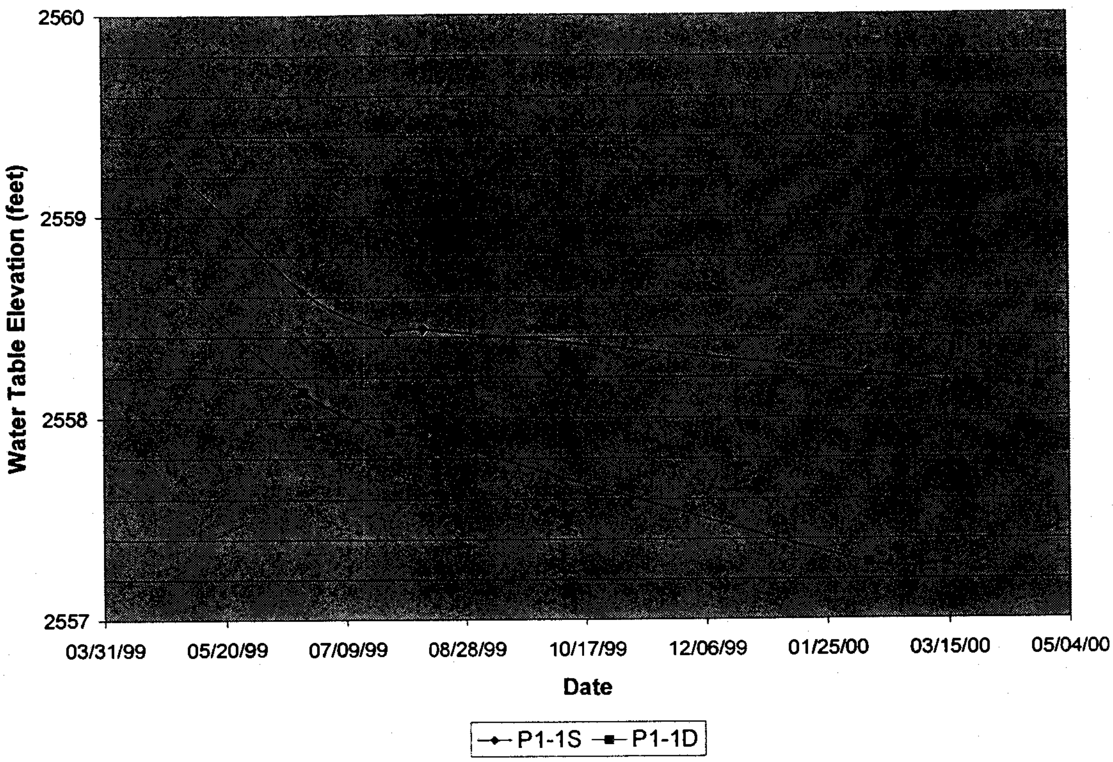
Since all shallow wells are installed directly on top of bedrock and are screened in the upper saprolite unit, and all deep wells are screened in the bedrock unit, the average hydraulic conductivity was calculated for each well nest, and was used in the calculation.

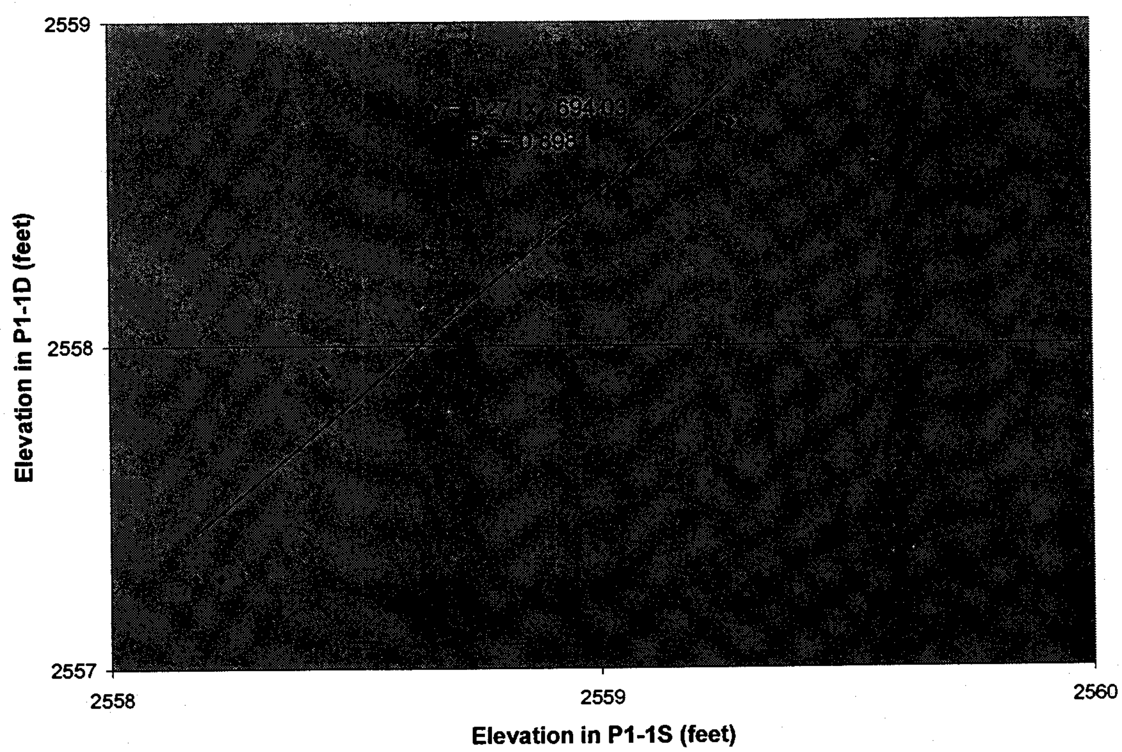
† Negative dh values indicate downward flow gradient.

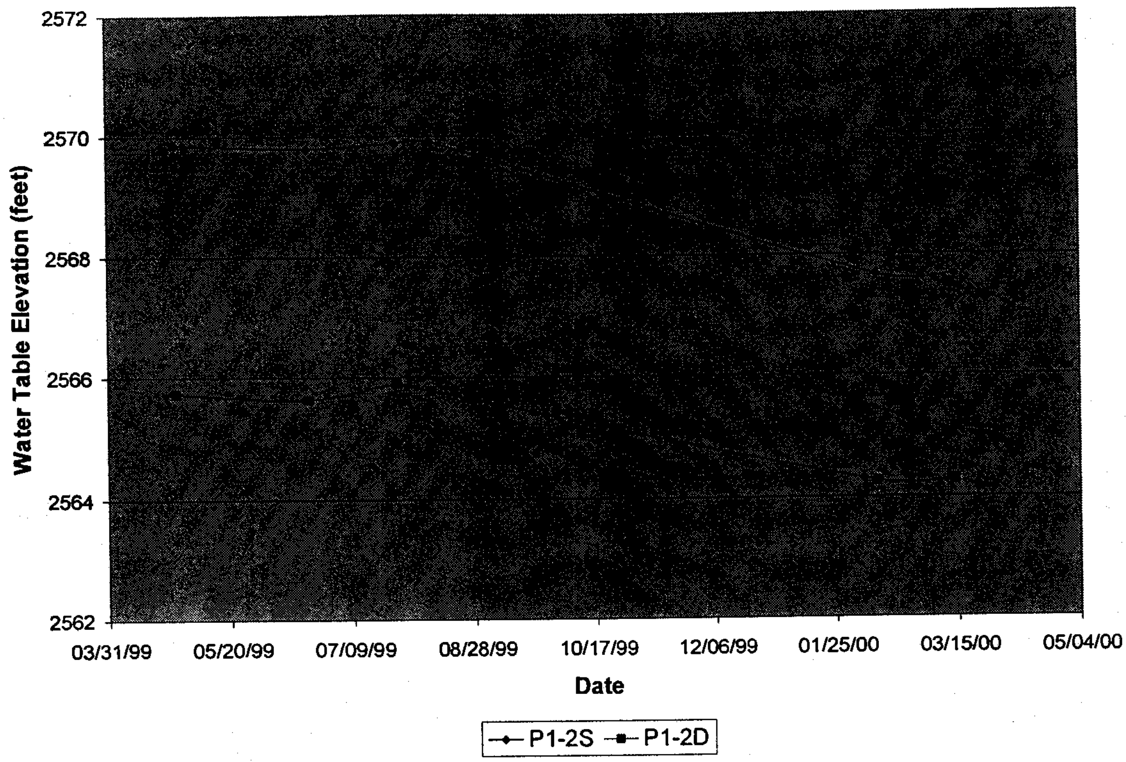
Water Table Elevation Charts
Haywood County White Oak Landfill



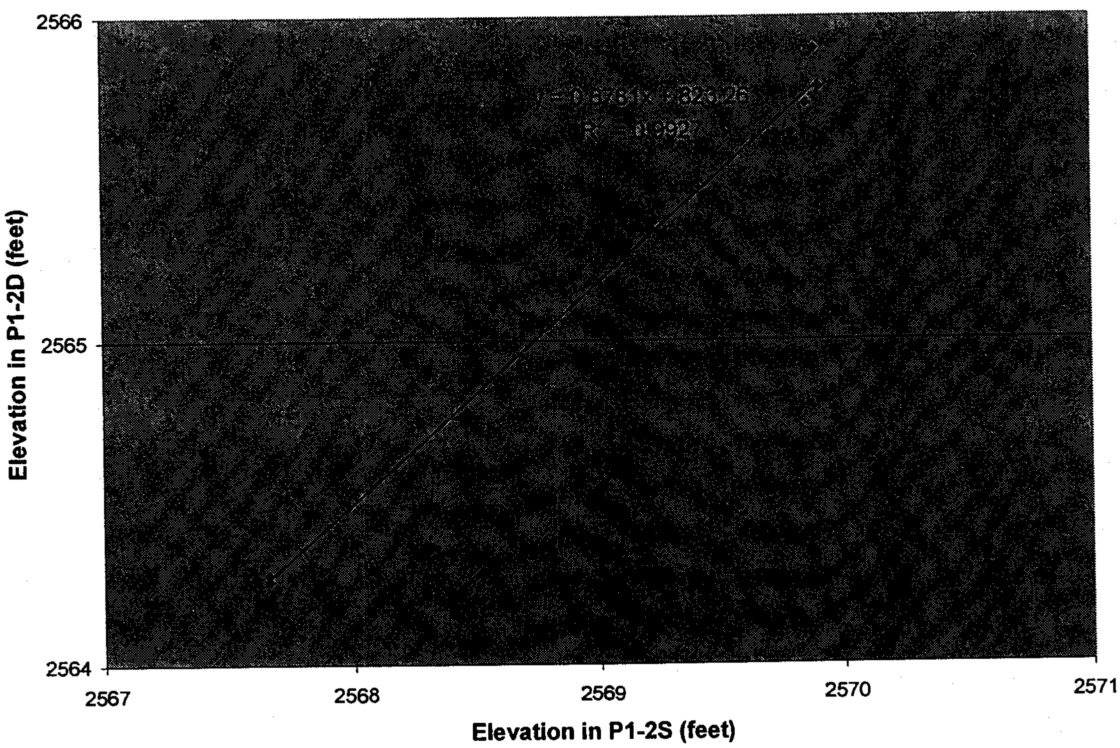



2560
2559
2558
2557
Water Table Elevation (feet)
03/31/99
05/20/99
07/09/99
08/28/99
10/17/99
12/06/99
01/25/00
03/15/00
05/04/00
Date
P1-1S
P1-1D

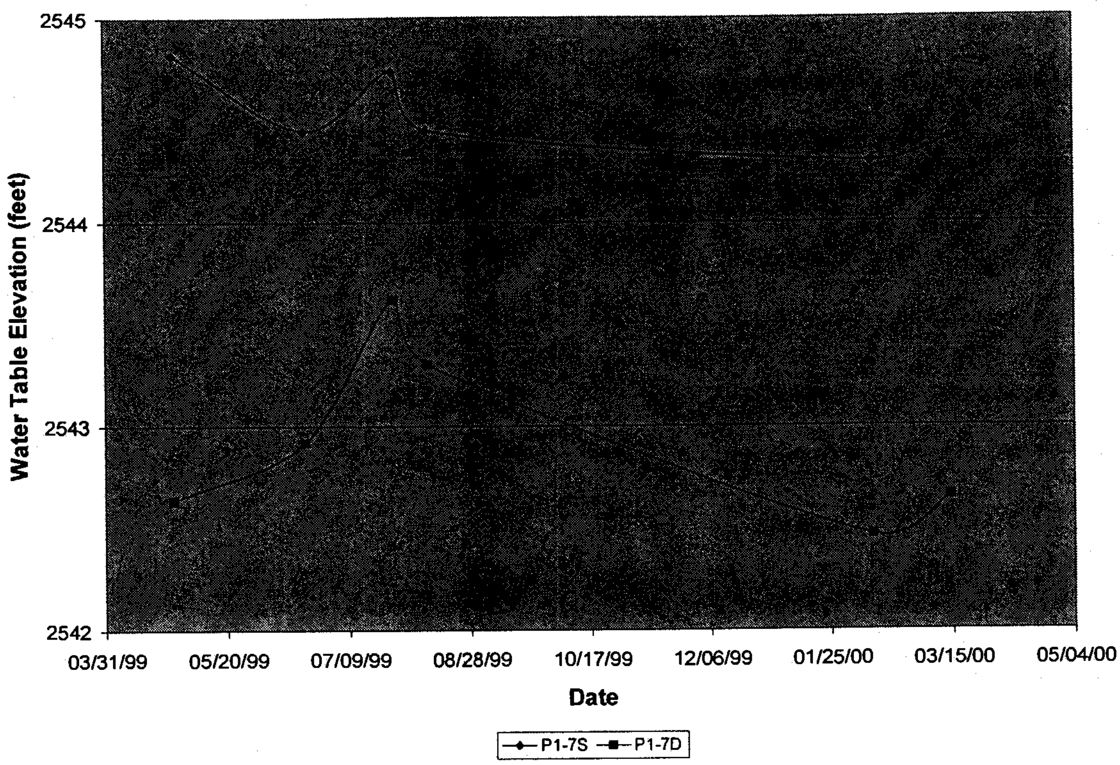

2559
2558
2557
Elevation in P1-1D (feet)
2558
2559
2560
Elevation in P1-1S (feet)

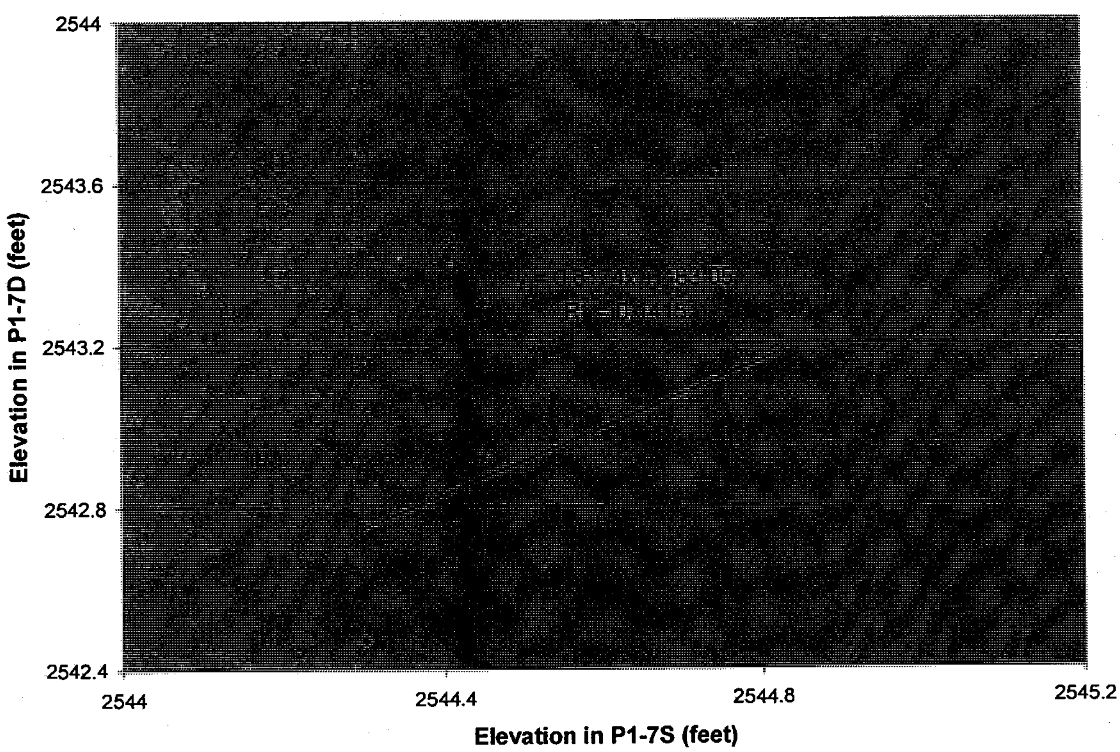


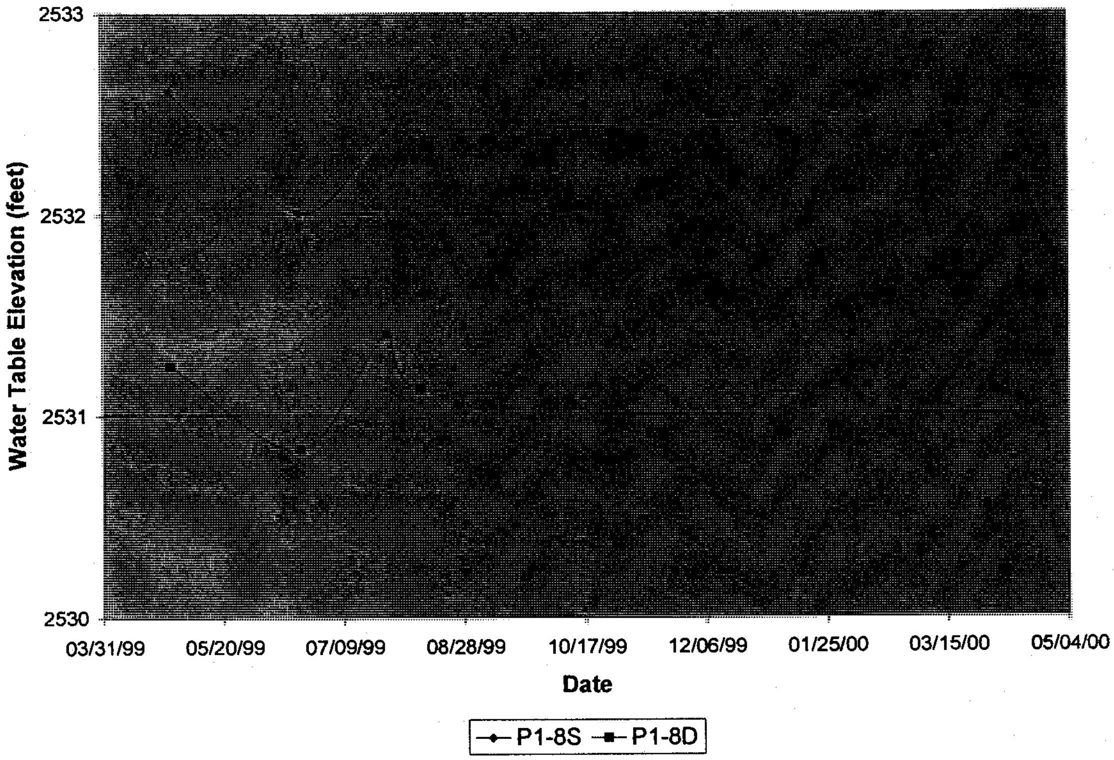
2572
2570
2568
2566
2564
2562
Water Table Elevation (feet)
03/31/99
05/20/99
07/09/99
08/28/99
10/17/99
12/06/99
01/25/00
03/15/00
05/04/00
Date
P1-2S
P1-2D

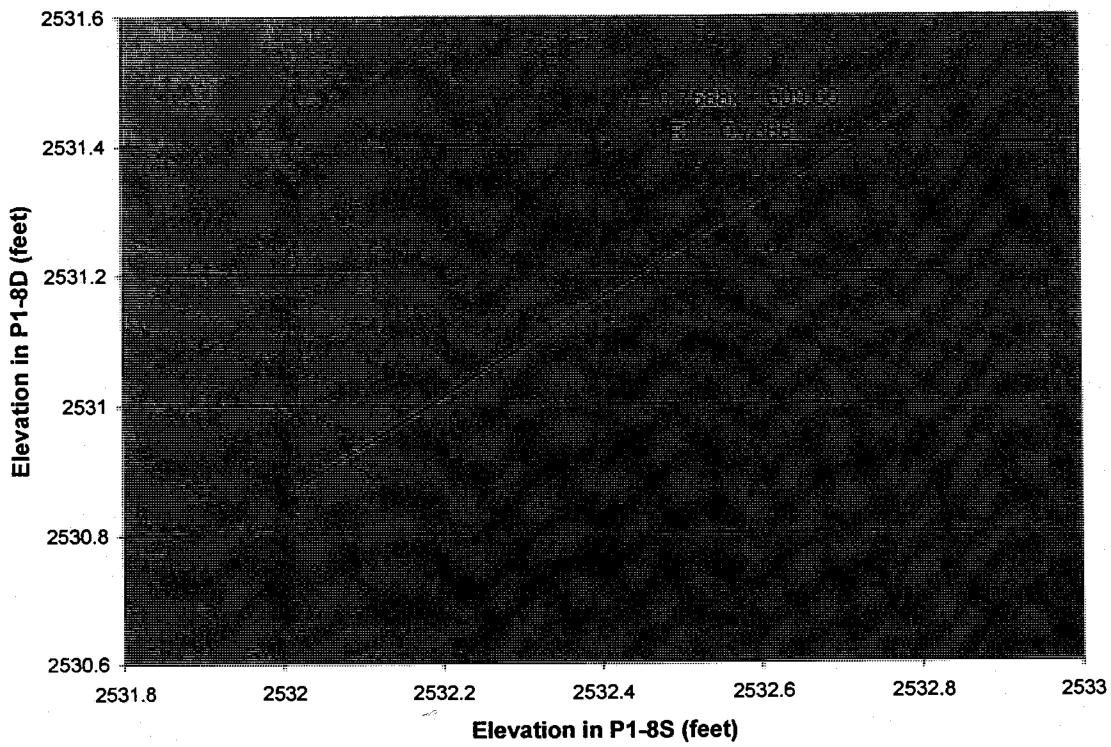


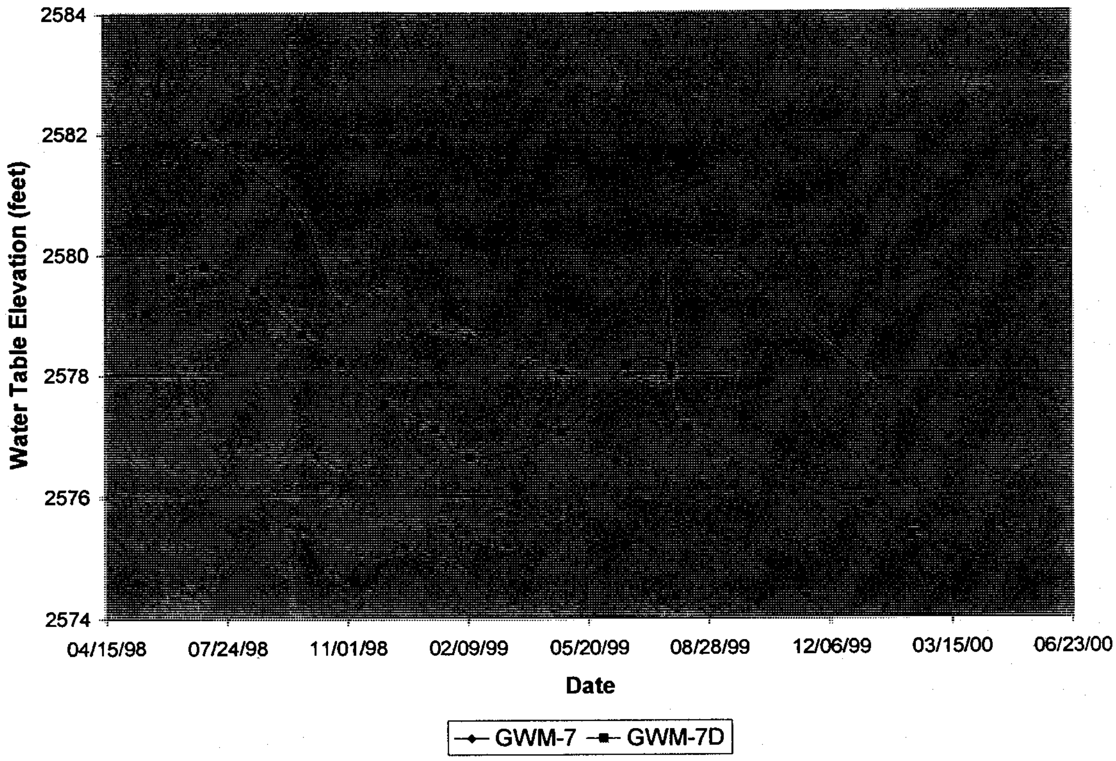
2566
2565
2564
Elevation in P1-2D (feet)
2567
2568
2569
2570
2571
Elevation in P1-2S (feet)

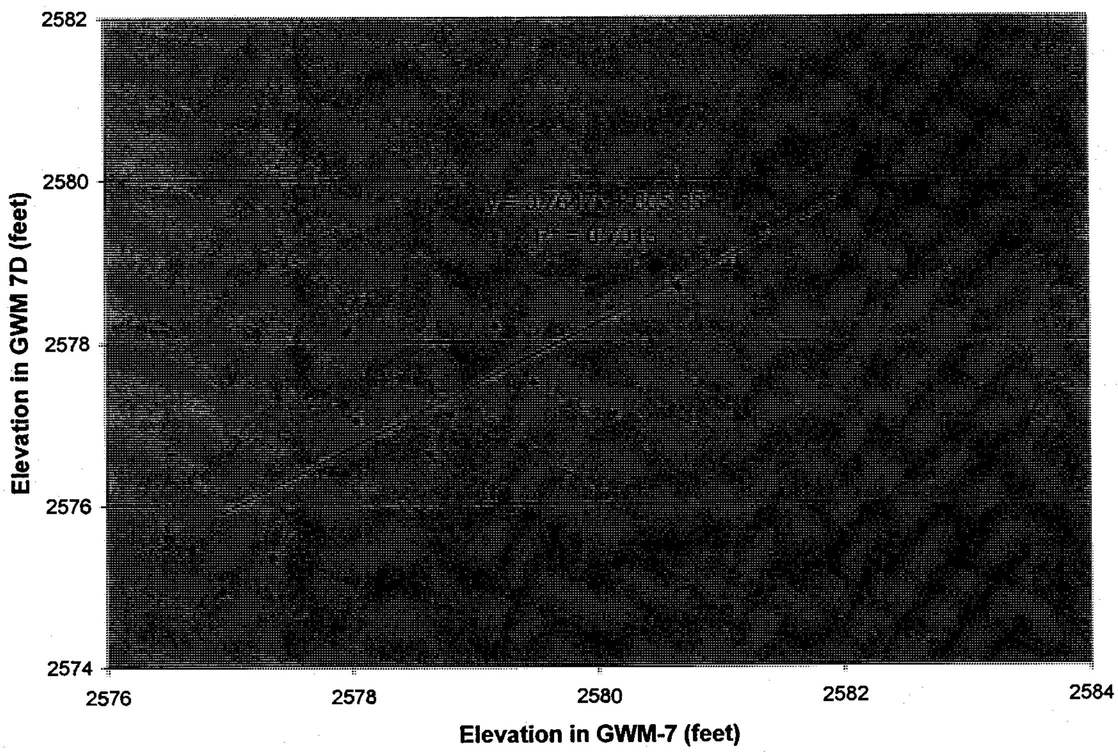

2545
2544
2543
2542
Water Table Elevation (feet)
03/31/99
05/20/99
07/09/99
08/28/99
10/17/99
12/06/99
01/25/00
03/15/00
05/04/00
Date
P1-7S
P1-7D

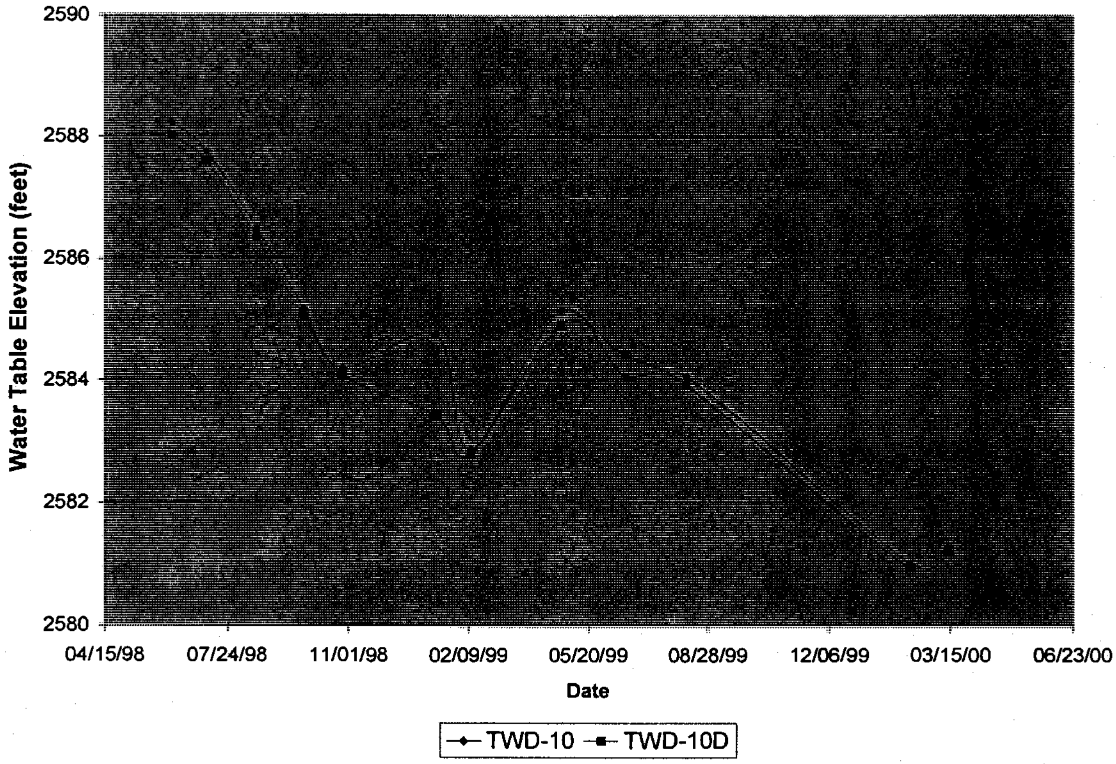

2544
2543.6
2543.2
2542.8
2542.4
Elevation in P1-7D (feet)
2544
2544.4
2544.8
2545.2
Elevation in P1-7S (feet)

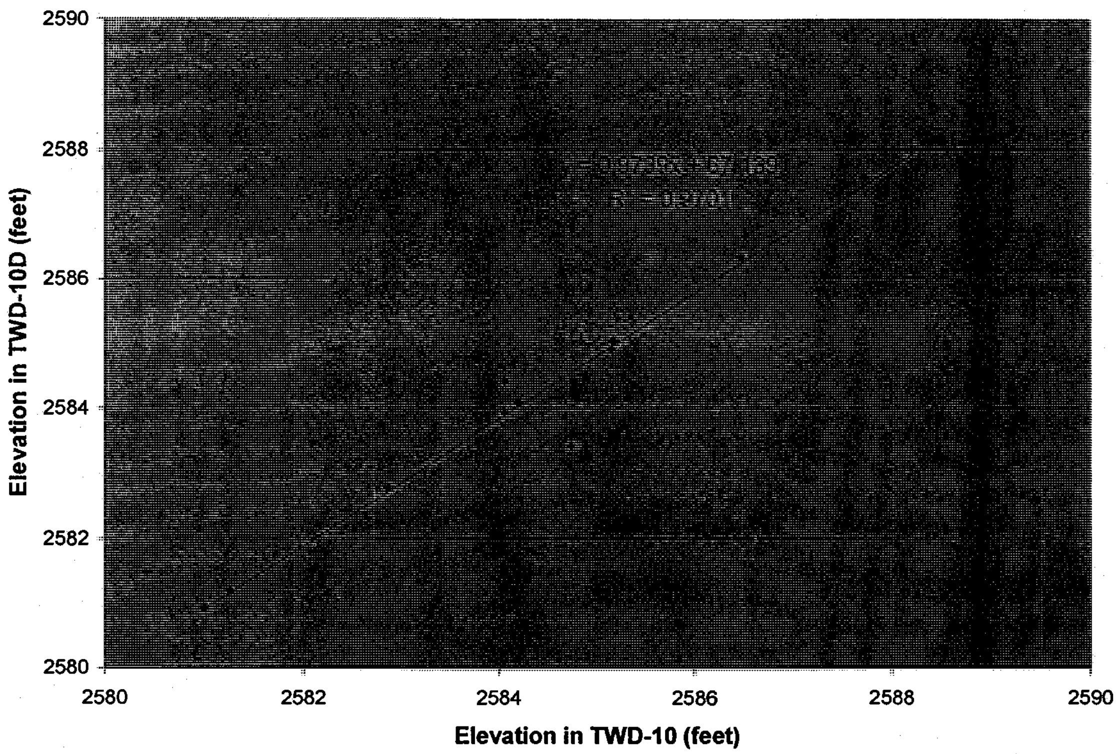

2533
2532
2531
2530
Water Table Elevation (feet)
03/31/99
05/20/99
07/09/99
08/28/99
10/17/99
12/06/99
01/25/00
03/15/00
05/04/00
Date
P1-8S
P1-8D


2531.6
2531.4
2531.2
2531
2530.8
2530.6
Elevation in P1-8D (feet)
2531.8
2532
2532.2
2532.4
2532.6
2532.8
2533
Elevation in P1-8S (feet)


2584
2582
2580
2578
2576
2574
Water Table Elevation (feet)
04/15/98
07/24/98
11/01/98
02/09/99
05/20/99
08/28/99
12/06/99
03/15/00
06/23/00
Date
GWM-7
GWM-7D


2582
2580
2578
2576
2574
Elevation in GWM 7D (feet)
2576
2578
2580
2582
2584
Elevation in GWM-7 (feet)


2590
2588
2586
2584
2582
2580
Water Table Elevation (feet)
04/15/98
07/24/98
11/01/98
02/09/99
05/20/99
08/28/99
12/06/99
03/15/00
06/23/00
Date
TWD-10
TWD-10D


2590
2588
2586
2584
2582
2580
Elevation in TWD-10D (feet)
2580
2582
2584
2586
2588
2590
Elevation in TWD-10 (feet)

Grain Size Summary
Haywood County White Oak Landfill

Boring	Sampled Depth (ft.)	%Sand **	%Silt	%Clay	Consistency	Natural Moisture Content (%)	Specific Gravity	Dry Density (lb/ft³)	Dry Density (kg/m³)	Soil Classification	Effective Porosity (%)	Total Porosity (%)
P1–8S	13.0 – 14.0	62.1	28.5	9.4	firm	32.3	2.69	–	1260 *	Silty Sand	20	53
P1–4	28.0 – 29.5	55.2	32.7	12.1	very hard	17.8	2.72	–	1800 *	Silty Sand	17	34
P1–1S	29.0 – 30.5	52.5	36.4	11.1	very stiff	17.2	2.74	–	1190 *	Silty Sand	18	56
P1–7S	0.0 – 1.5	40.9	23.8	35.3	firm	28.9	2.64	–	1260 *	Sandy Clay	4	52
P1–6	33.5 – 35.0	61.6	29.0	9.4	stiff	22.2	2.64	–	1190 *	Silty Sand	20	55
P1–4	13.0 – 14.5	64.9	26.3	8.8	hard	14.4	2.78	–	1800 *	Silty Sand	21	35
P1–4	33.0 – 34.5	49.5	41.2	9.3	very hard	21.2	2.74	–	1800 *	Silty Sand	18	34
P2–1	1.0 – 5.0	46.7	28.4	24.9	firm	24.0	2.71	–	1260 *	Clayey Sand	6	53
P2–1	6.0 – 10.0	49.3	26.1	24.6	stiff	22.9	2.69	–	1190 *	Clayey Sand	6	56
P2–1	10.0 – 12.0	59.3	24.7	16.0	stiff	22.1	2.71	90.4	1190	Silty Sand	14	56
P2–1	21.0 – 23.0	41.7	36.2	22.1	very stiff	30.4	2.72	84.6	1110	Clayey Sand	8	59
P2–2	3.0 – 4.0	57.4	28.4	14.2	firm	21.5	2.75	95.9	1260	Silty Sand	15	54

* Dry density values were estimated from available data.
** Recalculated percentages based on geological classification for use in specific yield estimation.

Dry Density Values for Clay Minerals

Material	Dry Density (kg/m³)
unconsolidated muds	900–1100
soft, open-structured	1100–1400
typical, normally consolidated	1300–1900
boulder clays (overocnsolidated)	1700–2200

Das, Braja M., 1990, Principles of geotechnical engineering 2nd ed.: PWS–KENT Publishing Company, p. 40

Dry Unit Weight for Typical Soils

Type of Soil	Dry Unit Weight (lb/ft³)	Dry Unit Weight (kg/m³)
Loose angular–grained silty sand	102	1652.4
Dense angular–grained silty sand	121	1960.2

Das, Braja M., 1990, Principles of geotechnical engineering 2nd ed.: PWS–KENT Publishing Company, p. 43

Consistency of Cohesive Soils

Consistency	Blows per Foot
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

Conversion Factor

$1\,lb/ft^3 = 16.2\,kg/m^3$

Equation Used

$$n = 1 - \frac{\gamma_d}{G_s \gamma_w}$$

n = total porosity (%)
γ_d = dry density (dry unit weight) (kg/m³)
G_s = specific gravity (dimentionless)
γ_w = density of water (997.044 kg/m³ @ 25°C)

VAN DER HORST

HAYWOOD COUNTY LANDFILL
VNC-99-010.006

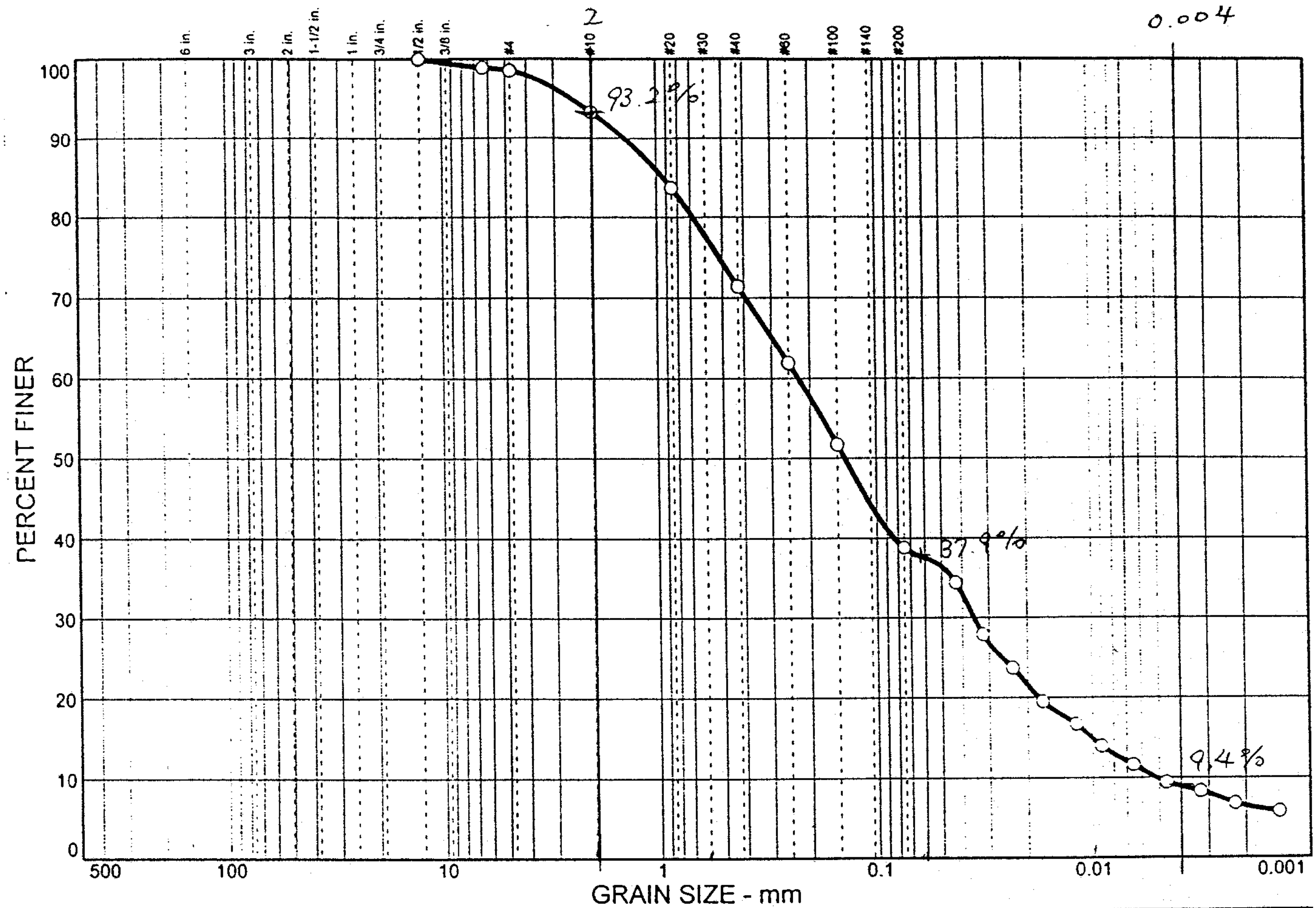
Laboratory Testing Summary

PI-7S

Test Method	99-174 (PI-8s@ 13-14')	99-175 (PL-4@ 28-29.5')	99-176 (PL-1@ 29-30.5')	99-177 ([illegible]@ 0-1.5')	99-178 (PL-6@ 33.5-35')	99-179 (PL-4@ 13-14.5')	99-180 (PL-4@ 33-34.5')
Natural Moisture Content (ASTM D-2216)	32.3%	17.8%	17.2%	28.9%	22.2%	14.4%	21.2%
Atterberg Limits (ASTM D-4318)							
LL	NV	NV	NV	52	NV	NV	NV
PL	NP	NP	NP	31	NP	NP	NP
PI	NP	NP	NP	21	NP	NP	NP
Grain-size Analysis (ASTM D-442)							
% Gravel	1.5	0.0	0.0	2.5	0.6	3.4	0.2
% Sand	59.7	51.2	51.4	38.2	61.9	57.0	44.3
% Silt	29.0	35.6	36.1	17.3	27.0	29.6	44.3
% Clay	9.8	13.2	12.5	42.0	10.5	10.0	11.2
Specific Gravity (ASTM D-854)	2.69	2.72	2.74	2.64	2.64	2.78	2.74
USCS Soil Classification	SM	SM	SM	MH	SM	SM	ML

Note: All atterberg samples were prepared using the wet method.

