Subsurface Investigation
and Geotechnical Testing
Proposed Harnett County Monofill (TIRES)
Johnsonville, North Carolina
May 17, 1991

Prepared For

Tribble & Richardson, Inc.
Raleigh, North Carolina

Prepared By

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Environmental Consultants

May 17, 1991

Tribble & Richardson, Inc.
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Raleigh, North Carolina 27607

Attention: Mr. Richard Wood, P.E.

Reference: Report of Subsurface Investigation and Geotechnical Testing
Proposed Harnett County Monofill
Johnsonville, North Carolina
Aquaterra Job No. 548

Dear Mr. Wood:

Aquaterra, Inc. (Aquaterra) is pleased to present you with the following report describing the findings of subsurface investigation and geotechnical testing activities at the above referenced site. The field investigation was performed in accordance with Aquaterra proposal No. P591-90. As requested, the investigation and supplementary data provided to Tribble & Richardson (T&R) will partially satisfy permitting requirements for the proposed site as specified by the North Carolina Solid Waste Management Rules as codified in the NCAC, Title 10, Subchapter 10G, .0504.

Following herein are the results of the subsurface drilling investigation, hydraulic conductivity testing, geotechnical testing, and regional reconnaissance. Also, included is a proposed ground water monitoring plan designed to characterize ground water conditions beneath and adjacent to the proposed monofill once it is operational.

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If we can be of further assistance or if you should have any questions concerning the data provided in this report, please feel free to call me at (919) 859-9987. Aquaterra appreciates the opportunity to be of service to Tribble & Richardson, Inc.

Sincerely,

AQUATERRA, INC.

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1 Introduction

Aquaterra, Inc. (Aquaterra) was retained by Tribble & Richardson (T & R) to perform a subsurface investigation and geotechnical testing activities to satisfy a portion of the application requirements of the North Carolina Solid Waste Management Rules, Title 10, NCAC, Subchapter 10G, .0504, *Application Requirements for Sanitary Landfills*. The purpose of the investigation was to provide information to T & R concerning subsurface conditions on a tract of land being considered as a potential scrap tire monofill.

1.1 Scope of Work

In accordance with Aquaterra Proposal No. P591-90, a tract of land located in Harnett County near Johnsonville, North Carolina was evaluated to determine subsurface and hydrogeological conditions. Specifically, the following information was included in the proposed scope of work:

- provide an aerial photograph (scale 1" = 400' or larger) of all homes, industrial buildings, public or private utilities, roads, wells, watercourses, perennial streams, dry runs, and topographic features within a 0.25 mile radius of the site (subject to availability at the North Carolina Department of Transportation)

- locate on a map (scale 1" = 1000' or larger) all significant ground water users, potential or existing sources of ground water or surface water pollution sources, water intakes, airports or runways, and subdivisions within a 2 mile radius of the site

- conduct a geological and hydrologic study of the site which provides

  - soil boring logs
  - standard penetration testing
  - grain size analysis
  - soil classifications
  - undisturbed representative geologic samples of the unconfined and/or semi-confined hydrologic unit(s) within a depth of 50 feet that provide the following information for each major lithologic unit(s):

    saturated hydraulic conductivity
    volume percent water
    porosity

- collect and remold a sample of the cover soils and conduct laboratory tests that provide
  - saturated hydraulic conductivity
  - total porosity
  - Atterberg limits
- construct stratigraphic cross-sections identifying the lithology of the hydrogeological units
- tabulate water table elevations at time of boring, 24 hours, and 7 days with the piezometer numbers and locations accepted by the North Carolina Department of Environment, Health, and Natural Resources, Division of Solid Waste Management (DSWM)
- construct a water table map of the surficial aquifer based on stabilized water table elevations referenced to a permanent on-site benchmark. It is our understanding that Tribble & Richardson will perform the surveying requirements of this work task.
- develop a proposed ground water monitoring plan including well location and schematics showing proposed screened interval, depth, and construction
- provide recommendations concerning the suitability, distribution and quantity of cover and cap materials
- address cut slope stability

1.2 Background

The subsurface investigation was performed on a tract approximately 300 acres in size located in the Johnsonville Township of Harnett County. The site is reported to be owned by Ms. Diane T. Womble and is bound on all sides by property owned by Mr. Billy S. Thomas. This site investigation was conducted to determine whether portions of the site would be suitable for construction of a tire monofill.