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.5	59.7	29.0	9.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.25 in.	98.9		
#4	98.5		
#10	93.3		
#20	83.7		
#40	71.4		
#60	61.9		
#100	51.7		
#200	38.8		

* (no specification provided)

Soil Description

Brown Micaceous Silty SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 0.928 D_{60}= 0.226 D_{50}= 0.139
D_{30}= 0.0353 D_{15}= 0.0101 D_{10}= 0.0052
C_u= 43.54 C_c= 1.06

Classification

USCS= SM AASHTO=

Remarks

99-174 - PI-8s 13.0-14.0'

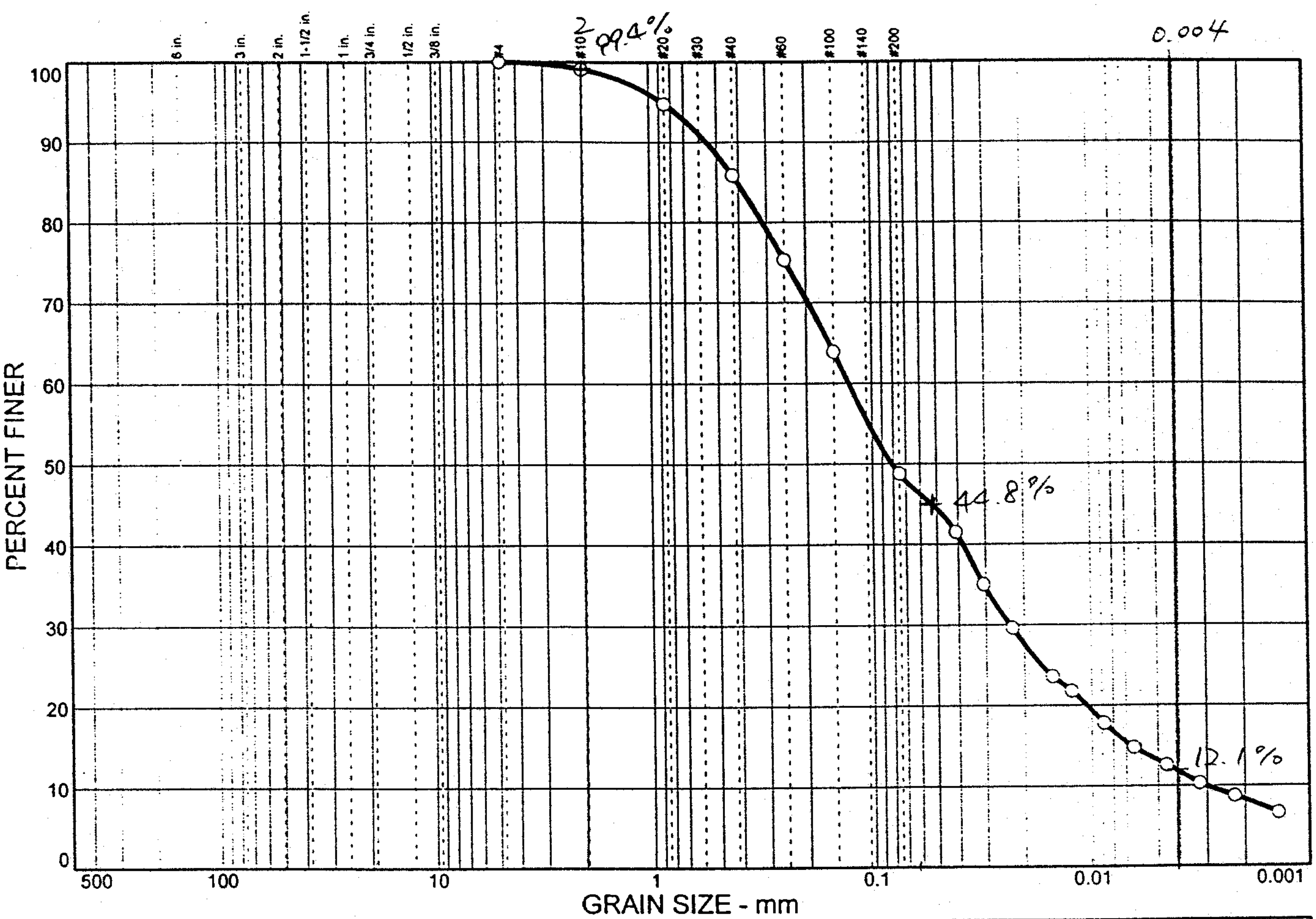
Sample No.: 99-174 **Source of Sample:** Piezometer samples **Date:** 05/05/99
Location: Haywood, NC **Elev./Depth:** 13.0 ft

VAN DER HORST ENGINEERING

Client: MUNICIPAL ENGINEERING, Co.
Project: HAYWOOD COUNTY LANDFILL
Project No: VNC-99-010 **Plate**

P1-4 @ 28.0 -29.5

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	51.2	35.6	13.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.1		
#20	94.8		
#40	85.9		
#60	75.3		
#100	63.9		
#200	48.8		

* (no specification provided)

Soil Description

Brown Micaceous Silty SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 0.404 D_{60}= 0.128 D_{50}= 0.0810
D_{30}= 0.0232 D_{15}= 0.0066 D_{10}= 0.0031
C_u= 41.81 C_c= 1.38

Classification

USCS= SM AASHTO=

Remarks

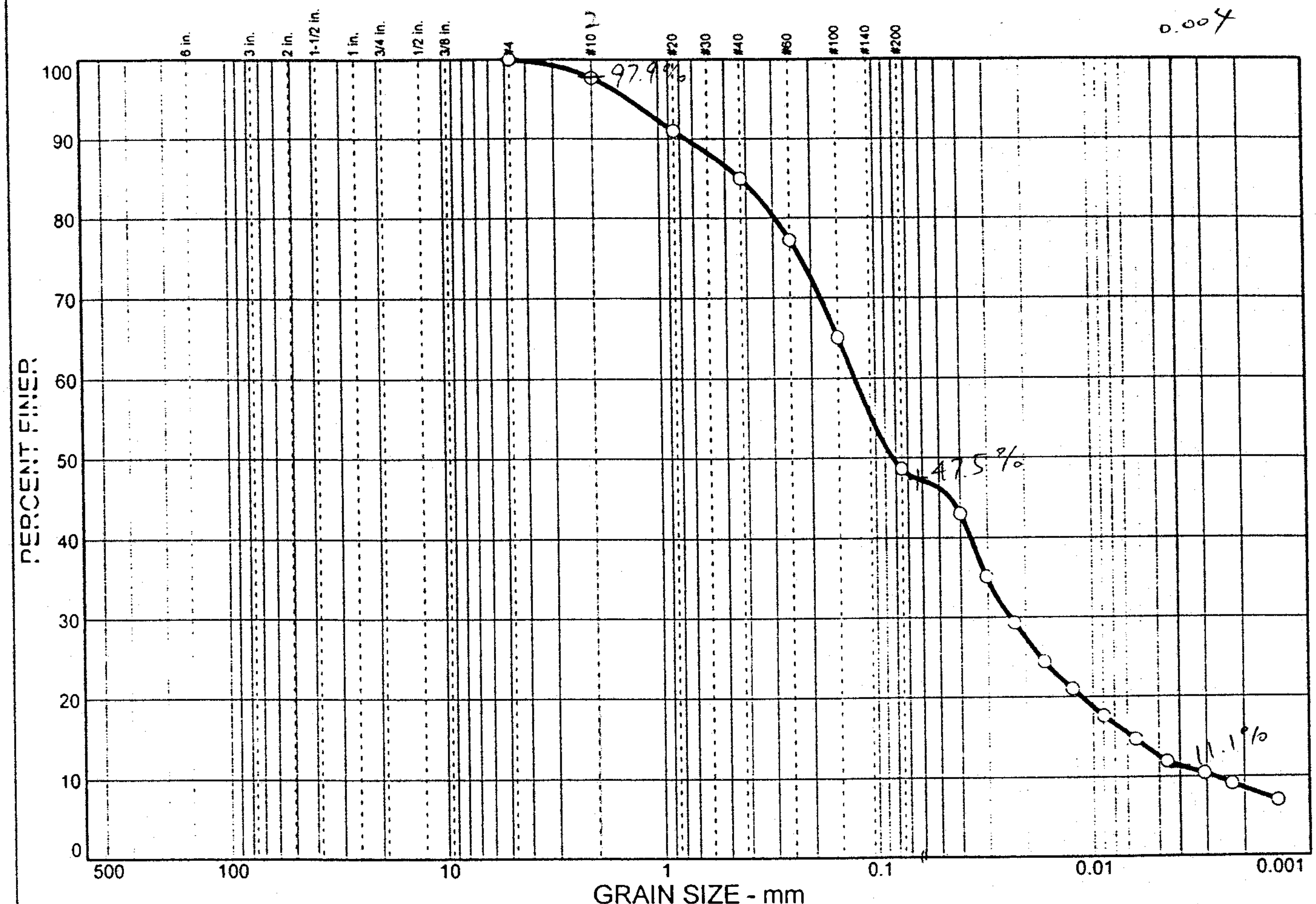
99-175 - PL-4, 28.0-29.5'

Sample No.: 99-175 **Source of Sample:** Piezometer samples **Date:** 05/05/99
Location: Haywood, NC **Elev./Depth:** 28.0 ft

VAN DER HORST ENGINEERING	**Client:** MUNICIPAL ENGINEERING, Co. **Project:** HAYWOOD COUNTY LANDFILL **Project No:** VNC-99-010 **Plate**

P1-1S @ 29.0 - 30.5

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	51.4	36.1	12.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	97.7		
#20	91.0		
#40	85.0		
#60	77.2		
#100	65.1		
#200	48.6		

* (no specification provided)

Soil Description

Reddish Brown Micaecious Silty SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 0.425 D_{60}= 0.125 D_{50}= 0.0828
D_{30}= 0.0235 D_{15}= 0.0066 D_{10}= 0.0028
C_u= 45.16 C_c= 1.59

Classification

USCS= SM AASHTO=

Remarks

99-176 - PL-1s, 29.0-30.5'

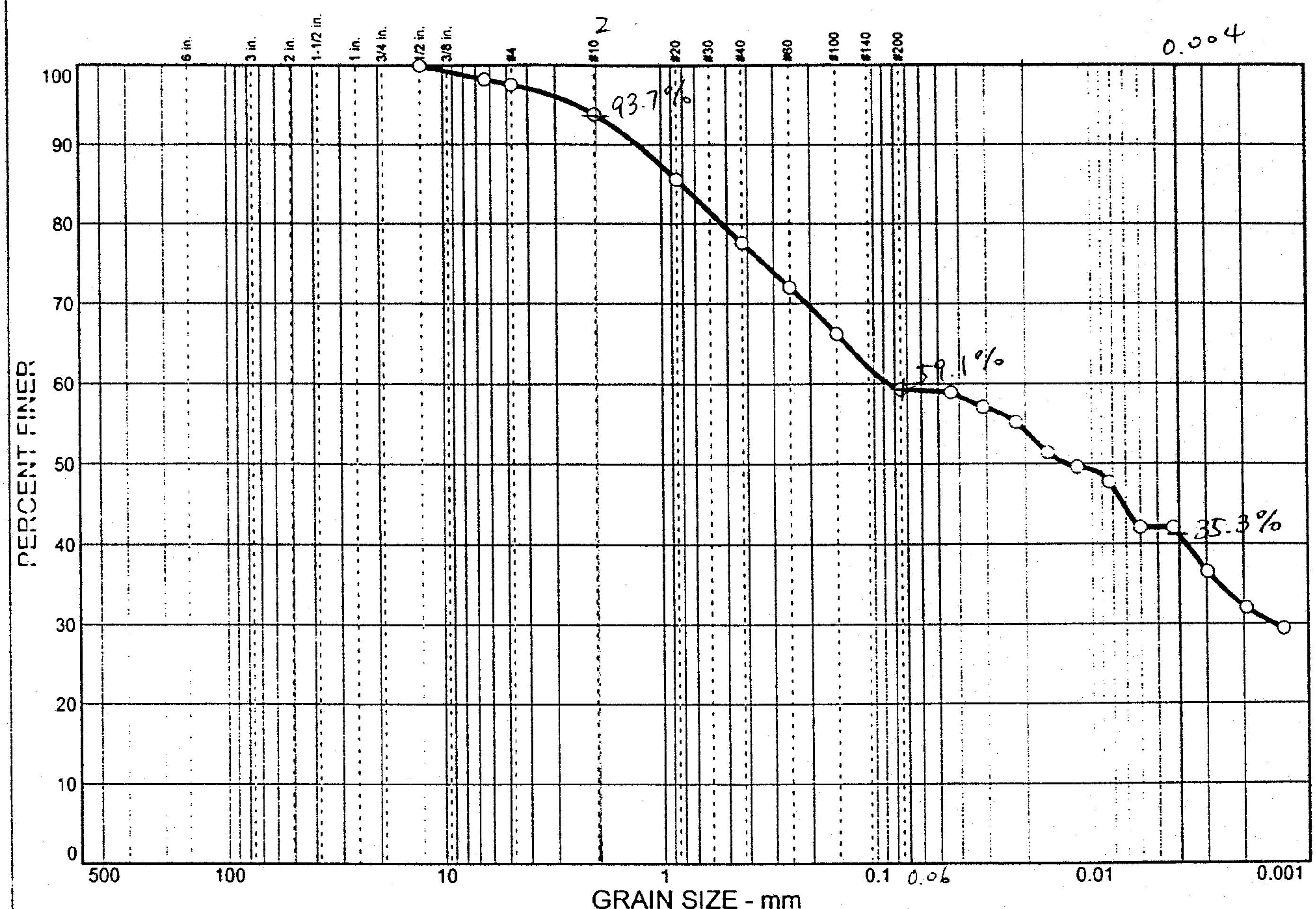
Sample No.: 99-176 **Source of Sample:** Piezometer samples **Date:** 05/05/99
Location: Haywood, NC **Elev./Depth:** 29.0 ft

VAN DER HORST ENGINEERING

Client: MUNICIPAL ENGINEERING, Co.
Project: HAYWOOD COUNTY LANDFILL
Project No: VNC-99-010 **Plate**

Pl-7S @ 0.0-1.5 4

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.5	38.2	17.3	42.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.25 in.	98.2		
#4	97.5		
#10	93.8		
#20	85.6		
#40	77.6		
#60	72.0		
#100	66.2		
#200	59.3		

* (no specification provided)

Soil Description

Reddish Brown Micaceous Sandy SILT

Atterberg Limits

PL= 31 LL= 52 PI= 21

Coefficients

D_{85}= 0.807 D_{60}= 0.0854 D_{50}= 0.0131
D_{30}= 0.0014 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= MH AASHTO=

Remarks

99-177 - PL-7s 0.0-1.5'

Sample No.: 99-177 **Source of Sample:** Piezometer samples **Date:** 05/06/99
Location: Haywood, NC **Elev./Depth:** 0.0 ft

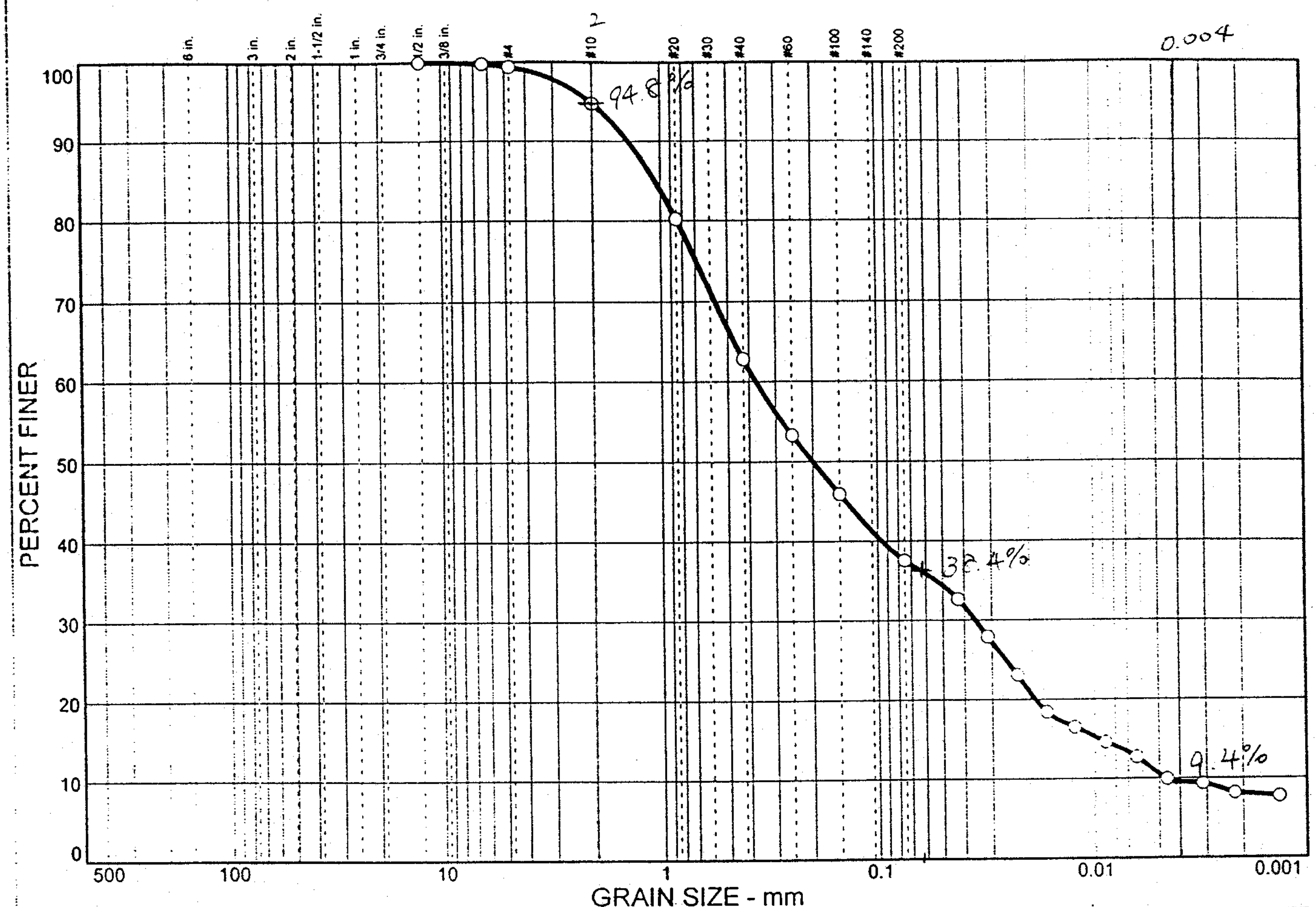
VAN DER HORST ENGINEERING

Client: MUNICIPAL ENGINEERING, Co.
Project: HAYWOOD COUNTY LANDFILL
Project No: VNC-99-010 **Plate**

P1-6 @ 33.5 - 35.0

5

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.6	61.9	27.0	10.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.25 in.	99.8		
#4	99.4		
#10	94.8		
#20	80.2		
#40	62.8		
#60	53.3		
#100	45.9		
#200	37.5		

* (no specification provided)

Soil Description

Light Brown Micaceous Silty SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 1.06 D_{60}= 0.371 D_{50}= 0.200
D_{30}= 0.0357 D_{15}= 0.0095 D_{10}= 0.0047
C_u= 79.77 C_c= 0.74

Classification

USCS= SM AASHTO=

Remarks

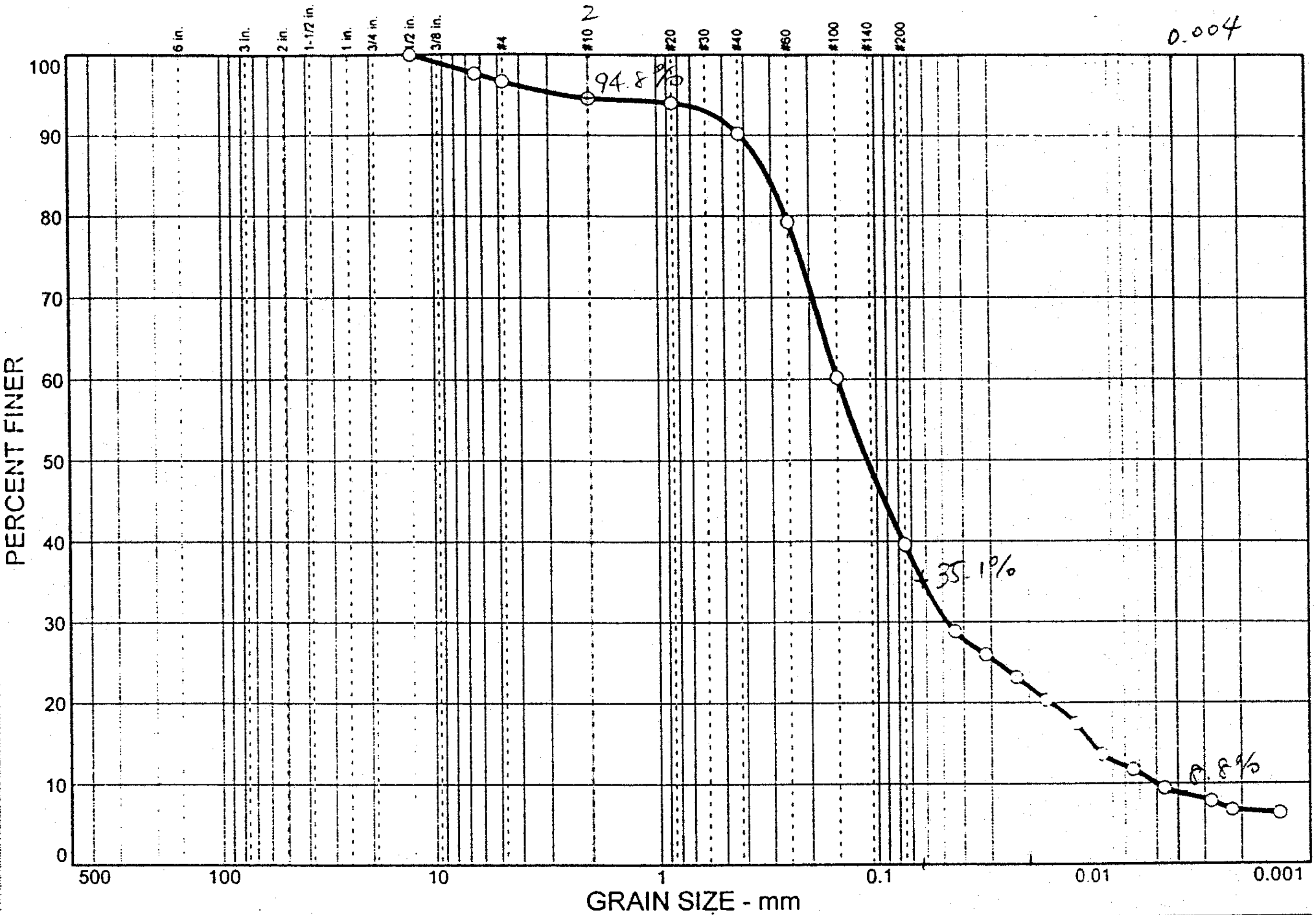
99-178 - PL-6 33.5-35.0'

Sample No.: 99-178 **Source of Sample:** Piezometer samples **Date:** 05/06/99
Location: Haywood, NC **Elev./Depth:** 33.5 ft

VAN DER HORST ENGINEERING	**Client:** MUNICIPAL ENGINEERING, Co. **Project:** HAYWOOD COUNTY LANDFILL **Project No:** VNC-99-010 **Plate**

P1-4 @ 13.0-14.5

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.4	57.0	29.6	10.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.25 in.	97.6		
#4	96.6		
#10	94.6		
#20	94.0		
#40	90.2		
#60	79.2		
#100	60.2		
#200	39.6		

* (no specification provided)

Soil Description

Olive Brown Micaceous Silty SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 0.311 D_{60}= 0.149 D_{50}= 0.110
D_{30}= 0.0478 D_{15}= 0.0100 D_{10}= 0.0050
C_u= 29.67 C_c= 3.04

Classification

USCS= SM AASHTO=

Remarks

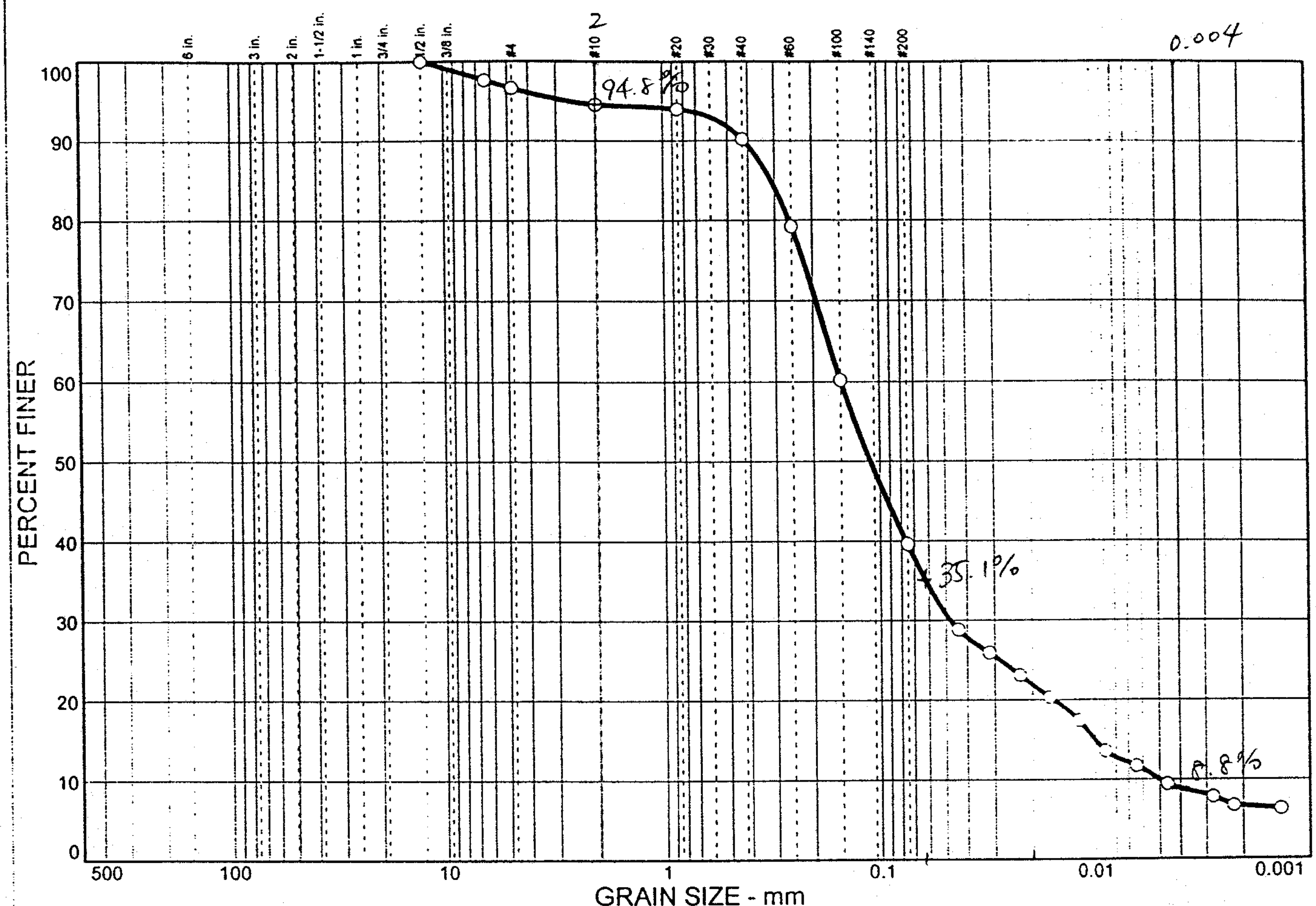
99-179 - PL-4 13.0-14.5'

Sample No.: 99-179 **Source of Sample:** Piezometer samples **Date:** 05/06/99
Location: Haywood, NC **Elev./Depth:** 13.0 ft

VAN DER HORST ENGINEERING	**Client:** MUNICIPAL ENGINEERING, Co. **Project:** HAYWOOD COUNTY LANDFILL **Project No:** VNC-99-010 **Plate**

P1-4 @ 13.0-14.5

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.4	57.0	29.6	10.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.25 in.	97.6		
#4	96.6		
#10	94.6		
#20	94.0		
#40	90.2		
#60	79.2		
#100	60.2		
#200	39.6		

* (no specification provided)

Soil Description

Olive Brown Micaceous Silty SAND

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 0.311 D_{60}= 0.149 D_{50}= 0.110
D_{30}= 0.0478 D_{15}= 0.0100 D_{10}= 0.0050
C_u= 29.67 C_c= 3.04

Classification

USCS= SM AASHTO=

Remarks

99-179 - PL-4 13.0-14.5'

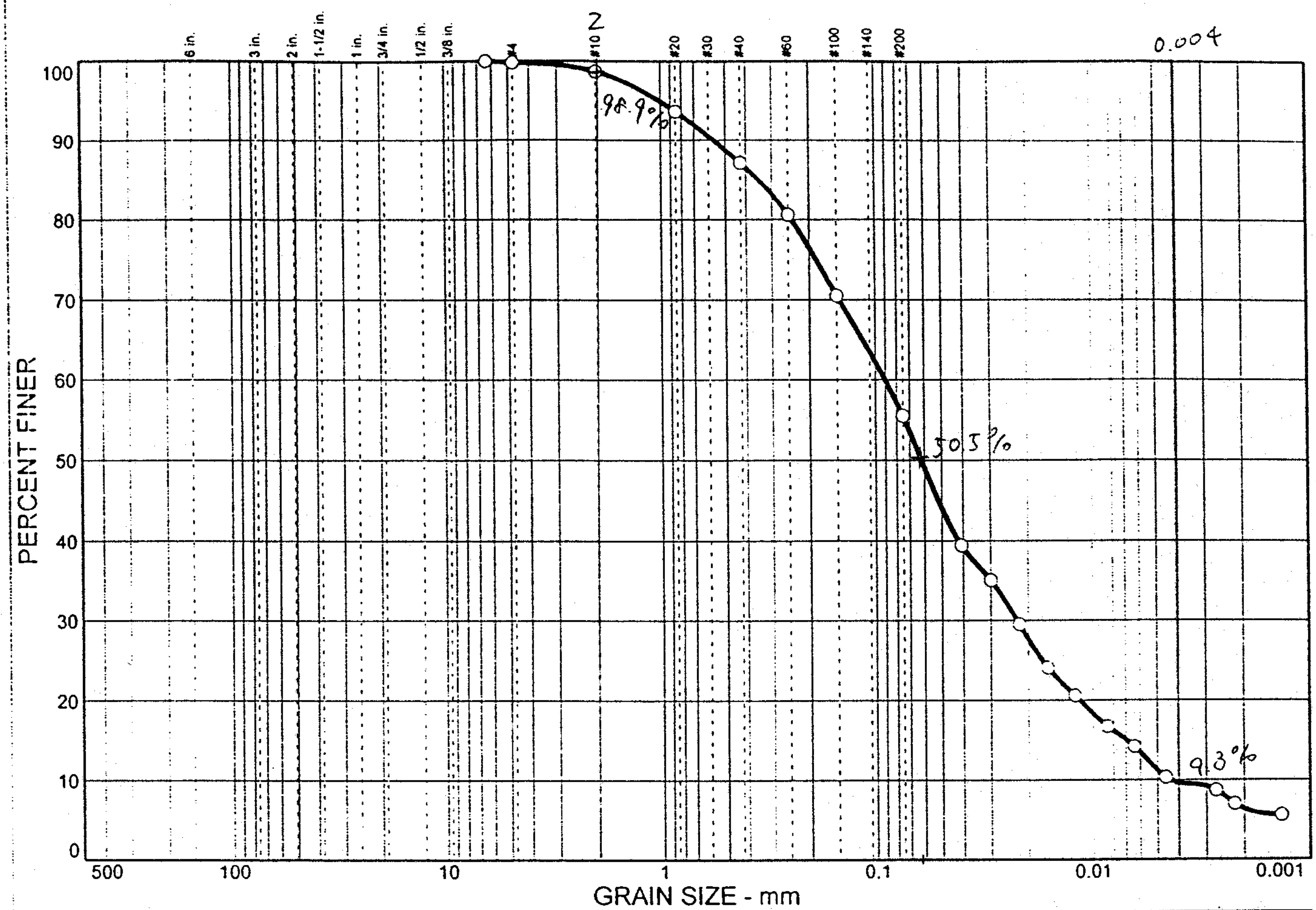
Sample No.: 99-179 **Source of Sample:** Piezometer samples **Date:** 05/06/99
Location: Haywood, NC **Elev./Depth:** 13.0 ft

VAN DER HORST ENGINEERING

Client: MUNICIPAL ENGINEERING, Co.
Project: HAYWOOD COUNTY LANDFILL
Project No: VNC-99-010 **Plate**

P1-4 @ 33.0 - 34.5

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	44.3	44.3	11.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.25 in.	100.0		
#4	99.8		
#10	98.7		
#20	93.7		
#40	87.1		
#60	80.6		
#100	70.5		
#200	55.5		

* (no specification provided)

Soil Description

Brown Micaceous Sandy SILT

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 0.348 D_{60}= 0.0901 D_{50}= 0.0617
D_{30}= 0.0226 D_{15}= 0.0069 D_{10}= 0.0044
C_u= 20.57 C_c= 1.30

Classification

USCS= ML AASHTO=

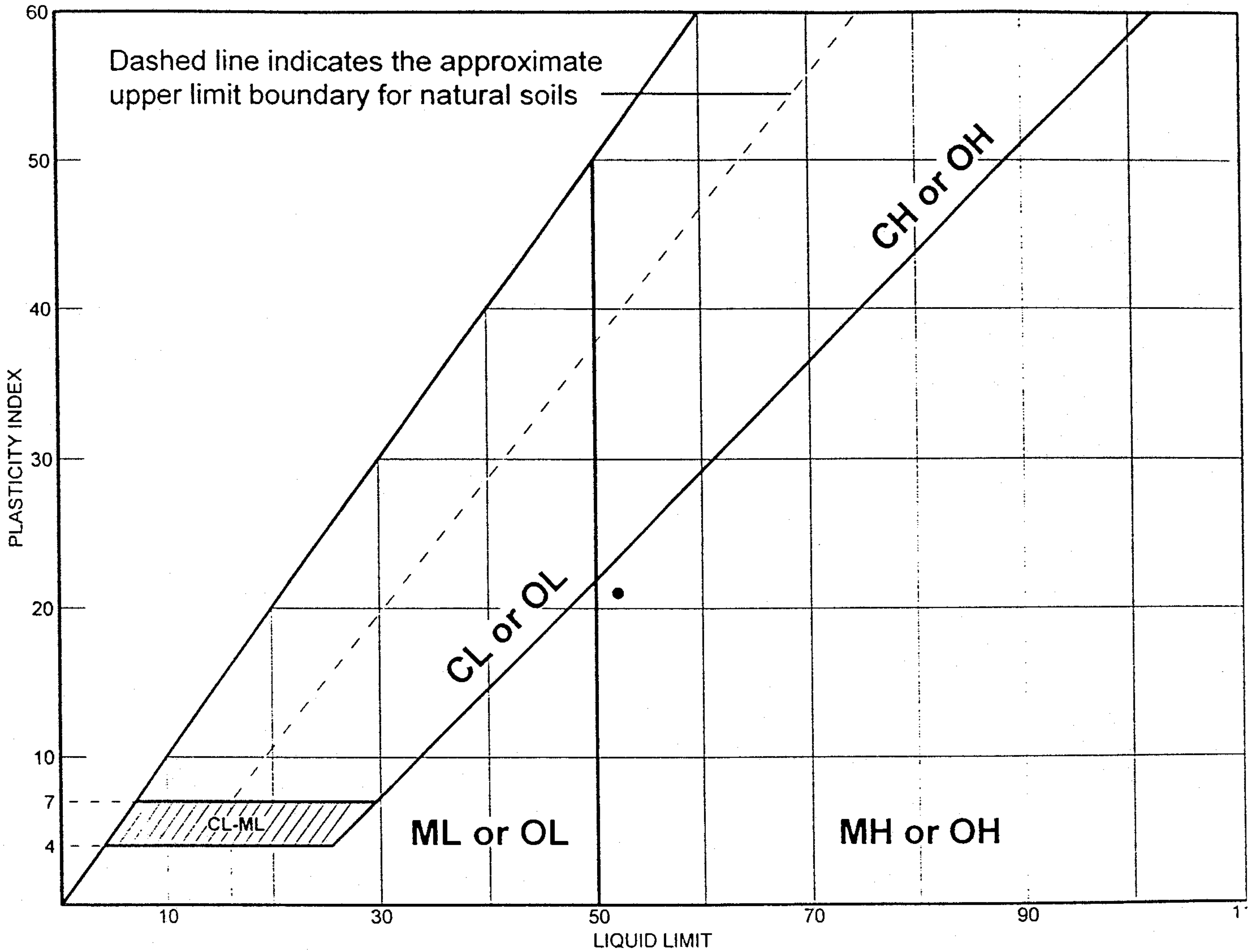
Remarks

99-180 - PL-4 33.0-34.5'

Sample No.: 99-180 **Source of Sample:** Piezometer samples **Date:** 05/06/99
Location: Haywood, NC **Elev./Depth:** 33.0 ft

VAN DER HORST ENGINEERING	**Client:** MUNICIPAL ENGINEERING, Co. **Project:** HAYWOOD COUNTY LANDFILL **Project No:** VNC-99-010 **Plate**

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Reddish Brown Micaceous Sandy SILT	52	31	21	77.6	59.3	MH

Project No. VNC-99-010 **Client:** MUNICIPAL ENGINEERING, Co.

Project: HAYWOOD COUNTY LANDFILL

● **Location:** Haywood, NC

Remarks:

● 99-177 - PL-7s 0.0-1.5'

LIQUID AND PLASTIC LIMITS TEST REPORT

VAN DER HORST ENGINEERING

Plate

VAN DER HORST

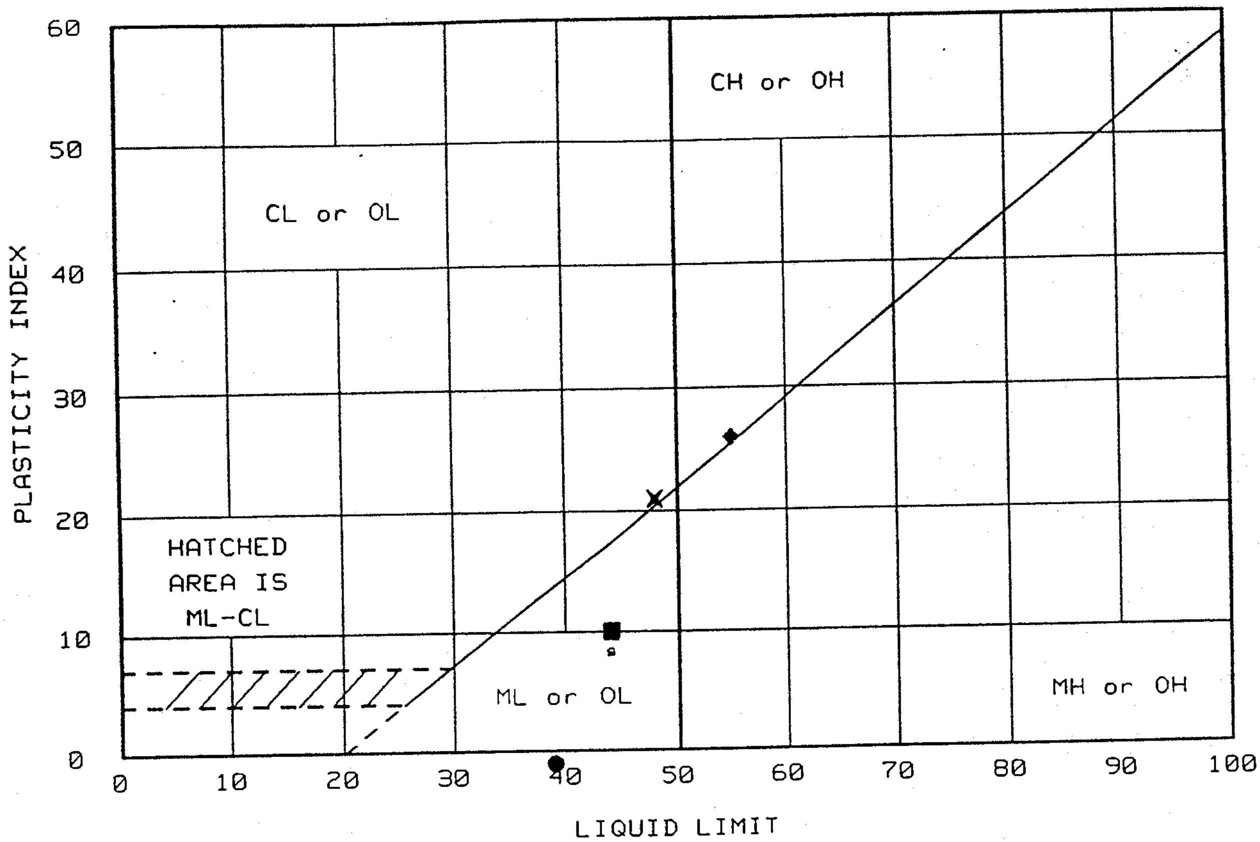
HAYWOOD COUNTY LANDFILL
VNC-98-018.001

Laboratory Testing Summary

Test Method	98-173 (P2-1@ 10-12')	98-174 (P2-1@ 21-23')	98-175 (P2-2@ 3-4')	98-176 (P2-1@ 1-5')	98-177 (P2-1@ 6-10')
Natural Moisture Content (ASTM D-2216)	22.1%	30.4%	21.5%	24.0%	22.9%
Atterberg Limits (ASTM D-4318)					
LL	39	37	44	55	48
PL	40	NP	34	29	27
PI	NP	--	10	26	21
Grain-size Analysis (ASTM D-442)					
% Gravel	1.6	0.3	8.4	2.4	3.5
% Sand	57.0	39.5	47.6	43.5	45.1
% Silt	23.5	36.2	28.2	26.4	24.6
% Clay	17.9	24.0	15.8	27.7	26.8
Specific Gravity (ASTM D-854)	2.71	2.72	2.75	2.71	2.69
USCS Soil Classification	SM	ML	SM	CH	CL
Shelby Tube Permeability (ASTM D-5084)					
Dry Density (pcf)	90.4	84.6	95.9	--	--
Moisture (%)	31.6	30.4	26.6	--	--
Permeability (cm/sec)	2.2×10^{-6}	1.3×10^{-5}	2.0×10^{-7}	--	--

Note: The atterberg for sample 98-174 was prepared using the dry method all other atterberg samples were prepared using the wet method. The bottom of the shelby tube for sample 98-174 contained 16 to 18 inches of weak weathered rock.

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-90
●	98-173 SHELBY TUBE P2-1 @ 10-12'	39	40	-1	41.4	SM, Silty sand
▲	98-174 SHELBY TUBE P2-1 @ 21-23'	37	NP	None	60.3	ML, Sandy silt
■	98-175 SHELBY TUBE P2-2 @ 3-4'	44	34	10	44.0	SM, Silty sand
◆	98-176 DRILL CUTTINGS P2-1 @1-5'	55	29	26	54.1	CH, Sandy fat clay
✕	98-177 DRILL CUTTINGS P2-1 @ 6-10'	48	27	21	51.4	CL, Sandy lean clay

NP - Non-Plastic

Project No.: VNC-98-018
Project: HAYWOOD COUNTY LANDFILL

Client: MUNICIPAL ENGINEERING
Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

Remarks:

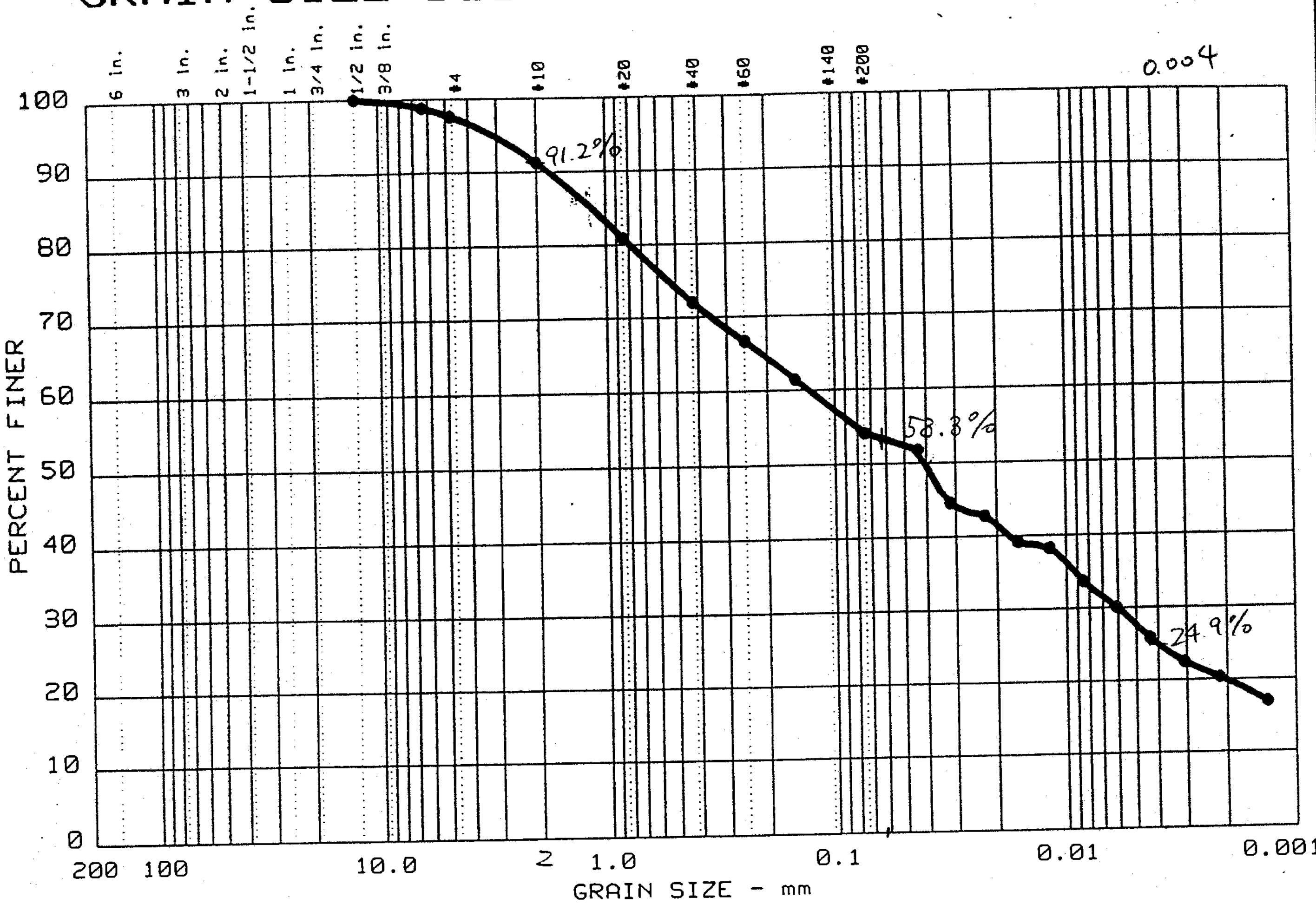
SAMPLES TAKEN FROM SHELBY TUBES AND DRILL CUTTINGS DELIVERED TO VANDERHORST ON 05/04/98.

LIQUID AND PLASTIC LIMITS TEST REPORT

VAN DER HORST ENGINEERING

Fig. No. 173

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	2.4	43.5	26.4	27.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	55	26	1.15	0.13	0.04	0.006				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN TO DARK BROWN SILTY SAND SOME CLAY.	CH	

Project No.: VNC-98-018 /98-176
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

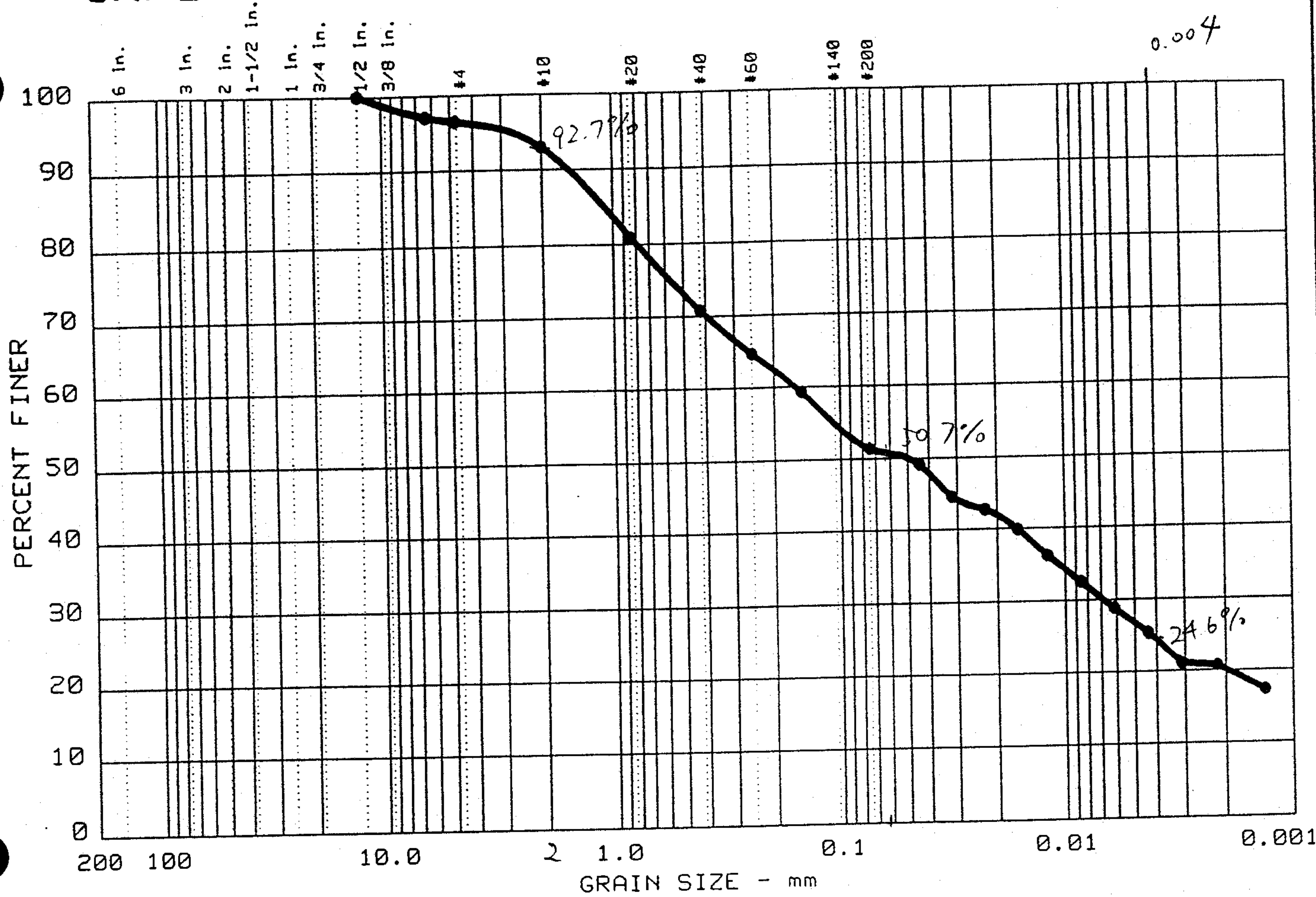
GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Remarks:
DRILL CUTTINGS SAMPLE P2-1 @ 1-5', DELIVERED TO VANDERHORST ON 05/04/98.

Figure No. 176

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	5	0.0	3.5	45.1	24.6	26.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	48	21	1.08	0.16	0.05	0.007				

MATERIAL DESCRIPTION	USCS	AASHTO
● BROWN SILTY SAND SOME CLAY.	CL	

Project No.: VNC-98-018 /98-177
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

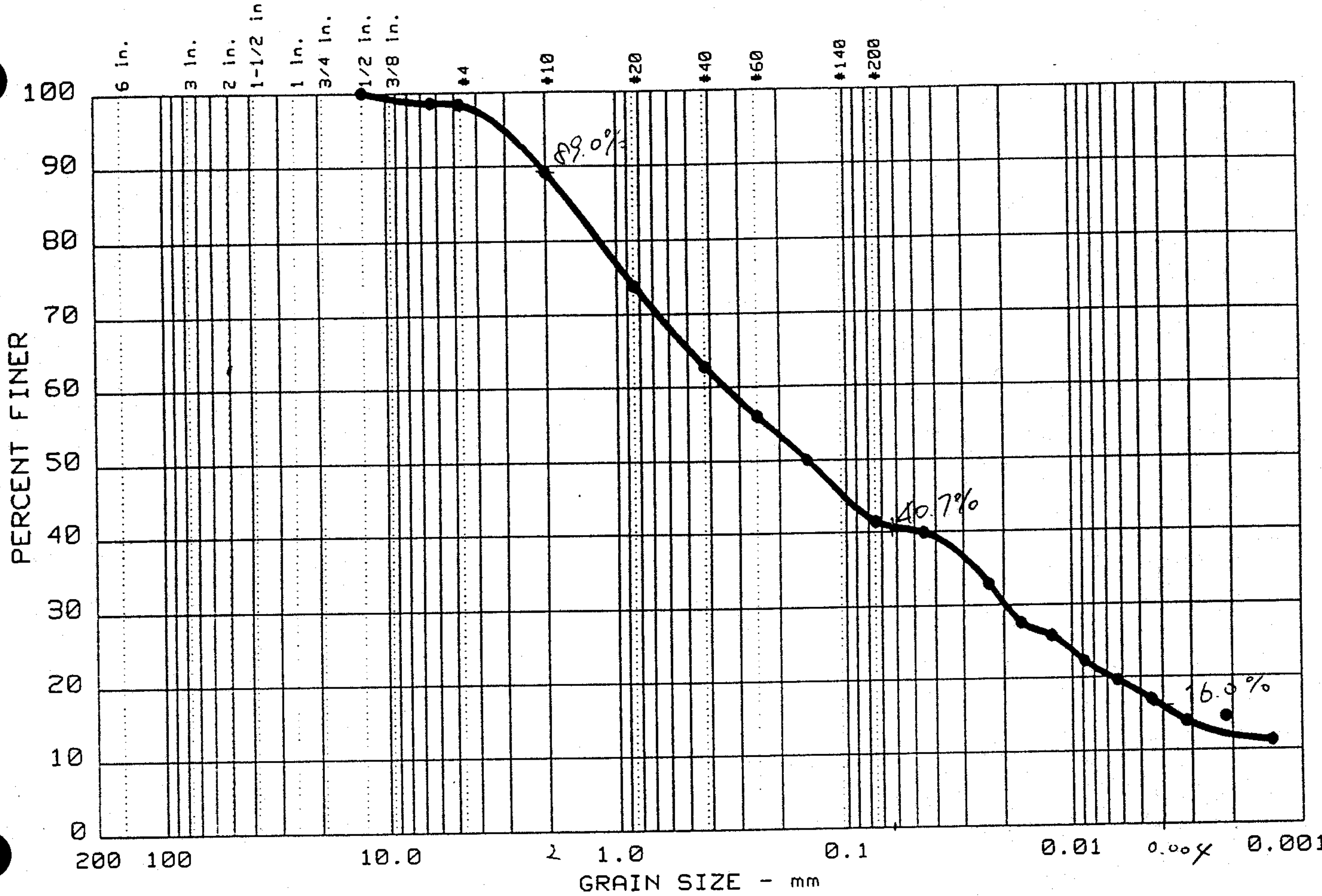
Remarks:
DRILL CUTTINGS SAMPLE
P2-1 @ 6-10', DELIVERED
TO VANDERHORST ON
05/04/98.

GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Figure No. 177

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	1.6	57.0	23.5	17.9

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	39	NP	1.57	0.34	0.15	0.020	0.0035			

MATERIAL DESCRIPTION	USCS	AASHTO
● OLIVE BROWN TO BROWN SILTY SAND LITTLE CLAY.	SM	

Project No.: VNC-98-018 /98-173
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

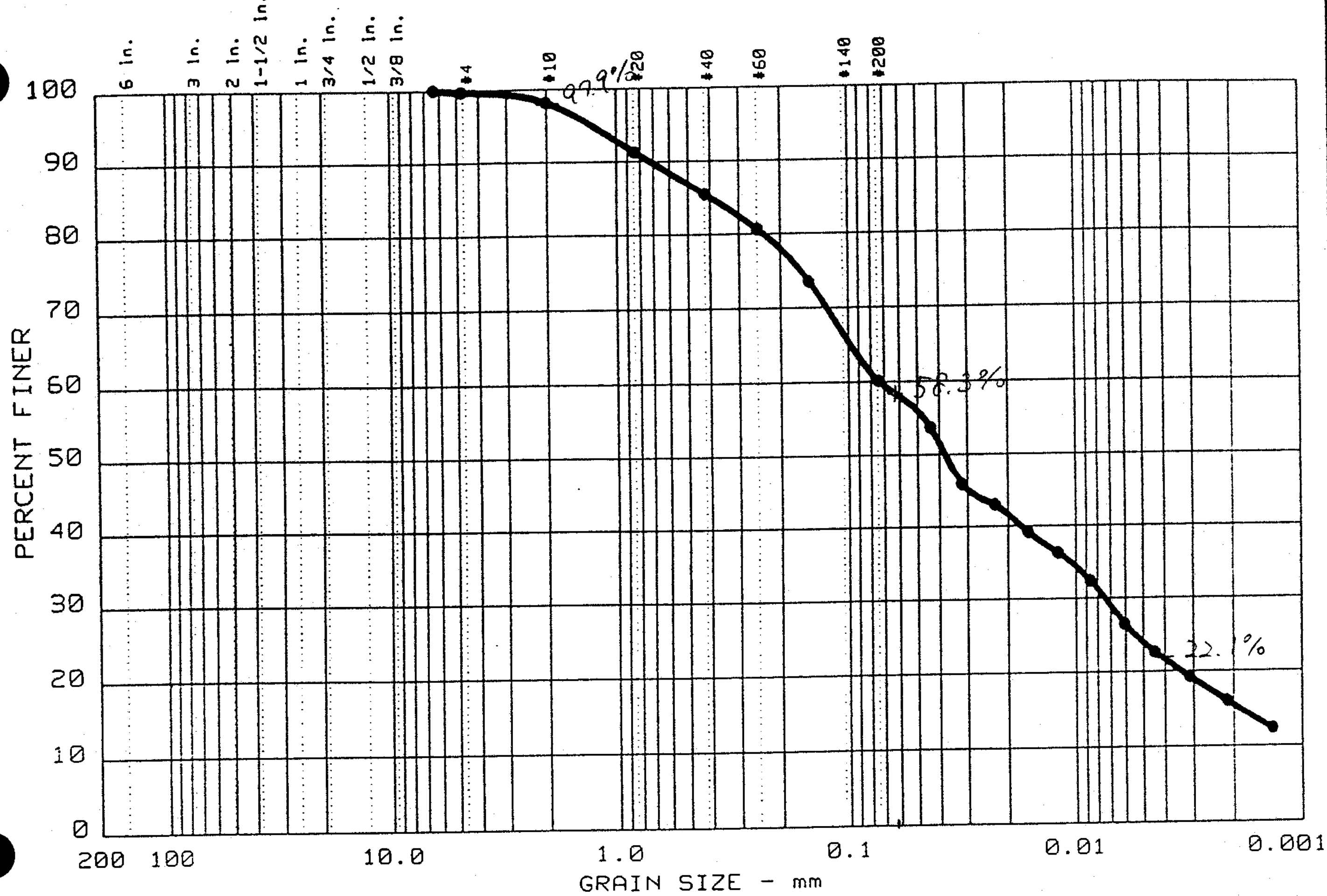
GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Remarks:
SHELBY TUBE SAMPLE P2-1 @ 10-12', DELIVERED TO VANDERHORST ON 05/04/98.

Figure No. 173

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	0.3	39.5	36.2	24.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	37	NP	0.39		0.04	0.007	0.0019			

MATERIAL DESCRIPTION	USCS	AASHTO
● OLIVE BROWN TO BROWN SANDY SILT SOME CLAY.	ML	

Project No.: VNC-98-018 /98-174
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

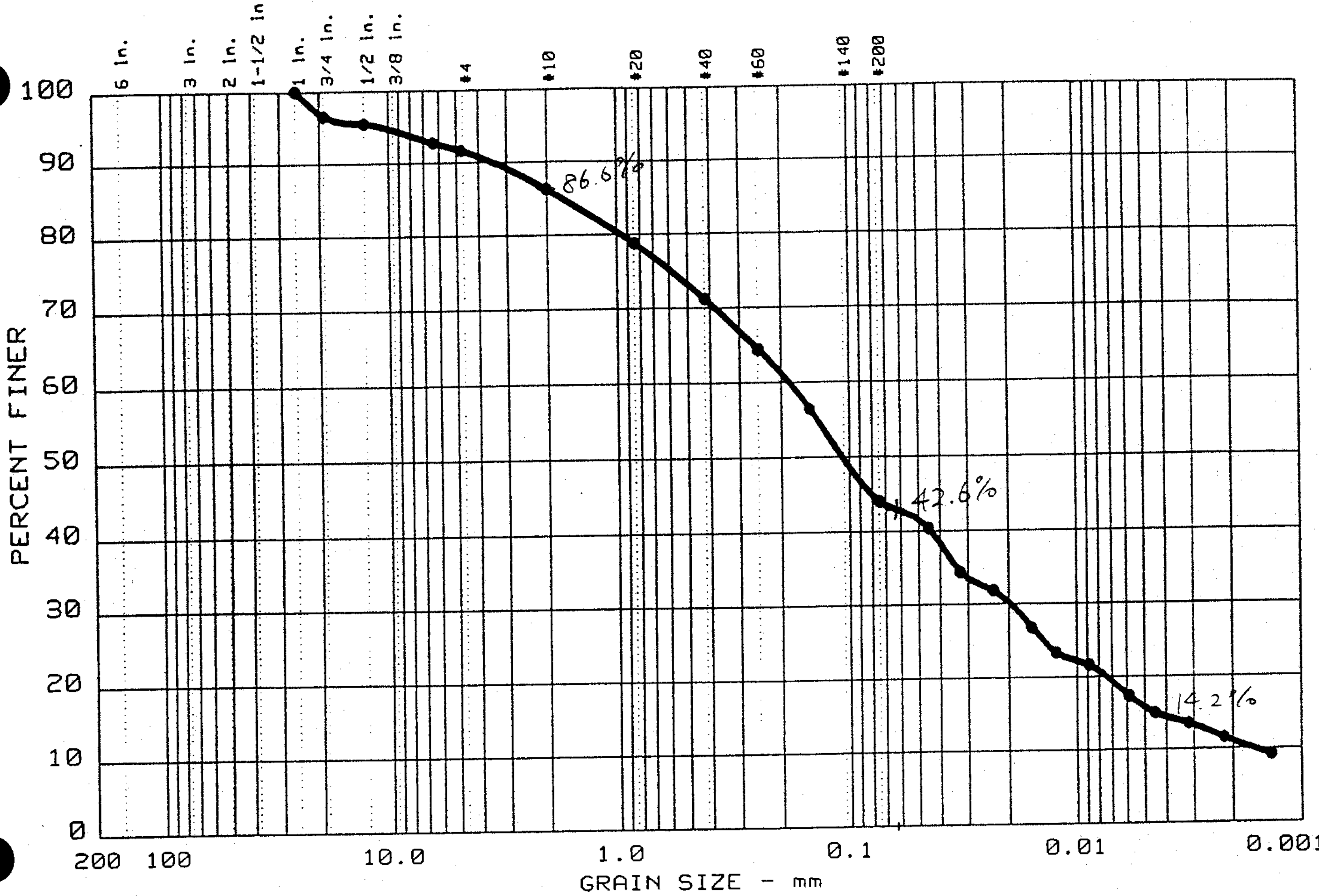
Remarks:
SHELBY TUBE SAMPLE P2-1 @ 21-23', DELIVERED TO VANDERHORST ON 05/04/98.

GRAIN SIZE DISTRIBUTION TEST REPORT
VAN DER HORST ENGINEERING

Figure No. 174

15

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	8.4	47.6	28.2	15.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	44	10	1.70	0.18	0.11	0.019	0.0045	0.0015	1.35	117.8

MATERIAL DESCRIPTION	USCS	AASHTO
● OLIVE BROWN TO BROWN SILTY SAND LITTLE CLAY.	SM	

Project No.: VNC-98-018 /98-175
Project: HAYWOOD COUNTY LANDFILL
● Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

Remarks:
SHELBY TUBE SAMPLE P2-2 @ 3-4', DELIVERED TO VANDERHORST ON 05/04/98.

GRAIN SIZE DISTRIBUTION TEST REPORT
VAN DER HORST ENGINEERING

Figure No. 175

P1-8S @ 13.0 - 14.0 ft.

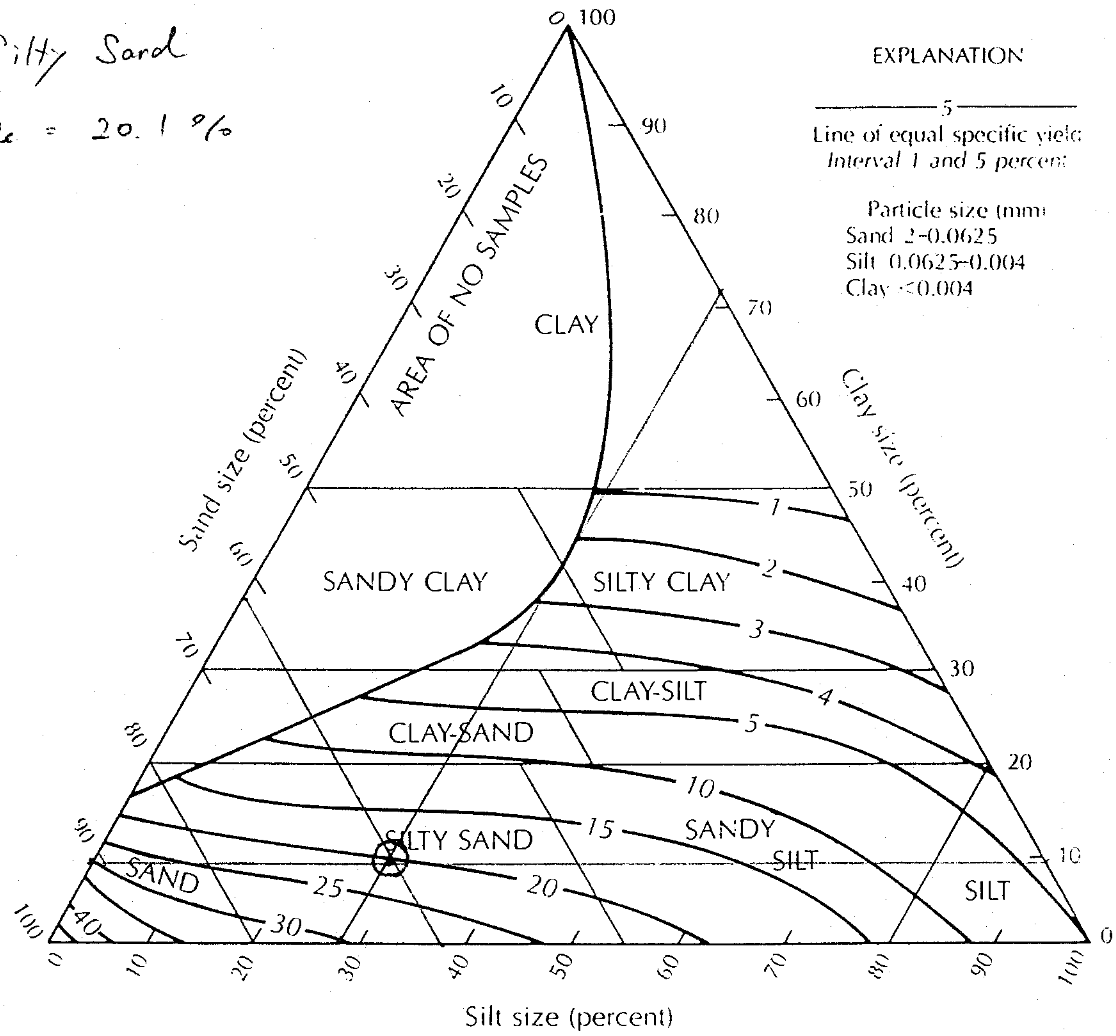
Sand = 62.1 %

Silt = 28.5 %

Clay = 9.4 %

Silty Sand

n_e = 20.1 %



P1-4 @ 28.0 - 29.5 ft.

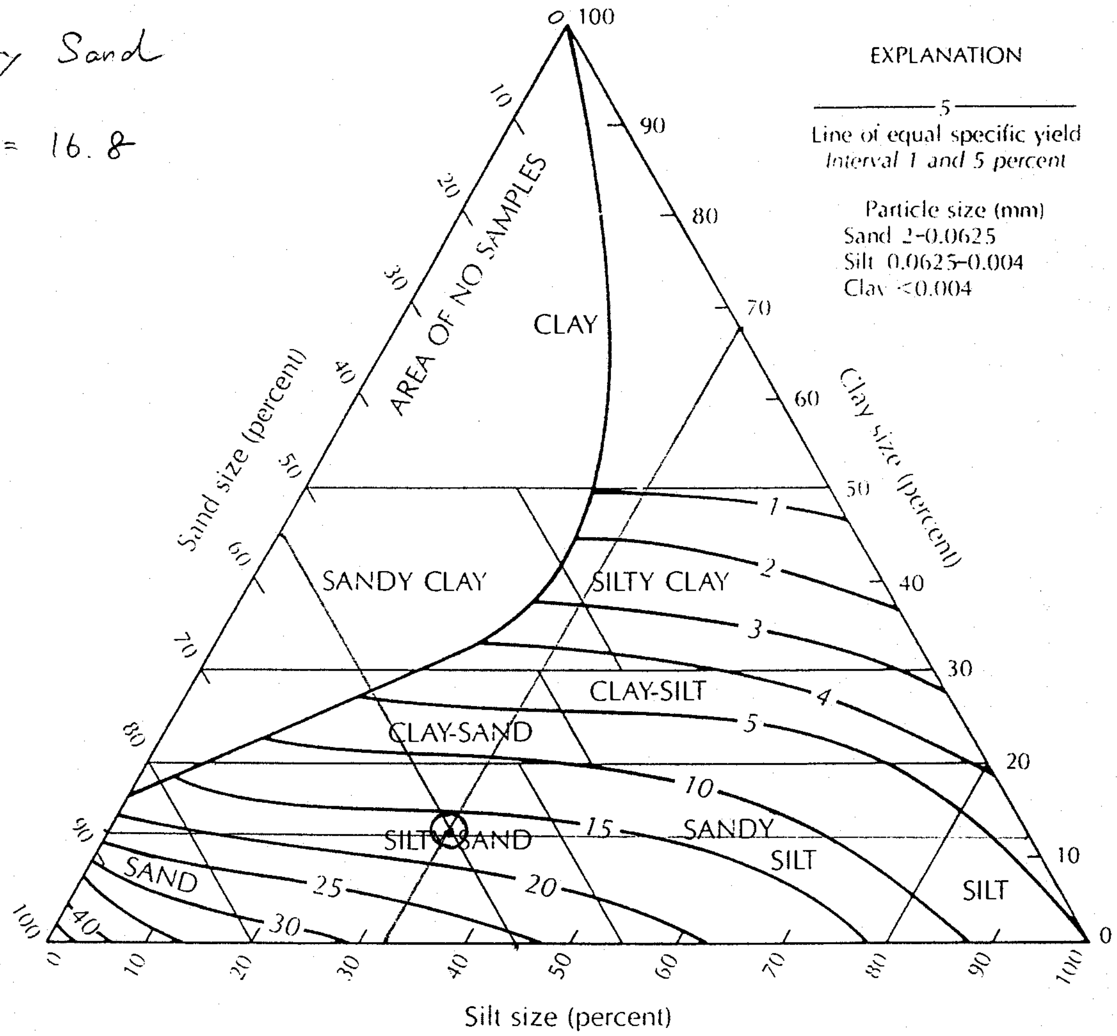
Sand = 53.2%

Silt = 32.7%

Clay = 12.1%

Silty Sand

n_e = 16.8



P1-1S @ 29.0 - 30.5 ft

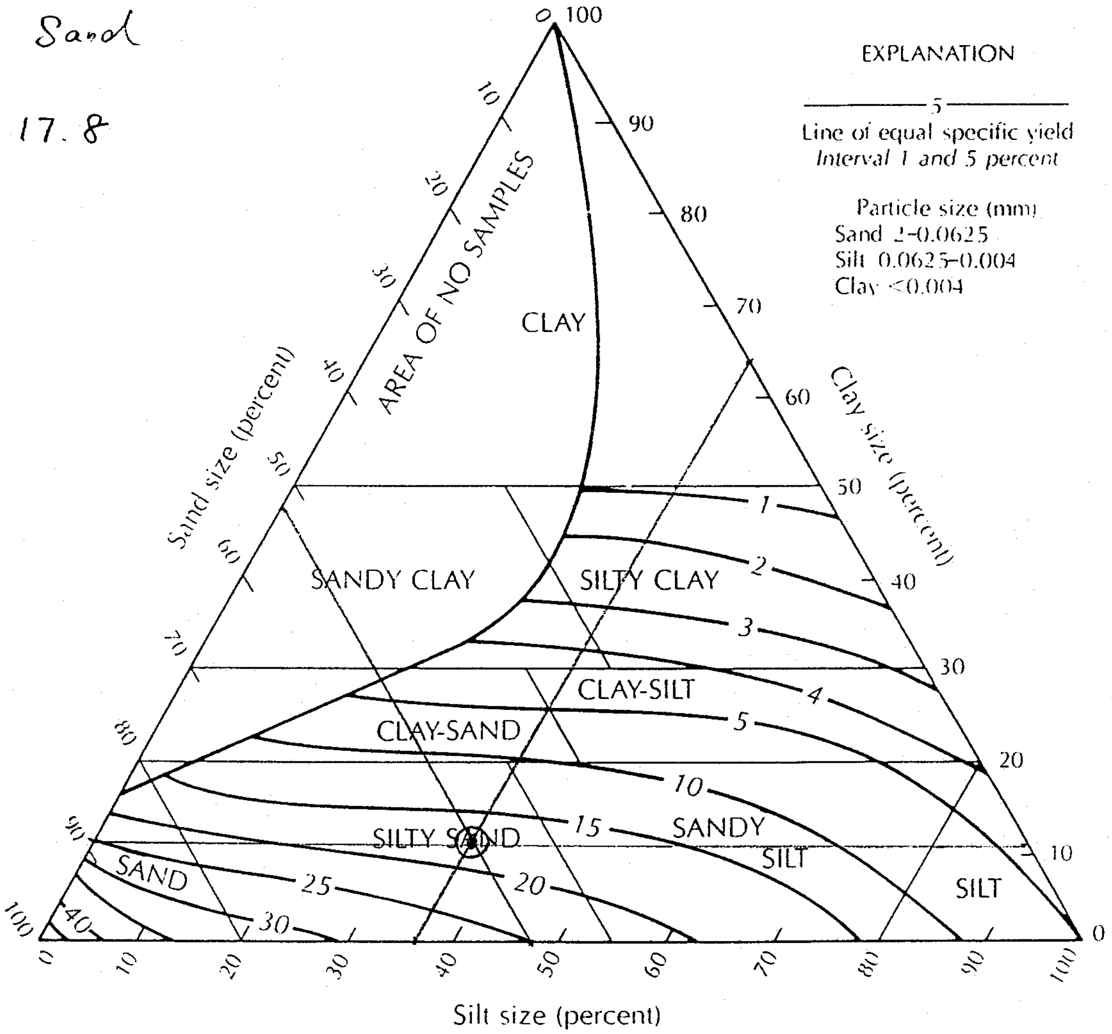
Sand = 52.5 %

Silt = 36.4 %

Clay = 11.1 %

Silty Sand

n = 17.8



P1-7S @ 0.0 - 1.5 ft.

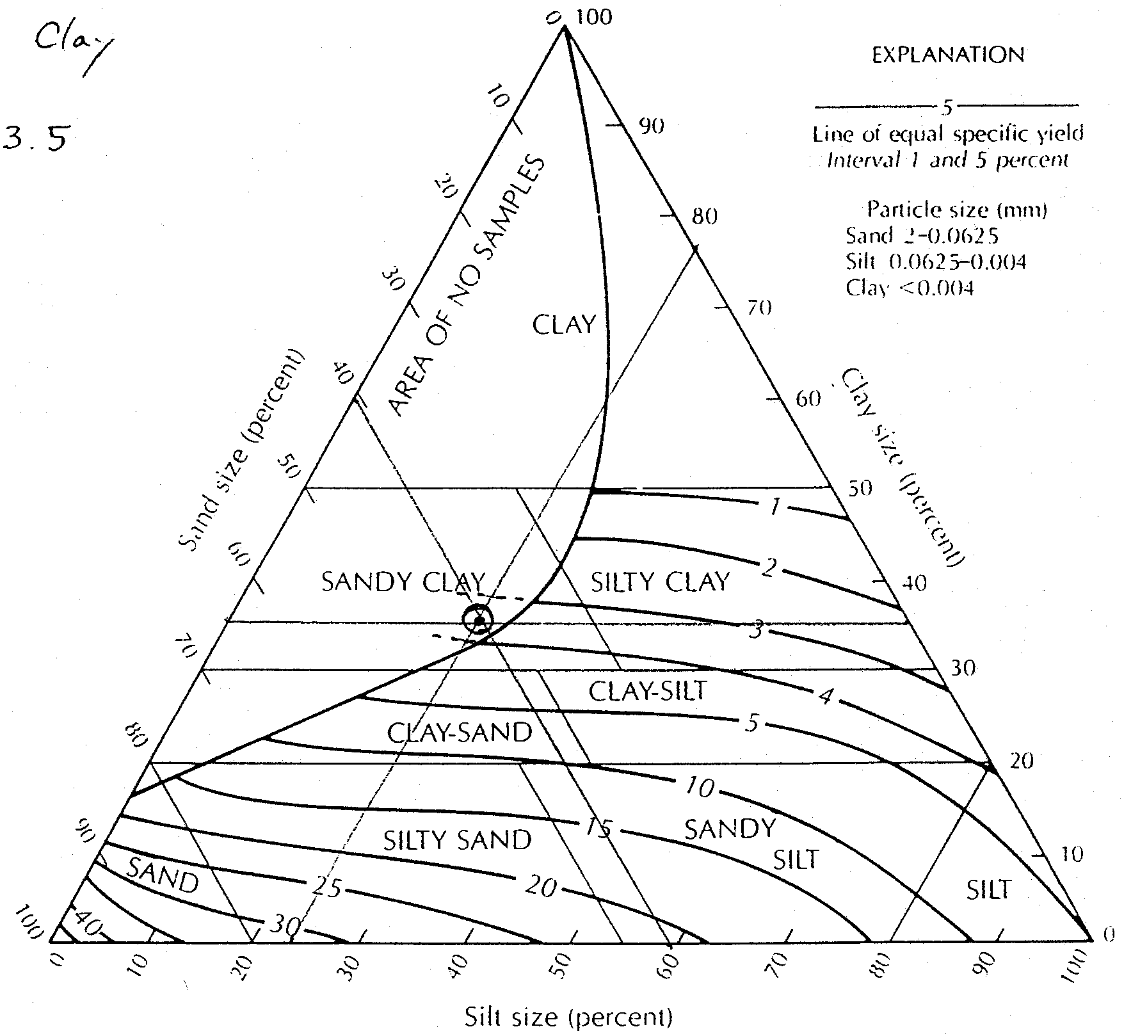
Sand = 40.9 %

Silt = 23.8 %

Clay = 35.3 %

Sandy Clay

n_e = 3.5



P1-6 @ 33.5 - 35.0 ft

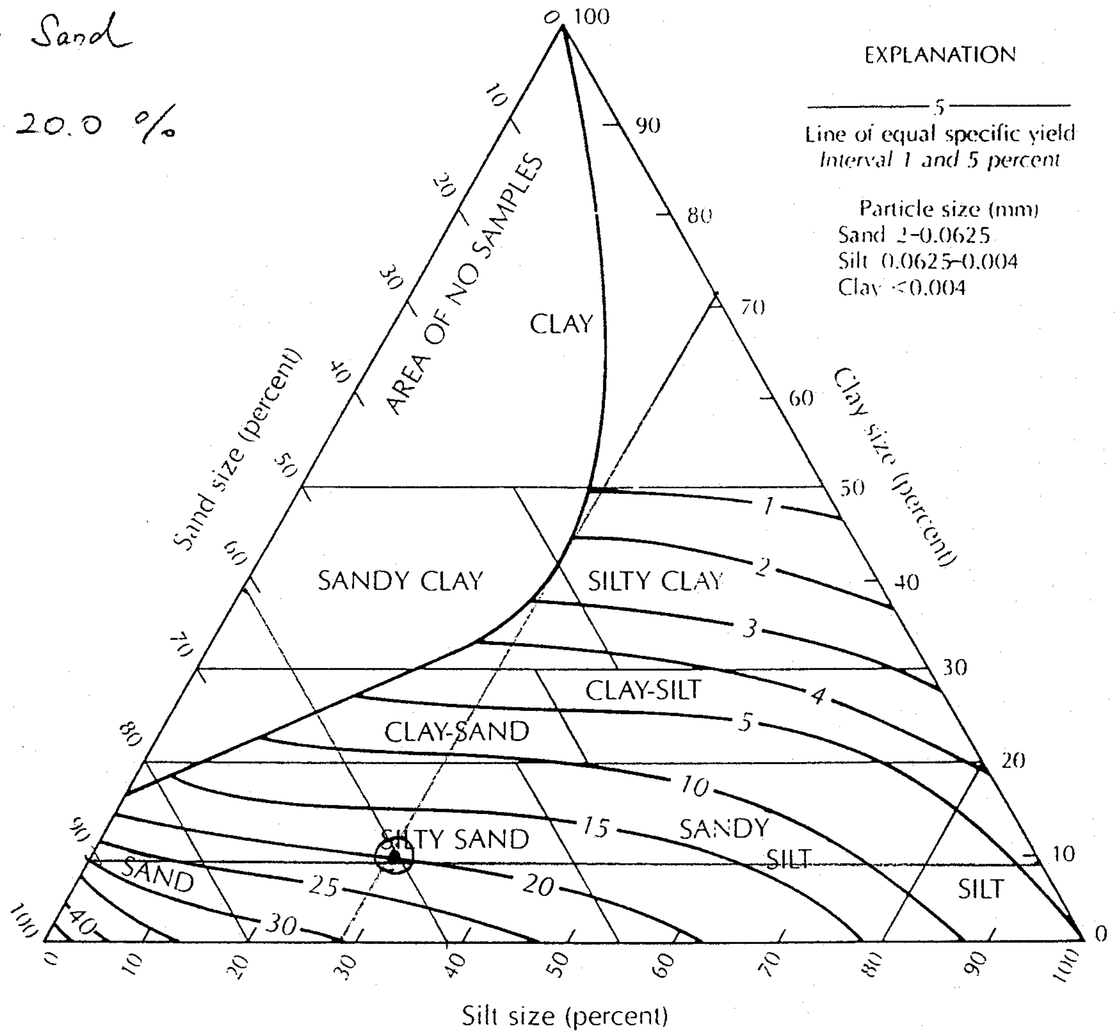
Sand = 61.6 %

Silt = 29.0 %

Clay = 9.4 %

Silty Sand

ne = 20.0 %



P1-4 @ 13.0 - 14.5 ft.

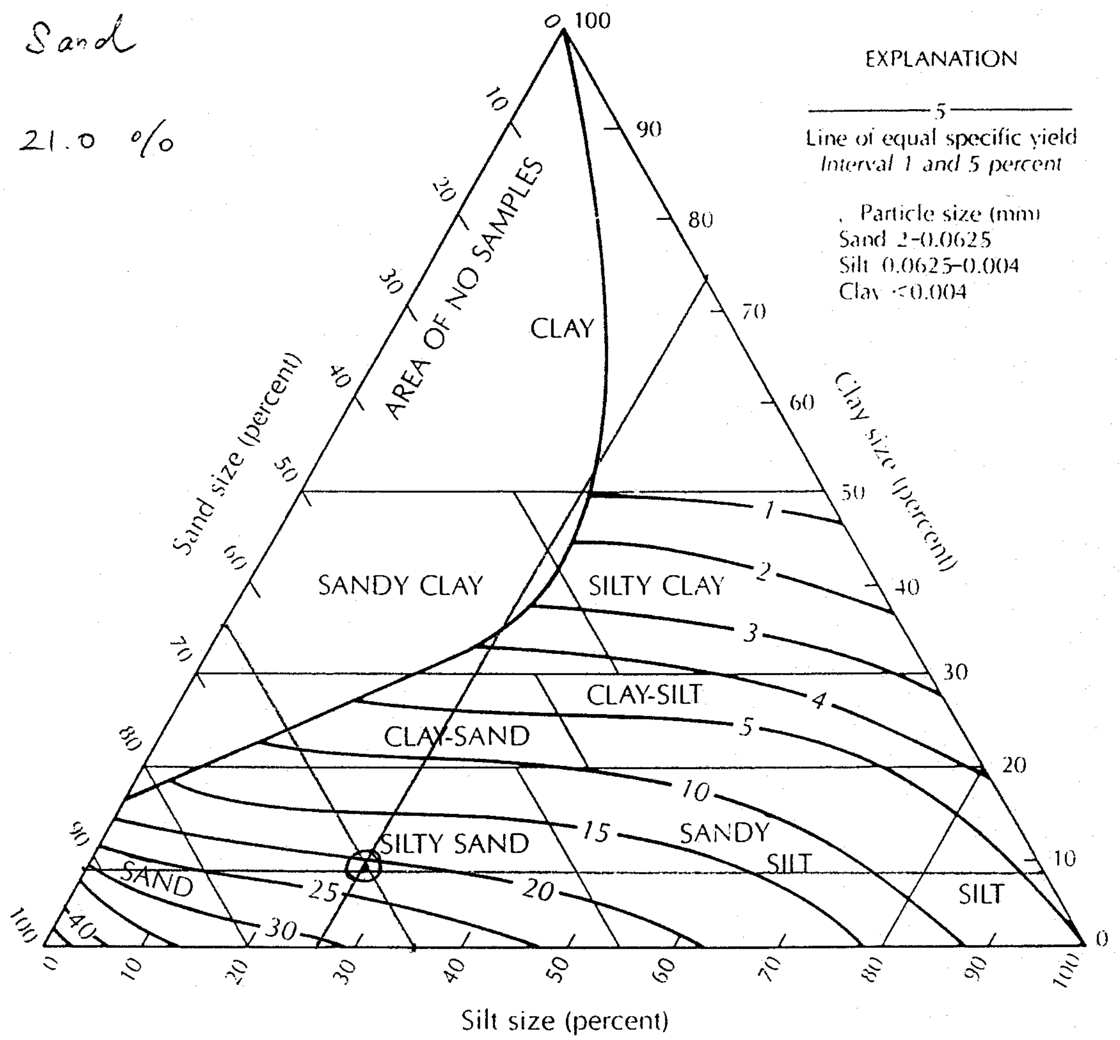
Sand = 64.9 %

Silt = 26.3 %

Clay = 8.8 %

Silty Sand

n_e = 21.0 %



P1-4 @ 33.0 - 34.5 ft

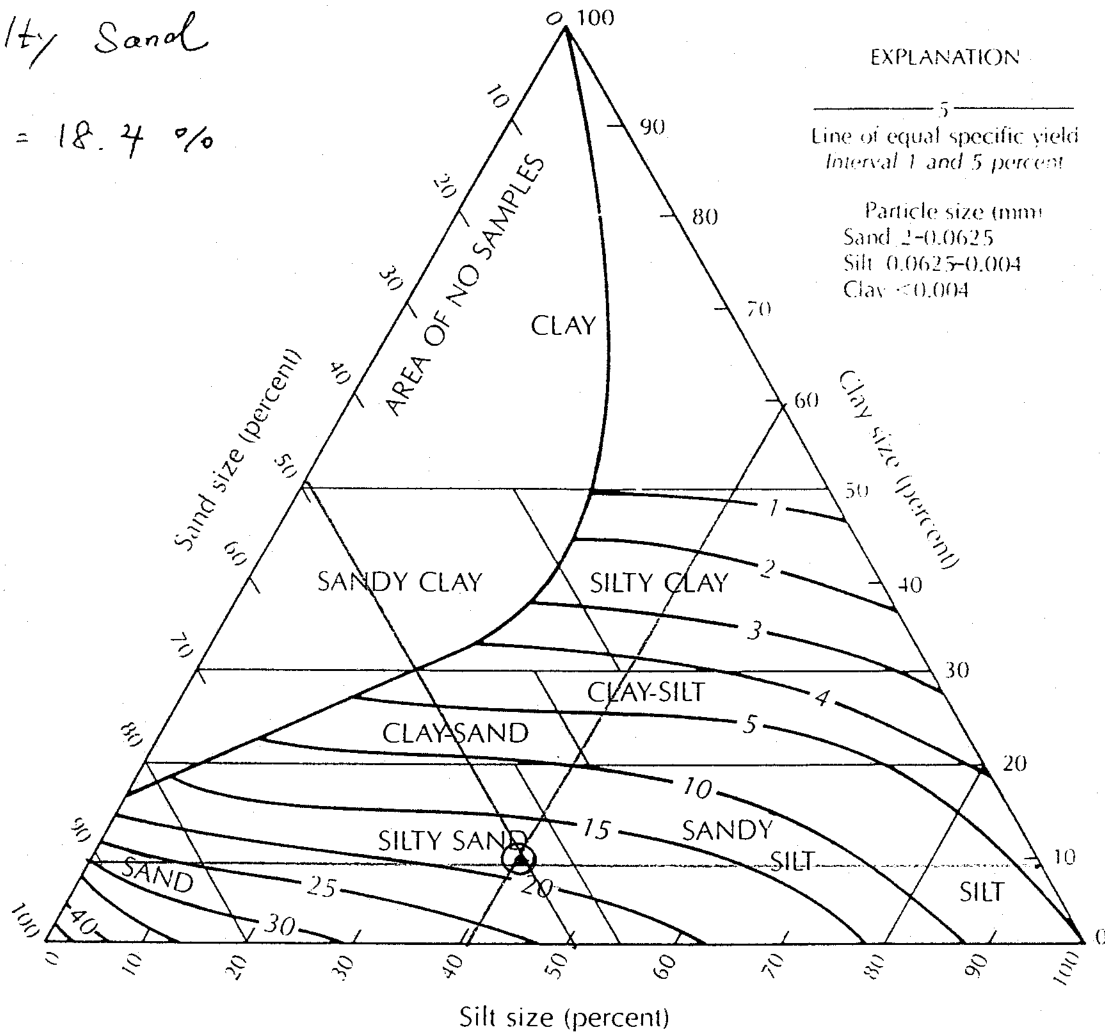
Sand = 49.5 %

Silt = 41.2 %

Clay = 9.3 %

Silty Sand

n_e = 18.4 %



P2-1 @ 1.0 - 3.0 ft

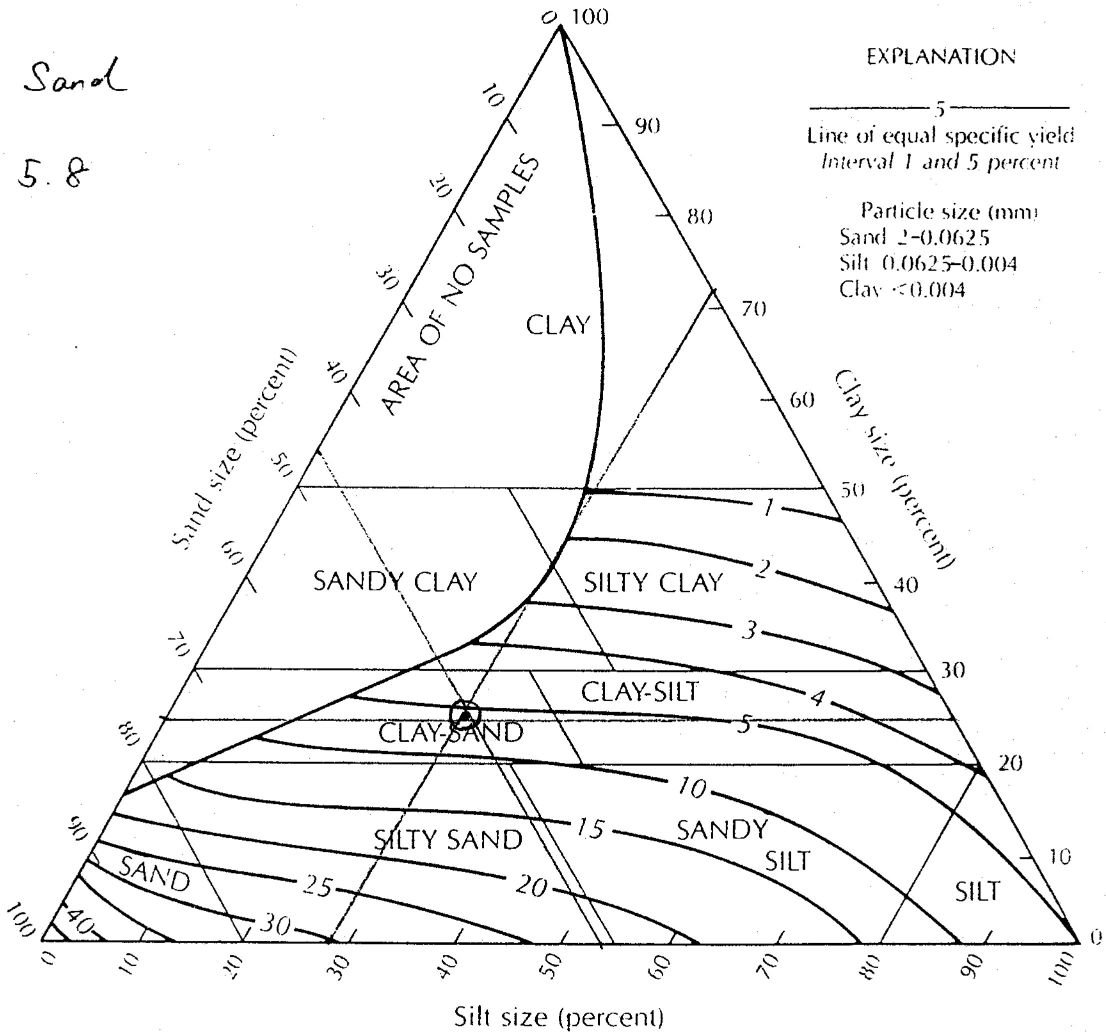
Sand = 46.7 %

Silt = 28.4 %

Clay = 24.9 %

Clayey Sand

n_e = 5.8



P2-1 @ 6.0 - 10.0 ft.