As required by the North Carolina application requirements, Plate 1 presents a blue line drawing of the area within 2 miles of the proposed monofill boundaries. Additional details regarding items such as the number of houses, dwellings, water users, surface water bodies, and others were inventoried from this map and are presented in Attachment A and Plate 1.

1.3 Site Topography

The site is located approximately 3,500 feet north of the Moore-Harnett County line (see Figure 1 and Plate 1) in Harnett County. Sloping from the western border of the site to its eastern extent, the site has approximately 80 feet of relief. The site is comprised primarily of rolling sand hills covered with sparse scrub vegetation. The site drains easterly into a

branch of an unnamed tributary of Buffalo Creek. The branch and adjacent lowland areas support wetland type vegetation and hydric soil types. During the course of this study, these areas were partially submerged due to high water table conditions. The site is located within the Little River drainage basin.

1.4 General Site Geology

The site is located just east of the Fall Line in the Sand Hills unit of the Western Inner Coastal Plain physiographic province. The dominant feature within the Sand Hills unit is a deep layer of unconsolidated to poorly consolidated surficial sands. The area is characterized by rolling hills that are flat crested with altitudes up to 550 feet and local relief of up to 200 feet.

Review of the North Carolina Geologic Map (1985) indicates that the site is mapped within the stratigraphic unit comprised of the Middendorf Formation–Upper Cretaceous (see Figure 2). The Middendorf Formation is composed of a heterogeneous mix of fine to medium grained sand and silty clay beds. Coarse channel sands and thin laminated beds of sand and clay are also common. Cross bedding, lenses, facies changes and lateral discontinuous bedding are common features of these non-marine deltaic sediments. Orange clasts and mottling within the unit are common. Other characteristic features of the predominant silts, sands, and clays include color tones of pale gray, white, tan, and red. Kaolinitic clay balls and iron-cemented concretions are intermittently distributed throughout the sand beds.

No bedrock or bedrock outcrops were encountered at the site during drilling operations. Review of the U.S. Geological Survey (USGS) Open File Report 87-690, Plate 4 shows that well 65 (Lobelia) was drilled into the upper surface of crystalline bedrock at a depth of approximately 175 feet below land surface. This well is located approximately 3 miles south of the site. Based on this data, the depth to bedrock at the proposed monofill site is estimated to be greater than 100 feet below land surface.

1.5 General Site and Regional Hydrogeology

Regionally, the Black Creek Aquifer is the predominant water bearing zone primarily consisting of sediments from both the Black Creek and underlying Middendorf Formations. The updip limit of the aquifer extends north eastwardly from the Fall Line at the South Carolina State line to Johnson County, and up to Virginia. The aquifer dips east-southeast at a rate of approximately 17 feet per mile and increases in thickness approximately 38 feet per mile north easterly.

The aquifer is comprised of nearly 60 percent uniformly distributed sand. Sand percentages are reported to range between 50 to 60 percent; large variations of sand percentages depend on depositional patterns of the heterogeneous Middendorf sediments. Fine grained units consisting of glauconite are characteristic throughout the region. According to USGS data, aquifer tests conducted in the Pinehurst area derived hydraulic conductivity (K) valves on the order of 19 ft/day. In the vicinity of the proposed monofill, the Black Creek Aquifer is composed of the Middendorf Formation.

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The aquifer is immediately overlain by the Black Creek confining unit or aquitard. The dense clay unit dips eastward and thickens from less than 10 feet in its western reaches to 168 feet in the eastern coastal plain. The unit is thinnest in the Sand Hills area (10 feet or less) due to the discontinuity of the Middendorf fluvial sand and clay. In the Sand Hills area, the confining unit is highly dissected and cut through by stream beds. The unit is defined as the first clay bed occurring at the top of the Middendorf Formation.

2 Field Investigations

for 300 acres

To perform the subsurface characterization, eleven borings were performed by using a Mobile B-50 truck-mounted rotary hollow stem auger rig (see Figure 3). In six of the borings, temporary piezometers were constructed in accordance with state well construction permit no. 42-0193-WM-0111 (see Attachment B). Four of the borings, B103, B109, B110, and B111 were backfilled with cuttings immediately upon completion. Boring depths ranged from 20 feet below land surface to 50.5 feet. Two of the borings were advanced 50.5 feet below land surface to provide vertical soil correlation across the site.