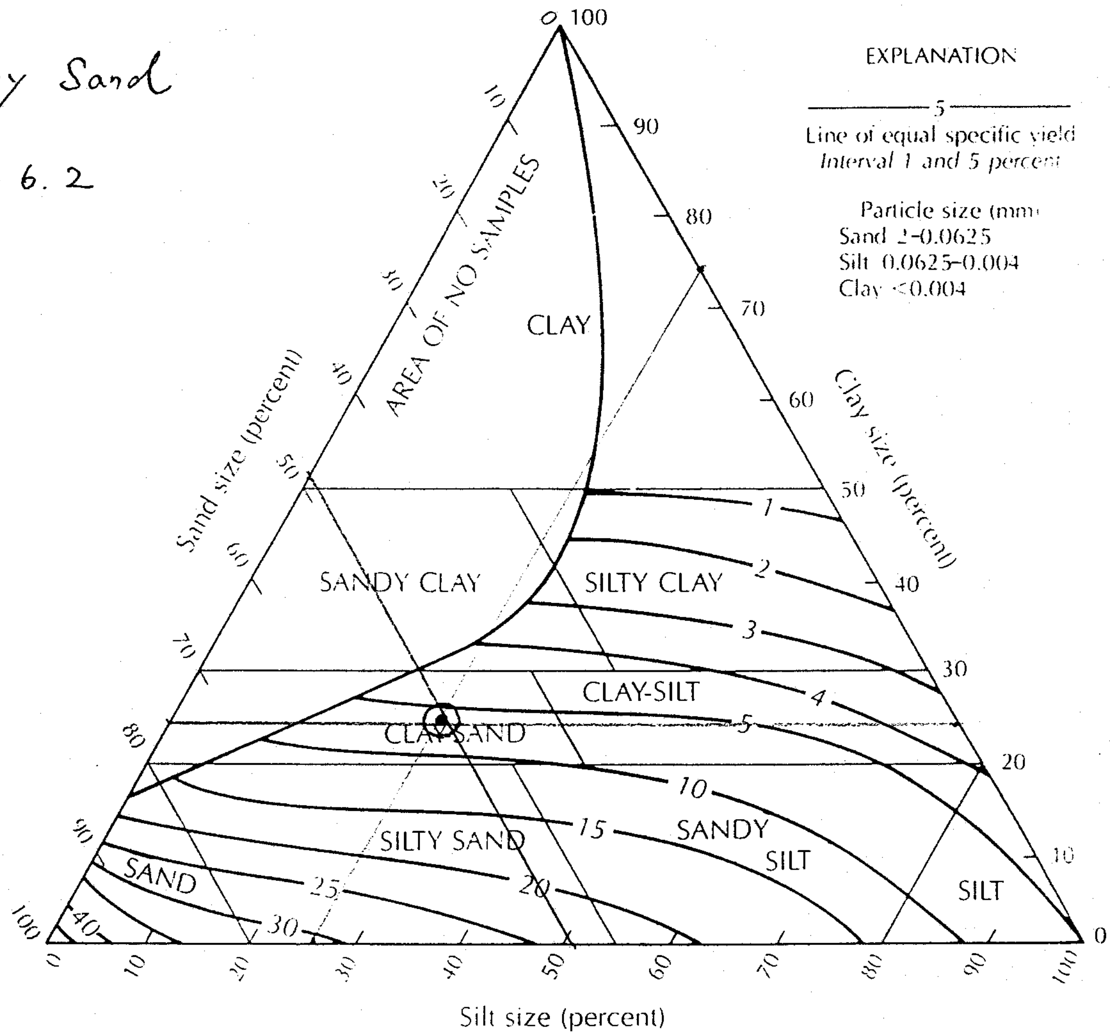
Sand = 49.3 %

Silt = 26.1 %

Clay = 24.6 %

Clayey Sand

ne = 6.2



P2-1 @ 10.0 - 12.0 ft

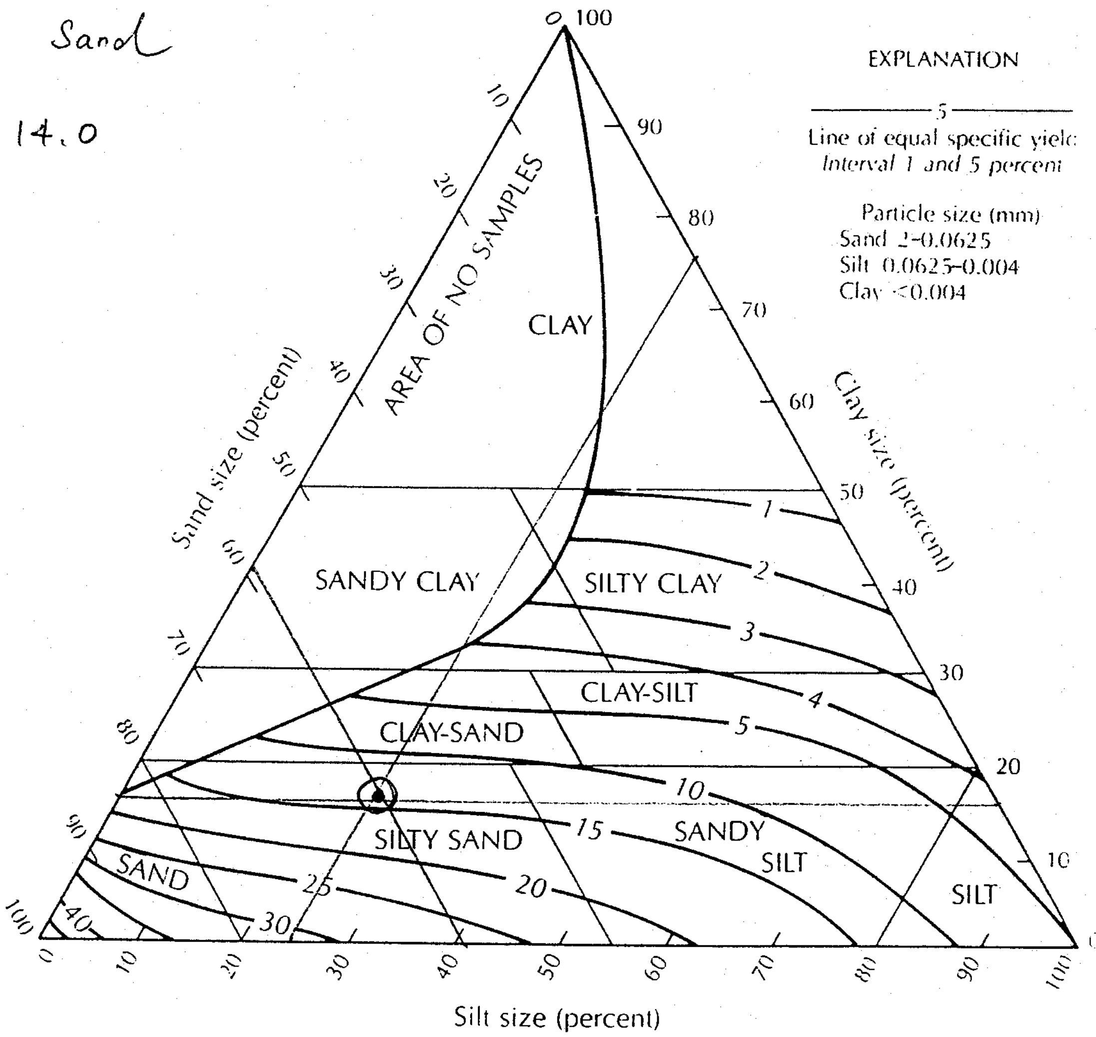
Sand = 59.3 %

Silt = 24.7 %

Clay = 16.0 %

Silty Sand

n_e = 14.0



P2-1 @ 21.0 – 23.0 ft

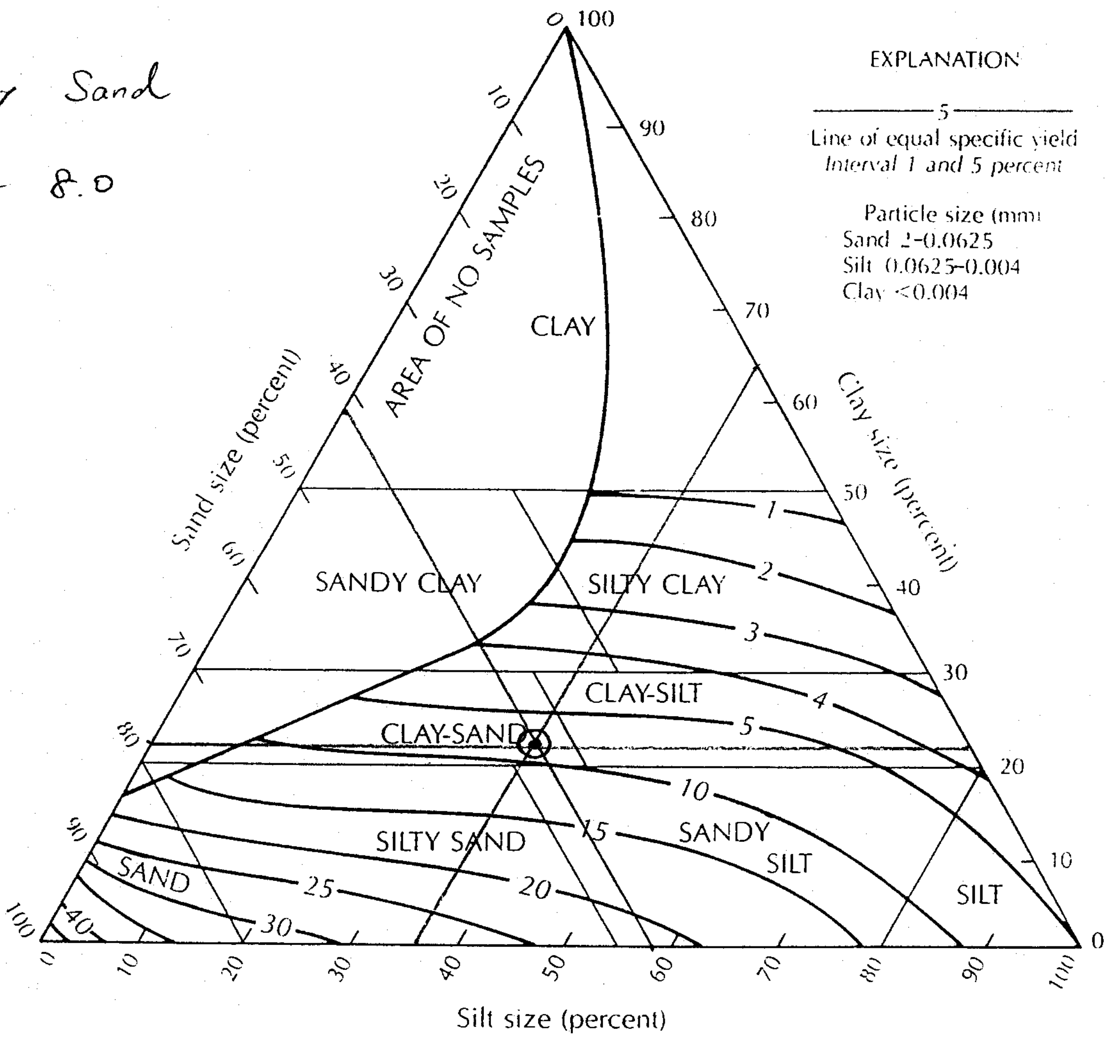
Sand = 41.7 %

Silt = 36.2 %

Clay = 22.1 %

Clayey Sand

n_e = 8.0



P2-2 @ 3.0 - 4.0 ft

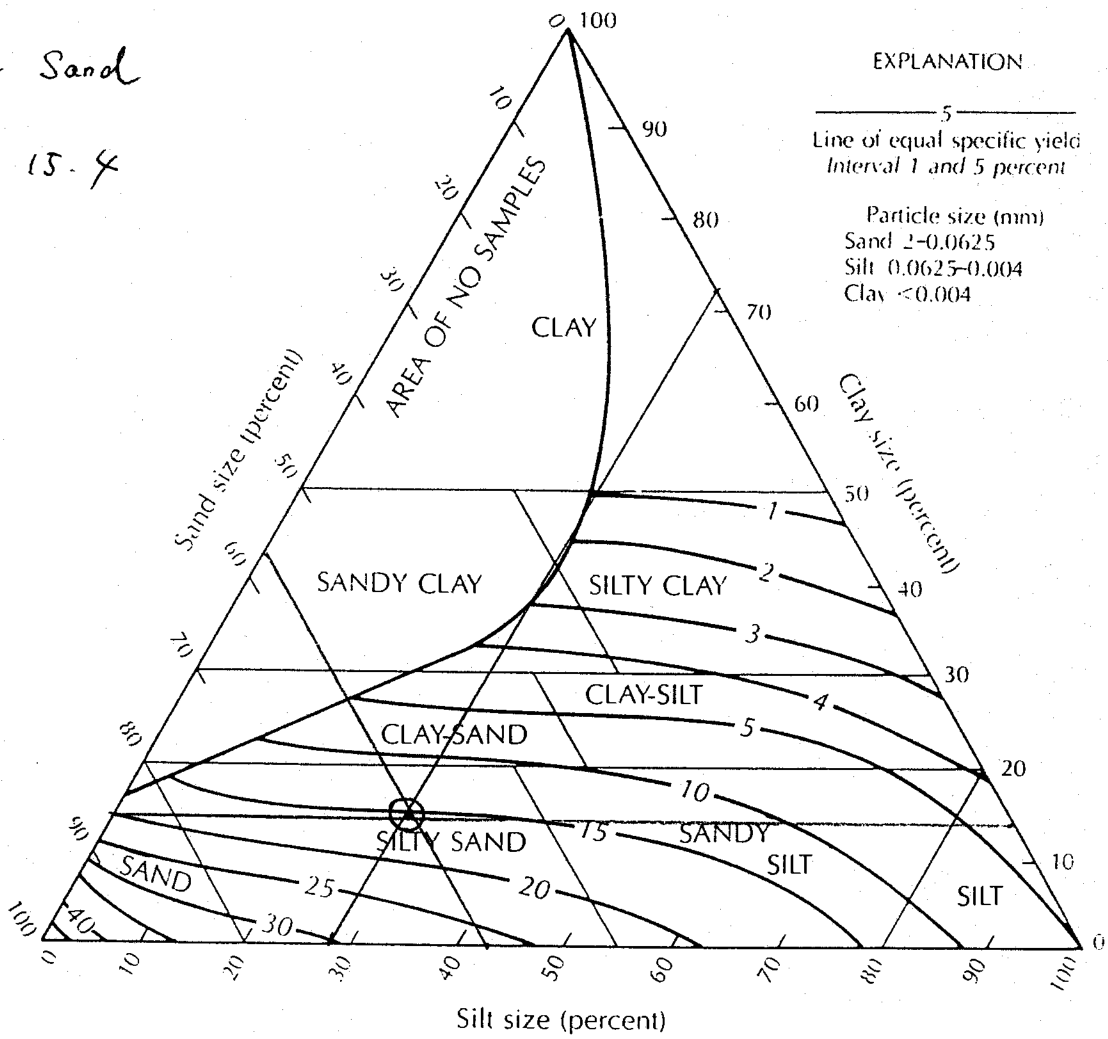
Sand = 57.4 %

Silt = 28.4 %

Clay = 14.2 %

Silty Sand

n = 15.4



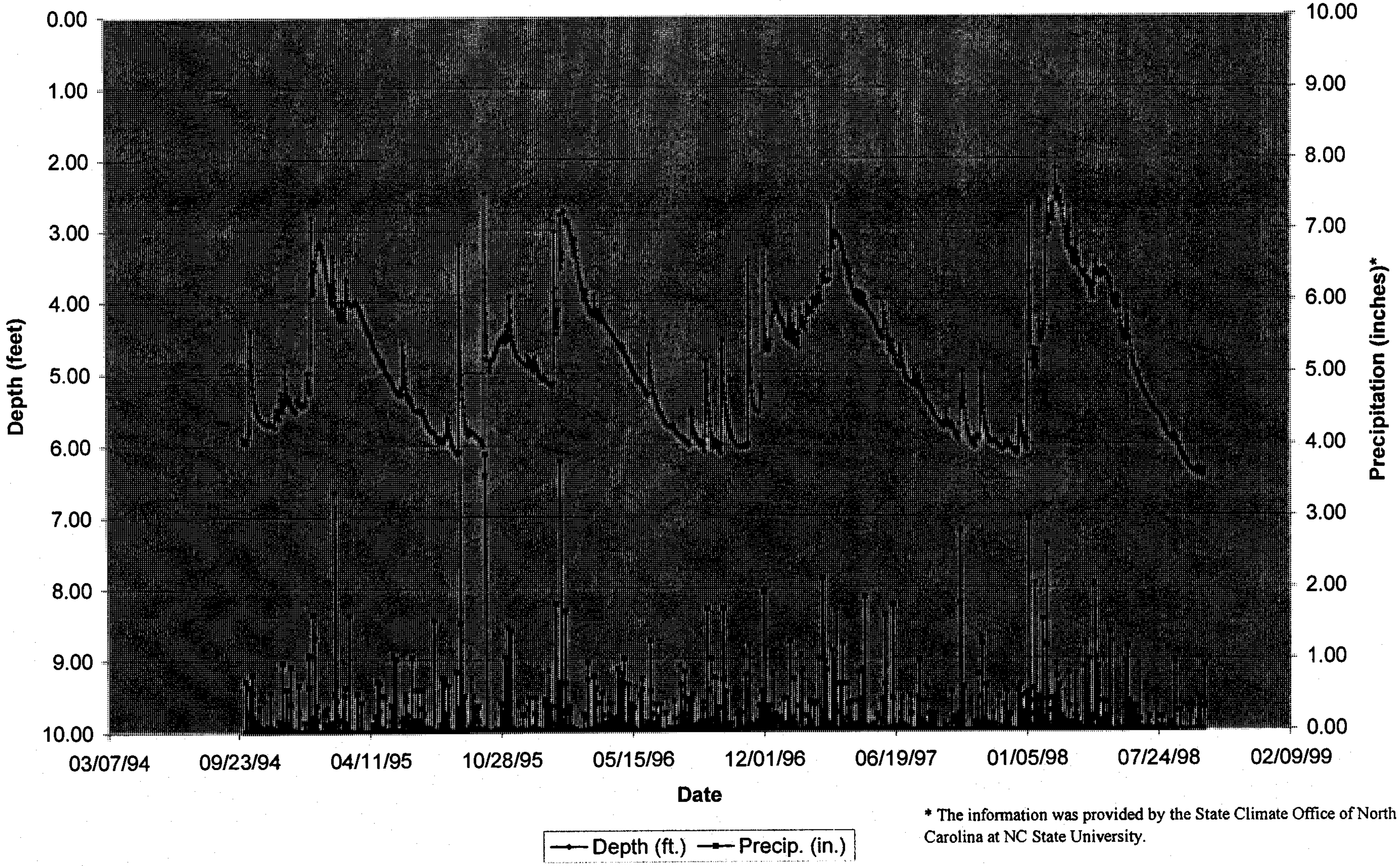
APPENDIX 14

Absolute density and absolute viscosity of water

Temperature (°C)	Density (kg/m³)	Density (g/cm³)	Viscosity (g/s·cm)
0	999.841	0.999841	0.017921
1	999.900	0.999900	0.017313
2	999.941	0.999941	0.016728
3	999.965	0.999965	0.016191
4	999.973	0.999973	0.015674
5	999.965	0.999965	0.015188
6	999.941	0.999941	0.014728
7	999.902	0.999902	0.014284
8	999.849	0.999849	0.013860
9	999.781	0.999781	0.013462
10	999.700	0.999700	0.013077
11	999.605	0.999605	0.012713
12	999.498	0.999498	0.012363
13	999.377	0.999377	0.012028
14	999.244	0.999244	0.011709
15	999.099	0.999099	0.011404
16	998.943	0.998943	0.011111
17	998.774	0.998774	0.010828
18	998.595	0.998595	0.010559
19	998.405	0.998405	0.010299
20	998.203	0.998203	0.010050
21	997.992	0.997992	0.009810
22	997.770	0.997770	0.009579
23	997.538	0.997538	0.009358
24	997.296	0.997296	0.009142
25	997.044	0.997044	0.008937
26	996.783	0.996783	0.008737
27	996.512	0.996512	0.008545
28	996.232	0.996232	0.008360
29	995.944	0.995944	0.008180
30	995.646	0.995646	0.008007
35	994.029	0.994029	0.007225
40	992.214	0.992214	0.006560
45	990.212	0.990212	0.005988
50	988.047	0.988047	0.005494

Source: *Handbook of Chemistry and Physics* (Cleveland, Ohio: CRC Publishing Company, 1986).

Water Level, NC-40, Haywood County



* The information was provided by the State Climate Office of North Carolina at NC State University.

Water Table and Precipitation Data
Haywood County White Oak Landfill

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
10/01/94	5.88	3143.38	0.00	43.0	61.5
10/02/94	5.94	3143.32	0.00	49.0	65.0
10/03/94	5.95	3143.31	0.71	59.0	66.0
10/04/94	5.93	3143.33	0.00	54.0	62.0
10/05/94	5.94	3143.32	0.00	38.0	53.0
10/06/94	5.96	3143.30	0.00	39.0	55.5
10/07/94	5.97	3143.29	0.00	39.0	57.0
10/08/94	5.95	3143.31	0.00	41.0	56.5
10/09/94	5.97	3143.29	0.62	53.0	60.0
10/10/94	5.89	3143.37	0.23	47.0	54.0
10/11/94	5.82	3143.44	0.00	37.0	49.0
10/12/94	5.77	3143.49	0.00	41.0	50.5
10/13/94	4.80	3144.46	0.80	44.0	50.5
10/14/94	4.40	3144.86	0.55	51.0	55.5
10/15/94	4.61	3144.65	0.21	50.0	58.5
10/16/94	4.88	3144.38	0.00	34.0	53.0
10/17/94	5.06	3144.20	0.00	34.0	53.0
10/18/94	5.19	3144.07	0.00	34.0	53.0
10/19/94	5.30	3143.96	0.00	41.0	56.0
10/20/94	5.38	3143.88	0.14	42.0	55.0
10/21/94	5.43	3143.83	0.05	38.0	55.0
10/22/94	5.47	3143.79	0.04	40.0	57.0
10/23/94	5.52	3143.74	0.33	54.0	61.0
10/24/94	5.54	3143.72	0.00	33.0	52.5
10/25/94	5.56	3143.70	0.00	35.0	53.5
10/26/94	5.58	3143.68	0.08	38.0	49.0
10/27/94	5.60	3143.66	0.00	24.0	41.5
10/28/94	5.62	3143.64	0.00	25.0	43.5
10/29/94	5.64	3143.62	0.00	23.0	47.5
10/30/94	5.65	3143.61	0.03	42.0	56.0
10/31/94	5.65	3143.61	0.00	47.0	59.5
11/01/94	5.65	3143.61	0.05	41.0	54.5
11/02/94	5.67	3143.59	0.00	26.0	46.5
11/03/94	5.68	3143.58	0.00	28.0	52.5
11/04/94	5.69	3143.57	0.00	29.0	54.0
11/05/94	5.69	3143.57	0.00	49.0	60.0
11/06/94	5.70	3143.56	0.08	55.0	64.5
11/07/94	5.71	3143.55	0.00	33.0	50.5
11/08/94	5.72	3143.54	0.00	28.0	51.0
11/09/94	5.72	3143.54	0.00	35.0	54.0
11/10/94	5.72	3143.54	0.55	48.0	57.5
11/11/94	5.68	3143.58	0.06	38.0	50.0
11/12/94	5.68	3143.58	0.00	29.0	48.0
11/13/94	5.68	3143.58	0.00	28.0	50.5
11/14/94	5.70	3143.56	0.00	26.0	50.5
11/15/94	5.71	3143.55	0.00	28.0	49.0
11/16/94	5.71	3143.55	0.00	32.0	48.0
11/17/94	5.72	3143.54	0.00	31.0	45.5
11/18/94	5.73	3143.53	0.05	50.0	59.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
11/19/94	5.74	3143.52	0.00	33.0	52.0
11/20/94	5.75	3143.51	0.00	32.0	49.5
11/21/94	5.59	3143.67	0.15	43.0	57.0
11/22/94	5.50	3143.76	0.00	30.0	46.5
11/23/94	5.52	3143.74	0.00	23.0	37.0
11/24/94	5.55	3143.71	0.00	18.0	37.5
11/25/94	5.58	3143.68	0.00	20.0	38.5
11/26/94	5.62	3143.64	0.10	35.0	42.5
11/27/94	5.63	3143.63	0.95	37.0	42.0
11/28/94	5.36	3143.90	0.95	36.0	49.0
11/29/94	5.27	3143.99	0.04	23.0	39.5
11/30/94	5.35	3143.91	0.00	21.0	35.0
12/01/94	5.42	3143.84	0.00	17.0	36.0
12/02/94	5.48	3143.78	0.00	18.0	39.0
12/03/94	5.53	3143.73	0.00	26.0	45.0
12/04/94	5.44	3143.82	0.59	45.0	52.5
12/05/94	4.90	3144.36	0.10	52.0	59.5
12/06/94	5.06	3144.20	0.00	40.0	55.5
12/07/94	5.18	3144.08	0.00	37.0	52.5
12/08/94	5.29	3143.97	0.00	37.0	52.0
12/09/94	5.36	3143.90	0.00	34.0	49.5
12/10/94	5.39	3143.87	0.91	39.0	49.5
12/11/94	5.32	3143.94	0.38	26.0	40.5
12/12/94	5.34	3143.92	0.00	15.0	30.5
12/13/94	5.38	3143.88	0.00	27.0	39.0
12/14/94	5.42	3143.84	0.00	37.0	44.5
12/15/94	5.45	3143.81	0.00	36.0	44.0
12/16/94	5.48	3143.78	0.02	37.0	43.0
12/17/94	5.49	3143.77	0.00	40.0	49.0
12/18/94	5.50	3143.76	0.00	20.0	36.5
12/19/94	5.52	3143.74	0.00	22.0	35.5
12/20/94	5.53	3143.73	0.00	16.0	34.5
12/21/94	5.54	3143.72	0.00	20.0	34.5
12/22/94	5.51	3143.75	0.65	38.0	42.5
12/23/94	5.38	3143.88	0.27	38.0	41.5
12/24/94	5.35	3143.91	0.00	26.0	34.5
12/25/94	5.37	3143.89	0.00	31.0	36.5
12/26/94	5.39	3143.87	0.00	21.0	41.0
12/27/94	5.42	3143.84	0.00	21.0	41.0
12/28/94	5.43	3143.83	0.00	21.0	41.0
12/29/94	5.45	3143.81	0.00	28.0	40.5
12/30/94	5.46	3143.80	0.00	33.0	43.0
12/31/94	5.46	3143.80	0.13	31.0	40.5
01/01/95	5.44	3143.82	0.00	39.0	51.0
01/02/95	5.43	3143.83	0.00	21.0	40.0
01/03/95	5.43	3143.83	0.02	16.0	30.5
01/04/95	5.44	3143.82	0.00	20.0	29.5
01/05/95	5.44	3143.82	0.00	4.0	21.5
01/06/95	5.38	3143.88	0.62	15.0	34.0
01/07/95	4.99	3144.27	1.06	32.0	44.5
01/08/95	5.09	3144.17	0.02	24.0	35.0
01/09/95	5.15	3144.11	0.00	28.0	38.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F) *	Mean Temp. (F) *
01/10/95	5.21	3144.05	0.00	21.0	40.0
01/11/95	5.25	3144.01	0.18	34.0	44.0
01/12/95	5.25	3144.01	0.19	44.0	50.5
01/13/95	5.26	3144.00	0.00	42.0	51.5
01/14/95	3.60	3145.66	1.63	49.0	56.0
01/15/95	2.81	3146.45	1.30	42.0	51.0
01/16/95	3.41	3145.85	0.00	39.0	44.5
01/17/95	3.72	3145.54	0.00	29.0	47.0
01/18/95	3.89	3145.37	0.00	29.0	47.0
01/19/95	3.83	3145.43	0.37	32.0	45.0
01/20/95	3.54	3145.72	0.16	27.0	39.0
01/21/95	3.56	3145.70	0.00	25.0	35.0
01/22/95	3.46	3145.80	0.00	15.0	31.0
01/23/95	3.33	3145.93	0.00	27.0	34.0
01/24/95	3.25	3146.01	0.00	12.0	26.5
01/25/95	3.20	3146.06	0.00	12.0	31.0
01/26/95	3.17	3146.09	0.00	20.0	34.5
01/27/95	3.16	3146.10	0.00	16.0	33.0
01/28/95	3.15	3146.11	0.24	39.0	48.0
01/29/95	3.17	3146.09	0.30	34.0	46.0
01/30/95	3.20	3146.06	0.10	27.0	32.5
01/31/95	3.25	3146.01	0.00	25.0	33.5
02/01/95	3.30	3145.96	0.00	16.0	34.5
02/02/95	3.35	3145.91	0.04	34.0	46.0
02/03/95	3.40	3145.86	0.06	26.0	41.5
02/04/95	3.43	3145.83	0.33	25.0	40.0
02/05/95	3.49	3145.77	0.00	12.0	19.5
02/06/95	3.55	3145.71	0.00	4.0	17.0
02/07/95	3.61	3145.65	0.00	10.0	22.5
02/08/95	3.67	3145.59	0.00	8.0	19.0
02/09/95	3.74	3145.52	0.00	2.0	20.5
02/10/95	3.78	3145.48	0.13	27.0	37.5
02/11/95	3.83	3145.43	0.02	32.0	39.5
02/12/95	3.90	3145.36	0.05	13.0	24.0
02/13/95	3.96	3145.30	0.00	15.0	26.5
02/14/95	4.02	3145.24	0.00	31.0	36.5
02/15/95	4.04	3145.22	0.52	36.0	44.5
02/16/95	3.36	3145.90	3.35	39.0	49.5
02/17/95	3.43	3145.83	0.44	45.0	52.0
02/18/95	3.69	3145.57	0.23	41.0	50.0
02/19/95	3.82	3145.44	0.00	40.0	49.5
02/20/95	3.92	3145.34	0.00	34.0	44.5
02/21/95	4.00	3145.26	0.17	31.0	43.0
02/22/95	4.08	3145.18	0.00	19.0	39.5
02/23/95	4.13	3145.13	0.00	33.0	49.0
02/24/95	4.18	3145.08	0.00	36.0	50.5
02/25/95	4.22	3145.04	0.00	20.0	39.0
02/26/95	4.26	3145.00	0.00	31.0	49.0
02/27/95	4.27	3144.99	0.14	39.0	51.0
02/28/95	4.14	3145.12	0.51	48.0	53.5
03/01/95	4.00	3145.26	0.61	42.0	48.5
03/02/95	4.07	3145.19	0.03	33.0	39.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F) *	Mean Temp. (F) *
03/03/95	4.15	3145.11	0.12	35.0	39.5
03/04/95	4.20	3145.06	0.09	35.0	44.5
03/05/95	4.24	3145.02	0.12	38.0	45.5
03/06/95	4.25	3145.01	0.09	44.0	56.0
03/07/95	4.27	3144.99	0.00	49.0	58.0
03/08/95	3.69	3145.57	1.62	31.0	47.5
03/09/95	3.71	3145.55	0.00	21.0	27.5
03/10/95	3.89	3145.37	0.00	17.0	38.0
03/11/95	3.97	3145.29	0.00	22.0	44.5
03/12/95	4.02	3145.24	0.00	23.0	45.5
03/13/95	4.04	3145.22	0.00	27.0	48.5
03/14/95	4.05	3145.21	0.00	29.0	49.0
03/15/95	4.05	3145.21	0.00	29.0	49.0
03/16/95	4.05	3145.21	0.00	32.0	52.5
03/17/95	4.04	3145.22	0.00	35.0	53.5
03/18/95	4.03	3145.23	0.00	32.0	51.5
03/19/95	4.03	3145.23	0.00	27.0	47.5
03/20/95	4.02	3145.24	0.00	36.0	52.5
03/21/95	4.00	3145.26	0.53	40.0	53.0
03/22/95	4.00	3145.26	0.00	39.0	56.5
03/23/95	4.00	3145.26	0.00	55.0	66.5
03/24/95	4.02	3145.24	0.00	41.0	58.0
03/25/95	4.04	3145.22	0.00	21.0	42.5
03/26/95	4.05	3145.21	0.00	25.0	49.0
03/27/95	4.06	3145.20	0.40	43.0	58.0
03/28/95	4.08	3145.18	0.00	34.0	50.5
03/29/95	4.11	3145.15	0.00	29.0	45.5
03/30/95	4.14	3145.12	0.00	31.0	46.0
03/31/95	4.16	3145.10	0.00	30.0	44.0
04/01/95	4.19	3145.07	0.00	23.0	40.0
04/02/95	4.22	3145.04	0.00	20.0	39.0
04/03/95	4.25	3145.01	0.00	23.0	46.5
04/04/95	4.27	3144.99	0.00	37.0	53.0
04/05/95	4.30	3144.96	0.00	28.0	46.0
04/06/95	4.32	3144.94	0.00	35.0	51.5
04/07/95	4.35	3144.91	0.00	30.0	52.0
04/08/95	4.38	3144.88	0.00	34.0	55.0
04/09/95	4.40	3144.86	0.00	41.0	61.0
04/10/95	4.43	3144.83	0.00	43.0	65.0
04/11/95	4.46	3144.80	0.00	54.0	68.5
04/12/95	4.43	3144.83	0.10	52.0	60.0
04/13/95	4.45	3144.81	0.00	42.0	53.5
04/14/95	4.49	3144.77	0.00	40.0	51.5
04/15/95	4.53	3144.73	0.00	30.0	51.0
04/16/95	4.56	3144.70	0.00	36.0	57.5
04/17/95	4.59	3144.67	0.22	44.0	60.5
04/18/95	4.62	3144.64	0.02	49.0	66.0
04/19/95	4.64	3144.62	0.00	56.0	69.5
04/20/95	4.67	3144.59	0.00	55.0	66.5
04/21/95	4.68	3144.58	0.70	60.0	67.5
04/22/95	4.70	3144.56	0.00	42.0	59.0
04/23/95	4.71	3144.55	0.30	48.0	59.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F) *	Mean Temp. (F) *
04/24/95	4.72	3144.54	0.66	42.0	47.0
04/25/95	4.75	3144.51	0.00	37.0	50.0
04/26/95	4.78	3144.48	0.00	32.0	49.5
04/27/95	4.80	3144.46	0.00	38.0	54.0
04/28/95	4.83	3144.43	0.00	43.0	55.5
04/29/95	4.85	3144.41	0.00	31.0	54.0
04/30/95	4.88	3144.38	0.04	45.0	58.5
05/01/95	4.89	3144.37	0.00	45.0	58.5
05/02/95	4.82	3144.44	0.49	46.0	57.0
05/03/95	4.86	3144.40	0.00	32.0	50.5
05/04/95	4.89	3144.37	0.02	44.0	56.0
05/05/95	4.93	3144.33	0.00	52.0	58.5
05/06/95	4.96	3144.30	0.00	33.0	51.0
05/07/95	4.98	3144.28	0.00	35.0	54.5
05/08/95	5.01	3144.25	0.00	41.0	60.5
05/09/95	5.03	3144.23	0.00	45.0	60.0
05/10/95	5.02	3144.24	0.15	52.0	65.5
05/11/95	5.04	3144.22	0.36	57.0	68.5
05/12/95	5.07	3144.19	0.00	47.0	61.0
05/13/95	5.09	3144.17	0.00	41.0	56.5
05/14/95	5.09	3144.17	1.05	61.0	68.5
05/15/95	5.09	3144.17	0.00	58.0	69.0
05/16/95	5.12	3144.14	0.00	45.0	64.0
05/17/95	5.16	3144.10	0.00	58.0	70.0
05/18/95	5.19	3144.07	0.00	56.0	70.0
05/19/95	5.19	3144.07	1.00	60.0	69.0
05/20/95	5.20	3144.06	0.00	36.0	54.0
05/21/95	5.22	3144.04	0.00	40.0	58.0
05/22/95	5.24	3144.02	0.00	44.0	60.5
05/23/95	5.26	3144.00	0.02	49.0	64.5
05/24/95	5.28	3143.98	0.00	49.0	65.5
05/25/95	5.30	3143.96	0.00	49.0	65.5
05/26/95	5.31	3143.95	0.00	51.0	67.0
05/27/95	5.30	3143.96	0.14	57.0	68.5
05/28/95	5.24	3144.02	0.20	61.0	69.5
05/29/95	5.24	3144.02	0.00	58.0	70.0
05/30/95	5.27	3143.99	0.00	56.0	67.5
05/31/95	5.31	3143.95	0.00	46.0	61.0
06/01/95	5.18	3144.08	0.18	60.0	69.5
06/02/95	4.58	3144.68	0.52	59.0	69.5
06/03/95	4.74	3144.52	0.43	54.0	68.0
06/04/95	4.94	3144.32	0.00	50.0	67.0
06/05/95	5.05	3144.21	0.00	58.0	68.5
06/06/95	5.13	3144.13	0.23	61.0	70.0
06/07/95	5.21	3144.05	0.13	56.0	68.0
06/08/95	5.28	3143.98	0.00	55.0	71.0
06/09/95	5.33	3143.93	0.00	58.0	74.0
06/10/95	5.36	3143.90	0.00	59.0	72.5
06/11/95	5.39	3143.87	0.00	59.0	71.5
06/12/95	5.36	3143.90	1.02	60.0	71.5
06/13/95	5.34	3143.92	0.09	51.0	57.5
06/14/95	5.38	3143.88	0.00	39.0	56.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F) *	Mean Temp. (F) *
06/15/95	5.42	3143.84	0.00	45.0	61.5
06/16/95	5.45	3143.81	0.00	47.0	63.0
06/17/95	5.48	3143.78	0.16	48.0	62.5
06/18/95	5.51	3143.75	0.00	50.0	64.0
06/19/95	5.51	3143.75	0.15	53.0	65.0
06/20/95	5.51	3143.75	0.58	53.0	62.5
06/21/95	5.53	3143.73	0.08	53.0	64.0
06/22/95	5.52	3143.74	0.32	56.0	67.0
06/23/95	5.53	3143.73	0.00	55.0	66.0
06/24/95	5.53	3143.73	0.00	59.0	70.0
06/25/95	5.52	3143.74	0.13	60.0	70.5
06/26/95	5.51	3143.75	0.00	60.0	73.0
06/27/95	5.52	3143.74	0.15	58.0	71.0
06/28/95	5.54	3143.72	0.00	52.0	68.0
06/29/95	5.55	3143.71	0.57	55.0	68.5
06/30/95	5.51	3143.75	0.04	60.0	71.0
07/01/95	5.50	3143.76	0.25	61.0	70.5
07/02/95	5.53	3143.73	0.00	58.0	69.5
07/03/95	5.57	3143.69	0.00	55.0	69.0
07/04/95	5.59	3143.67	0.05	60.0	71.0
07/05/95	5.62	3143.64	0.00	60.0	74.5
07/06/95	5.65	3143.61	0.00	62.0	75.5
07/07/95	5.67	3143.59	0.00	55.0	69.5
07/08/95	5.70	3143.56	0.00	54.0	67.0
07/09/95	5.73	3143.53	0.00	49.0	66.5
07/10/95	5.74	3143.52	0.02	54.0	70.5
07/11/95	5.74	3143.52	0.05	57.0	73.0
07/12/95	5.77	3143.49	0.00	55.0	71.5
07/13/95	5.78	3143.48	0.00	56.0	72.5
07/14/95	5.80	3143.46	0.00	61.0	75.0
07/15/95	5.81	3143.45	0.00	60.0	74.5
07/16/95	5.81	3143.45	1.55	66.0	77.0
07/17/95	5.81	3143.45	0.00	64.0	76.0
07/18/95	5.81	3143.45	0.00	59.0	73.0
07/19/95	5.83	3143.43	0.00	55.0	70.5
07/20/95	5.84	3143.42	0.00	60.0	73.5
07/21/95	5.86	3143.40	0.00	63.0	74.0
07/22/95	5.86	3143.40	0.00	60.0	72.5
07/23/95	5.88	3143.38	0.00	62.0	75.5
07/24/95	5.90	3143.36	0.00	57.0	73.5
07/25/95	5.92	3143.34	0.00	60.0	75.5
07/26/95	5.94	3143.32	0.10	58.0	74.0
07/27/95	5.94	3143.32	0.06	64.0	75.0
07/28/95	5.90	3143.36	0.74	62.0	73.5
07/29/95	5.90	3143.36	0.00	60.0	73.0
07/30/95	5.92	3143.34	0.06	59.0	74.0
07/31/95	5.95	3143.31	0.72	58.0	73.5
08/01/95	5.93	3143.33	0.15	60.0	73.0
08/02/95	5.94	3143.32	0.00	60.0	72.5
08/03/95	5.96	3143.30	0.00	61.0	71.5
08/04/95	5.91	3143.35	0.05	62.0	72.0
08/05/95	5.88	3143.38	0.14	63.0	72.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
08/06/95	5.89	3143.37	0.25	63.0	72.5
08/07/95	5.84	3143.42	0.64	65.0	73.0
08/08/95	5.63	3143.63	0.00	63.0	71.5
08/09/95	5.64	3143.62	0.00	62.0	72.0
08/10/95	5.71	3143.55	0.00	60.0	71.0
08/11/95	5.78	3143.48	0.00	63.0	74.0
08/12/95	5.85	3143.41	0.00	61.0	74.5
08/13/95	5.90	3143.36	0.00	62.0	76.0
08/14/95	5.93	3143.33	0.00	64.0	78.0
08/15/95	5.96	3143.30	0.00	61.0	77.5
08/16/95	6.00	3143.26	0.00	62.0	77.0
08/17/95	6.03	3143.23	0.00	60.0	76.0
08/18/95	6.05	3143.21	0.00	61.0	76.5
08/19/95	6.06	3143.20	0.83	65.0	78.0
08/20/95	6.07	3143.19	0.29	63.0	71.0
08/21/95	6.08	3143.18	0.00	62.0	73.0
08/22/95	6.10	3143.16	0.32	63.0	74.0
08/23/95	6.12	3143.14	0.00	59.0	71.0
08/24/95	6.12	3143.14	0.00	59.0	71.5
08/25/95	6.11	3143.15	0.00	60.0	72.5
08/26/95	5.14	3144.12	1.50	67.0	73.0
08/27/95	3.20	3146.06	3.90	65.0	69.0
08/28/95	4.08	3145.18	0.13	59.0	71.5
08/29/95	4.70	3144.56	0.00	58.0	71.5
08/30/95	5.02	3144.24	0.00	60.0	73.5
08/31/95	5.22	3144.04	0.00	64.0	75.0
09/01/95	5.36	3143.90	0.49	59.0	72.5
09/02/95	5.47	3143.79	0.00	55.0	65.5
09/03/95	5.58	3143.68	0.00	46.0	62.0
09/04/95	5.67	3143.59	0.00	49.0	64.0
09/05/95	5.72	3143.54	0.00	47.0	64.5
09/06/95	5.76	3143.50	0.00	52.0	65.5
09/07/95	5.79	3143.47	0.00	48.0	65.0
09/08/95	5.82	3143.44	0.00	47.0	65.0
09/09/95	5.85	3143.41	0.00	52.0	67.0
09/10/95	5.87	3143.39	0.08	53.0	68.0
09/11/95	5.86	3143.40	0.74	60.0	68.5
09/12/95	5.79	3143.47	0.00	58.0	68.5
09/13/95	5.80	3143.46	0.00	54.0	68.5
09/14/95	5.82	3143.44	0.49	61.0	71.5
09/15/95	5.83	3143.43	0.00	56.0	66.5
09/16/95	5.83	3143.43	0.29	60.0	67.5
09/17/95	5.82	3143.44	0.20	63.0	69.0
09/18/95	5.83	3143.43	0.00	52.0	63.0
09/19/95	5.84	3143.42	0.00	49.0	63.0
09/20/95	5.86	3143.40	0.00	48.0	62.5
09/21/95	5.88	3143.38	0.02	61.0	67.0
09/22/95	5.89	3143.37	0.35	54.0	63.5
09/23/95	5.88	3143.38	0.15	50.0	53.0
09/24/95	5.88	3143.38	0.03	49.0	59.5
09/25/95	5.89	3143.37	0.00	52.0	64.0
09/26/95	5.91	3143.35	0.02	57.0	66.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F) *	Mean Temp. (F) *
09/27/95	5.92	3143.34	0.00	50.0	61.5
09/28/95	5.94	3143.32	0.00	52.0	63.5
09/29/95	5.96	3143.30	0.00	44.0	58.5
09/30/95	5.98	3143.28	0.00	40.0	56.5
10/01/95	6.00	3143.26	0.00	43.0	60.0
10/02/95	6.01	3143.25	0.00	46.0	63.0
10/03/95	6.01	3143.25	0.05	54.0	64.0
10/04/95	4.79	3144.47	3.58	58.0	62.0
10/05/95	2.48	3146.78	3.88	57.0	66.5
10/06/95	3.60	3145.66	0.00	54.0	66.0
10/07/95	4.17	3145.09	0.00	45.0	62.5
10/08/95	4.49	3144.77	0.00	40.0	56.5
10/09/95	4.70	3144.56	0.00	40.0	57.5
10/10/95	4.83	3144.43	0.00	44.0	60.5
10/11/95	4.92	3144.34	0.00	47.0	62.0
10/12/95	4.97	3144.29	0.00	47.0	62.0
10/13/95	4.98	3144.28	0.00	57.0	66.0
10/14/95	4.91	3144.35	0.00	59.0	61.5
10/15/95	4.82	3144.44	0.00	35.0	49.0
10/16/95	4.82	3144.44	0.00	34.0	49.5
10/17/95	4.82	3144.44	0.00	29.0	49.0
10/18/95	4.80	3144.46	0.00	30.0	50.0
10/19/95	4.78	3144.48	0.00	34.0	53.0
10/20/95	4.75	3144.51	0.02	32.0	51.0
10/21/95	4.72	3144.54	0.00	26.0	44.0
10/22/95	4.70	3144.56	0.00	25.0	47.5
10/23/95	4.68	3144.58	0.00	26.0	51.5
10/24/95	4.65	3144.61	0.00	45.0	60.0
10/25/95	4.62	3144.64	0.00	29.0	49.5
10/26/95	4.59	3144.67	0.00	34.0	54.5
10/27/95	4.57	3144.69	0.38	45.0	58.0
10/28/95	4.55	3144.71	0.26	38.0	47.5
10/29/95	4.55	3144.71	0.00	30.0	42.5
10/30/95	4.51	3144.75	0.00	25.0	46.0
10/31/95	4.56	3144.70	0.07	45.0	50.5
11/01/95	4.57	3144.69	0.02	47.0	57.0
11/02/95	4.52	3144.74	1.03	55.0	61.0
11/03/95	4.49	3144.77	0.10	46.0	53.5
11/04/95	4.53	3144.73	0.00	24.0	36.0
11/05/95	4.56	3144.70	0.00	18.0	31.5
11/06/95	4.58	3144.68	0.00	22.0	41.0
11/07/95	4.43	3144.83	1.45	43.0	50.5
11/08/95	4.34	3144.92	0.00	35.0	44.0
11/09/95	4.45	3144.81	0.00	18.0	35.5
11/10/95	4.53	3144.73	0.00	24.0	43.0
11/11/95	3.96	3145.30	1.40	38.0	50.0
11/12/95	3.92	3145.34	0.03	21.0	34.5
11/13/95	4.14	3145.12	0.00	27.0	40.5
11/14/95	4.27	3144.99	0.05	30.0	37.5
11/15/95	4.39	3144.87	0.00	17.0	32.0
11/16/95	4.48	3144.78	0.00	13.0	30.5
11/17/95	4.56	3144.70	0.00	20.0	40.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
11/18/95	4.61	3144.65	0.00	26.0	43.0
11/19/95	4.65	3144.61	0.00	26.0	44.0
11/20/95	4.68	3144.58	0.00	24.0	45.5
11/21/95	4.70	3144.56	0.00	28.0	46.0
11/22/95	4.73	3144.53	0.00	15.0	32.5
11/23/95	4.75	3144.51	0.00	22.0	38.5
11/24/95	4.77	3144.49	0.02	39.0	44.0
11/25/95	4.78	3144.48	0.00	28.0	42.0
11/26/95	4.80	3144.46	0.00	22.0	44.5
11/27/95	4.80	3144.46	0.00	35.0	49.5
11/28/95	4.82	3144.44	0.04	55.0	58.5
11/29/95	4.82	3144.44	0.23	39.0	51.0
11/30/95	4.83	3144.43	0.00	30.0	44.0
12/01/95	4.84	3144.42	0.00	27.0	45.0
12/02/95	4.86	3144.40	0.00	24.0	46.5
12/03/95	4.87	3144.39	0.00	29.0	47.5
12/04/95	4.88	3144.38	0.00	44.0	53.0
12/05/95	4.89	3144.37	0.00	41.0	48.0
12/06/95	4.90	3144.36	0.00	25.0	41.0
12/07/95	4.90	3144.36	0.31	30.0	42.0
12/08/95	4.91	3144.35	0.00	15.0	30.0
12/09/95	4.76	3144.50	0.47	22.0	32.5
12/10/95	4.77	3144.49	0.00	5.0	17.0
12/11/95	4.81	3144.45	0.00	10.0	23.0
12/12/95	4.85	3144.41	0.00	15.0	30.0
12/13/95	4.88	3144.38	0.00	24.0	39.0
12/14/95	4.90	3144.36	0.00	32.0	46.0
12/15/95	4.93	3144.33	0.00	45.0	56.5
12/16/95	4.94	3144.32	0.02	41.0	52.0
12/17/95	4.96	3144.30	0.06	22.0	38.5
12/18/95	4.97	3144.29	0.24	40.0	45.0
12/19/95	4.82	3144.44	0.47	40.0	51.5
12/20/95	4.78	3144.48	0.03	22.0	38.0
12/21/95	4.84	3144.42	0.00	12.0	23.0
12/22/95	4.89	3144.37	0.00	20.0	27.0
12/23/95	4.92	3144.34	0.00	19.0	23.5
12/24/95	4.95	3144.31	0.02	12.0	20.5
12/25/95	4.98	3144.28	0.00	8.0	22.0
12/26/95	5.00	3144.26	0.00	8.0	21.5
12/27/95	5.03	3144.23	0.00	12.0	23.5
12/28/95	5.06	3144.20	--	19.0	25.5
12/29/95	5.08	3144.18	0.00	9.0	31.5
12/30/95	5.09	3144.17	0.00	10.0	31.5
12/31/95	5.09	3144.17	0.02	30.0	44.0
01/01/96	5.10	3144.16	0.35	39.0	46.0
01/02/96	5.08	3144.18	0.44	41.0	52.0
01/03/96	5.06	3144.20	0.23	27.0	43.5
01/04/96	5.07	3144.19	0.00	17.0	31.0
01/05/96	5.09	3144.17	0.00	19.0	32.0
01/06/96	5.10	3144.16	0.42	30.0	36.0
01/07/96	5.10	3144.16	0.85	11.0	22.0
01/08/96	5.12	3144.14	0.04	9.0	21.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F) *
01/09/96	5.13	3144.13	0.00	-5.0	20.5
01/10/96	5.14	3144.12	0.00	26.0	36.0
01/11/96	5.15	3144.11	0.00	12.0	27.0
01/12/96	5.15	3144.11	0.35	20.0	28.5
01/13/96	5.17	3144.09	0.00	21.0	35.5
01/14/96	5.18	3144.08	0.00	14.0	36.5
01/15/96	5.19	3144.07	0.00	22.0	38.5
01/16/96	5.19	3144.07	0.00	30.0	42.5
01/17/96	5.13	3144.13	0.00	34.0	46.0
01/18/96	3.87	3145.39	0.10	46.0	54.5
01/19/96	3.03	3146.23	1.78	20.0	42.0
01/20/96	3.82	3145.44	0.00	10.0	27.5
01/21/96	4.16	3145.10	0.00	19.0	29.5
01/22/96	4.34	3144.92	0.00	14.0	33.0
01/23/96	4.46	3144.80	0.00	25.0	43.5
01/24/96	4.37	3144.89	0.68	39.0	49.5
01/25/96	4.37	3144.89	0.00	17.0	33.0
01/26/96	4.12	3145.14	0.25	21.0	32.0
01/27/96	2.78	3146.48	3.78	34.0	43.5
01/28/96	3.41	3145.85	0.00	14.0	29.5
01/29/96	3.54	3145.72	0.02	22.0	32.0
01/30/96	3.53	3145.73	0.03	35.0	44.0
01/31/96	3.43	3145.83	0.14	26.0	39.0
02/01/96	3.32	3145.94	0.00	25.0	33.5
02/02/96	2.74	3146.52	1.68	28.0	35.0
02/03/96	2.72	3146.54	0.66	11.0	21.0
02/04/96	2.84	3146.42	0.00	-6.0	4.0
02/05/96	2.87	3146.39	0.00	-13.0	7.5
02/06/96	2.88	3146.38	0.00	3.0	21.0
02/07/96	2.90	3146.36	0.00	28.0	35.0
02/08/96	2.88	3146.38	0.25	34.0	41.5
02/09/96	2.87	3146.39	0.33	40.0	47.5
02/10/96	2.93	3146.33	0.00	23.0	44.0
02/11/96	2.96	3146.30	0.00	47.0	54.0
02/12/96	3.01	3146.25	0.05	22.0	34.5
02/13/96	3.06	3146.20	0.02	11.0	28.0
02/14/96	3.09	3146.17	0.00	31.0	41.5
02/15/96	3.14	3146.12	0.00	35.0	43.5
02/16/96	3.19	3146.07	0.02	22.0	32.5
02/17/96	3.25	3146.01	0.03	1.0	20.0
02/18/96	3.31	3145.95	0.00	17.0	31.5
02/19/96	3.36	3145.90	0.00	31.0	44.0
02/20/96	3.14	3146.12	0.00	40.0	49.0
02/21/96	3.29	3145.97	0.00	31.0	48.0
02/22/96	3.39	3145.87	0.00	34.0	51.5
02/23/96	3.46	3145.80	0.00	34.0	56.5
02/24/96	3.53	3145.73	0.00	43.0	59.0
02/25/96	3.60	3145.66	0.00	20.0	46.0
02/26/96	3.64	3145.62	0.00	41.0	57.0
02/27/96	3.69	3145.57	0.00	44.0	59.5
02/28/96	3.73	3145.53	0.23	50.0	61.0
02/29/96	3.78	3145.48	0.00	20.0	36.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
03/01/96	3.83	3145.43	0.00	22.0	33.0
03/02/96	3.86	3145.40	0.00	22.0	34.5
03/03/96	3.91	3145.35	0.00	28.0	35.0
03/04/96	3.96	3145.30	0.00	18.0	31.5
03/05/96	3.99	3145.27	0.17	23.0	40.5
03/06/96	3.86	3145.40	0.94	48.0	58.0
03/07/96	3.85	3145.41	0.71	46.0	56.5
03/08/96	3.90	3145.36	0.01	10.0	32.0
03/09/96	3.99	3145.27	0.00	3.0	15.0
03/10/96	4.05	3145.21	0.00	6.0	22.0
03/11/96	4.09	3145.17	0.00	8.0	29.0
03/12/96	4.12	3145.14	0.00	13.0	35.0
03/13/96	4.15	3145.11	0.00	18.0	41.5
03/14/96	4.18	3145.08	0.00	28.0	48.5
03/15/96	4.19	3145.07	0.02	46.0	55.5
03/16/96	4.19	3145.07	0.76	39.0	49.5
03/17/96	4.19	3145.07	0.17	39.0	53.0
03/18/96	4.21	3145.05	0.00	32.0	49.0
03/19/96	3.92	3145.34	0.59	35.0	48.5
03/20/96	4.00	3145.26	0.07	24.0	35.0
03/21/96	4.10	3145.16	0.00	23.0	27.0
03/22/96	4.16	3145.10	0.00	16.0	24.5
03/23/96	4.20	3145.06	0.00	16.0	31.0
03/24/96	4.24	3145.02	0.00	20.0	37.5
03/25/96	4.25	3145.01	0.00	33.0	51.0
03/26/96	4.27	3144.99	0.39	32.0	47.0
03/27/96	4.29	3144.97	0.00	36.0	46.5
03/28/96	4.13	3145.13	0.52	37.0	44.5
03/29/96	4.12	3145.14	0.21	39.0	46.0
03/30/96	4.19	3145.07	0.00	43.0	50.5
03/31/96	4.22	3145.04	0.11	45.0	52.0
04/01/96	4.25	3145.01	0.10	44.0	48.0
04/02/96	4.28	3144.98	0.04	25.0	36.5
04/03/96	4.30	3144.96	0.00	25.0	42.5
04/04/96	4.31	3144.95	0.00	37.0	56.0
04/05/96	4.33	3144.93	0.02	36.0	54.5
04/06/96	4.34	3144.92	0.03	38.0	48.0
04/07/96	4.36	3144.90	0.00	21.0	32.5
04/08/96	4.37	3144.89	0.22	33.0	40.0
04/09/96	4.38	3144.88	0.16	31.0	36.5
04/10/96	4.40	3144.86	0.00	28.0	36.0
04/11/96	4.41	3144.85	0.00	23.0	37.0
04/12/96	4.42	3144.84	0.00	25.0	50.5
04/13/96	4.43	3144.83	0.00	36.0	57.0
04/14/96	4.45	3144.81	0.10	38.0	51.5
04/15/96	4.46	3144.80	0.04	50.0	63.0
04/16/96	4.48	3144.78	0.18	35.0	51.0
04/17/96	4.50	3144.76	0.00	30.0	44.0
04/18/96	4.52	3144.74	0.00	32.0	50.0
04/19/96	4.53	3144.73	0.00	35.0	54.5
04/20/96	4.54	3144.72	0.05	55.0	61.5
04/21/96	4.55	3144.71	0.86	51.0	61.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
04/22/96	4.57	3144.69	0.00	47.0	60.5
04/23/96	4.58	3144.68	0.00	50.0	64.0
04/24/96	4.61	3144.65	0.18	29.0	53.0
04/25/96	4.63	3144.63	0.00	33.0	49.0
04/26/96	4.61	3144.65	0.80	36.0	55.0
04/27/96	4.62	3144.64	0.24	33.0	52.5
04/28/96	4.65	3144.61	0.00	34.0	54.0
04/29/96	4.67	3144.59	0.00	42.0	57.5
04/30/96	4.61	3144.65	1.01	46.0	63.0
05/01/96	4.62	3144.64	0.00	29.0	43.0
05/02/96	4.66	3144.60	0.00	35.0	52.5
05/03/96	4.70	3144.56	0.00	42.0	58.5
05/04/96	4.73	3144.53	0.00	50.0	65.5
05/05/96	4.76	3144.50	0.00	53.0	69.0
05/06/96	4.78	3144.48	0.08	60.0	73.0
05/07/96	4.78	3144.48	0.65	52.0	67.0
05/08/96	4.81	3144.45	0.00	55.0	64.0
05/09/96	4.83	3144.43	0.00	51.0	65.5
05/10/96	4.85	3144.41	0.00	50.0	66.0
05/11/96	4.87	3144.39	0.00	53.0	67.5
05/12/96	4.89	3144.37	0.37	44.0	59.0
05/13/96	4.91	3144.35	0.00	37.0	55.0
05/14/96	4.93	3144.33	0.04	41.0	48.0
05/15/96	4.96	3144.30	0.33	45.0	55.0
05/16/96	4.97	3144.29	0.04	49.0	55.0
05/17/96	4.99	3144.27	0.00	48.0	62.5
05/18/96	5.01	3144.25	0.00	49.0	67.5
05/19/96	5.04	3144.22	0.00	50.0	68.5
05/20/96	5.06	3144.20	0.00	54.0	73.0
05/21/96	5.08	3144.18	0.00	54.0	72.0
05/22/96	5.11	3144.15	0.00	57.0	72.0
05/23/96	5.13	3144.13	0.00	47.0	62.5
05/24/96	5.14	3144.12	0.00	55.0	69.5
05/25/96	5.13	3144.13	0.49	54.0	70.5
05/26/96	5.13	3144.13	0.00	56.0	69.5
05/27/96	5.10	3144.16	0.72	57.0	66.0
05/28/96	5.11	3144.15	0.57	59.0	70.0
05/29/96	5.13	3144.13	0.05	55.0	67.5
05/30/96	5.15	3144.11	0.02	54.0	67.0
05/31/96	5.17	3144.09	0.00	42.0	57.0
06/01/96	5.21	3144.05	0.00	41.0	56.5
06/02/96	5.23	3144.03	0.00	45.0	59.5
06/03/96	5.25	3144.01	0.00	58.0	66.5
06/04/96	5.28	3143.98	0.00	50.0	64.0
06/05/96	5.30	3143.96	0.12	43.0	59.0
06/06/96	5.32	3143.94	0.00	44.0	60.5
06/07/96	5.33	3143.93	0.00	50.0	67.0
06/08/96	5.30	3143.96	0.10	54.0	68.5
06/09/96	4.61	3144.65	1.26	60.0	67.5
06/10/96	4.74	3144.52	0.55	49.0	63.0
06/11/96	4.87	3144.39	0.23	53.0	64.0
06/12/96	4.96	3144.30	0.00	56.0	65.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F) *	Mean Temp. (F) *
06/13/96	5.05	3144.21	0.10	53.0	63.5
06/14/96	5.13	3144.13	0.00	56.0	68.0
06/15/96	5.21	3144.05	0.00	57.0	69.5
06/16/96	5.27	3143.99	0.00	56.0	69.5
06/17/96	5.30	3143.96	0.00	58.0	72.0
06/18/96	5.32	3143.94	0.37	60.0	72.5
06/19/96	5.35	3143.91	0.00	62.0	72.0
06/20/96	5.37	3143.89	0.00	59.0	72.0
06/21/96	5.41	3143.85	0.20	61.0	72.5
06/22/96	5.45	3143.81	0.00	58.0	72.0
06/23/96	5.48	3143.78	0.00	58.0	72.5
06/24/96	5.51	3143.75	0.00	62.0	77.0
06/25/96	5.53	3143.73	0.37	62.0	75.5
06/26/96	5.55	3143.71	0.00	58.0	70.0
06/27/96	5.56	3143.70	0.00	59.0	70.5
06/28/96	5.58	3143.68	0.00	58.0	70.0
06/29/96	5.60	3143.66	0.00	57.0	71.0
06/30/96	5.62	3143.64	0.00	59.0	73.5
07/01/96	5.64	3143.62	0.00	57.0	72.0
07/02/96	5.66	3143.60	0.00	62.0	75.0
07/03/96	5.67	3143.59	0.24	61.0	74.5
07/04/96	5.69	3143.57	0.00	46.0	63.0
07/05/96	5.71	3143.55	0.00	52.0	64.0
07/06/96	5.72	3143.54	0.00	54.0	69.5
07/07/96	5.74	3143.52	0.00	60.0	72.5
07/08/96	5.74	3143.52	0.03	63.0	75.0
07/09/96	5.75	3143.51	0.00	63.0	71.5
07/10/96	5.76	3143.50	0.04	56.0	70.5
07/11/96	5.76	3143.50	0.00	48.0	63.5
07/12/96	5.75	3143.51	0.00	54.0	65.0
07/13/96	5.76	3143.50	0.00	54.0	67.5
07/14/96	5.77	3143.49	0.00	61.0	72.5
07/15/96	5.73	3143.53	0.41	65.0	76.5
07/16/96	5.72	3143.54	0.17	59.0	68.0
07/17/96	5.75	3143.51	0.00	58.0	72.5
07/18/96	5.78	3143.48	0.00	60.0	73.0
07/19/96	5.81	3143.45	0.00	62.0	75.0
07/20/96	5.84	3143.42	0.00	69.0	77.5
07/21/96	5.85	3143.41	0.00	65.0	74.0
07/22/96	5.83	3143.43	0.06	65.0	75.0
07/23/96	5.84	3143.42	0.01	64.0	75.5
07/24/96	5.86	3143.40	0.91	61.0	73.0
07/25/96	5.88	3143.38	0.20	61.0	73.0
07/26/96	5.87	3143.39	0.65	54.0	67.0
07/27/96	5.90	3143.36	0.00	53.0	66.0
07/28/96	5.91	3143.35	0.08	55.0	68.5
07/29/96	5.91	3143.35	0.23	58.0	69.0
07/30/96	5.93	3143.33	0.05	60.0	70.0
07/31/96	5.91	3143.35	0.48	61.0	66.5
08/01/96	5.90	3143.36	0.82	61.0	66.5
08/02/96	5.92	3143.34	0.01	55.0	67.0
08/03/96	5.94	3143.32	0.00	56.0	68.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
08/04/96	5.96	3143.30	0.00	60.0	72.0
08/05/96	5.95	3143.31	0.00	60.0	71.0
08/06/96	5.95	3143.31	0.41	61.0	71.5
08/07/96	5.96	3143.30	0.03	61.0	72.5
08/08/96	5.99	3143.27	0.00	60.0	72.5
08/09/96	6.01	3143.25	0.44	62.0	73.0
08/10/96	6.02	3143.24	0.00	59.0	69.5
08/11/96	6.01	3143.25	0.00	61.0	72.5
08/12/96	5.56	3143.70	0.45	57.0	69.5
08/13/96	5.52	3143.74	0.51	59.0	65.5
08/14/96	5.60	3143.66	0.00	57.0	66.0
08/15/96	5.69	3143.57	0.00	56.0	68.0
08/16/96	5.77	3143.49	0.00	56.0	69.0
08/17/96	5.83	3143.43	0.00	56.0	70.0
08/18/96	5.87	3143.39	0.00	56.0	68.0
08/19/96	5.91	3143.35	0.00	59.0	71.0
08/20/96	5.88	3143.38	0.07	60.0	72.5
08/21/96	5.90	3143.36	0.00	58.0	71.0
08/22/96	5.93	3143.33	0.00	57.0	71.0
08/23/96	5.97	3143.29	0.11	58.0	71.5
08/24/96	5.98	3143.28	0.07	57.0	72.0
08/25/96	5.99	3143.27	0.00	58.0	70.5
08/26/96	6.00	3143.26	0.12	60.0	69.5
08/27/96	6.00	3143.26	0.40	60.0	70.5
08/28/96	5.96	3143.30	0.30	61.0	70.5
08/29/96	5.95	3143.31	0.00	56.0	68.5
08/30/96	5.98	3143.28	0.08	57.0	68.5
08/31/96	6.02	3143.24	0.00	60.0	71.0
09/01/96	6.08	3143.18	0.00	56.0	67.0
09/02/96	6.10	3143.16	0.00	58.0	68.0
09/03/96	5.88	3143.38	0.13	60.0	65.0
09/04/96	4.98	3144.28	1.70	57.0	67.5
09/05/96	4.84	3144.42	0.56	58.0	69.0
09/06/96	5.09	3144.17	0.03	57.0	66.0
09/07/96	5.31	3143.95	0.00	54.0	68.0
09/08/96	5.45	3143.81	0.12	58.0	71.0
09/09/96	5.56	3143.70	0.00	59.0	70.0
09/10/96	5.65	3143.61	0.00	58.0	70.0
09/11/96	5.75	3143.51	1.01	57.0	66.0
09/12/96	5.84	3143.42	0.00	55.0	67.0
09/13/96	5.90	3143.36	0.00	49.0	64.5
09/14/96	5.96	3143.30	0.00	38.0	52.0
09/15/96	6.02	3143.24	0.00	38.0	53.5
09/16/96	6.04	3143.22	0.15	41.0	59.0
09/17/96	5.95	3143.31	0.74	58.0	64.0
09/18/96	5.94	3143.32	0.00	48.0	59.0
09/19/96	5.94	3143.32	0.00	42.0	55.0
09/20/96	5.96	3143.30	0.00	41.0	55.5
09/21/96	5.99	3143.27	0.00	41.0	56.0
09/22/96	6.01	3143.25	0.32	46.0	57.0
09/23/96	6.06	3143.20	0.00	45.0	57.5
09/24/96	6.07	3143.19	0.00	45.0	60.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
09/25/96	6.09	3143.17	0.00	45.0	60.0
09/26/96	6.11	3143.15	0.00	50.0	64.0
09/27/96	6.12	3143.14	0.06	53.0	64.0
09/28/96	4.69	3144.57	0.71	61.0	68.0
09/29/96	4.55	3144.71	1.70	42.0	55.5
09/30/96	5.00	3144.26	0.15	42.0	55.0
10/01/96	5.18	3144.08	0.14	50.0	57.5
10/02/96	5.30	3143.96	0.02	54.0	62.0
10/03/96	5.38	3143.88	0.54	59.0	68.0
10/04/96	5.46	3143.80	0.00	50.0	61.0
10/05/96	5.54	3143.72	0.00	34.0	50.0
10/06/96	5.61	3143.65	0.00	34.0	48.5
10/07/96	5.67	3143.59	0.00	35.0	49.5
10/08/96	5.72	3143.54	0.06	48.0	55.0
10/09/96	5.77	3143.49	0.00	46.0	55.0
10/10/96	5.81	3143.45	0.00	30.0	47.0
10/11/96	5.84	3143.42	0.10	32.0	46.0
10/12/96	5.87	3143.39	0.00	30.0	47.5
10/13/96	5.89	3143.37	0.00	32.0	48.0
10/14/96	5.92	3143.34	0.00	33.0	52.0
10/15/96	5.94	3143.32	0.00	35.0	55.5
10/16/96	5.95	3143.31	0.00	35.0	57.0
10/17/96	5.97	3143.29	0.00	41.0	59.0
10/18/96	5.98	3143.28	0.00	41.0	59.5
10/19/96	5.99	3143.27	0.24	33.0	47.5
10/20/96	6.00	3143.26	0.00	23.0	37.0
10/21/96	6.02	3143.24	0.00	28.0	44.0
10/22/96	6.02	3143.24	0.00	33.0	52.5
10/23/96	6.03	3143.23	0.28	43.0	60.0
10/24/96	6.03	3143.23	0.00	30.0	50.0
10/25/96	6.04	3143.22	0.00	33.0	51.0
10/26/96	6.04	3143.22	0.00	36.0	54.5
10/27/96	6.04	3143.22	0.25	48.0	57.5
10/28/96	6.03	3143.23	0.00	52.0	64.5
10/29/96	6.03	3143.23	0.03	52.0	64.0
10/30/96	6.04	3143.22	0.01	54.0	66.0
10/31/96	6.04	3143.22	0.00	34.0	55.5
11/01/96	6.04	3143.22	0.00	37.0	56.0
11/02/96	6.02	3143.24	0.78	35.0	47.0
11/03/96	6.01	3143.25	0.00	19.0	32.0
11/04/96	6.02	3143.24	0.00	22.0	36.0
11/05/96	6.02	3143.24	0.00	24.0	42.5
11/06/96	6.03	3143.23	0.00	41.0	56.5
11/07/96	5.98	3143.28	0.00	46.0	59.0
11/08/96	3.44	3145.82	1.20	50.0	60.5
11/09/96	4.24	3145.02	0.08	30.0	41.0
11/10/96	4.69	3144.57	0.08	22.0	30.0
11/11/96	4.95	3144.31	--	18.0	27.5
11/12/96	5.14	3144.12	0.00	17.0	28.0
11/13/96	5.28	3143.98	0.00	18.0	31.5
11/14/96	5.37	3143.89	0.05	27.0	36.0
11/15/96	5.44	3143.82	0.03	29.0	38.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
11/16/96	5.48	3143.78	0.00	18.0	32.0
11/17/96	5.52	3143.74	0.00	27.0	41.0
11/18/96	5.53	3143.73	0.08	43.0	51.5
11/19/96	5.54	3143.72	0.12	40.0	48.5
11/20/96	5.54	3143.72	0.00	33.0	46.5
11/21/96	5.55	3143.71	0.02	35.0	48.0
11/22/96	5.55	3143.71	0.35	30.0	44.0
11/23/96	5.56	3143.70	0.00	19.0	30.5
11/24/96	5.56	3143.70	0.00	23.0	40.0
11/25/96	5.55	3143.71	0.00	27.0	47.0
11/26/96	5.22	3144.04	0.55	44.0	54.0
11/27/96	5.28	3143.98	0.00	16.0	30.5
11/28/96	5.33	3143.93	0.00	15.0	32.0
11/29/96	5.38	3143.88	0.00	20.0	37.5
11/30/96	5.29	3143.97	0.22	25.0	37.5
12/01/96	3.35	3145.91	1.94	45.0	53.0
12/02/96	3.71	3145.55	0.28	28.0	46.0
12/03/96	4.17	3145.09	0.00	24.0	37.0
12/04/96	4.41	3144.85	0.00	22.0	39.5
12/05/96	4.56	3144.70	0.00	22.0	37.0
12/06/96	4.63	3144.63	0.20	21.0	35.0
12/07/96	4.67	3144.59	0.20	22.0	40.0
12/08/96	4.70	3144.56	0.34	21.0	34.5
12/09/96	4.70	3144.56	0.00	19.0	32.0
12/10/96	4.67	3144.59	0.00	18.0	28.0
12/11/96	4.62	3144.64	0.00	24.0	42.0
12/12/96	4.54	3144.72	0.01	52.0	59.0
12/13/96	4.36	3144.90	0.79	36.0	49.5
12/14/96	4.28	3144.98	0.00	22.0	34.0
12/15/96	4.23	3145.03	0.00	22.0	41.5
12/16/96	4.17	3145.09	0.00	24.0	42.0
12/17/96	4.09	3145.17	0.23	25.0	41.5
12/18/96	4.04	3145.22	0.00	29.0	42.5
12/19/96	4.03	3145.23	0.10	20.0	29.0
12/20/96	4.06	3145.20	0.00	4.0	15.0
12/21/96	4.09	3145.17	0.00	4.0	16.5
12/22/96	4.13	3145.13	0.00	8.0	24.0
12/23/96	4.16	3145.10	0.00	26.0	39.0
12/24/96	4.19	3145.07	0.16	35.0	48.5
12/25/96	4.22	3145.04	0.13	14.0	33.5
12/26/96	4.24	3145.02	0.00	17.0	30.0
12/27/96	4.27	3144.99	0.19	20.0	33.5
12/28/96	4.30	3144.96	0.00	40.0	52.5
12/29/96	4.27	3144.99	0.44	51.0	57.0
12/30/96	4.27	3144.99	0.00	41.0	54.5
12/31/96	4.32	3144.94	0.00	45.0	55.0
01/01/97	4.37	3144.89	0.09	41.0	51.0
01/02/97	4.41	3144.85	0.00	45.0	52.5
01/03/97	4.46	3144.80	0.00	44.0	54.5
01/04/97	4.50	3144.76	0.00	39.0	53.5
01/05/97	4.43	3144.83	0.44	41.0	54.5
01/06/97	4.43	3144.83	0.00	29.0	45.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F) *	Mean Temp. (F) *
01/07/97	4.49	3144.77	0.00	29.0	39.0
01/08/97	4.54	3144.72	0.00	20.0	29.0
01/09/97	4.15	3145.11	1.25	29.0	33.5
01/10/97	4.15	3145.11	0.04	26.0	35.0
01/11/97	4.33	3144.93	0.17	6.0	23.0
01/12/97	4.44	3144.82	0.00	6.0	17.5
01/13/97	4.51	3144.75	0.00	9.0	21.5
01/14/97	4.56	3144.70	0.00	8.0	21.5
01/15/97	4.59	3144.67	0.00	10.0	28.5
01/16/97	4.34	3144.92	0.72	24.0	39.0
01/17/97	4.42	3144.84	0.00	4.0	22.0
01/18/97	4.50	3144.76	0.00	5.0	14.0
01/19/97	4.56	3144.70	0.00	12.0	20.0
01/20/97	4.61	3144.65	0.00	12.0	23.0
01/21/97	4.64	3144.62	0.00	16.0	34.0
01/22/97	4.65	3144.61	0.00	24.0	44.5
01/23/97	4.66	3144.60	0.34	38.0	47.0
01/24/97	4.45	3144.81	0.10	34.0	44.5
01/25/97	4.12	3145.14	1.05	31.0	39.0
01/26/97	4.27	3144.99	0.00	17.0	36.5
01/27/97	4.36	3144.90	0.00	17.0	30.5
01/28/97	4.22	3145.04	0.85	37.0	44.5
01/29/97	4.24	3145.02	0.00	20.0	33.5
01/30/97	4.31	3144.95	0.00	23.0	36.0
01/31/97	4.35	3144.91	0.00	22.0	38.5
02/01/97	4.38	3144.88	0.00	24.0	40.5
02/02/97	4.40	3144.86	0.00	27.0	45.5
02/03/97	4.41	3144.85	0.00	29.0	48.0
02/04/97	4.30	3144.96	0.21	29.0	46.5
02/05/97	4.08	3145.18	0.04	41.0	49.5
02/06/97	4.14	3145.12	0.00	27.0	37.5
02/07/97	4.19	3145.07	0.00	27.0	40.5
02/08/97	4.11	3145.15	0.40	38.0	50.0
02/09/97	4.10	3145.16	0.07	28.0	35.5
02/10/97	4.14	3145.12	0.00	25.0	35.0
02/11/97	4.16	3145.10	0.11	23.0	30.5
02/12/97	4.17	3145.09	0.00	18.0	28.0
02/13/97	4.17	3145.09	0.03	20.0	31.0
02/14/97	4.16	3145.10	0.37	22.0	28.0
02/15/97	3.97	3145.29	0.39	30.0	39.5
02/16/97	3.98	3145.28	0.00	14.0	30.5
02/17/97	4.02	3145.24	0.00	20.0	36.0
02/18/97	4.04	3145.22	0.00	21.0	40.0
02/19/97	4.06	3145.20	0.00	32.0	48.5
02/20/97	4.08	3145.18	0.00	32.0	48.0
02/21/97	3.96	3145.30	0.00	36.0	51.5
02/22/97	3.83	3145.43	1.00	31.0	49.0
02/23/97	3.94	3145.32	0.00	18.0	37.5
02/24/97	3.98	3145.28	0.00	19.0	33.5
02/25/97	4.01	3145.25	0.00	22.0	37.0
02/26/97	4.02	3145.24	0.00	31.0	44.5
02/27/97	4.02	3145.24	0.04	45.0	55.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
02/28/97	3.67	3145.59	2.12	55.0	60.5
03/01/97	3.66	3145.60	1.05	53.0	59.0
03/02/97	3.75	3145.51	0.00	62.0	69.0
03/03/97	3.56	3145.70	0.96	53.0	60.5
03/04/97	3.62	3145.64	0.34	35.0	52.5
03/05/97	3.70	3145.56	0.00	36.0	55.0
03/06/97	3.70	3145.56	0.84	30.0	52.5
03/07/97	3.73	3145.53	0.00	31.0	39.0
03/08/97	3.74	3145.52	0.00	34.0	46.0
03/09/97	3.74	3145.52	0.00	27.0	46.0
03/10/97	3.73	3145.53	0.10	36.0	51.5
03/11/97	3.72	3145.54	0.00	36.0	52.0
03/12/97	3.71	3145.55	0.00	30.0	48.5
03/13/97	3.58	3145.68	0.00	33.0	51.5
03/14/97	2.71	3146.55	1.11	41.0	51.5
03/15/97	3.10	3146.16	0.00	25.0	45.0
03/16/97	3.20	3146.06	0.00	17.0	30.0
03/17/97	3.24	3146.02	0.00	23.0	36.5
03/18/97	3.26	3146.00	0.00	34.0	48.0
03/19/97	3.04	3146.22	1.68	49.0	56.0
03/20/97	3.03	3146.23	0.25	42.0	50.5
03/21/97	3.06	3146.20	0.00	30.0	45.5
03/22/97	3.07	3146.19	0.00	36.0	54.5
03/23/97	3.09	3146.17	0.00	28.0	47.0
03/24/97	3.11	3146.15	0.00	24.0	39.5
03/25/97	3.12	3146.14	0.00	32.0	48.5
03/26/97	3.11	3146.15	0.65	47.0	57.5
03/27/97	3.14	3146.12	0.00	25.0	42.5
03/28/97	3.16	3146.10	0.00	35.0	54.5
03/29/97	3.18	3146.08	1.22	45.0	53.5
03/30/97	3.23	3146.03	0.00	33.0	52.5
03/31/97	3.26	3146.00	0.16	33.0	53.0
04/01/97	3.31	3145.95	0.06	27.0	38.0
04/02/97	3.37	3145.89	0.00	21.0	38.0
04/03/97	3.42	3145.84	0.00	25.0	45.0
04/04/97	3.47	3145.79	0.00	30.0	50.0
04/05/97	3.51	3145.75	0.00	41.0	58.0
04/06/97	3.46	3145.80	0.65	55.0	64.5
04/07/97	3.50	3145.76	0.37	41.0	56.5
04/08/97	3.58	3145.68	0.00	25.0	42.5
04/09/97	3.64	3145.62	0.00	27.0	43.5
04/10/97	3.70	3145.56	0.00	20.0	37.5
04/11/97	3.75	3145.51	0.00	21.0	42.5
04/12/97	3.56	3145.70	0.39	34.0	52.5
04/13/97	3.64	3145.62	0.08	41.0	55.0
04/14/97	3.75	3145.51	0.00	28.0	41.5
04/15/97	3.81	3145.45	0.00	25.0	41.5
04/16/97	3.85	3145.41	0.00	26.0	45.0
04/17/97	3.89	3145.37	0.02	29.0	49.5
04/18/97	3.93	3145.33	0.00	30.0	41.5
04/19/97	3.95	3145.31	0.08	30.0	41.5
04/20/97	3.99	3145.27	0.00	33.0	45.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
04/21/97	4.01	3145.25	0.01	37.0	51.0
04/22/97	4.00	3145.26	0.41	42.0	57.0
04/23/97	3.86	3145.40	0.81	45.0	59.5
04/24/97	3.93	3145.33	0.03	33.0	41.5
04/25/97	3.99	3145.27	0.00	30.0	45.0
04/26/97	4.04	3145.22	0.00	30.0	46.0
04/27/97	4.06	3145.20	0.00	40.0	47.0
04/28/97	3.98	3145.28	0.27	47.0	51.5
04/29/97	3.90	3145.36	0.84	46.0	59.0
04/30/97	3.98	3145.28	0.00	42.0	56.0
05/01/97	4.03	3145.23	0.00	45.0	62.0
05/02/97	4.08	3145.18	0.00	32.0	52.5
05/03/97	3.92	3145.34	1.86	37.0	56.0
05/04/97	3.95	3145.31	0.00	42.0	55.5
05/05/97	4.03	3145.23	0.00	29.0	44.0
05/06/97	4.07	3145.19	0.00	34.0	52.0
05/07/97	4.11	3145.15	0.00	33.0	53.5
05/08/97	4.12	3145.14	0.00	37.0	55.0
05/09/97	4.14	3145.12	0.05	40.0	57.0
05/10/97	4.16	3145.10	0.05	41.0	55.5
05/11/97	4.17	3145.09	0.00	29.0	45.0
05/12/97	4.18	3145.08	0.00	35.0	53.0
05/13/97	4.19	3145.07	0.01	40.0	57.0
05/14/97	4.20	3145.06	0.00	31.0	48.0
05/15/97	4.22	3145.04	0.09	32.0	53.5
05/16/97	4.24	3145.02	0.00	27.0	48.0
05/17/97	4.25	3145.01	0.00	28.0	46.5
05/18/97	4.27	3144.99	0.00	35.0	56.0
05/19/97	4.29	3144.97	0.00	44.0	64.0
05/20/97	4.31	3144.95	0.23	60.0	70.5
05/21/97	4.34	3144.92	0.00	40.0	59.0
05/22/97	4.36	3144.90	0.00	34.0	52.5
05/23/97	4.39	3144.87	0.00	38.0	55.0
05/24/97	4.41	3144.85	0.00	44.0	61.0
05/25/97	4.43	3144.83	0.02	48.0	63.0
05/26/97	4.46	3144.80	0.15	53.0	63.5
05/27/97	4.49	3144.77	0.00	54.0	69.0
05/28/97	4.48	3144.78	0.43	49.0	56.0
05/29/97	4.50	3144.76	0.13	45.0	55.0
05/30/97	4.52	3144.74	0.12	48.0	54.0
05/31/97	4.54	3144.72	0.10	54.0	60.0
06/01/97	4.08	3145.18	0.64	58.0	66.0
06/02/97	4.19	3145.07	0.23	51.0	63.5
06/03/97	4.20	3145.06	1.60	51.0	63.0
06/04/97	4.19	3145.07	0.91	49.0	60.5
06/05/97	4.31	3144.95	0.02	49.0	58.0
06/06/97	4.41	3144.85	0.00	42.0	51.0
06/07/97	4.48	3144.78	0.01	49.0	57.5
06/08/97	4.53	3144.73	0.00	51.0	55.5
06/09/97	4.58	3144.68	0.00	52.0	60.5
06/10/97	4.64	3144.62	0.04	49.0	54.5
06/11/97	4.69	3144.57	0.00	53.0	64.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F) *
06/12/97	4.71	3144.55	0.01	57.0	64.5
06/13/97	4.73	3144.53	0.45	58.0	69.0
06/14/97	4.67	3144.59	1.74	58.0	70.5
06/15/97	4.57	3144.69	0.12	55.0	67.0
06/16/97	4.66	3144.60	0.00	53.0	67.0
06/17/97	4.72	3144.54	0.00	58.0	68.5
06/18/97	4.77	3144.49	0.05	63.0	71.5
06/19/97	4.83	3144.43	0.02	52.0	65.5
06/20/97	4.85	3144.41	0.00	53.0	67.5
06/21/97	4.87	3144.39	0.00	55.0	70.0
06/22/97	4.89	3144.37	0.00	55.0	69.5
06/23/97	4.93	3144.33	0.00	57.0	69.0
06/24/97	4.94	3144.32	0.00	57.0	71.0
06/25/97	4.77	3144.49	0.22	58.0	69.5
06/26/97	4.65	3144.61	0.12	62.0	73.5
06/27/97	4.71	3144.55	0.45	63.0	73.0
06/28/97	4.75	3144.51	0.00	61.0	68.5
06/29/97	4.82	3144.44	0.00	62.0	68.5
06/30/97	4.88	3144.38	0.00	57.0	68.0
07/01/97	4.91	3144.35	0.07	60.0	71.0
07/02/97	4.95	3144.31	0.05	55.0	67.5
07/03/97	5.00	3144.26	0.00	58.0	72.5
07/04/97	5.05	3144.21	0.00	52.0	71.0
07/05/97	5.07	3144.19	0.03	55.0	72.5
07/06/97	5.09	3144.17	0.00	50.0	65.5
07/07/97	5.12	3144.14	0.00	51.0	67.5
07/08/97	5.13	3144.13	0.00	52.0	67.0
07/09/97	5.13	3144.13	0.00	55.0	70.0
07/10/97	5.14	3144.12	0.48	57.0	71.0
07/11/97	5.13	3144.13	0.23	60.0	72.0
07/12/97	5.15	3144.11	0.00	56.0	65.0
07/13/97	5.16	3144.10	0.00	59.0	71.0
07/14/97	5.17	3144.09	0.00	58.0	71.5
07/15/97	5.19	3144.07	0.00	60.0	75.0
07/16/97	5.13	3144.13	0.00	60.0	74.5
07/17/97	4.98	3144.28	0.00	58.0	72.5
07/18/97	5.06	3144.20	0.00	53.0	68.5
07/19/97	5.12	3144.14	0.00	55.0	69.0
07/20/97	5.15	3144.11	0.00	58.0	72.0
07/21/97	5.17	3144.09	0.46	64.0	76.0
07/22/97	5.22	3144.04	0.00	61.0	73.0
07/23/97	5.19	3144.07	0.00	65.0	76.5
07/24/97	5.05	3144.21	0.97	62.0	68.0
07/25/97	5.12	3144.14	0.00	60.0	72.5
07/26/97	5.19	3144.07	0.00	61.0	73.0
07/27/97	5.23	3144.03	0.00	59.0	72.5
07/28/97	5.25	3144.01	0.02	61.0	73.5
07/29/97	5.28	3143.98	0.13	59.0	74.5
07/30/97	5.29	3143.97	0.09	62.0	72.0
07/31/97	5.31	3143.95	0.41	56.0	65.0
08/01/97	5.34	3143.92	0.00	43.0	60.0
08/02/97	5.37	3143.89	0.00	44.0	62.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
08/03/97	5.40	3143.86	0.00	50.0	67.5
08/04/97	5.42	3143.84	0.00	53.0	68.0
08/05/97	5.44	3143.82	0.03	55.0	70.5
08/06/97	5.44	3143.82	0.06	51.0	65.5
08/07/97	5.45	3143.81	0.00	52.0	65.0
08/08/97	5.45	3143.81	0.23	55.0	66.5
08/09/97	5.47	3143.79	0.00	54.0	65.0
08/10/97	5.47	3143.79	0.08	56.0	65.0
08/11/97	5.48	3143.78	0.05	59.0	69.5
08/12/97	5.51	3143.75	0.15	60.0	71.0
08/13/97	5.53	3143.73	0.00	60.0	73.5
08/14/97	5.55	3143.71	0.00	61.0	72.0
08/15/97	5.57	3143.69	0.02	57.0	71.0
08/16/97	5.59	3143.67	0.00	59.0	73.5
08/17/97	5.61	3143.65	0.00	58.0	73.5
08/18/97	5.62	3143.64	0.23	65.0	77.5
08/19/97	5.63	3143.63	0.00	57.0	70.0
08/20/97	5.65	3143.61	0.00	58.0	72.5
08/21/97	5.66	3143.60	0.00	56.0	68.0
08/22/97	5.67	3143.59	0.00	44.0	60.5
08/23/97	5.68	3143.58	0.00	42.0	56.5
08/24/97	5.69	3143.57	0.00	42.0	58.5
08/25/97	5.71	3143.55	0.00	47.0	63.5
08/26/97	5.72	3143.54	0.00	49.0	64.0
08/27/97	5.73	3143.53	0.00	53.0	68.0
08/28/97	5.74	3143.52	0.00	55.0	70.0
08/29/97	5.76	3143.50	0.00	52.0	68.5
08/30/97	5.77	3143.49	0.00	53.0	68.5
08/31/97	5.78	3143.48	0.00	53.0	69.0
09/01/97	5.74	3143.52	0.05	56.0	71.5
09/02/97	5.69	3143.57	0.00	58.0	72.5
09/03/97	5.53	3143.73	0.00	57.0	72.0
09/04/97	5.58	3143.68	0.00	41.0	60.5
09/05/97	5.66	3143.60	0.00	34.0	54.5
09/06/97	5.71	3143.55	0.00	35.0	57.5
09/07/97	5.75	3143.51	0.00	44.0	63.0
09/08/97	5.77	3143.49	0.00	47.0	64.0
09/09/97	5.77	3143.49	0.00	50.0	66.5
09/10/97	5.73	3143.53	0.54	56.0	65.0
09/11/97	5.71	3143.55	0.10	52.0	65.0
09/12/97	5.72	3143.54	0.00	50.0	64.0
09/13/97	5.73	3143.53	0.00	50.0	64.5
09/14/97	5.76	3143.50	0.00	51.0	66.5
09/15/97	5.78	3143.48	0.00	50.0	65.0
09/16/97	5.81	3143.45	0.00	47.0	63.5
09/17/97	5.83	3143.43	0.00	48.0	65.5
09/18/97	5.87	3143.39	0.18	50.0	67.5
09/19/97	5.90	3143.36	0.00	50.0	67.5
09/20/97	5.92	3143.34	0.00	49.0	67.5
09/21/97	5.92	3143.34	0.22	52.0	67.0
09/22/97	5.94	3143.32	0.14	54.0	61.0
09/23/97	5.94	3143.32	0.00	55.0	62.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F) *
09/24/97	5.73	3143.53	1.78	56.0	68.0
09/25/97	5.38	3143.88	2.78	52.0	58.0
09/26/97	5.40	3143.86	0.02	54.0	64.5
09/27/97	5.50	3143.76	0.00	41.0	55.5
09/28/97	5.32	3143.94	0.12	41.0	57.0
09/29/97	4.99	3144.27	0.60	45.0	55.5
09/30/97	5.28	3143.98	0.00	45.0	59.0
10/01/97	5.43	3143.83	0.00	42.0	59.0
10/02/97	5.52	3143.74	0.00	35.0	50.0
10/03/97	5.60	3143.66	0.00	39.0	57.5
10/04/97	5.69	3143.57	0.00	39.0	57.0
10/05/97	5.77	3143.49	0.00	37.0	57.0
10/06/97	5.81	3143.45	0.00	38.0	59.0
10/07/97	5.84	3143.42	0.00	45.0	62.5
10/08/97	5.88	3143.38	0.00	50.0	65.0
10/09/97	5.90	3143.36	0.00	46.0	63.0
10/10/97	5.92	3143.34	0.00	47.0	63.5
10/11/97	5.94	3143.32	0.00	49.0	63.5
10/12/97	5.95	3143.31	0.00	50.0	63.0
10/13/97	5.98	3143.28	0.00	50.0	63.0
10/14/97	6.00	3143.26	0.01	45.0	61.5
10/15/97	6.02	3143.24	0.11	37.0	52.0
10/16/97	6.03	3143.23	0.00	34.0	50.0
10/17/97	6.04	3143.22	0.05	33.0	50.5
10/18/97	6.04	3143.22	0.00	45.0	53.5
10/19/97	5.93	3143.33	0.77	46.0	53.0
10/20/97	5.89	3143.37	0.03	32.0	43.5
10/21/97	5.89	3143.37	0.00	32.0	46.5
10/22/97	5.90	3143.36	0.09	35.0	47.5
10/23/97	5.92	3143.34	0.00	22.0	38.0
10/24/97	5.93	3143.33	0.00	24.0	43.5
10/25/97	5.88	3143.38	0.45	48.0	53.0
10/26/97	5.22	3144.04	1.30	51.0	59.5
10/27/97	4.97	3144.29	1.20	41.0	53.0
10/28/97	5.23	3144.03	0.00	26.0	35.5
10/29/97	5.39	3143.87	0.00	26.0	43.5
10/30/97	5.50	3143.76	0.00	23.0	44.5
10/31/97	5.59	3143.67	0.00	26.0	45.5
11/01/97	5.67	3143.59	0.12	31.0	49.0
11/02/97	5.72	3143.54	0.63	34.0	47.5
11/03/97	5.76	3143.50	0.00	36.0	45.5
11/04/97	5.80	3143.46	0.04	28.0	40.5
11/05/97	5.84	3143.42	0.00	23.0	36.0
11/06/97	5.88	3143.38	0.00	25.0	41.0
11/07/97	5.91	3143.35	0.08	31.0	38.0
11/08/97	5.93	3143.33	0.00	29.0	40.0
11/09/97	5.95	3143.31	0.00	29.0	36.5
11/10/97	5.97	3143.29	0.00	26.0	35.5
11/11/97	5.97	3143.29	0.00	29.0	38.5
11/12/97	5.98	3143.28	0.00	30.0	40.0
11/13/97	5.98	3143.28	0.24	32.0	37.5
11/14/97	5.96	3143.30	0.09	37.0	41.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
11/15/97	5.95	3143.31	0.00	23.0	38.5
11/16/97	5.95	3143.31	0.00	17.0	31.0
11/17/97	5.95	3143.31	0.00	18.0	29.0
11/18/97	5.97	3143.29	0.00	15.0	32.5
11/19/97	5.99	3143.27	0.00	16.0	34.0
11/20/97	6.00	3143.26	0.00	17.0	34.5
11/21/97	6.01	3143.25	0.00	18.0	39.0
11/22/97	6.02	3143.24	0.47	40.0	48.0
11/23/97	6.03	3143.23	0.00	40.0	52.0
11/24/97	6.05	3143.21	0.00	24.0	37.5
11/25/97	6.06	3143.20	0.00	15.0	29.0
11/26/97	6.06	3143.20	0.00	20.0	39.5
11/27/97	6.07	3143.19	0.00	19.0	36.5
11/28/97	6.07	3143.19	0.00	26.0	45.5
11/29/97	6.08	3143.18	0.00	32.0	47.5
11/30/97	6.08	3143.18	0.04	38.0	46.5
12/01/97	6.08	3143.18	0.35	39.0	50.5
12/02/97	6.07	3143.19	0.00	22.0	34.5
12/03/97	6.06	3143.20	0.00	24.0	43.0
12/04/97	6.00	3143.26	0.54	37.0	47.0
12/05/97	5.96	3143.30	0.02	32.0	43.5
12/06/97	5.95	3143.31	0.00	19.0	26.5
12/07/97	5.98	3143.28	0.00	14.0	21.5
12/08/97	6.00	3143.26	0.00	17.0	26.0
12/09/97	6.03	3143.23	0.22	20.0	32.0
12/10/97	6.04	3143.22	0.22	30.0	44.0
12/11/97	6.03	3143.23	0.00	28.0	43.5
12/12/97	6.03	3143.23	0.00	30.0	36.5
12/13/97	6.04	3143.22	0.00	25.0	30.5
12/14/97	6.05	3143.21	0.00	26.0	33.0
12/15/97	6.07	3143.19	0.00	13.0	26.5
12/16/97	6.08	3143.18	0.00	14.0	33.0
12/17/97	6.09	3143.17	0.00	14.0	37.0
12/18/97	6.11	3143.15	0.00	18.0	37.5
12/19/97	6.12	3143.14	0.00	18.0	37.0
12/20/97	6.13	3143.13	0.00	18.0	40.5
12/21/97	6.14	3143.12	0.00	22.0	42.5
12/22/97	6.11	3143.15	0.56	26.0	39.0
12/23/97	6.06	3143.20	0.00	28.0	43.0
12/24/97	5.92	3143.34	0.24	31.0	43.0
12/25/97	5.64	3143.62	0.64	40.0	46.0
12/26/97	5.68	3143.58	0.00	26.0	42.5
12/27/97	5.73	3143.53	0.47	32.0	45.5
12/28/97	5.77	3143.49	0.10	15.0	25.0
12/29/97	5.81	3143.45	0.00	12.0	26.5
12/30/97	5.86	3143.40	0.06	21.0	28.5
12/31/97	5.91	3143.35	0.25	20.0	26.5
01/01/98	5.96	3143.30	0.00	0.0	17.0
01/02/98	5.99	3143.27	0.00	15.0	31.0
01/03/98	6.02	3143.24	0.50	21.0	38.5
01/04/98	6.06	3143.20	0.00	26.0	42.0
01/05/98	6.08	3143.18	0.00	29.0	46.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
01/06/98	5.94	3143.32	0.00	42.0	52.0
01/07/98	3.81	3145.45	0.52	51.0	58.0
01/08/98	2.65	3146.61	2.95	57.0	62.5
01/09/98	3.62	3145.64	0.22	40.0	53.5
01/10/98	4.13	3145.13	0.00	29.0	39.0
01/11/98	4.45	3144.81	0.00	26.0	42.0
01/12/98	4.67	3144.59	0.00	30.0	40.0
01/13/98	4.84	3144.42	0.05	43.0	50.5
01/14/98	4.96	3144.30	0.00	35.0	47.0
01/15/98	4.86	3144.40	0.58	35.0	46.5
01/16/98	4.68	3144.58	0.40	37.0	40.0
01/17/98	4.69	3144.57	2.06	32.0	38.5
01/18/98	4.83	3144.43	0.00	23.0	36.5
01/19/98	4.89	3144.37	0.28	24.0	35.0
01/20/98	4.93	3144.33	0.00	25.0	32.5
01/21/98	4.95	3144.31	0.00	24.0	34.5
01/22/98	4.86	3144.40	0.00	26.0	38.0
01/23/98	4.30	3144.96	0.46	38.0	44.5
01/24/98	4.46	3144.80	0.00	34.0	43.0
01/25/98	4.55	3144.71	0.02	26.0	31.5
01/26/98	4.58	3144.68	0.00	21.0	34.5
01/27/98	4.55	3144.71	0.43	22.0	36.5
01/28/98	4.51	3144.75	1.55	28.0	31.5
01/29/98	4.48	3144.78	0.00	11.0	27.5
01/30/98	4.42	3144.84	0.00	15.0	36.0
01/31/98	4.36	3144.90	0.00	19.0	32.0
02/01/98	4.31	3144.95	0.00	11.0	28.0
02/02/98	4.25	3145.01	0.00	12.0	31.0
02/03/98	3.19	3146.07	1.18	30.0	36.5
02/04/98	2.55	3146.71	2.60	33.0	39.0
02/05/98	2.97	3146.29	0.27	29.0	32.0
02/06/98	3.07	3146.19	0.00	29.0	32.0
02/07/98	3.03	3146.23	0.00	30.0	34.5
02/08/98	2.96	3146.30	0.00	33.0	37.5
02/09/98	2.87	3146.39	0.08	34.0	39.0
02/10/98	2.82	3146.44	0.00	25.0	39.5
02/11/98	2.66	3146.60	0.00	37.0	48.5
02/12/98	2.65	3146.61	0.44	40.0	46.0
02/13/98	2.74	3146.52	0.00	34.0	39.0
02/14/98	2.81	3146.45	0.00	32.0	39.5
02/15/98	2.88	3146.38	0.00	19.0	33.0
02/16/98	2.51	3146.75	0.24	25.0	37.5
02/17/98	2.13	3147.13	0.92	40.0	46.5
02/18/98	2.39	3146.87	0.75	42.0	49.0
02/19/98	2.51	3146.75	0.00	32.0	41.0
02/20/98	2.56	3146.70	0.00	36.0	47.0
02/21/98	2.59	3146.67	0.00	36.0	43.0
02/22/98	2.61	3146.65	0.00	23.0	36.5
02/23/98	2.44	3146.82	0.63	29.0	38.5
02/24/98	2.54	3146.72	0.02	30.0	37.5
02/25/98	2.60	3146.66	0.00	27.0	41.0
02/26/98	2.67	3146.59	0.00	27.0	46.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F) *
02/27/98	2.68	3146.58	0.18	30.0	49.5
02/28/98	2.77	3146.49	0.00	36.0	52.0
03/01/98	2.85	3146.41	0.00	35.0	50.0
03/02/98	2.91	3146.35	0.00	29.0	43.0
03/03/98	2.99	3146.27	0.12	24.0	35.5
03/04/98	3.06	3146.20	0.00	27.0	32.0
03/05/98	3.14	3146.12	0.00	31.0	39.5
03/06/98	3.21	3146.05	0.08	35.0	45.0
03/07/98	3.27	3145.99	0.00	40.0	46.0
03/08/98	2.98	3146.28	0.80	43.0	50.5
03/09/98	2.70	3146.56	0.34	42.0	52.5
03/10/98	3.02	3146.24	0.00	22.0	36.0
03/11/98	3.16	3146.10	0.00	14.0	22.5
03/12/98	3.27	3145.99	0.01	10.0	22.5
03/13/98	3.34	3145.92	0.00	11.0	21.0
03/14/98	3.40	3145.86	0.00	19.0	32.5
03/15/98	3.44	3145.82	0.00	23.0	42.0
03/16/98	3.47	3145.79	0.10	37.0	48.0
03/17/98	3.50	3145.76	0.00	37.0	42.5
03/18/98	3.42	3145.84	0.20	38.0	42.5
03/19/98	3.31	3145.95	0.78	41.0	47.5
03/20/98	3.16	3146.10	0.33	48.0	60.0
03/21/98	3.23	3146.03	0.15	33.0	48.0
03/22/98	3.35	3145.91	0.00	31.0	34.5
03/23/98	3.42	3145.84	0.00	23.0	34.0
03/24/98	3.47	3145.79	0.07	24.0	35.5
03/25/98	3.53	3145.73	0.00	29.0	42.0
03/26/98	3.56	3145.70	0.00	34.0	51.5
03/27/98	3.58	3145.68	0.00	46.0	60.5
03/28/98	3.60	3145.66	0.00	54.0	65.5
03/29/98	3.62	3145.64	0.00	42.0	58.5
03/30/98	3.64	3145.62	0.00	42.0	61.0
03/31/98	3.66	3145.60	0.00	52.0	67.0
04/01/98	3.62	3145.64	0.88	58.0	65.0
04/02/98	3.66	3145.60	0.02	46.0	58.0
04/03/98	3.65	3145.61	0.00	35.0	55.0
04/04/98	3.59	3145.67	1.20	42.0	51.0
04/05/98	3.68	3145.58	0.02	32.0	42.5
04/06/98	3.73	3145.53	0.00	25.0	43.0
04/07/98	3.75	3145.51	0.00	26.0	49.0
04/08/98	3.78	3145.48	0.00	36.0	55.0
04/09/98	3.71	3145.55	0.99	55.0	68.0
04/10/98	3.74	3145.52	0.03	42.0	54.0
04/11/98	3.81	3145.45	0.00	33.0	38.5
04/12/98	3.86	3145.40	0.00	25.0	41.5
04/13/98	3.90	3145.36	0.00	30.0	49.5
04/14/98	3.93	3145.33	0.20	31.0	49.0
04/15/98	3.96	3145.30	0.02	37.0	53.5
04/16/98	3.98	3145.28	0.00	41.0	58.5
04/17/98	3.60	3145.66	2.05	58.0	63.0
04/18/98	3.78	3145.48	0.15	53.0	63.0
04/19/98	3.50	3145.76	0.35	52.0	58.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F) *	Mean Temp. (F) *
04/20/98	3.46	3145.80	1.00	42.0	51.0
04/21/98	3.64	3145.62	0.00	33.0	48.0
04/22/98	3.60	3145.66	0.51	38.0	50.0
04/23/98	3.57	3145.69	0.89	41.0	48.0
04/24/98	3.63	3145.63	0.10	35.0	46.0
04/25/98	3.66	3145.60	0.00	31.0	47.0
04/26/98	3.68	3145.58	0.00	33.0	52.5
04/27/98	3.68	3145.58	0.00	42.0	59.0
04/28/98	3.67	3145.59	0.13	45.0	57.0
04/29/98	3.67	3145.59	0.00	41.0	51.5
04/30/98	3.63	3145.63	0.10	36.0	53.5
05/01/98	3.57	3145.69	0.40	52.0	56.5
05/02/98	3.57	3145.69	0.03	44.0	57.0
05/03/98	3.59	3145.67	0.00	41.0	53.5
05/04/98	3.61	3145.65	0.13	45.0	56.5
05/05/98	3.63	3145.63	0.13	40.0	52.5
05/06/98	3.66	3145.60	0.00	38.0	52.5
05/07/98	3.67	3145.59	0.18	43.0	59.5
05/08/98	3.68	3145.58	0.38	45.0	59.0
05/09/98	3.72	3145.54	0.00	56.0	64.0
05/10/98	3.74	3145.52	0.00	56.0	65.0
05/11/98	3.71	3145.55	1.36	55.0	60.0
05/12/98	3.78	3145.48	0.00	40.0	55.0
05/13/98	3.84	3145.42	0.00	42.0	56.5
05/14/98	3.90	3145.36	0.00	47.0	63.5
05/15/98	3.95	3145.31	0.00	50.0	67.0
05/16/98	3.99	3145.27	0.00	54.0	69.5
05/17/98	4.03	3145.23	0.00	60.0	70.0
05/18/98	4.06	3145.20	0.00	45.0	62.5
05/19/98	4.10	3145.16	0.00	45.0	64.0
05/20/98	4.12	3145.14	0.00	53.0	70.5
05/21/98	4.02	3145.24	0.00	55.0	71.0
05/22/98	3.94	3145.32	0.09	58.0	71.5
05/23/98	3.93	3145.33	0.00	59.0	70.0
05/24/98	3.97	3145.29	0.00	59.0	72.0
05/25/98	4.09	3145.17	0.00	54.0	70.0
05/26/98	4.23	3145.03	0.01	56.0	71.5
05/27/98	4.31	3144.95	0.00	62.0	74.0
05/28/98	4.37	3144.89	0.00	57.0	70.0
05/29/98	4.42	3144.84	0.00	59.0	72.0
05/30/98	4.46	3144.80	0.00	62.0	74.5
05/31/98	4.51	3144.75	0.00	55.0	69.0
06/01/98	4.55	3144.71	0.32	63.0	74.5
06/02/98	4.54	3144.72	0.95	53.0	69.0
06/03/98	4.57	3144.69	0.00	60.0	73.0
06/04/98	4.57	3144.69	0.00	69.0	78.5
06/05/98	4.28	3144.98	1.17	59.0	70.0
06/06/98	4.23	3145.03	1.15	58.0	70.5
06/07/98	4.31	3144.95	0.23	39.0	52.0
06/08/98	4.42	3144.84	0.00	39.0	52.0
06/09/98	4.51	3144.75	0.00	40.0	56.0
06/10/98	4.56	3144.70	0.40	56.0	63.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
06/11/98	4.55	3144.71	0.35	57.0	69.0
06/12/98	4.64	3144.62	0.00	60.0	72.5
06/13/98	4.74	3144.52	0.00	66.0	75.5
06/14/98	4.80	3144.46	0.00	53.0	68.0
06/15/98	4.83	3144.43	0.26	61.0	70.5
06/16/98	4.89	3144.37	0.00	67.0	75.0
06/17/98	4.92	3144.34	0.33	51.0	65.5
06/18/98	4.96	3144.30	0.00	50.0	65.0
06/19/98	4.98	3144.28	0.00	56.0	71.5
06/20/98	5.00	3144.26	0.15	51.0	63.5
06/21/98	5.05	3144.21	0.00	55.0	69.5
06/22/98	5.06	3144.20	0.15	59.0	71.5
06/23/98	5.00	3144.26	0.90	57.0	71.5
06/24/98	5.03	3144.23	0.00	60.0	74.0
06/25/98	5.08	3144.18	0.15	56.0	72.0
06/26/98	5.12	3144.14	0.00	60.0	75.5
06/27/98	5.16	3144.10	0.00	60.0	75.0
06/28/98	5.19	3144.07	0.00	60.0	74.0
06/29/98	5.21	3144.05	0.00	62.0	76.0
06/30/98	5.24	3144.02	0.00	66.0	76.0
07/01/98	5.25	3144.01	0.03	57.0	72.0
07/02/98	5.27	3143.99	0.00	55.0	67.5
07/03/98	5.31	3143.95	0.00	55.0	69.5
07/04/98	5.33	3143.93	0.00	57.0	70.5
07/05/98	5.33	3143.93	0.43	61.0	73.0
07/06/98	5.37	3143.89	0.00	61.0	73.0
07/07/98	5.38	3143.88	0.06	59.0	72.0
07/08/98	5.39	3143.87	0.00	62.0	74.0
07/09/98	5.41	3143.85	0.18	63.0	73.0
07/10/98	5.44	3143.82	0.03	64.0	75.0
07/11/98	5.45	3143.81	0.00	57.0	70.0
07/12/98	5.45	3143.81	0.00	57.0	69.5
07/13/98	5.48	3143.78	0.00	61.0	71.5
07/14/98	5.50	3143.76	0.00	62.0	73.5
07/15/98	5.52	3143.74	0.00	55.0	66.0
07/16/98	5.51	3143.75	0.00	60.0	73.0
07/17/98	5.50	3143.76	0.00	65.0	75.5
07/18/98	5.54	3143.72	0.00	58.0	71.0
07/19/98	5.55	3143.71	0.00	56.0	71.0
07/20/98	5.57	3143.69	0.36	59.0	74.0
07/21/98	5.58	3143.68	0.00	58.0	73.5
07/22/98	5.56	3143.70	0.00	60.0	75.0
07/23/98	5.58	3143.68	0.05	64.0	76.0
07/24/98	5.60	3143.66	0.03	60.0	72.5
07/25/98	5.61	3143.65	0.00	63.0	73.0
07/26/98	5.61	3143.65	0.04	58.0	69.5
07/27/98	5.63	3143.63	0.00	62.0	72.0
07/28/98	5.65	3143.61	0.18	64.0	69.5
07/29/98	5.69	3143.57	0.03	58.0	71.5
07/30/98	5.71	3143.55	0.00	58.0	72.0
07/31/98	5.73	3143.53	0.00	60.0	72.5
08/01/98	5.75	3143.51	0.00	62.0	71.0

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
08/02/98	5.78	3143.48	0.00	51.0	66.0
08/03/98	5.80	3143.46	0.00	46.0	63.0
08/04/98	5.82	3143.44	0.00	44.0	63.0
08/05/98	5.84	3143.42	0.00	50.0	67.5
08/06/98	5.86	3143.40	0.00	50.0	65.5
08/07/98	5.88	3143.38	0.00	52.0	69.5
08/08/98	5.89	3143.37	0.09	53.0	68.0
08/09/98	5.90	3143.36	0.00	60.0	73.0
08/10/98	5.91	3143.35	0.10	63.0	74.0
08/11/98	5.92	3143.34	0.02	57.0	70.0
08/12/98	5.94	3143.32	0.00	57.0	70.5
08/13/98	5.95	3143.31	0.00	55.0	71.0
08/14/98	5.95	3143.31	0.00	59.0	72.0
08/15/98	5.92	3143.34	0.00	60.0	70.0
08/16/98	5.87	3143.39	0.95	64.0	73.0
08/17/98	5.88	3143.38	0.00	65.0	74.0
08/18/98	5.91	3143.35	0.00	57.0	70.5
08/19/98	5.93	3143.33	0.00	59.0	72.0
08/20/98	5.96	3143.30	0.00	59.0	72.0
08/21/98	5.99	3143.27	0.00	53.0	69.5
08/22/98	6.02	3143.24	0.00	54.0	70.5
08/23/98	6.04	3143.22	0.00	56.0	72.5
08/24/98	6.06	3143.20	0.27	60.0	76.5
08/25/98	6.08	3143.18	0.00	60.0	75.0
08/26/98	6.11	3143.15	0.00	59.0	75.5
08/27/98	6.13	3143.13	0.00	58.0	73.5
08/28/98	6.15	3143.11	0.00	57.0	72.5
08/29/98	6.17	3143.09	0.00	56.0	73.0
08/30/98	6.18	3143.08	0.00	58.0	73.5
08/31/98	6.19	3143.07	0.00	56.0	73.0
09/01/98	6.22	3143.04	0.00	52.0	69.0
09/02/98	6.22	3143.04	0.00	50.0	67.5
09/03/98	6.22	3143.04	0.00	54.0	70.5
09/04/98	6.23	3143.03	0.00	55.0	67.5
09/05/98	6.28	3142.98	0.00	53.0	69.5
09/06/98	6.29	3142.97	0.00	54.0	72.0
09/07/98	6.30	3142.96	0.00	53.0	70.5
09/08/98	6.32	3142.94	0.00	57.0	73.5
09/09/98	6.33	3142.93	0.24	38.0	56.5
09/10/98	6.34	3142.92	0.00	34.0	54.5
09/11/98	6.33	3142.93	0.00	36.0	57.0
09/12/98	6.34	3142.92	0.00	39.0	62.0
09/13/98	6.36	3142.90	0.00	48.0	69.0
09/14/98	6.37	3142.89	0.00	48.0	70.0
09/15/98	6.37	3142.89	0.00	49.0	70.0
09/16/98	6.37	3142.89	0.00	52.0	71.0
09/17/98	6.37	3142.89	0.00	57.0	72.0
09/18/98	6.39	3142.87	0.00	55.0	71.0
09/19/98	6.41	3142.85	0.00	57.0	71.0
09/20/98	6.42	3142.84	0.00	55.0	69.5
09/21/98	6.40	3142.86	0.10	58.0	71.5
09/22/98	6.33	3142.93	0.43	59.0	68.5

Date	Depth (ft.) †	Elev. (ft.)	Precip. (in.) *	Min. Temp. (F)*	Mean Temp. (F)*
09/23/98	6.35	3142.91	0.00	59.0	71.5
09/24/98	6.38	3142.88	0.00	56.0	67.0
09/25/98	6.40	3142.86	0.00	50.0	64.5
09/26/98	6.42	3142.84	0.00	51.0	67.0
09/27/98	6.44	3142.82	0.00	47.0	67.0
09/28/98	6.45	3142.81	0.00	48.0	68.0
09/29/98	6.41	3142.85	0.90	60.0	74.0
09/30/98	6.36	3142.90	0.32	60.0	67.5

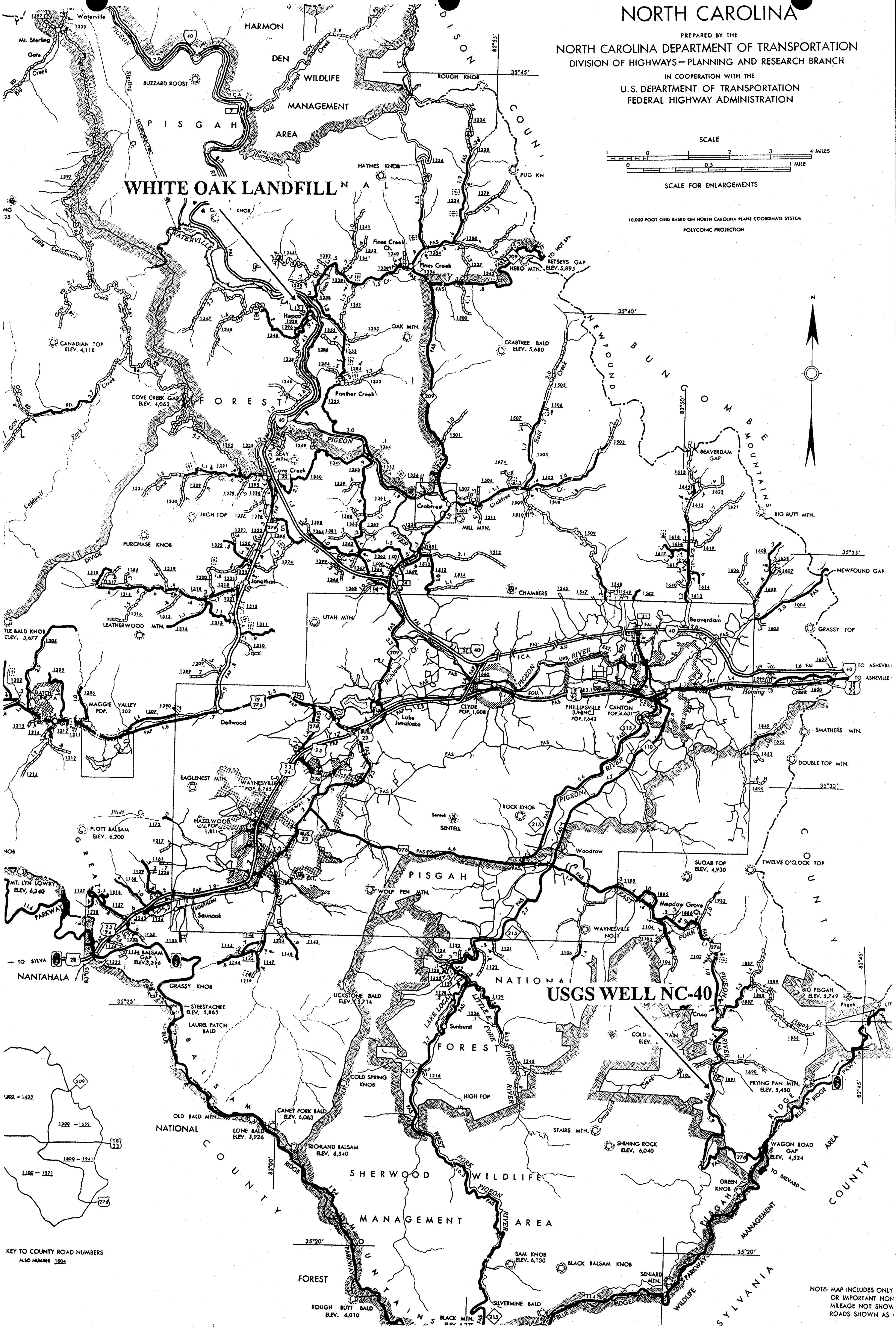
* The precipitation, minimum temperature and mean temperature were provided by the State Climate Office of North Carolina at NC State University.

† The data was imported from USGS Water Resources Data 1995–1998.

HAYWOOD COUNTY

NORTH CAROLINA

PREPARED BY THE
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS—PLANNING AND RESEARCH BRANCH
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION



HAYWOOD COUNTY

352315082484401. Local number, NC-40.

LOCATION.--Lat 35°23'15", long 82°48'44", Hydrologic Unit 06010106, 2 mi south of Cruso on U.S. Highway 276 at Camp Hope. Owner: Champion International Corporation.

AQUIFER.--Unconfined saprolite derived from muscovite-biotite gneiss of Precambrian age.

WELL CHARACTERISTICS.--Dug observation well, depth 18.5 ft, diameter 12 in., cased to 18.5 ft, open end, backfilled with gravel from 4 to 18.5 ft.

INSTRUMENTATION.--Digital recorder with a 60-minute punch interval.

DATUM.--Land-surface datum is 3,148.26 ft above sea level. Measuring point: Top of casing, 1.00 ft above land-surface datum.

REMARKS.--Well is part of climatic-effects network.

PERIOD OF RECORD.--December 1955 to current year.

EXTREMES FOR PERIOD OF RECORD.--Highest water level recorded, 1.24 ft below land-surface datum, Mar. 12, 1977; lowest water level recorded, 6.90 ft below land-surface datum, Oct. 7, 8, and 9, 1986.

WATER LEVEL, IN FEET BELOW LAND SURFACE DATUM, WATER YEAR OCTOBER 1994 TO SEPTEMBER 1995

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5.88	5.65	5.42	5.44	3.30	4.00	4.19	4.89	5.18	5.50	5.93	5.36
2	5.94	5.67	5.48	5.43	3.35	4.07	4.22	4.82	4.58	5.53	5.94	5.47
3	5.95	5.68	5.53	5.43	3.40	4.15	4.25	4.86	4.74	5.57	5.96	5.58
4	5.93	5.69	5.44	5.44	3.43	4.20	4.27	4.89	4.94	5.59	5.91	5.67
5	5.94	5.69	4.90	5.44	3.49	4.24	4.30	4.93	5.05	5.62	5.88	5.72
6	5.96	5.70	5.06	5.38	3.55	4.25	4.32	4.96	5.13	5.65	5.89	5.76
7	5.97	5.71	5.18	4.99	3.61	4.27	4.35	4.98	5.21	5.67	5.84	5.79
8	5.95	5.72	5.29	5.09	3.67	3.69	4.38	5.01	5.28	5.70	5.63	5.82
9	5.97	5.72	5.36	5.15	3.74	3.71	4.40	5.03	5.33	5.73	5.64	5.85
10	5.89	5.72	5.39	5.21	3.78	3.89	4.43	5.02	5.36	5.74	5.71	5.87
11	5.82	5.68	5.32	5.25	3.83	3.97	4.46	5.04	5.39	5.74	5.78	5.86
12	5.77	5.68	5.34	5.25	3.90	4.02	4.43	5.07	5.36	5.77	5.85	5.79
13	4.80	5.68	5.38	5.26	3.96	4.04	4.45	5.09	5.34	5.78	5.90	5.80
14	4.40	5.70	5.42	3.60	4.02	4.05	4.49	5.09	5.38	5.80	5.93	5.82
15	4.61	5.71	5.45	2.81	4.04	4.05	4.53	5.09	5.42	5.81	5.96	5.83
16	4.88	5.71	5.48	3.41	3.36	4.05	4.56	5.12	5.45	5.81	6.00	5.83
17	5.06	5.72	5.49	3.72	3.43	4.04	4.59	5.16	5.48	5.81	6.03	5.82
18	5.19	5.73	5.50	3.89	3.69	4.03	4.62	5.19	5.51	5.81	6.05	5.83
19	5.30	5.74	5.52	3.83	3.82	4.03	4.64	5.19	5.51	5.83	6.06	5.84
20	5.38	5.75	5.53	3.54	3.92	4.02	4.67	5.20	5.51	5.84	6.07	5.86
21	5.43	5.59	5.54	3.56	4.00	4.00	4.68	5.22	5.53	5.86	6.08	5.88
22	5.47	5.50	5.51	3.46	4.08	4.00	4.70	5.24	5.52	5.86	6.10	5.89
23	5.52	5.52	5.38	3.33	4.13	4.00	4.71	5.26	5.53	5.88	6.12	5.88
24	5.54	5.55	5.35	3.25	4.18	4.02	4.72	5.28	5.53	5.90	6.12	5.88
25	5.56	5.58	5.37	3.20	4.22	4.04	4.75	5.30	5.52	5.92	6.11	5.89
26	5.58	5.62	5.39	3.17	4.26	4.05	4.78	5.31	5.51	5.94	5.14	5.91
27	5.60	5.63	5.42	3.16	4.27	4.06	4.80	5.30	5.52	5.94	3.20	5.92
28	5.62	5.36	5.43	3.15	4.14	4.08	4.83	5.24	5.54	5.90	4.08	5.94
29	5.64	5.27	5.45	3.17	---	4.11	4.85	5.24	5.55	5.90	4.70	5.96
30	5.65	5.35	5.46	3.20	---	4.14	4.88	5.27	5.51	5.92	5.02	5.98
31	5.65	---	5.46	3.25	---	4.16	---	5.31	---	5.95	5.22	---

WTR YR 1995 MEAN 5.08 HIGH 2.81 LOW 6.12

HAYWOOD COUNTY

352315082484401. Local number, NC-40.

LOCATION.--Lat 35°23'15", long 82°48'44", Hydrologic Unit 06010106, 2 mi south of Cruso on U.S. Highway 276 at Camp Hope. Owner: Champion International Corporation.

AQUIFER.--Unconfined saprolite derived from muscovite-biotite gneiss of Precambrian age.

WELL CHARACTERISTICS.--Dug observation well, depth 18.5 ft, diameter 12 in., cased to 18.5 ft, open end, backfilled with gravel from 4 to 18.5 ft.

INSTRUMENTATION.--Digital recorder with a 60-minute punch interval.

DATUM.--Land-surface datum is 3,148.26 ft above sea level. Measuring point: Top of casing, 1.00 ft above land-surface datum.

REMARKS.--Well is part of climatic-effects network.

PERIOD OF RECORD.--December 1955 to current year.

EXTREMES FOR PERIOD OF RECORD.--Highest water level recorded, 1.24 ft below land-surface datum, Mar. 12, 1977; lowest water level recorded, 6.90 ft below land-surface datum, Oct. 7, 8, and 9, 1986.

WATER LEVEL, IN FEET BELOW LAND SURFACE DATUM, WATER YEAR OCTOBER 1995 TO SEPTEMBER 1996

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	6.00	4.57	4.84	5.10	3.32	3.83	4.25	4.62	5.21	5.64	5.90	6.08
2	6.01	4.52	4.86	5.08	2.74	3.86	4.28	4.66	5.23	5.66	5.92	6.10
3	6.01	4.49	4.87	5.06	2.72	3.91	4.30	4.70	5.25	5.67	5.94	5.88
4	4.79	4.53	4.88	5.07	2.84	3.96	4.31	4.73	5.28	5.69	5.96	4.98
5	2.48	4.56	4.89	5.09	2.87	3.99	4.33	4.76	5.30	5.71	5.95	4.84
6	3.60	4.58	4.90	5.10	2.88	3.86	4.34	4.78	5.32	5.72	5.95	5.09
7	4.17	4.43	4.90	5.10	2.90	3.85	4.36	4.78	5.33	5.74	5.96	5.31
8	4.49	4.34	4.91	5.12	2.88	3.90	4.37	4.81	5.30	5.74	5.99	5.45
9	4.70	4.45	4.76	5.13	2.87	3.99	4.38	4.83	4.61	5.75	6.01	5.56
10	4.83	4.53	4.77	5.14	2.93	4.05	4.40	4.85	4.74	5.76	6.02	5.65
11	4.92	3.96	4.81	5.15	2.96	4.09	4.41	4.87	4.87	5.76	6.01	5.75
12	4.97	3.92	4.85	5.15	3.01	4.12	4.42	4.89	4.96	5.75	5.56	5.84
13	4.98	4.14	4.88	5.17	3.06	4.15	4.43	4.91	5.05	5.76	5.52	5.90
14	4.91	4.27	4.90	5.18	3.09	4.18	4.45	4.93	5.13	5.77	5.60	5.96
15	4.82	4.39	4.93	5.19	3.14	4.19	4.46	4.96	5.21	5.73	5.69	6.02
16	4.82	4.48	4.94	5.19	3.19	4.19	4.48	4.97	5.27	5.72	5.77	6.04
17	4.82	4.56	4.96	5.13	3.25	4.19	4.50	4.99	5.30	5.75	5.83	5.95
18	4.80	4.61	4.97	3.87	3.31	4.21	4.52	5.01	5.32	5.78	5.87	5.94
19	4.78	4.65	4.82	3.03	3.36	3.92	4.53	5.04	5.35	5.81	5.91	5.94
20	4.75	4.68	4.78	3.82	3.14	4.00	4.54	5.06	5.37	5.84	5.88	5.96
21	4.72	4.70	4.84	4.16	3.29	4.10	4.55	5.08	5.41	5.85	5.90	5.99
22	4.70	4.73	4.89	4.34	3.39	4.16	4.57	5.11	5.45	5.83	5.93	6.01
23	4.68	4.75	4.92	4.46	3.46	4.20	4.58	5.13	5.48	5.84	5.97	6.06
24	4.65	4.77	4.95	4.37	3.53	4.24	4.61	5.14	5.51	5.86	5.98	6.07
25	4.62	4.78	4.98	4.37	3.60	4.25	4.63	5.13	5.53	5.88	5.99	6.09
26	4.59	4.80	5.00	4.12	3.64	4.27	4.61	5.13	5.55	5.87	6.00	6.11
27	4.57	4.80	5.03	2.78	3.69	4.29	4.62	5.10	5.56	5.90	6.00	6.12
28	4.55	4.82	5.06	3.41	3.73	4.13	4.65	5.11	5.58	5.91	5.96	4.69
29	4.55	4.82	5.08	3.54	3.78	4.12	4.67	5.13	5.60	5.91	5.95	4.55
30	4.56	4.83	5.09	3.53	---	4.19	4.61	5.15	5.62	5.93	5.98	5.00
31	4.56	---	5.09	3.43	---	4.22	---	5.17	---	5.91	6.02	---

WTR YR 1996 MEAN 4.85 HIGH 2.48L OW 6.12

HAYWOOD COUNTY

352315082484401. Local number, NC-40.

LOCATION.--Lat 35°23'15", long 82°48'44", Hydrologic Unit 06010106, 2 mi south of Cruso on U.S. Highway 276 at Camp Hope. Owner: Champion International Corporation.

AQUIFER.--Unconfined saprolite derived from muscovite-biotite gneiss of Precambrian age.

WELL CHARACTERISTICS.--Dug observation well, depth 18.5 ft, diameter 12 in., cased to 18.5 ft, open end, backfilled with gravel from 4 to 18.5 ft.

INSTRUMENTATION.--Digital recorder with a 60-minute punch interval. Digital recorder replaced with electronic data logger on July 14, 1997.

DATUM.--Land-surface datum is 3,148.26 ft above sea level. Measuring point: Top of casing, 1.00 ft above land-surface datum.

REMARKS.--Well is part of climatic-effects network.

PERIOD OF RECORD.--December 1955 to current year.

EXTREMES FOR PERIOD OF RECORD.--Highest water level recorded, 1.24 ft below land-surface datum, Mar. 12, 1977; lowest water level recorded, 6.90 ft below land-surface datum, Oct. 7, 8, and 9, 1986.

WATER LEVEL, IN FEET BELOW LAND SURFACE DATUM, WATER YEAR OCTOBER 1996 TO SEPTEMBER 1997

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5.18	6.04	3.35	4.37	4.38	3.66	3.31	4.03	4.08	4.91	5.34	5.74
2	5.30	6.02	3.71	4.41	4.40	3.75	3.37	4.08	4.19	4.95	5.37	5.69
3	5.38	6.01	4.17	4.46	4.41	3.56	3.42	3.92	4.20	5.00	5.40	5.53
4	5.46	6.02	4.41	4.50	4.30	3.62	3.47	3.95	4.19	5.05	5.42	5.58
5	5.54	6.02	4.56	4.43	4.08	3.70	3.51	4.03	4.31	5.07	5.44	5.66
6	5.61	6.03	4.63	4.43	4.14	3.70	3.46	4.07	4.41	5.09	5.44	5.71
7	5.67	5.98	4.67	4.49	4.19	3.73	3.50	4.11	4.48	5.12	5.45	5.75
8	5.72	3.44	4.70	4.54	4.11	3.74	3.58	4.12	4.53	5.13	5.45	5.77
9	5.77	4.24	4.70	4.15	4.10	3.74	3.64	4.14	4.58	5.13	5.47	5.77
10	5.81	4.69	4.67	4.15	4.14	3.73	3.70	4.16	4.64	5.14	5.47	5.73
11	5.84	4.95	4.62	4.33	4.16	3.72	3.75	4.17	4.69	5.13	5.48	5.71
12	5.87	5.14	4.54	4.44	4.17	3.71	3.56	4.18	4.71	5.15	5.51	5.72
13	5.89	5.28	4.36	4.51	4.17	3.58	3.64	4.19	4.73	5.16	5.53	5.73
14	5.92	5.37	4.28	4.56	4.16	2.71	3.75	4.20	4.67	5.17	5.55	5.76
15	5.94	5.44	4.23	4.59	3.97	3.10	3.81	4.22	4.57	5.19	5.57	5.78
16	5.95	5.48	4.17	4.34	3.98	3.20	3.85	4.24	4.66	5.13	5.59	5.81
17	5.97	5.52	4.09	4.42	4.02	3.24	3.89	4.25	4.72	4.98	5.61	5.83
18	5.98	5.53	4.04	4.50	4.04	3.26	3.93	4.27	4.77	5.06	5.62	5.87
19	5.99	5.54	4.03	4.56	4.06	3.04	3.95	4.29	4.83	5.12	5.63	5.90
20	6.00	5.54	4.06	4.61	4.08	3.03	3.99	4.31	4.85	5.15	5.65	5.92
21	6.02	5.55	4.09	4.64	3.96	3.06	4.01	4.34	4.87	5.17	5.66	5.92
22	6.02	5.55	4.13	4.65	3.83	3.07	4.00	4.36	4.89	5.22	5.67	5.94
23	6.03	5.56	4.16	4.66	3.94	3.09	3.86	4.39	4.93	5.19	5.68	5.94
24	6.03	5.56	4.19	4.45	3.98	3.11	3.93	4.41	4.94	5.05	5.69	5.73
25	6.04	5.55	4.22	4.12	4.01	3.12	3.99	4.43	4.77	5.12	5.71	5.38
26	6.04	5.22	4.24	4.27	4.02	3.11	4.04	4.46	4.65	5.19	5.72	5.40
27	6.04	5.28	4.27	4.36	4.02	3.14	4.06	4.49	4.71	5.23	5.73	5.50
28	6.03	5.33	4.30	4.22	3.67	3.16	3.98	4.48	4.75	5.25	5.74	5.32
29	6.03	5.38	4.27	4.24	---	3.18	3.90	4.50	4.82	5.28	5.76	4.99
30	6.04	5.29	4.27	4.31	---	3.23	3.98	4.52	4.88	5.29	5.77	5.28
31	6.04	---	4.32	4.35	---	3.26	---	4.54	---	5.31	5.78	---

WTR YR 1997 MEAN 4.71 HIGH 2.71 LOW 6.04

HAYWOOD COUNTY

352315082484401. Local number, NC-40.

LOCATION.--Lat 35°23'15", long 82°48'44", Hydrologic Unit 06010106, 2 mi south of Cruso on U.S. Highway 276 at Camp Hope. Owner: Champion International Corporation.

AQUIFER.--Unconfined saprolite derived from muscovite-biotite gneiss of Precambrian age.

WELL CHARACTERISTICS.--Dug observation well, depth 18.5 ft, diameter 12 in., cased to 18.5 ft, open end, backfilled with gravel from 4 to 18.5 ft.

INSTRUMENTATION.--Digital recorder with a 60-minute punch interval. Digital recorder replaced with electronic data logger on July 14, 1997.

DATUM.--Land-surface datum is 3,148.26 ft above sea level. Measuring point: Top of casing, 1.00 ft above land-surface datum.

REMARKS.--Well is part of climatic-effects network.

PERIOD OF RECORD.--December 1955 to current year.

EXTREMES FOR PERIOD OF RECORD.--Highest water level recorded, 1.24 ft below land-surface datum, Mar. 12, 1977; lowest water level recorded, 6.90 ft below land-surface datum, Oct. 7, 8, and 9, 1986.

WATER LEVEL, IN FEET BELOW LAND SURFACE DATUM, WATER YEAR OCTOBER 1997 TO SEPTEMBER 1998

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5.43	5.67	6.08	5.96	4.31	2.85	3.62	3.57	4.55	5.25	5.75	6.22
2	5.52	5.72	6.07	5.99	4.25	2.91	3.66	3.57	4.54	5.27	5.78	6.22
3	5.60	5.76	6.06	6.02	3.19	2.99	3.65	3.59	4.57	5.31	5.80	6.22
4	5.69	5.80	6.00	6.06	2.55	3.06	3.59	3.61	4.57	5.33	5.82	6.23
5	5.77	5.84	5.96	6.08	2.97	3.14	3.68	3.63	4.28	5.33	5.84	6.28
6	5.81	5.88	5.95	5.94	3.07	3.21	3.73	3.66	4.23	5.37	5.86	6.29
7	5.84	5.91	5.98	3.81	3.03	3.27	3.75	3.67	4.31	5.38	5.88	6.30
8	5.88	5.93	6.00	2.65	2.96	2.98	3.78	3.68	4.42	5.39	5.89	6.32
9	5.90	5.95	6.03	3.62	2.87	2.70	3.71	3.72	4.51	5.41	5.90	6.33
10	5.92	5.97	6.04	4.13	2.82	3.02	3.74	3.74	4.56	5.44	5.91	6.34
11	5.94	5.97	6.03	4.45	2.66	3.16	3.81	3.71	4.55	5.45	5.92	6.33
12	5.95	5.98	6.03	4.67	2.65	3.27	3.86	3.78	4.64	5.45	5.94	6.34
13	5.98	5.98	6.04	4.84	2.74	3.34	3.90	3.84	4.74	5.48	5.95	6.36
14	6.00	5.96	6.05	4.96	2.81	3.40	3.93	3.90	4.80	5.50	5.95	6.37
15	6.02	5.95	6.07	4.86	2.88	3.44	3.96	3.95	4.83	5.52	5.92	6.37
16	6.03	5.95	6.08	4.68	2.51	3.47	3.98	3.99	4.89	5.51	5.87	6.37
17	6.04	5.95	6.09	4.69	2.13	3.50	3.60	4.03	4.92	5.50	5.88	6.37
18	6.04	5.97	6.11	4.83	2.39	3.42	3.78	4.06	4.96	5.54	5.91	6.39
19	5.93	5.99	6.12	4.89	2.51	3.31	3.50	4.10	4.98	5.55	5.93	6.41
20	5.89	6.00	6.13	4.93	2.56	3.16	3.46	4.12	5.00	5.57	5.96	6.42
21	5.89	6.01	6.14	4.95	2.59	3.23	3.64	4.02	5.05	5.58	5.99	6.40
22	5.90	6.02	6.11	4.86	2.61	3.35	3.60	3.94	5.06	5.56	6.02	6.33
23	5.92	6.03	6.06	4.30	2.44	3.42	3.57	3.93	5.00	5.58	6.04	6.35
24	5.93	6.05	5.92	4.46	2.54	3.47	3.63	3.97	5.03	5.60	6.06	6.38
25	5.88	6.06	5.64	4.55	2.60	3.53	3.66	4.09	5.08	5.61	6.08	6.40
26	5.22	6.06	5.68	4.58	2.67	3.56	3.68	4.23	5.12	5.61	6.11	6.42
27	4.97	6.07	5.73	4.55	2.68	3.58	3.68	4.31	5.16	5.63	6.13	6.44
28	5.23	6.07	5.77	4.51	2.77	3.60	3.67	4.37	5.19	5.65	6.15	6.45
29	5.39	6.08	5.81	4.48	---	3.62	3.67	4.42	5.21	5.69	6.17	6.41
30	5.50	6.08	5.86	4.42	---	3.64	3.63	4.46	5.24	5.71	6.18	6.36
31	5.59	---	5.91	4.36	---	3.66	---	4.51	---	5.73	6.19	---

WTR YR 1998 MEAN 4.92 HIGH 2.13 LOW 6.45

Municipal Services
Garner, N.C.

Engineering Company, P.A.
Boone, N.C.

Ground and Surface Water Sampling and Analysis Plan

inclusion for

Haywood County White Oak Landfill, Phase 2

Haywood County
North Carolina

G98010.6

CONTENTS

LIST OF TABLE AND PLATES

1 GROUND AND SURFACE WATER SAMPLING AND ANALYSIS PLAN

The objective of the ground and surface water Sampling and Analysis Plan is to provide clear guidelines and procedures to be followed by field and laboratory personnel when obtaining and testing ground and surface water samples. Monitoring wells and surface water will be sampled prior to acceptance of waste to provide background information on water quality.

Four independent sampling events will be placed within six months after the date the Permit to Construct is issued with at least one sampling event occurring prior to issuance of the Permit to Operate. Monitoring wells, surface water locations, and the leachate lagoon will be sampled semi-annually thereafter for the Appendix I list of constituents. In addition to the Appendix I list of constituents, the leachate lagoon will be sampled semi-annually for biochemical oxygen demand, chemical oxygen demand, nitrate, nitrite, sulfate, total phosphorus, and pH.

1.1 Water Quality Monitoring Summary

The locations for three monitoring wells (GWM-12, and GWM-13S/D), one surface water monitoring point (SW-5), and 26 piezometers (P-1, P-2, P-3, P-4, P-5, P-6, P-7, P-9, P-11, P-14, P-15, P-16, P-17, P-18, P-19, P1-3, P-1S, P-2S/D, P-3S/D, P-4S, P-6S/D, and PZ-1S/D) are shown on Plate A. The three monitoring wells GWM-12, GWM-13S and GWM-13D are located immediately to the north of the Phase 2 area, which is hydraulically downgradient. The surface water monitoring point SW-5 is located to the north of the Phase 4 site in the vicinity of the wetland area.

These monitoring locations (three monitoring wells and one surface water location) are to be sampled in conjunction with monitoring wells and surface water monitoring points for the Phase 1 portion of the existing landfill. Upon sampling, depths to groundwater are to be measured in the aforementioned piezometers located throughout the property. These piezometers are for the sole purpose of measuring groundwater depths, and are not to be sampled.

The goal of the sampling plan is to obtain the desired sample while neither adding nor subtracting any constituent to or from the sample or the monitoring well. The plan details described below, when followed, are considered adequate to eliminate any cross-contamination or contamination from external sources of the wells sampled. These guidelines are drawn, in part, directly from and are intended to be used in conjunction with the N.C. Water Quality Monitoring Guidance Document for Solid Waste Facilities (Guidance Document); a copy is included at the end of the Sampling and Analysis Plan.

Sampling procedures will be completed by guidelines set forth in the Water Quality Monitoring Plan.

1.2 Sampling Equipment

Groundwater samples will be obtained in the field using a laboratory-cleaned, stainless steel bailer. Each bailer will be cleaned in a laboratory controlled environment prior to sampling in accordance with the following steps.

1. Completely disassemble bailer.
2. Phosphate-free, laboratory grade soap and organic-free, distilled water wash.
3. Organic-free, deionized water rinse.
4. Isopropyl alcohol rinse.
5. Organic-free, deionized water rinse.
6. Air dry.
7. Wrap bailer in aluminum foil, shiny side out.
8. Wrap bailer in plastic.

In addition to a laboratory cleaned bailer for each well sampled, standard equipment necessary to conduct the sampling include: sample containers (including trip blanks and equipment blanks), a wide-mouth container, at least two 600-ft spools of -inch nylon rope, at least two boxes of latex gloves, one box of large plastic bags, temperature indicator, pH indicator, conductivity indicator, water level indicator, storage coolers, and ice. In case of emergency, supplies to clean bailers as described above may also be brought to the site. If the total depth of all wells to be sampled exceeds 1200 feet, additional spools of rope will be obtained to complete the sampling. If the number of wells to be sampled exceeds one third of the number of pairs of gloves in stock, additional boxes of gloves will be obtained. The bailers, wrapped in foil and plastic, will be transported between pieces of peaked foam rubber to prevent damage to the wrappings. Other equipment subject to damage and contamination will be transported in sealed, plastic bags. The water level indicator will be cleaned in accordance with Steps 2 and 3 described above prior to placement in a clean plastic bag.

1.3 Sample Containers

Ground and surface water monitoring will include organic and inorganic analyses as described in more detail below. Samples will be collected for the various analyses in the containers described below in the order listed.

1. Each sample container will be labeled providing the following information: site name and county location, well identification number, parameters to be analyzed, preservative added, date and time of sampling, and initials of the sampler.

2. Samples to be analyzed for organic content will be collected in four 40-ml glass vials with Teflon caps. The sample vials will be completely filled with no air left in the vials.

3. Samples to be analyzed for inorganic contamination will be collected next in a -quart/1-liter polyethylene container.

All sample containers will be obtained from an independent laboratory in a sterilized condition. Some of the containers will have a pre-measured amount of preservative in them as necessary. In this event, care will be taken not to rinse the container or allow the preservative to wash out during sampling.

1.4 Groundwater Sampling

Wells will be sampled from upgradient to downgradient or, when previous analytical data is available, from least contaminated to the most contaminated.

Preparation A clean sheet of plastic should be placed around the well to provide a clean surface for sampling equipment. The depth to water will be determined using the water level indicator. Before storage and/or reuse, the water level indicator will be cleaned in accordance with Steps 2 and 3 described above and replaced in a clean plastic bag.

The total well depth read from the well tag and the measured depth to water will be used to compute the depth of water in the well. The total well depth will be measured and compared to the depth indicated on the well tag as a check for siltation or blockage at depth. Using the chart on Plate C, the volume of water in the well will be determined. For example, if a two-inch well is 29 feet deep and has a measured depth to water of 10 feet, there are 19 feet of standing water or 3.3 gallons in the well. Each well will be purged three to five well volumes (quantity of water in the well), or until dry, prior to sampling. In the example, 10 gallons would be adequate. Purged water will be measured in 5-gallon buckets until the required amount is purged. Care will be taken not to bring the bailer into contact with the bucket during purging.

The EPA recommends that in addition to wells being purged a minimum of three (3) well volumes, the indicator parameters for temperature, specific conductance, and pH must have stabilized. The indicator parameters of pH, specific conductance, and temperature will be measured on purged and recovered monitoring wells before collecting samples. When three consecutive measurements are within 10%, temperature and specific conductance are considered stable and when three consecutive measurements are within 0.2 units, pH is considered stable.

All of the above information will be recorded on a field data sheet or a field log book and copies submitted to the Division of Waste Management with the analytical results.

All meters will be calibrated immediately prior to purging and sampling and those readings recorded in a field logbook. The meters should be recalibrated at the end of each sampling event and those readings recorded in the log also. Entries will always include pre- and post-calibration readings as well as the model and serial number of the equipment and the date, time, and person performing the calibration(s). Two standards which bracket the average or suspected measurements for pH and specific conductance will be used at the site.

Based on the number of wells to be sampled and their proximity to each other, all the wells may be purged one after another with sampling to follow. In this manner, if a well is purged dry, it may be allowed to recharge prior to sampling.

Purging After the amount of water to be purged from a well is determined, the equipment necessary for purging will be assembled at the well including rope, 5-gallon bucket, bailer, and gloves. With the wrapped bailer maintained in a stable, upright position, the top portion of aluminum foil will be pulled away exposing only the eyelet used for securing the rope to the bailer. After the rope has been secured to the bailer with gloved hands, the bailer will be suspended as the aluminum foil and plastic are removed. The gloved hand used to remove the aluminum foil and plastic will be considered contaminated and may not come into contact with the bailer or rope. The bailer will be lowered slowly into the well using the uncontaminated gloved hand that suspended the bailer, until the bailer contacts the bottom of the well. The rope will be cut to an adequate length and secured to prevent losing the bailer in the well. The gloves will be discarded and a new pair used during the purging.

In order not to allow the rope to touch the ground during purging, the rope will be gathered when raising the bailer either by gathering in loops in one hand or by the wind mill method. The wind mill method requires hooking the rope with alternating thumbs as the rope is pulled from the well. When purging deep wells (in excess of 40 feet), the ground around the well head may be covered with a clean plastic bag or sheet of plastic with a slit cut to allow the plastic to slide over the well head. This will be a separate sheet of plastic from the one used for the sampling equipment. The plastic will be placed over the sampler's boots to allow the rope to fall onto the plastic without contamination. Alternatively, the rope may be lowered into an open bag placed in a 5-gallon bucket beside the well head. In any case, the rope will not contact anything considered contaminated including ground, boots, dirtied plastic, etc.

If purging and sampling of a well is performed at separate times, the bailer will be left suspended in the well above the water table and the rope secured. The remaining rope will be doubled and grasped in a tight loop in one hand. With the free hand, the glove on the hand holding the rope will be removed by pulling it away from the hand and over the rope in an inside-out position until rope is encased in the glove. The rope will be transferred to the opposite hand and the procedure repeated to cover any portion of rope remaining uncovered. The glove-encased rope will be set on top of the well head until time to sample. Alternatively, the rope remaining after securing may be gathered in a tight loop and pushed into the 2-inch PVC well pipe and left. Even when sampling immediately follows purging, new gloves will be necessary.

Equipment Blank Prior to sampling the wells, when using non-disposable bailers, an equipment blank will be prepared using a representative bailer. This procedure entails removing the top and bottom portions of the aluminum foil while sustaining the bailer in one hand, removing the lid of the bailer, filling the bailer with distilled water, and replacing the lid. The distilled water is then dispensed through the holes at the bottom of the bailer into the appropriately labeled equipment blank containers.

Sampling Prior to sampling the wells, the necessary equipment will be assembled at the wells, including sampling jars, pH, conductivity, and temperature indicators, a thoroughly cleansed wide mouthed container, and a box of latex gloves.

With gloves on, the bailer will be lowered into the well slowly. To avoid releasing any volatiles from the groundwater, care will be exercised while the bailer is lowered so that it does not splash or smack the water surface. Once full, the bailer will be retrieved and containers filled in the order described above. The containers will be filled by emptying the water through the hole at the bottom of the bailer. The VOCs will be topped off by collecting some of the groundwater in the cap and pouring it onto the samples contents to acquire the needed meniscus to eliminate air bubbles. The polyethylene containers will be filled and sealed with the cap, leaving an airspace at the top of about 1/2 inch. In addition to collecting the samples, water will be collected in the wide-mouth container for pH, temperature, and conductivity measurements. The pH, temperature, and conductivity indicators, and wide-mouth container will be rinsed with organic-free, deionized water after sampling each well and will be cleaned in accordance with Steps 2 and 3 described above at the completion of the project.

Following completion of the sampling, the containers placed in sealed plastic bags, including the equipment blank and trip blank, will be stored and transported on ice. The used latex gloves and rope will be discarded.

1.5 Surface Water Sampling

Surface water samples will be obtained from the location on Plate A. Actual sampling at the designated location for surface water samples will be done with consideration given to minimizing turbulence and aeration.

Surface water sample containers will be handled with gloves on, one hand near the base. When collecting surface water samples, sample containers will be dipped at location points with extreme caution in order to avoid contamination at the mouth of the container. The container will be pushed rapidly at an angle into the water, mouth up, and tilted towards the stream current to fill, so as not to lose any of the preservative into the surrounding water. If there is little current movement, the container will be moved slowly through the water laterally. During times of drought, if the water is not deep enough to allow filling of the container, a pool may be scooped out of the bottom of the stream to obtain a sample. The pool will be allowed to clear before sampling. Glass vial containers collected for organic analyses will be filled completely as described above. The VOCs will be topped off by collecting some of the surface water in the cap and pouring it onto the samples contents to acquire the needed meniscus to eliminate air bubbles. The polyethylene containers will be lifted from the water and sealed with the cap, leaving an airspace at the top of about inch. The samples will be sealed in plastic bags, stored and transported on ice. In addition to collecting the samples, water will be collected in the wide-mouth container for pH, temperature, and conductivity measurements. The pH, temperature, and conductivity indicators, and wide-mouth container will be rinsed with organic-free, deionized water after sampling.

1.6 Leachate Sampling

Leachate will be obtained from the inflow pipe at the lagoon on Plate A. Leachate sample containers will be handled with gloves on. When collecting leachate samples, sample containers will be handled with extreme caution in order to avoid contamination at the mouth of the container. Containers will be filled by holding them in the leachate flowing out of the pipe. The polyethylene containers will be sealed with the cap, leaving an airspace at the top of about 1/2 inch. Glass vial containers collected for organic analyses will be filled completely as described above. The VOCs will be topped off by collecting some of the leachate in the cap and pouring it onto the samples contents to acquire the needed meniscus to eliminate air bubbles. The samples will be sealed in plastic bags, stored and transported on ice.

1.7 Sample Transport and Chain-of-Custody

Sample containers will be clearly labeled as the samples are obtained and stored on ice along with the equipment blanks and trip blanks. Trip blanks will remain in the condition they are received from the laboratory and will not be opened or tampered with during the sampling. A chain-of-custody record will be completed for each day's samples, indicating the date and time, sample location, sample matrix (soil, water, etc.), and laboratory analyses to be conducted. In addition, a field sampling data sheet will be completed indicating the depth to water measured in each well sampled and the pH, temperature, and specific conductivity of the sample measured in the field.

1.8 Groundwater, Surface Water, and Leachate Analysis

Water samples obtained in the field will be maintained in the sample containers on ice and transported to an approved laboratory for analysis. If the individual transporting the samples is different from the individual that did the sampling, the chain of custody forms will be used to document the transfer of custody from the water sampler to the water transporter. When the water samples reach the laboratory, they will be transferred to a sample custodian who will sign the chain of custody documentation for receipt of the samples. Internal control of the water samples in the laboratory will be in accordance with QA/QC procedures for the laboratory. Copies of QA/QC manuals for approved laboratories are on file at the Division of Solid Waste.

Groundwater, surface water, and leachate samples will be analyzed for the list of chemical constituents in Table E-1. In addition, practical quantitation limits for each of the constituents and a list of the equipment that will be used in the laboratory testing are presented in Table 1. QA/QC procedures utilized during the testing will be in conformance with laboratory QA/QC manual. Leachate samples will also be analyzed for biochemical oxygen demand (BOD), chemical oxygen demand (COD), phosphate, nitrate, nitrite, sulfate, and pH.

Table E-1: Ground and Surface Water Analyses Methodology[1]

Constituent	CAS Number[2]	Test Method	Equipment	PQL (ug/l)[3]
Antimony	(Total)	EPA 7041[4]	GF/AA[5]	30
Arsenic	(Total)	EPA 7060	GF/AA	10
Barium	(Total)	EPA 6010	ICP[6]	20
Beryllium	(Total)	EPA 7091	GF/AA	2
Cadmium	(Total)	EPA 7131	GF/AA	1
Chromium	(Total)	EPA 7191	GF/AA	10
Cobalt	(Total)	EPA 7201	GF/AA	10
Copper	(Total)	EPA 6010	ICP	60
Lead	(Total)	EPA 7421	GF/AA	10
Nickel	(Total)	EPA 6010	ICP	150
Selenium	(Total)	EPA 7740	GF/AA	20
Silver	(Total)	EPA 7761	GF/AA	10
Thallium	(Total)	EPA 7841	GF/AA	10
Vanadium	(Total)	EPA 7911	GF/AA	40
Zinc	(Total)	EPA 6010	ICP	20
Acetone	67-64-1	EPA 8260	GC/MS[7]	100
Acrylonitrile	107-13-1	EPA 8260	GC/MS	200
Benzene	71-43-2	EPA 8260	GC/MS	5
Bromochloromethane	74-97-5	EPA 8260	GC/MS	5
Bromodichloromethane	75-27-4	EPA 8260	GC/MS	5
Bromoform	75-25-2	EPA 8260	GC/MS	5
Carbon disulfide	75-15-0	EPA 8260	GC/MS	100
Carbon tetrachloride	56-23-5	EPA 8260	GC/MS	10
Chlorobenzene	108-90-7	EPA 8260	GC/MS	5
Chloroethane	75-00-3	EPA 8260	GC/MS	10
Chloroform	67-66-3	EPA 8260	GC/MS	5
Dibromochloromethane	124-48-1	EPA 8260	GC/MS	5
1,2-Dibromo-3-chloropropane	96-12-8	EPA 8260	GC/MS	25
1,2-Dibromoethane	106-93-4	EPA 8260	GC/MS	5
1,2-Dichlorobenzene	95-50-1	EPA 8260	GC/MS	5
1,4-Dichlorobenzene	106-46-7	EPA 8260	GC/MS	5
trans-1,4-Dichloro-2-butene	110-57-6	EPA 8260	GC/MS	100
1,1-Dichloroethane	75-34-3	EPA 8260	GC/MS	5
1,2-Dichloroethane	107-06-2	EPA 8260	GC/MS	5
1,1-Dichloroethylene	75-35-4	EPA 8260	GC/MS	5
cis-1,2-Dichloroethylene	156-59-2	EPA 8260	GC/MS	5
trans-1,2-Dichloroethylene	156-60-5	EPA 8260	GC/MS	5
1,2-Dichloropropane	78-87-5	EPA 8260	GC/MS	5
cis-1,3-Dichloropropene	10061-01-5	EPA 8260	GC/MS	10
trans-1,3-Dichloropropene	10061-02-6	EPA 8260	GC/MS	10

(continued on next page)

(*continued from previous page*)

Constituent	CAS Number	Test Method	Equipment	PQL (ug/l)
Ethylbenzene	100-41-4	EPA 8260	GC/MS	5
2-Hexanone	591-78-6	EPA 8260	GC/MS	50
Methyl bromide	74-83-9	EPA 8260	GC/MS	10
Methyl chloride	74-87-3	EPA 8260	GC/MS	10
Methylene bromide	74-95-3	EPA 8260	GC/MS	10
Methylene chloride	75-09-2	EPA 8260	GC/MS	10
Methyl ethyl ketone	78-93-3	EPA 8260	GC/MS	100
Methyl iodide	74-88-4	EPA 8260	GC/MS	10
4-Methyl-2-pentanone	108-10-1	EPA 8260	GC/MS	100
Styrene	100-42-5	EPA 8260	GC/MS	10
1,1,1,2-Tetrachloroethane	630-20-6	EPA 8260	GC/MS	5
1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260	GC/MS	5
Tetrachloroethylene	127-18-4	EPA 8260	GC/MS	5
Toluene	108-88-3	EPA 8260	GC/MS	5
1,1,1-Trichloroethane	71-55-6	EPA 8260	GC/MS	5
1,1,2-Trichloroethane	79-00-5	EPA 8260	GC/MS	5
Trichloroethylene	79-01-6	EPA 8260	GC/MS	5
Trichlorofluoromethane	75-69-4	EPA 8260	GC/MS	5
1,2,3-Trichloropropane	96-18-4	EPA 8260	GC/MS	15
Vinyl acetate	108-05-4	EPA 8260	GC/MS	50
Vinyl chloride	75-01-4	EPA 8260	GC/MS	10
Xylenes	(Total)	EPA 8260	GC/MS	5

[1]Excerpted from "40 CFR Ch. I (7-1-98 edition), Part 258, App. II".
[2]Chemical Abstracts Service registry number. Where "Total" is entered, all species in the groundwater that contain this element are included.
[3]Practical Quantitation Limits (PQLs) are the lowest concentrations of analytes in ground waters that can be reliably determined within specified limits of precision and accuracy by the indicated methods under routine laboratory operating conditions.
[4]Suggested methods refer to analytical procedure numbers used in EPA Report SW-846 "Test Methods for Evaluating Solid Waste", third edition, November 1986, as revised, December 1987.
[5]Graphite Furnace - Atomic Absorption Spectrophotometer
[6]Inductively Coupled Plasma - Atomic Emission Spectrophotometer
[7]Gas Chromatograph - Mass Spectrometer

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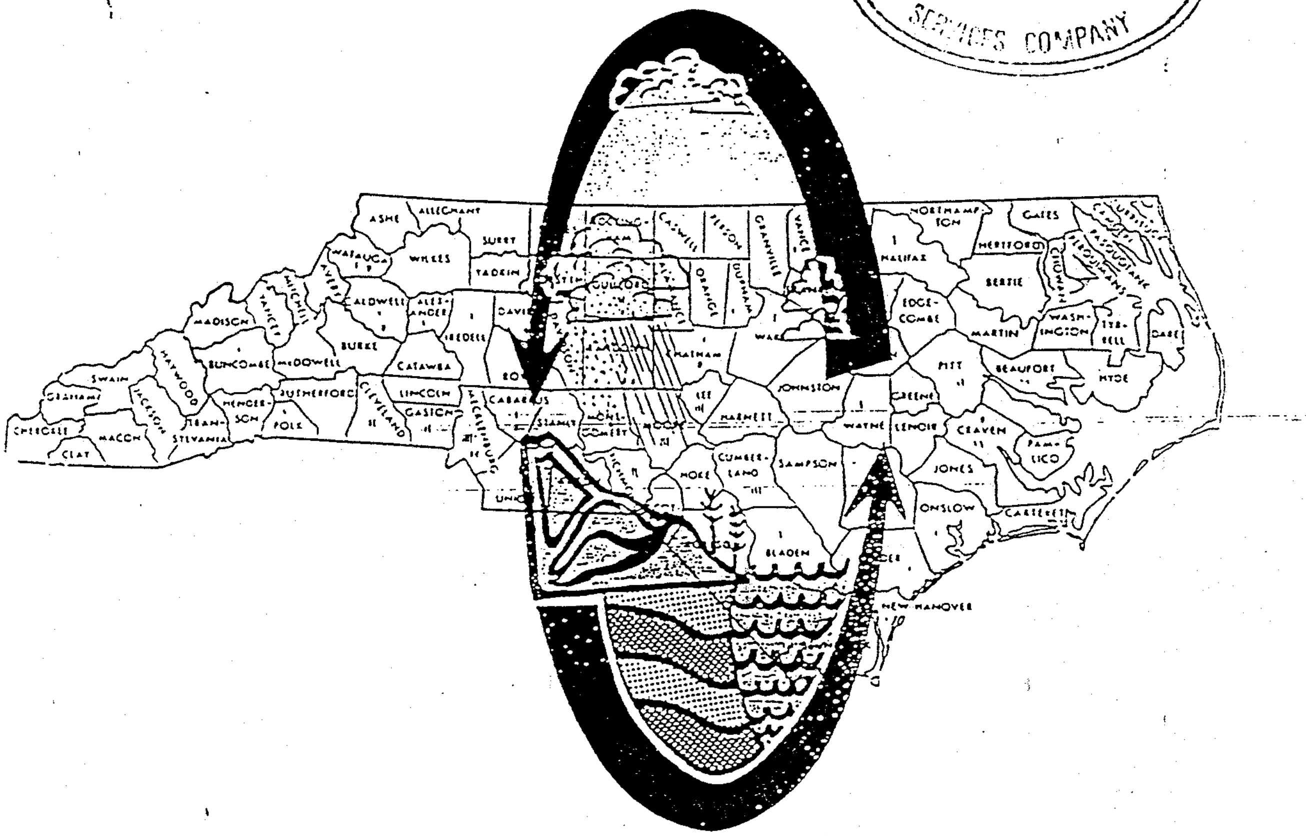
NORTH CAROLINA WATER QUALITY MONITORING GUIDANCE DOCUMENT FOR SOLID WASTE FACILITIES



SOLID WASTE SECTION
DIVISION SOLID WASTE MANAGEMENT
DEPARTMENT OF ENVIRONMENT, HEALTH AND NATURAL RESOURCES

March 1995

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Introduction

It is important to understand the difference between a ground water monitoring well and a water supply well. This distinction is obvious when comparing well construction techniques characteristic of various formations throughout the State. For instance, the western part of North Carolina is dominated by a series of crystalline metamorphic rocks. Subsequently, water supply wells in these regions are typically constructed by drilling through the saprolite (weathered rock) and into very hard resistant rock below the true water table. Because of the resistant lithologic character of these units, well drillers often feel that it is unnecessary to case a well drilled in rock. This rationale may hold true for drinking water supply wells but it is unacceptable for ground water monitoring purposes due to contamination problems associated with uncased or partially cased wells. Subsequently the Solid Waste Section requires completely cased boreholes for all ground water monitoring wells.

The Section strongly urges all contractors and consultants to become familiar with well construction techniques and specifications of monitoring wells as illustrated by the ground water monitoring well schematic (figure 1). Monitoring well construction standards must conform to requirements cited in 15A NCAC 2C "Well Construction Standards: Criteria and Standards Applicable to Water Supply and Certain Other Wells".

A. Specific Monitoring Well Construction Requirements

Because the location and design of ground water monitoring wells at landfills is one of the most critical phases of site development, the importance of a thorough hydrogeologic evaluation which clearly delineates ground water elevation and flow characteristics is of highest significance. In order to assure consistent and proper installation techniques which are in accordance with EPA regulations, all deviations to the following methods, or questions regarding materials, monitoring well locations or other techniques, should be directed to the Solid Waste Section Hydrogeologist at (919) 733-0692, c.o. the Solid Waste Section, P.O. Box 27687, Raleigh, N.C. 27611-7687. The Solid Waste Section reserves the right to evaluate in the field, the actual well installation techniques and procedures.

Proper installation of monitoring wells and placement of well screens is critical to assure that the ground water sample represents the portion of the aquifer where contaminants may migrate. The maximum length of the well screen is 15 feet. Well screens should be placed at depths based on hydrogeologic data collected during previous site investigations. Well sorted sand to be used as a pre-screening filter pack of influent ground water should be washed to remove all fines in order to prevent clogging of the well screen. In connecting well casing sections threaded pipe fittings are required as opposed to various types of glues or other cements which have the potential for contaminating ground water samples.

Various casing types and sizes are available and acceptable for installation of monitoring wells. Generally, 2" inside diameter PVC casing is used. Under certain circumstances stainless

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s. . or Teflon well casings are preferred, however, Teflon casings are relatively malleable and may not hold-up under stressed conditions.

The most common size bore holes include those which are drilled with an 8" hollow-stem auger. These will accommodate 2" and 4" I.D. casings. The Solid Waste Section recommends the use of 2" I.D. casings for wells drilled 100' or less. Monitoring wells drilled to depths exceeding 100' such as wells designed to monitor water quality through possible fracture patterns may be cased with 4" I.D. casings to allow for the use of pumps to purge the wells.

A typical monitoring well schematic is shown in figure 1. In general all Type II monitoring wells used for detection monitoring should conform to the construction design specifications indicated.

Because accidental or natural events may influence the condition of monitoring wells, an on-going well inspection and maintenance program should be conducted by landfill personnel. Some of the items which should be regularly maintained by facility personnel include: 1) insuring that all wells are locked at all times, 2) insuring that all casings have a secure cap, 3) insuring that the outer casing is upright and undamaged by equipment or vehicles, 4) insuring that each well location is clearly marked and an unobstructed path exists, free of dense vegetation. These maintenance factors are critical for helping insure proper ground water monitoring.

B. Ground-water Monitoring

Because a tremendous liability is associated with water quality data obtained from analytical laboratory results, it is of the utmost importance to insure the validity and integrity of sampling techniques and methodology. Two distinct monitoring systems exist which may be used to purge and sample a monitoring well. These two systems are the portable monitoring system and the dedicated monitoring system.

Portable Monitoring

1. Bailers

The portable monitoring system is by far the most common method used to collect samples to monitor ground water quality. The most popular portable purging and sampling device is the Teflon bailer. Teflon is considered to be a preferred material to use for ground water monitoring because of its relatively inert chemical character. Stainless steel bailers are also acceptable but are not used as frequently. Because of the possibility of an interaction between the sample and bailer components, the use of high density polyethylene (HDPE) bailers or PVC bailers is generally not allowed for collecting samples for analysis of ground water quality .

The bailer line that attaches to bailers should consist of either 1) nylon rope, 2) Teflon coated w..e, 3) single stranded stainless steel wire, or 4) some other monofilament line. A new segment

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of line should always be used for each well. Unused line should be protected from contamination as much as possible.

2. Pumps

A number of types of submersible electric pumps are available with stainless steel and Teflon components that are allowed to be used in certain circumstances (ie. deep wells with large diameter casings) for purging of wells prior to sampling. Purge rates must be carefully controlled or the resulting agitation within the well may change the sample chemistry.

Electric pumps designed to remain outside the well on the ground surface with an intake pipe inside the well can also be used for purging. However, intake tubing placed in the well must be composed of Teflon and properly decontaminated prior to use. Sampling is discouraged with this system because of the obvious problem with flow control rate.

Hand pumps are useful for purging wells in a relatively short period of time, but unfortunately, are usually unsuitable for sampling. The primary reasons being the possibility of contamination and lack of availability of Teflon or stainless hand-pumps in the commercial market. In addition, the regulation of flow rate, which is very important for most sampling situations, is difficult to control. Proper cleaning and decontamination can be a problem in the field if a pump is used for more than one well.

Dedicated Monitoring

So far previous discussions have focused on equipment related to portable monitoring systems. A short overview of dedicated systems is in order. Dedicated well monitoring differs from portable monitoring primarily by the permanency of the set-up. Because portable systems require the use of much of the same equipment from well to well, great care must be exercised to avoid cross contamination. Dedicated systems, however, require no between-well cleaning procedures. These systems offer permanently affixed down-well and well-head components that are capped after initial set-up. All dedicated monitoring systems must be approved by the Solid Waste Section before installation.

Most dedicated monitoring systems are comprised of an in-well submersible bladder pump, with air supply and sample discharge tubing, and an above-ground driver/controller for regulation of flow rates and volumes. The pump and all tubing housed within the well should be composed of Teflon or stainless steel components. This includes seals inside the pump, the pump body and fittings used to connect tubing to the pump. Because ground water will not be in contact with incompatible constituents and because the well is sealed from the surface, virtually no contamination is possible from intrinsic sources during sampling and between sampling intervals.

Flow rate during sample collection is very important when using any type of pump system.

Cha s in sample pH, sample chemistry and volatilization of organic constituents are possible with nigh flow rates during purging and sample collection. Flow rates as low as 100ml/ min. are necessary when collecting samples.

In contrast to the above described system, occasionally individuals are under the false impression that bailers which are initially cleaned in a laboratory and permanently placed in monitoring wells are considered dedicated systems and subsequently are acceptable for monitoring purposes. While it is permissible to assign a particular bailer to an individual well, the bailer should always be decontaminated between sampling events and never stored inside the well. A separate laboratory cleaned Teflon or stainless steel bailer is required for each monitoring well during each sampling episode.

Equipment Cleaning Procedures

The preferred setting for cleaning all equipment coming in contact with samples or ground water inside a monitoring well is within an established and properly equipped laboratory. In general, field cleaning of sampling equipment such as bailers is not allowed. With detection limits of parts per million or even parts per billion for various sample constituents, extreme care should be taken to insure that all sampling equipment is properly cleaned before use.

The following procedures have been established by EPA Region IV as a minimum for cle g equipment for sample collection for RCRA based programs.

Teflon bailers, etc.:

1. Phosphate-free soap and tap water wash
2. Tap water rinse
3. 10% nitric acid or 10% hydrochloric acid soak
4. Deionized or distilled water rinse
5. Isopropyl alcohol rinse
6. Deionized or distilled water rinse
7. Air dry
8. Aluminum foil wrap with shiny side out

Stainless steel bailers, etc.:

1. Phosphate-free soap and tap water wash
2. Tap water rinse
3. Deionized or distilled water rinse
4. Isopropyl alcohol rinse
5. Deionized or distilled water rinse
6. Air dry

Aluminum foil wrap with shiny side out

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Sample Collection

Of primary importance in the collection of monitoring well samples is the need to collect a sample that is as representative of the ground water as possible. It is very important not to add to, delete from, or cause any change in the sample being collected. The use of properly decontaminated equipment with acceptable sampling and sample handling technique cannot be over-emphasized. Nothing should be placed inside the well casing that has not been decontaminated and decontaminated equipment should never be handled without the use of new clean disposable gloves. Once the well cap is removed from the casing all equipment and all sampling procedures should be performed while wearing gloves. Extreme care should always be taken to prevent bailers, bailing line, and open sample containers from coming in contact with anything other than the well contents.

Each monitoring well should be treated as a separate entity. All disposable equipment, such as gloves and bailer line, should be discarded after being used at each well. Never use the same equipment between wells unless it has been properly decontaminated. Each sampling episode should have enough laboratory cleaned supplies available for one-time use for each well.

1. Purging Methods

The primary purpose of purging a monitoring well is to remove stagnant water within the casing and surrounding filter pack, thereby helping insure that the sample collected will closely represent actual ground water in the vicinity of the well. The accepted standard is to purge 3 to 5 well volumes or until the well is dry once before sampling. Purging may need to be continued beyond 3 to 5 well volumes if the pH and specific conductivity have not stabilized. At no time should purge rates cause cascading of recharge water inside the casing because of the possibility of increased loss of volatile compounds.

In some instances, dependent upon the hydrogeologic setting, the recharge rate may be exceptionally slow after purging and sampling may not be possible until the next day. However, efforts should be made to sample all wells within 24 hours after purging.

As a rule, the water level in all wells is measured and standing volumes are calculated before any well purging begins. The most accurate method of determining water level is with the use of an electronic indicator. Measurements should always be recorded to the nearest 0.01 foot. The use of carpenter's measuring tapes, monofilament lines, lead pipe "plopers", etc. is not recommended. Water level indicator cables and probes should always be decontaminated before and between well usage, and stored and transported in such a manner as to prevent contamination from outside sources.

2. Sample Containers

Because samples are analyzed for various parameters, several types of containers are required

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f complete sampling scheme. All sample containers must be properly decontaminated before use. The number of containers for sample collection and the use of acid for preservation of samples is dependent upon the protocol required by the laboratory performing the analyses. As a rule, samples for organics analyses are collected in glass containers, and samples for metals analyses are collected in plastic containers. If containers have a pre-measured amount of acid, no rinsing should be done prior to the addition of the sample.

3. Sampling Order

Samples should always be collected in the order of parameter volatilization sensitivity. A preferred collection order for some parameters is as follows:

* Volatile Organic Compounds (VOCs)
* Total Organic Halogens (TOX)
* Total Organic Carbon (TOC)
* Extractable Organic Compounds (Semi-volatiles)
* Total Metals
* Cations and Anions

4. Field Filtering of Samples

EPA regulations for analyses of samples from RCRA based programs require an analysis for t analyte concentrations. As a result, field filtration of monitoring samples to be evaluated for compliance purposes is **not** allowed. The 3030C preparation method required by the Division of Environmental Management is **not** allowed for solid waste management facilities.

5. Transport and Storage of Samples

Upon completion of sample collection, all samples should be stored and transported on ice or in a refrigerated state to the laboratory performing the analyses. Samples should be stored in such a manner as to prohibit breakage or accidental spillage. Unless unusual circumstances prevent otherwise, all samples should be delivered to the laboratory on the same day as collected.

6. Administrative Procedures

A chain-of-custody record should be completed and accompany each sample to the laboratory. The record should contain the following information:

* Sample number
* Signature of collector
* Date and time of collection
* Sample type
* Well identification
* Total number of containers

Signature of person(s) involved in chain-of-possession

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* Inclusive dates of possession

7. Quality Assurance/Quality Control

All sampling events should include provisions for quality assurance and quality control to help insure the reliability and validity of the sampling data. At a minimum, one trip blank and one equipment blank must be included for each sampling episode.

Analytical Procedures

1. Detection Monitoring Requirements

The detection monitoring program for each Municipal Solid Waste Landfill (MSWLF) receiving solid waste after April 9, 1994 is required to comply with Solid Waste Management Rules 15A NCAC 13B .1630 through .1633. Generally, all monitoring well and surface water samples should be analyzed for the constituents listed in Appendix I of CFR Part 258 (Table 1). After the initial 4 independent sampling events to establish background water quality, sampling should be on a semi-annual basis unless otherwise specified by the Solid Waste Section. Field measurements for temperature, pH, specific conductivity, and the determination of rate and direction of ground water flow must also be included for each well at each sampling event.

All analytical monitoring well data from the above referenced landfills must be evaluated statistically for compliance purposes. Surface water data does not have to be statistically analyzed. Acceptable statistical methods are listed under Rule .1632(g) of the North Carolina Solid Waste Management Rules 15A NCAC 13B.

Construction and Demolition (C&D) Landfills are also required to be monitored semi-annually. At a minimum C&D landfill monitoring should be done for RCRA metals and volatile organic compounds (EPA Method 8240 or 8260), specific conductance, pH, and temperature. Determination of ground water flow rate and direction is not required during each sampling episode of C&D landfills.

Landfills that stopped receiving solid waste before April 9, 1994 or landfills that do not have to comply with the Subtitle D monitoring requirements should sample and analyze for the parameters listed in Tables 1 and 2, unless otherwise directed by the Solid Waste Section. A statistical analysis of the monitoring well data is not required.

Monitoring data, quality assurance/quality control data, statistical analyses, chain of custody records and any other required information should be submitted to the Solid Waste Section within 15 days of receipt by the facility owner/operator.

2. Laboratory Certification

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'l monitoring samples should be analyzed by a laboratory certified under the Division of Environmental Management (DEM) Certification program. Tables 1 and 2 list lab certification requirements, sampling analytical methods, reporting limits and methodologies for analyses for the various sample parameters.

C. Surface Water Monitoring

Landfill sites which contain or border small rivers, streams or branches should include surface water sampling as part of the detection monitoring program for each sampling event. A simple procedure for selecting surface water monitoring sites is to locate a point on a stream where drainage leaves the site. This provides detection of contamination through, and possibly downstream, of site via discharge of surface waters. The sampling points selected should be downstream from any waste areas. An upstream sample should be obtained in order to determine water quality upstream of the influence of the landfill.

The following procedure is recommended regarding sample collection of surface waters. Prior to collecting the sample, specific collection points should be determined. Samples should be collected in areas with minimal turbulence and aeration. Because sample containers may be dipped by hand into the stream, caution must be taken in avoiding contamination of the mouth of the container. The following procedure is recommended:

Hold the container near the base with one hand, and with he other hand remove the cap.

2. Rinse the sample container with the water to be sampled prior to filling the container unless it has a pre-measured amount of preservatives such as acid for metals samples.

3. Push the sample container rapidly into the water (mouth down) and tilt upwards toward the current to fill. A depth of about 6 inches is satisfactory. Do not breach the water surface while filling the container.

4. During times of little current flow, move the container laterally slowly through the water.

5. During times of drought when stream water depths are too shallow to allow submersion of the container, a pool may be scooped out of the channel bottom and allowed to clear prior to sampling.

6. Lift the container from the water and leave one-half inch of air space and place the cap on the container. Volatile organic samples should have no head space.

7. Place the samples on ice and transport to the laboratory with completed paperwork.

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Summary of Important Sampling Requirements

1. Monitoring requirements for MSWLF units must comply with Solid Waste Management Rules 15A NCAC 13B .1630 through .1633.

2. All monitoring wells that are part of the detection monitoring system must be sampled semi-annually unless otherwise specified by the Solid Waste Section.

3. All sampling equipment should be properly decontaminated before use according to EPA Region IV protocol. Once equipment has been cleaned it should be protected from contamination. This includes bailers, bailer line, water level indicator cable and probe. Equipment should not be transported unprotected from possible contamination sources.

4. Field cleaning of bailers and most other equipment is not allowed. A sufficient number of laboratory cleaned bailers should be available to provide a separate bailer for each monitoring well for a sampling episode. Water level indicator cable and probe should be cleaned and protected from contamination after usage between each well. When taking measurements at more than one well during a sampling event, a minimum cleaning for water level indicator probes and cables should be a thorough rinse with distilled or deionized water.

5. Always use clean disposable gloves when sampling or handling any sampling equipment. Frequent glove changes will lesson the possibility of cross-contamination between wells and equipment.

6. If bailers are used to sample monitoring wells, only bailers composed of Teflon or stainless steel are allowed. If disposable Teflon bailers are used, documentation of proper cleaning protocol must be provided. HDPE and PVC bailers may not be used.

7. Wells should be purged a minimum of 3 well volumes or to dryness at least once before being sampled.

8. If a well is not immediately sampled after purging and bailers are used as the sampling device, the bailer and line may be secured and temporarily stored inside the well casing above the water level until the well is sampled. However the well should be sampled as soon as recharge is sufficient.

9. Monitoring well samples should be collected in the following order:
   a. Volatile organics
   b. Semi-volatile organics
   c. Metals
   d. Cations and anions (ie. chlorides, sulfates, etc.)

Figure 1

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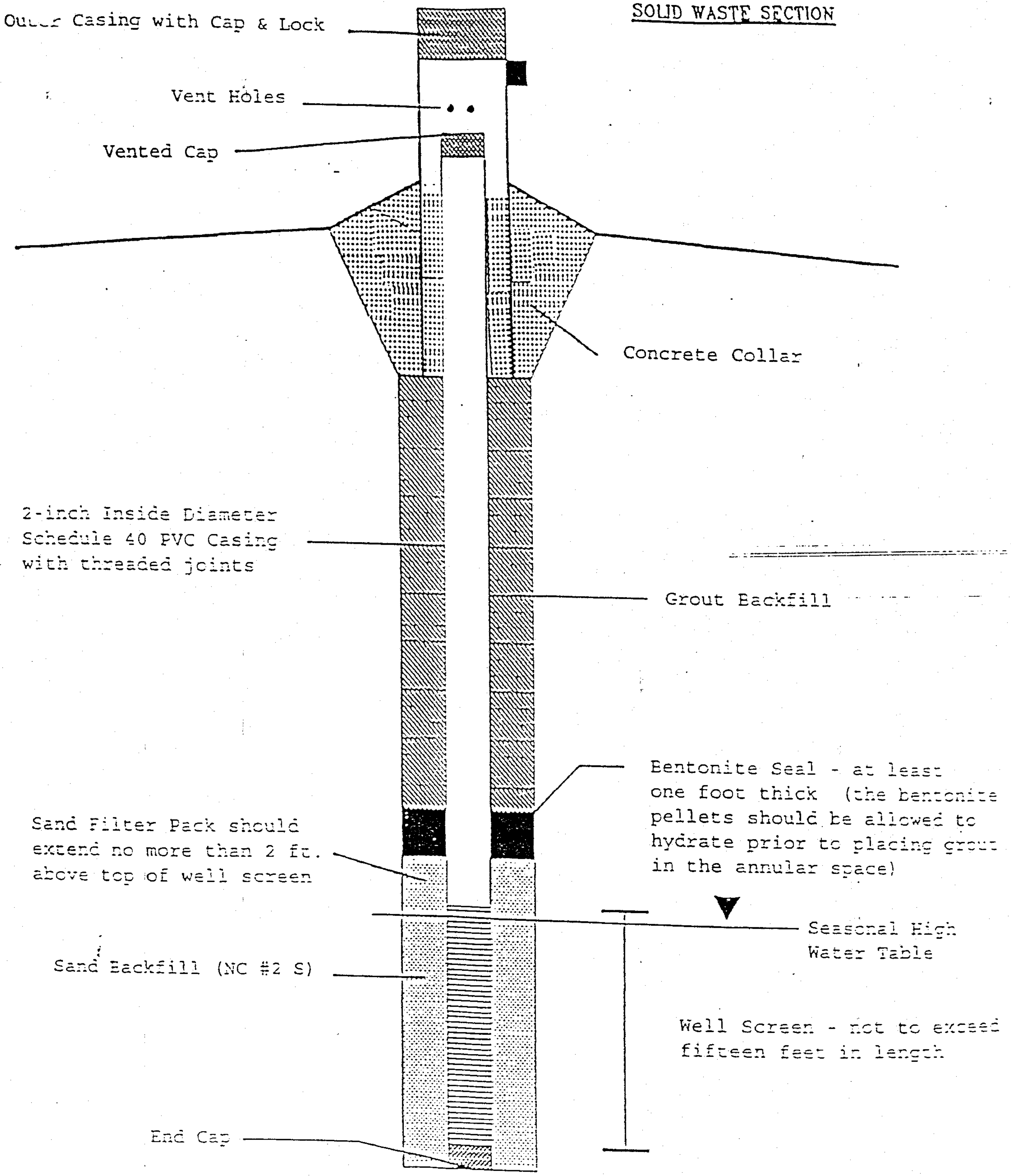
TYPICAL MONITORING WELL SCHEMATIC

SOLID WASTE SECTION



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e. Indicator parameters (ie. BOD, COD, etc.)
f. Other parameters (ie. TDS, etc.)

10. If pumps are used for sampling, flow rates should not exceed 100 ml/min.

11. Field filtration of ground water samples used for compliance monitoring is not permitted. Samples must be analyzed for total concentrations of all parameters unless otherwise specified by the Solid Waste Section.

12. QA/QC samples should be a part of each sampling episode.

13. Chain-of-Custody must be maintained for all samples.

14. Samples must be analyzed by laboratories meeting DEM certification requirements for each parameter using the methods approved by the Solid Waste Section.

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Table 1
INORGANIC CONSTITUENTS

Parameter	Certification by DEM	PQL in ppb
(1) Antimony	Metals, Group II - low level	30
(2) Arsenic	Metals, Group I - low level	10
(3) Barium	Barium (20)	500
(4) Beryllium	Metals, Group I - low level	2
(5) Cadmium	Metals, Group I - low level	1
(6) Chromium	Metals, Group I - low level	10
(7) Cobalt	Metals, Group I - low level	10
(8) Copper	Metals, Group I - regular level	200
(9) Lead	Metals, Group I - low level	10
(10) Nickel	Metals, Group I - regular level	50
(11) Selenium	Metals, Group I - low level	20
(12) Silver	Metals, Group II - low level	10
(13) Thallium	Metals, Group II - low level	10
(14) Vanadium	Metals, Group I - low level	40
(15) Zinc	Metals, Group I - regular level	50

- The data shall be reported at the specified Practical Quantitation Limit (PQL). In addition to sampling for the constituents referenced above, all sampling should also include field testing of pH, temperature, and specific conductivity. No filtering of samples is allowed. The 3030C preparation method for metals analysis is not allowed.

- Regular ICP (Method 6010) is <u>not</u> approved for analysis of constituents for which low-level certification is required.

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Table 2
VOLATILE ORGANIC COMPOUNDS

GANIC NSTITUENT	PQL (UG/L)	ORGANIC CONSTITUENT	PQL (UG/L)
6) ACETONE	100	(40) T-1,3-DICHLOROPROPENE	10
7) ACRYLONITRILE	200	(41) ETHYLBENZENE	5
8) BENZENE	5	(42) METHYL BUTYL KETONE	50
9) BROMOCHLOROMETHANE	5	(43) METHYL BROMIDE	10
0) BROMODICHLOROMETHANE	5	(44) METHYL CHLORIDE	10
1) BROMOFORM	5	(45) METHYLENE BROMIDE	10
2) CARBON DISULFIDE	100	(46) METHYLENE CHLORIDE	10
3) CARBON TETRACHLORIDE	10	(47) MEK; 2-BUTANONE	100
4) CHLOROBENZENE	5	(48) METHYL IODIDE	10
5) CHLOROETHANE	10	(49) METHYL ISOBUTYL KETONE	100
6) CHLOROFORM	5	(50) STYRENE	10
7) CHLORODIBROMOMETHANE	5	(51) 1,1,1,2-TETRACHLOROETHANE	5
8) DBCP	25	(52) 1,1,2,2-TETRACHLOROETHANE	5
29) ETHYLENE DIBROMIDE	5	(53) TETRACHLOROETHYLENE	5
30) O-DICHLOROBENZENE	5	(54) TOLUENE	5
31) P-DICHLOROBENZENE	5	(55) 1,1,1,-TRICHLOROETHANE	5
32) T-1,4-DICHLORO-2-BUTENE	100	(56) 1,1,2-TRICHLOROETHANE	5
33) 1,1-DICHLOROETHANE	5	(57) TRICHLOROETHYLENE	5
34) ETHYLENE DICHLORIDE	5	(58) CFC-11	5
35) VINYLIDENE CHLORIDE	5	(59) 1,2,3-TRICHLOROPROPANE	15
36) CIS-1,2-DICHLOROETHENE	5	(60) VINYL ACETATE	50
37) T-1,2-DICHLOROETHENE	5	(61) VINYL CHLORIDE	10
38) PROPYLENE DICHLORIDE	5	(62) XYLENES	5
39) CIS-1,3-DICHLOROPROPENE	10		

ALSO KNOWN AS: (21)-TRIBROMOMETHANE, (25)-ETHYL CHLORIDE, (26)-TRICHLOROMETHANE, (27)-DIBROMOCHLOROMETHANE, (28)-1,2-DIBROMO-3-CHLOROPROPANE, (29)-1,2-DIBROMOETHANE, (30)-1,2-DICHLOROBENZENE, (31)-1,4-DICHLOROBENZENE, (33)-ETHYLIDENE CHLORIDE, (34)-1,2-DICHLOROETHANE, (35)-1,1-DICHLOROETHENE (ETHYLENE), (36)-CIS-1,2-DICHLOROETHYLENE, (37)-TRANS-1,2-DICHLOROETHYLENE, (38)-1,2-DICHLOROPROPANE, (42)-2-HEXANONE, (43)-BROMOMETHANE,
(44)-CHLOROMETHANE, (45)-DIBROMOMETHANE, (46)-DICHLOROMETHANE, (47)-METHYL ETHYL KETONE, (48)-IODOMETHANE, (49)-4-METHYL-2-PENTANONE, (53)-TETRACHLOROETHENE, PERCHLOROETHYLENE, (55)-METHYLCHLOROFORM, (57)-TRICHLOROETHENE, (58)-TRICHLOROFLUOROMETHANE

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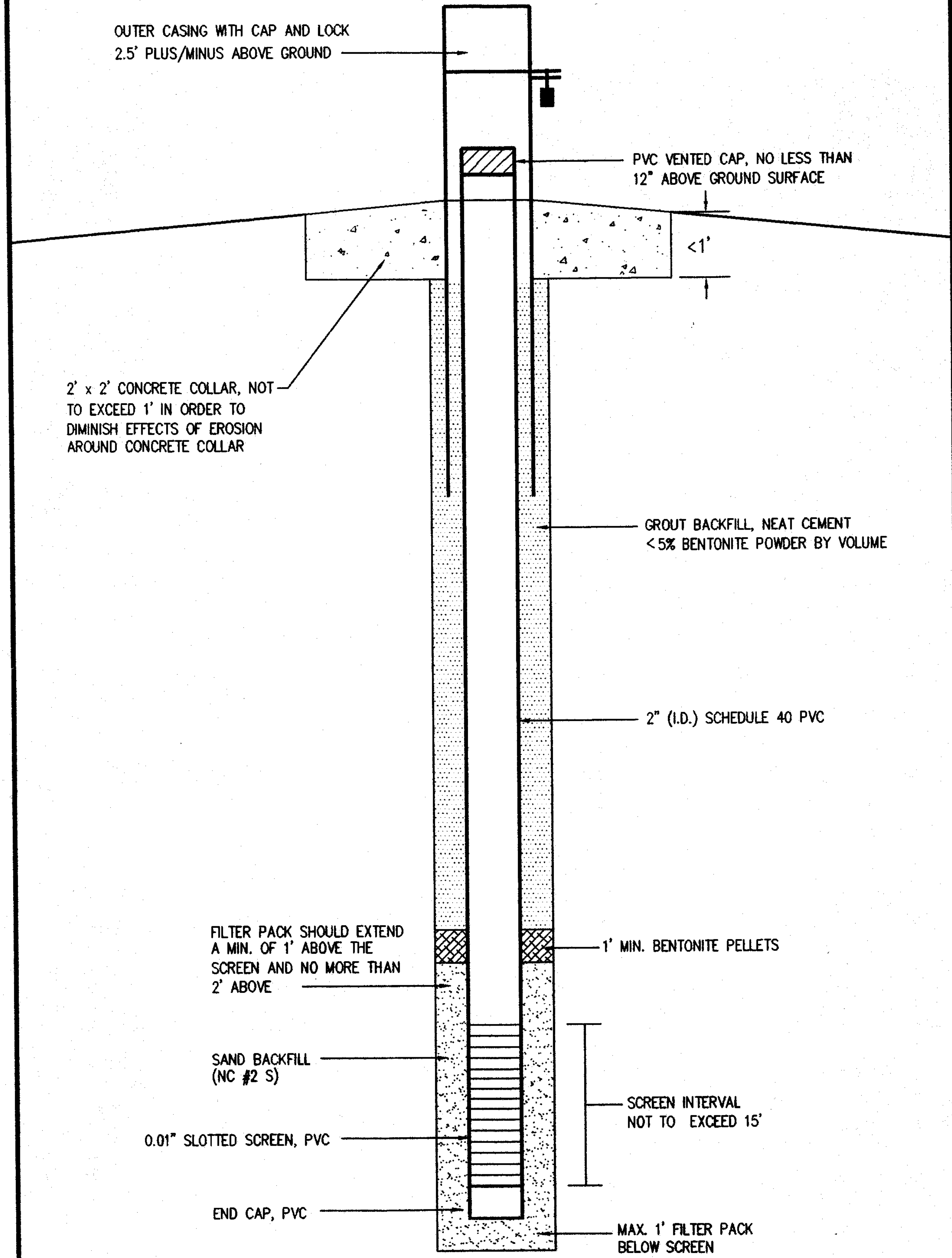
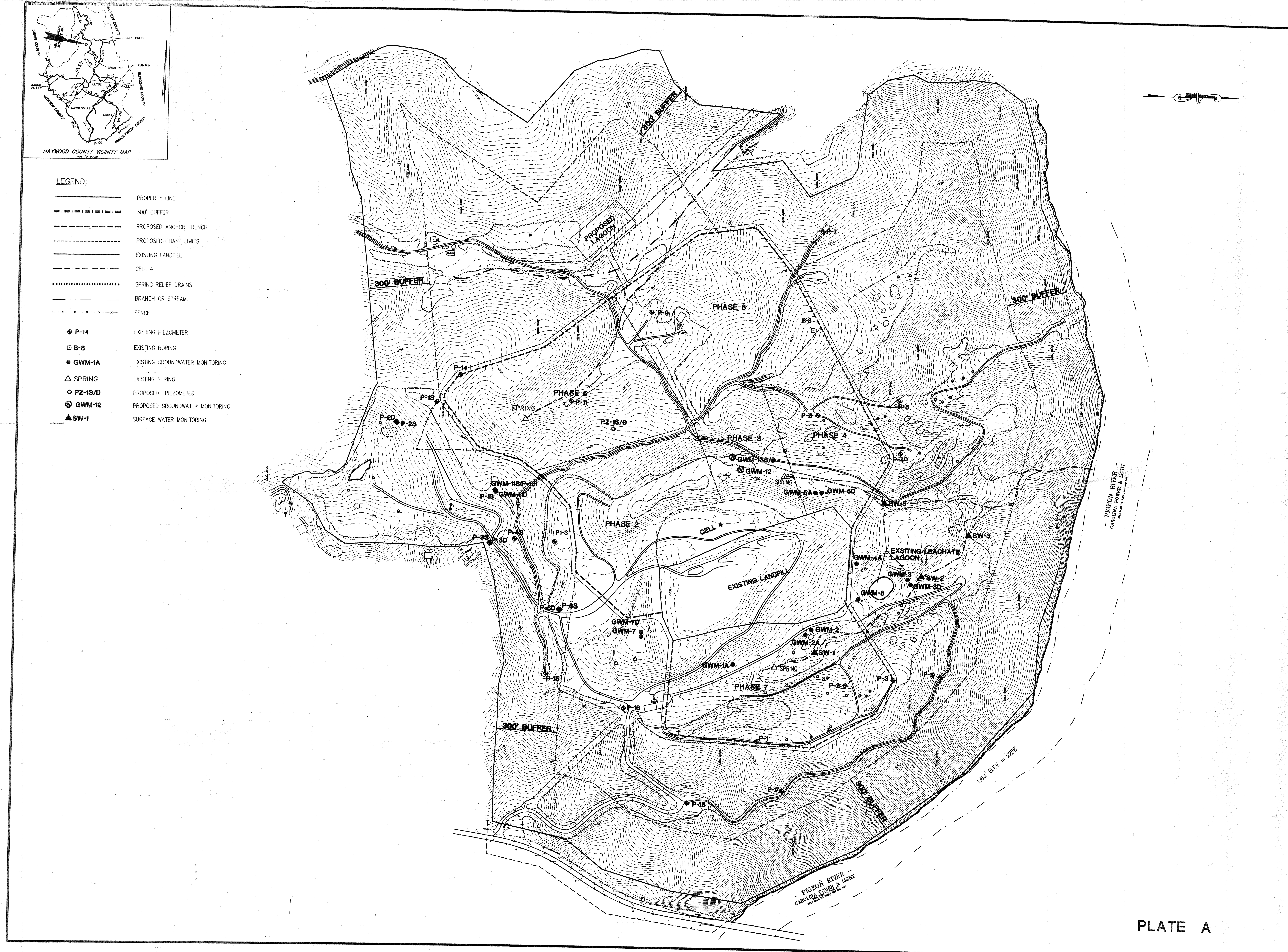


NOTE: SHALLOW WELLS REQUIRE A MINIMUM OF 5' COMBINED THICKNESS OF GROUT AND BENTONITE.

TYPICAL MONITORING WELL
PLATE B



MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY NORTH CAROLINA

Municipal Services Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 P.O. BOX 349 BOONE, N.C. 28607

PROPOSED MONITORING WELL LOCATION

SCALE:	1"= 200'
DATE:	4/8/00
DRWN. BY:	B. BADEY
CHKD. BY:	E. CUSTER
PROJECT NUMBER	G98010
DRAWING NO. PA	SHEET NO. 1 OF 1

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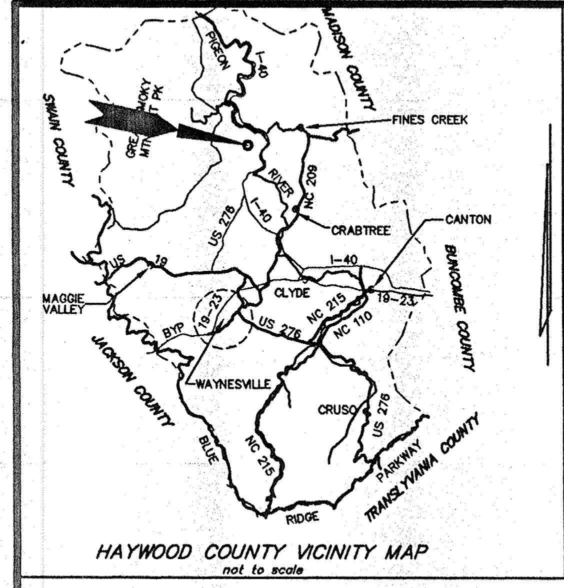


LEGEND:

	PROPERTY LINE
	300' BUFFER
	PROPOSED ANCHOR TRENCH
	PROPOSED PHASE LIMITS
	EXISTING LANDFILL
	CELL 4
	SPRING RELIEF DRAINS
	BRANCH OR STREAM
—x—x—x—x—	FENCE
P-14	EXISTING PIEZOMETER
B-8	EXISTING BORING
GWM-1A	EXISTING GROUNDWATER MONITORING
△ SPRING	EXISTING SPRING

PLATE 1

Municipal Services
Engineering Company, P.A.
P.O. BOX 97, GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

MUNICIPAL SOLID WASTE LANDFILL FACILITY HAYWOOD COUNTY NORTH CAROLINA

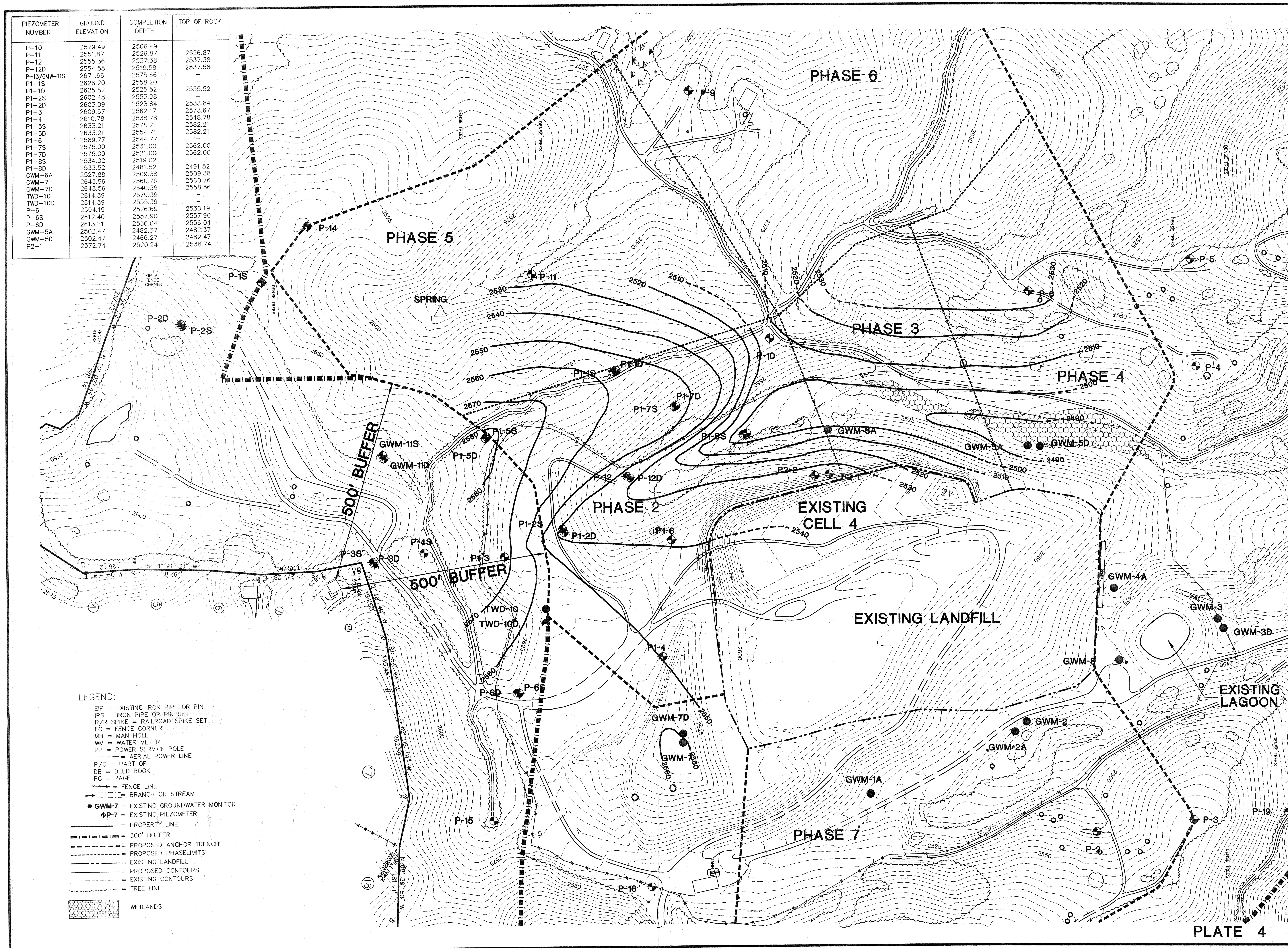
DATE	BY	REV.	DESCRIPTION

DESIGN HYDROGEOLOGIC STUDY
GENERAL SITE MAP

SCALE:	1"= 200'
DATE:	4/7/00
DRWN. BY:	L. HAMPTON
CHKD. BY:	E. CUSTER
PROJECT NUMBER	G98010
DRAWING NO. GS	SHEET NO. 1 OF 1

\\lisa\dwgs\haywood\hygeo\98010-gs1.dwg Sat Apr 08 17:00:17 2000 BMB

PIEZOMETER NUMBER	GROUND ELEVATION	COMPLETION DEPTH	TOP OF ROCK
P-10	2579.49	2506.49	–
P-11	2551.87	2526.87	2526.87
P-12	2555.36	2537.38	2537.38
P-12D	2554.58	2519.58	2537.58
P-13/GMW-11S	2671.66	2575.66	–
P1-1S	2626.20	2558.20	–
P1-1D	2625.52	2525.52	2555.52
P1-2S	2602.48	2553.98	–
P1-2D	2603.09	2523.84	2533.84
P1-3	2609.67	2562.17	2573.67
P1-4	2610.78	2538.78	2548.78
P1-5S	2633.21	2575.21	2582.21
P1-5D	2633.21	2554.71	2582.21
P1-6	2589.77	2544.77	–
P1-7S	2575.00	2531.00	2562.00
P1-7D	2575.00	2521.00	2562.00
P1-8S	2534.02	2519.02	–
P1-8D	2533.52	2481.52	2491.52
GWM-6A	2527.88	2509.38	2509.38
GWM-7	2643.56	2560.76	2560.76
GWM-7D	2643.56	2540.36	2558.56
TWD-10	2614.39	2579.39	–
TWD-10D	2614.39	2555.39	–
P-6	2594.19	2526.69	2536.19
P-6S	2612.40	2557.90	2557.90
P-6D	2613.21	2536.04	2556.04
GWM-5A	2502.47	2482.37	2482.37
GWM-5D	2502.47	2466.27	2482.47
P2-1	2572.74	2520.24	2538.74



Municipal Engineering Services Company, P.A.
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P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

MUNICIPAL SOLID WASTE LANDFILL

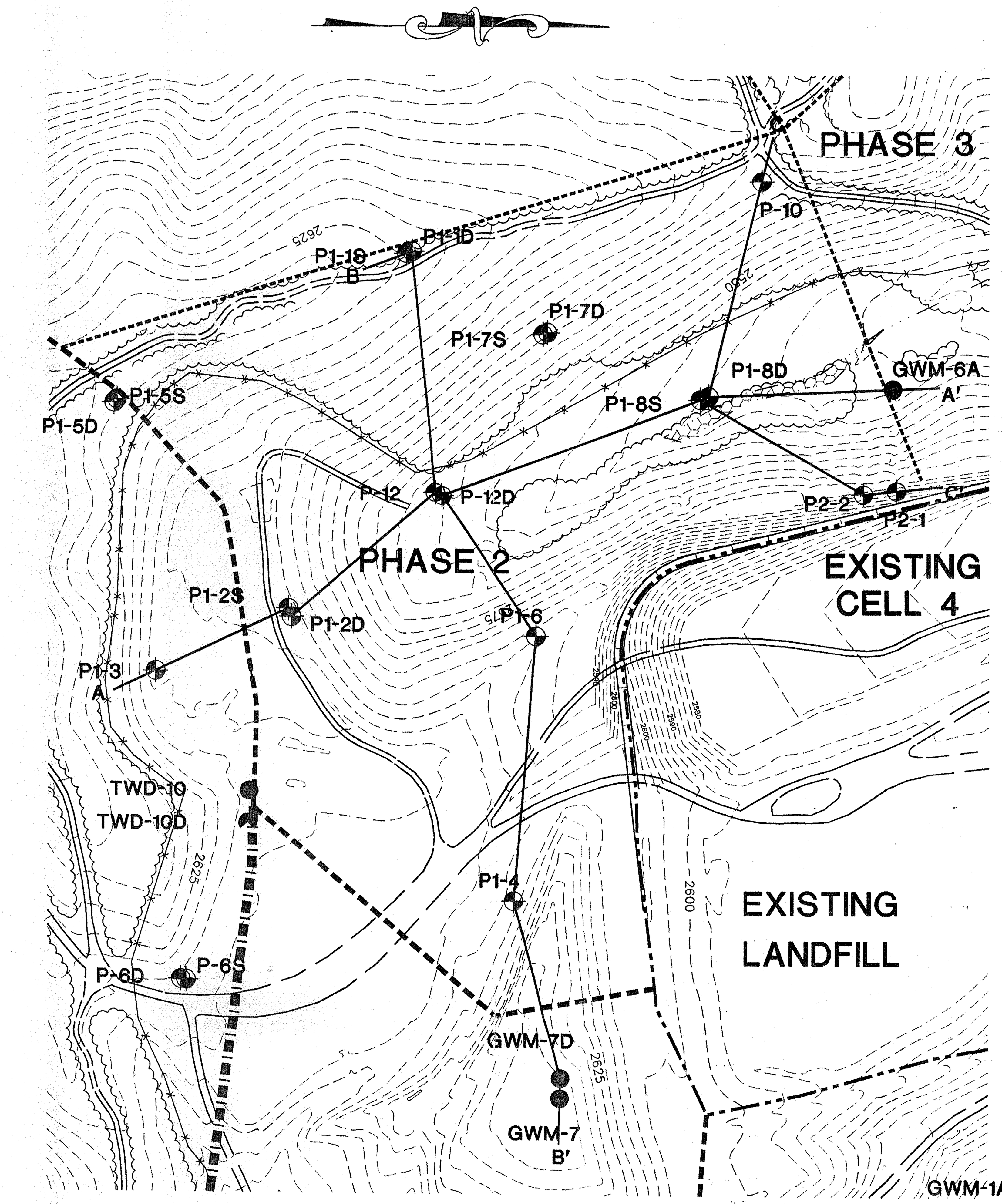
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

TOP OF ROCK MAP

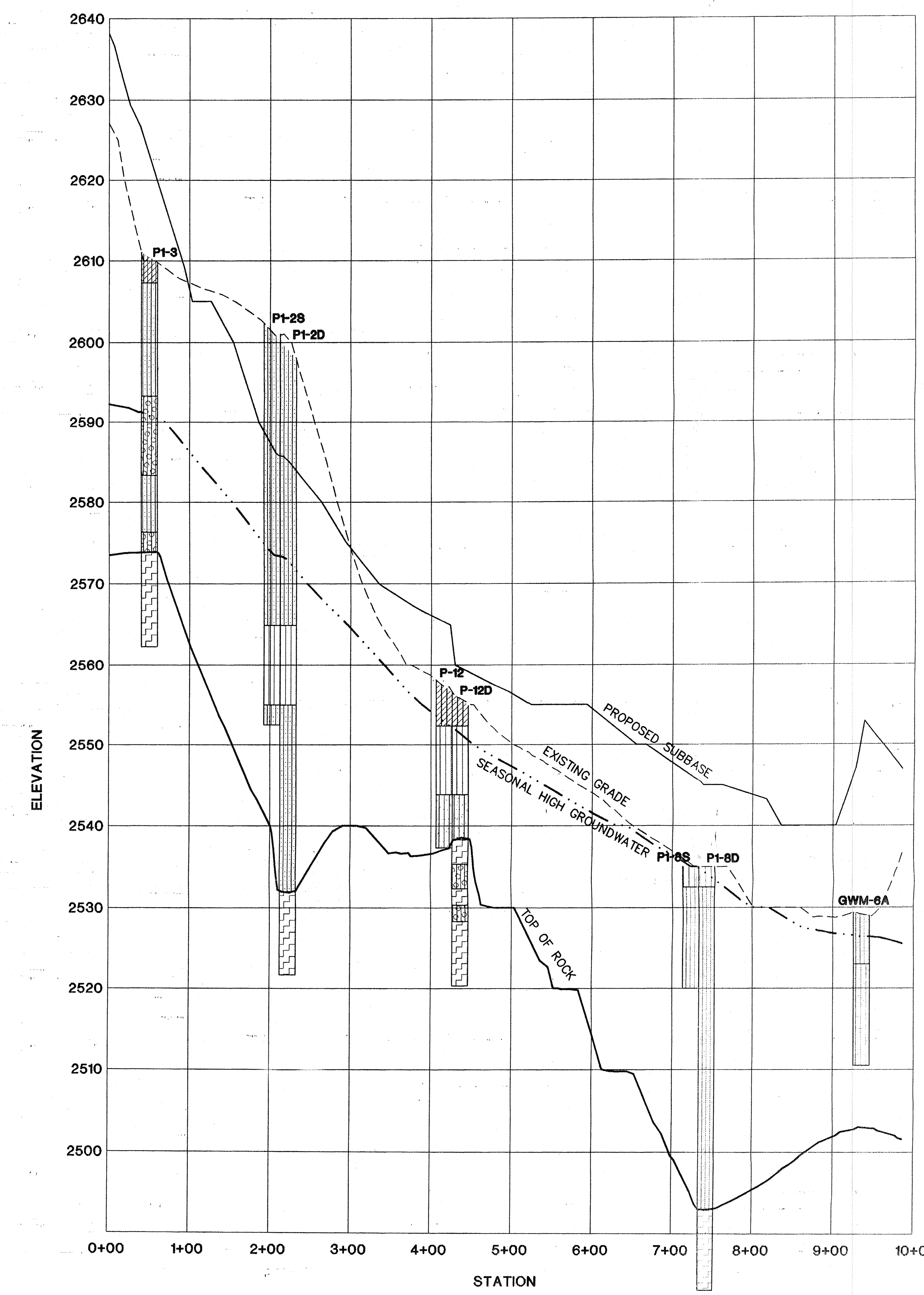
SCALE:	1" = 100'
DATE:	3/29/00
DRWN. BY:	L. HAMPTON
CHKD. BY:	E. CUSTER
PROJECT NUMBER	G98010
DRAWING NO.	TR
SHEET NO.	1 OF 1

\dwgs\haywood\hydro\98010-tr.dwg Fri Mar 31 11:05:24 2000 LCH



PLAN VIEW

SCALE: 1" = 100'



SECTION A-A'

SCALE: HORIZ.: 1" = 100'
VERT.: 1" = 10'

LEGEND:

- EXISTING GRADE
- PROPOSED SUBGRADE
- SEASONAL HIGH GROUNDWATER
- TOP OF ROCK

SOIL TYPE LEGEND

- CLAYEY SILT
- SILTY SAND
- SANDY SILT
- CLAY
- PARTIALLY WEATHERED ROCK
- SILT
- SANDY SILT
- SILTY CLAY
- SAND
- GNEISS

NOTE:
ALL BOUNDARIES ARE APPROXIMATE.
INFERRED BETWEEN BORING LOCATIONS.

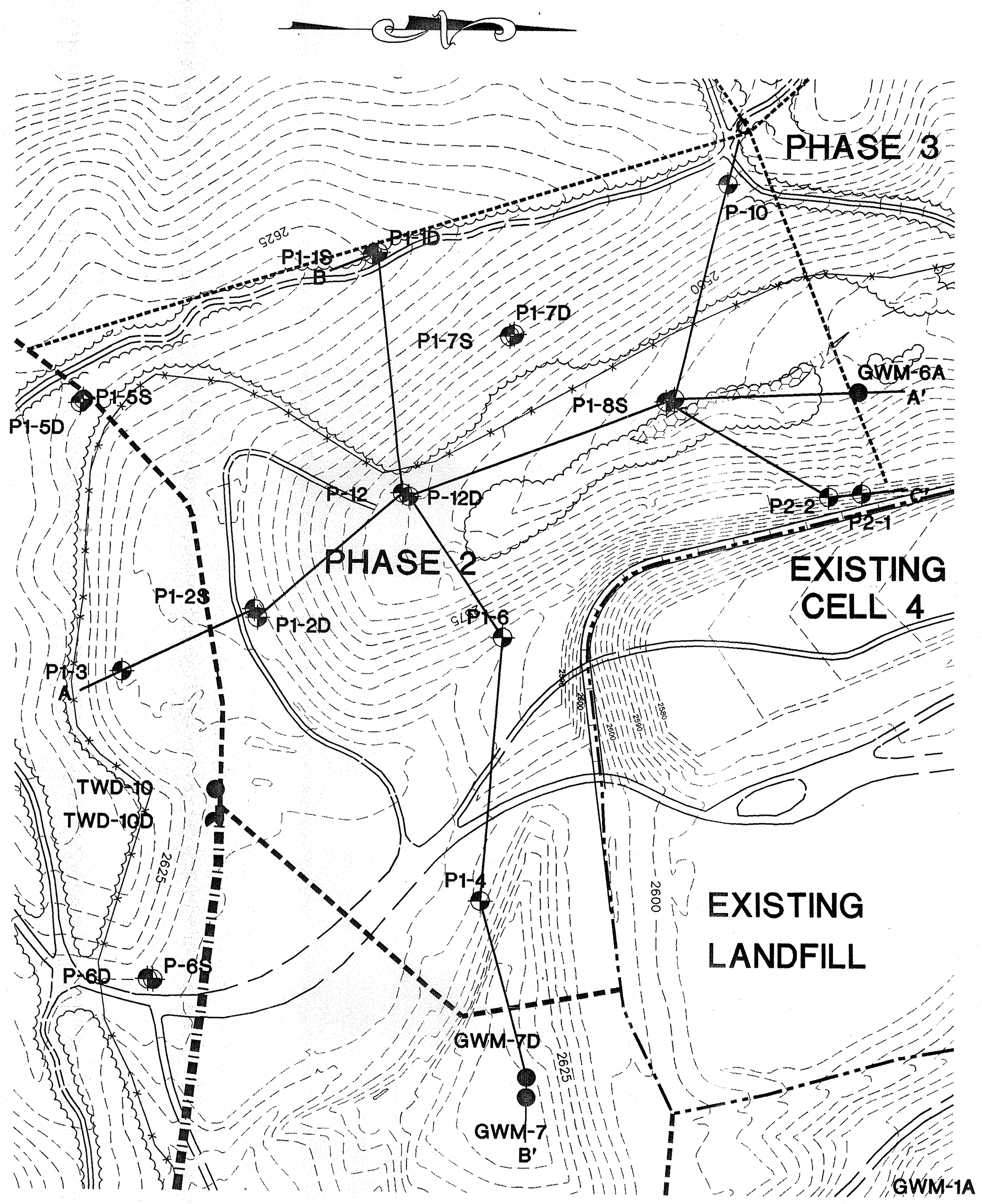
PLATE 5A

Municipal Services
Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529
P.O. BOX 349 BOONE, N.C. 28607

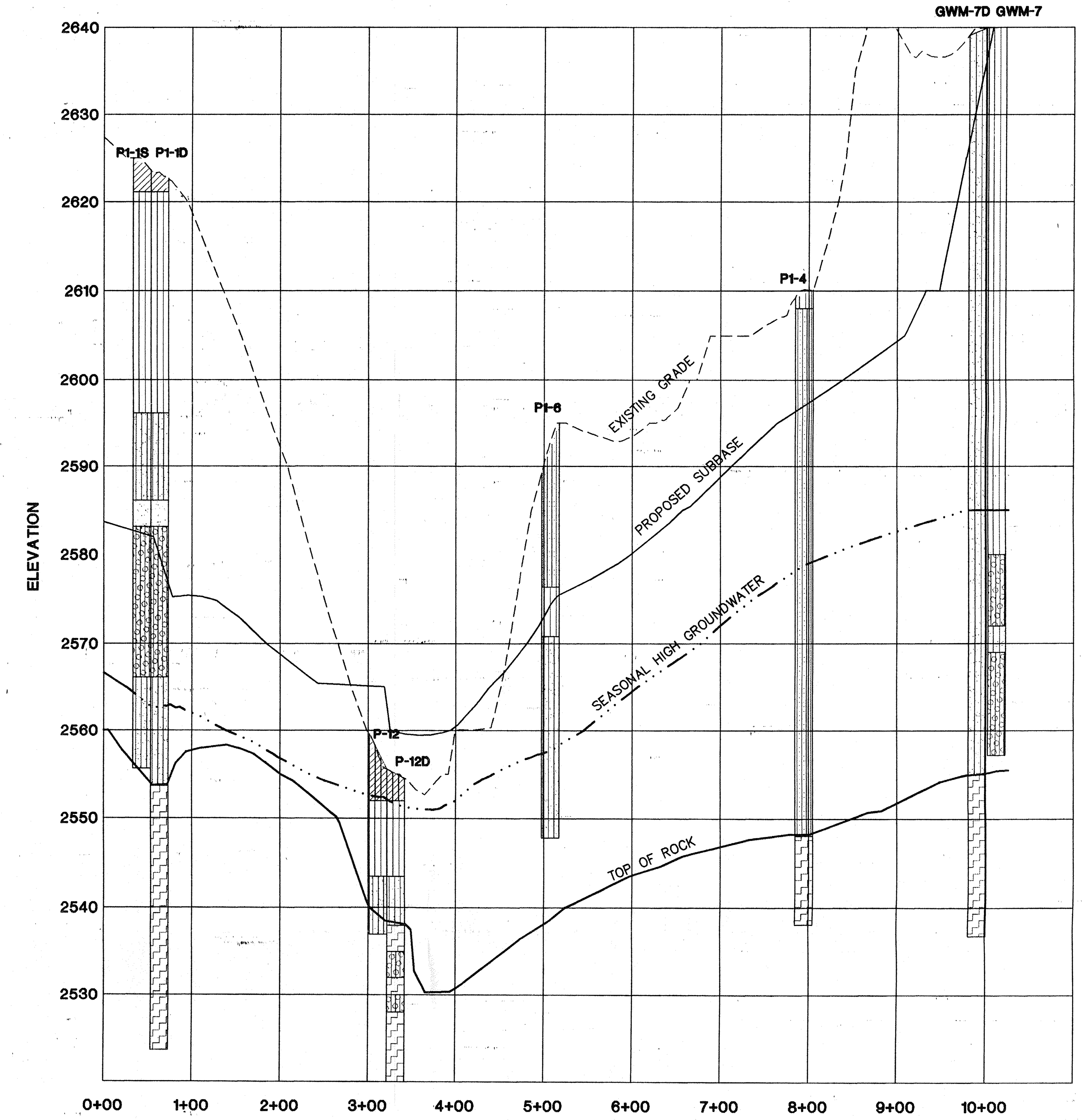
MUNICIPAL SOLID WASTE LANDFILL
HAYWOOD COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
			CROSS SECTION A-A'

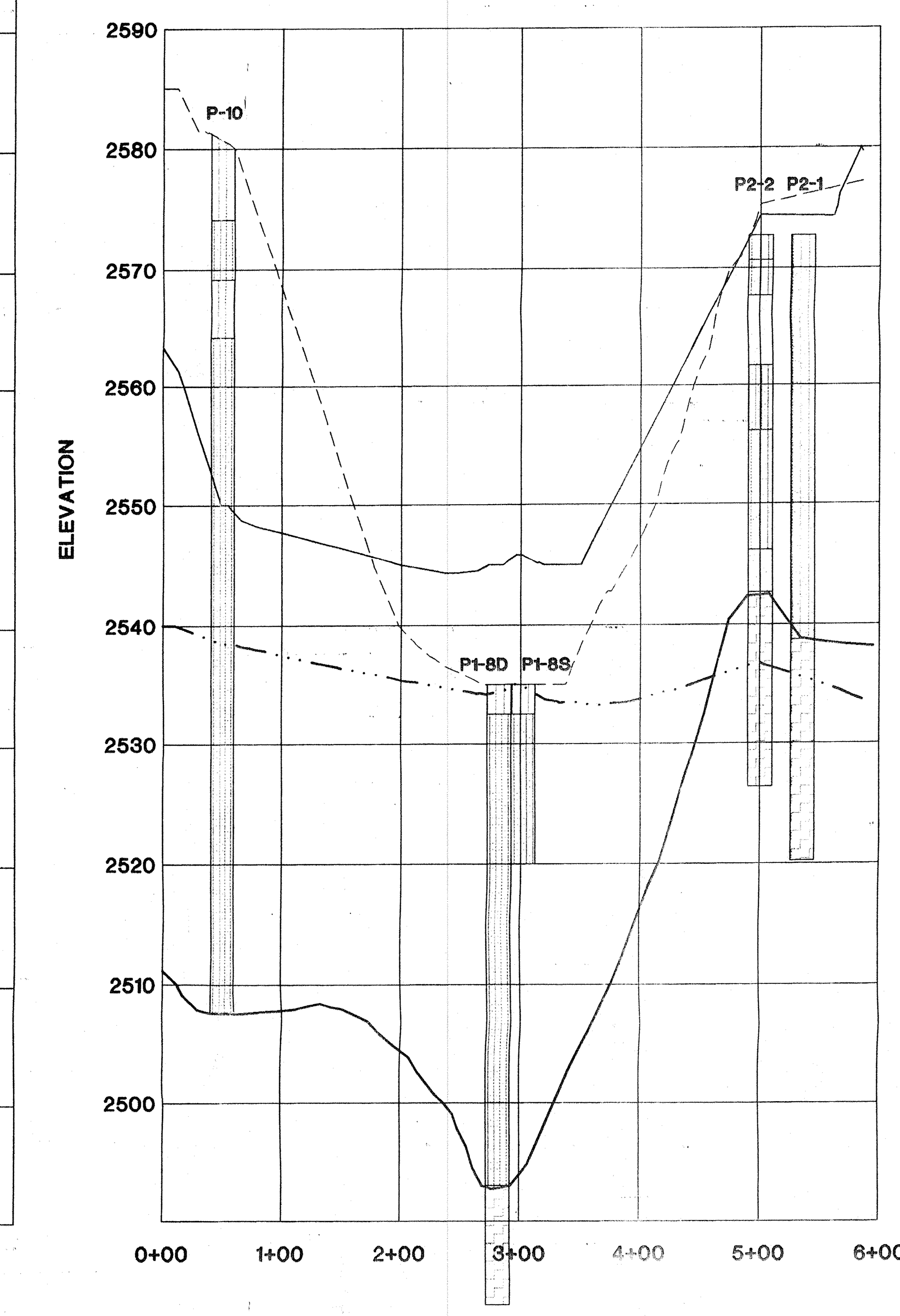
SCALE: 1" = 100'
DATE: 3/29/00
DRWN. BY: L. HAMPTON
CHKD. BY: E. CUSTER
PROJECT NUMBER: G98010
DRAWING NO.: CS
SHEET NO.: 2 OF 3



PLAN VIEW
SCALE: 1" = 100'



SECTION B-B'
SCALE: HORIZ.: 1" = 100'
VERT.: 1" = 10'



SECTION C-C'
SCALE: HORIZ.: 1" = 100'
VERT.: 1" = 10'

LEGEND:

- EXISTING GRADE
- PROPOSED SUBGRADE
- SEASONAL HIGH GROUNDWATER
- TOP OF ROCK

NOTE:
ALL BOUNDARIES ARE APPROXIMATE.
INFERRED BETWEEN BORING LOCATIONS.

SOIL TYPE LEGEND

CLAYEY SILT
SILTY SAND
SANDY SILT
CLAY
PARTIALLY WEATHERED ROCK
SILT
SANDY SILT
SILTY CLAY
SAND
GNEISS

PLATE 5B

Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529
P.O. BOX 349 BOONE, N.C. 28607

MUNICIPAL SOLID WASTE LANDFILL
HAYWOOD COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

CROSS SECTION B–B' AND CROSS SECTION C–C'

SCALE:	1" = 100'
DATE:	3/29/00
DRWN. BY:	L. HAMPTON
CHKD. BY:	E. CUSTER
PROJECT NUMBER	G98010
DRAWING NO.	SHEET NO.
CS	3 OF 3

SINGLE DAY GROUNDWATER READINGS 3/14/00		
PIEZOMETER NUMBER	TOP OF PIPE	WATER ELEVATION
P-6	2594.19	2536.72
P-6S	2612.40	2563.47
P-10	2581.86	2528.33
P-11	2553.87	2535.42
P-12	2557.62	2547.27
P1-1S	2628.07	2558.17
P1-2S	2604.01	2567.66
P1-3	2612.35	2586.87
P1-5S	2636.07	2581.22
P1-6	2592.18	2551.83
P1-7S	2576.76	2544.41
P1-8S	2536.11	2532.81
GWM-5A	2504.06	2496.71
GWM-6A	2530.52	2523.12
GWM-7	2645.74	2576.94
TWD-10	2617.16	2581.26
P1-4	2613.42	2575.47

FLOW RATE CHART		
LINE TABLE		
LINE	LENGTH	BEARING
L1	65.69	N73°57'31"E
L2	116.36	S71°24'17"E
L3	156.61	N41°03'05"E
L4	24.04	N84°02'56"W
L5	45.19	N08°11'01"W
L6	77.38	N25°21'57"W
L7	75.81	N40°07'49"W
L8	57.28	N22°19'07"W
L9	88.91	N25°20'10"W
L10	104.63	N66°39'42"W
L11	65.82	N20°20'00"E
L12	61.95	N14°27'07"W
L13	65.35	N22°27'39"E
L14	43.45	N24°10'02"W
L15	94.07	N00°30'15"W
L16	77.02	N33°08'11"W
L17	94.22	N45°47'11"W

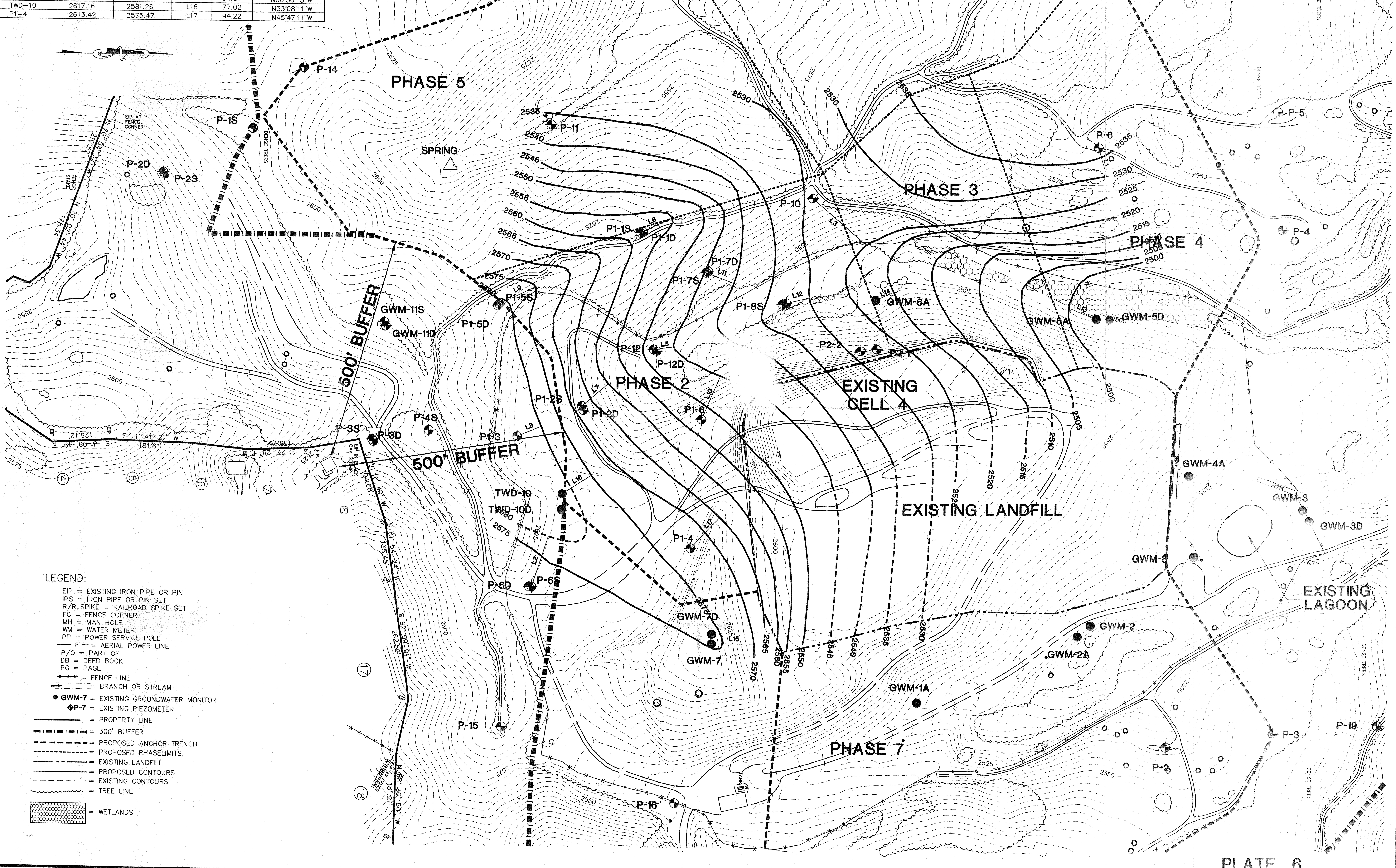


PLATE 6

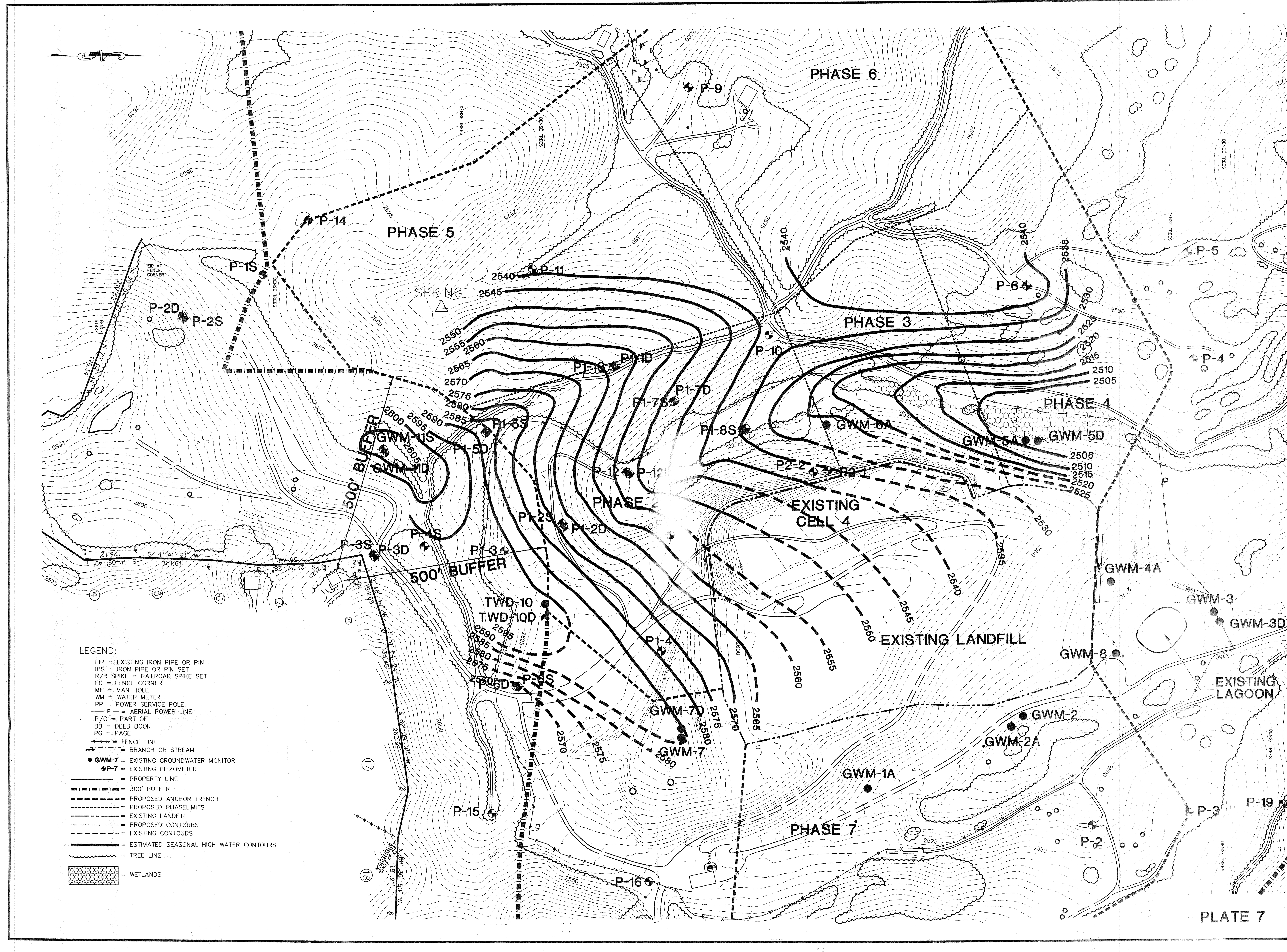
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 / P.O. BOX 349 BOONE, N.C. 28607

MUNICIPAL SOLID WASTE LANDFILL
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SINGLE DAY POTENTIOMETRIC MAP READINGS FROM MARCH 14, 2000

SCALE:	1" = 100'
DATE:	3/29/00
DRWN. BY:	L. HAMPTON
CHKD. BY:	E. CUSTER
PROJECT NUMBER	G98010
DRAWING NO.	SD
SHEET NO.	1 OF 1



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P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

MUNICIPAL SOLID WASTE LANDFILL
HAYWOOD COUNTY NORTH CAROLINA

SEASONAL HIGH POTENTIOMETRIC MAP

SCALE:	1"= 100'
DATE:	3/30/00
DRWN. BY:	B. BADEY
CHKD. BY:	E. CUSTER
PROJECT NUMBER	G98010
DRAWING NO.	SH2
SHEET NO.	1 OF 1