2.1 Standard Penetration Testing

At each boring location, standard penetration testing was performed in general accordance with ASTM D 1586 specifications. Testing was performed by advancing a 1 3/8 inch I.D. split spoon sampler with a 140 pound hammer at 5-foot intervals. As the sampler was advanced through the sub strata, the number of blows required to advance the sampler was recorded in the drilling log. The results of the standard penetration testing are found in Attachment C.

2.2 Soil Classification

As the augers and drill rods were advanced and split spoon samples collected, boring logs were developed in the field. The samples were visually classified in general accordance with ASTM D 2488 (Unified Soil Classification System). Predominant soil types encountered included fine to medium sands (SM) and coarse grained sands (SC). Silts were present ranging in classification from fine to medium sandy silts and clayey silts (ML). Dense silty clays classified as (CL) and (CH) were also encountered.

As the boring logs indicate and published historical data support, lithology varies significantly in a horizontal direction across the site. Figure 4 shows the locations of the borings, piezometers, and orientation of cross sections A-A', B-B', and C-C'. Cross sections depicting subsurface conditions encountered are shown in Figures 5,6, and 7. The geology observed along each transect is described in Section 3.

2.3 *Piezometer Construction*

To determine the site hydrogeological conditions, drilling operations included the construction of seven piezometers. Six shallow and one deep piezometer locations were proposed by Aquaterra to assess the hydrogeologic conditions. Prior to construction, the proposed piezometer locations were reviewed and approved by the T&R project manager. Mr. Bobby Lutfy of the DSWM was also consulted prior to construction of the piezometers. Mr. Lutfy also approved the piezometer locations for the purpose of the site investigation.

During drilling operations, the open boreholes advanced by the 10.25 inch outside diameter hollow stem augers were converted to piezometers at boring locations B101 (PZ-1), B102 (PZ-2), B104 (PZ-3), B105 (PZ-4), B106 (PZ-5), B107 (PZ-6), and B109 (PZ-7). The piezometers were constructed to observe water table conditions and determine the direction of ground water flow. PZ-6 was nested with PZ-5 and screened deeper (below the Black Creek confining unit) to determine the vertical hydraulic head differential between the upper and lower aquifer.

To construct the piezometers, 2-inch diameter schedule 40 PVC casing was inserted into the open borehole. At each of the specified borings, a 10-foot length sections of 0.01-inch slotted screen was used at the bottom of the piezometer. Solid casing was extended from the top of the screen to approximately 2 feet above land surface. The annulus was backfilled with a clean coarse sand pack envelope to approximately 1 to 2 feet above the top of the screen. A bentonite seal was emplaced immediately on top of the sand pack and was extended up the annular space to slightly above the land surface. The piezometer casings were provided with watertight locking caps to prevent unauthorized entry. The piezometers were purged by manual bailing to remove fine grain sediments from the filter packs and to hydraulically connect the piezometer to the surrounding formation. Well schematics and well construction records are found in Attachment D.

2.4 *Shelby Tube Soil Sampling*

Near completion of the drilling operations, two lithologic units were identified for future use as potential cover and bottom liner material. These soil types were described as fine to medium grained sand and silts, SM and ML, respectively, and were selected for in situ sampling. At boring locations B109 and B110, one soil sample was collected by advancing Shelby Tubes into representative zones of the silty fine sand (SM). Shelby tube samples were collected at depths of 2.0 to 5.0 feet and 7.0 to 9.5 feet respectively from the boreholes. These zones were selected in the field due to the high probability that the monofill bottom would be constructed within the soil types encountered in these zones. Shelby sampling was performed in general accordance with ASTM D 1587. The tubes were advanced two feet through the subsurface into the selected zones to collect in situ samples of the monofill bottom liner material. The sample tubes were immediately sealed upon retrieval from the boring and transported to the laboratory.

2.5 Bulk Soil Sampling

Bulk soil samples were collected from boring locations B109 and B110. The samples were collected with a spade, placed in containers, and transported to the laboratory for geotechnical testing to determine the suitability of the soils for potential use as a cover material. At each location, approximately 25 pounds of soil was collected for laboratory analyses. At B109 the bulk sample was collected from 0.5 feet to 1.5 feet below land surface. At B110, the sample was collected from approximately 2.0 to 6.0 feet below land surface.

2.6 Surveying

A survey was performed by T&R's subcontractor, Tri-County Surveying of Clinton, North Carolina to establish the vertical elevations and horizontal locations of each boring location and piezometer. The elevations of the piezometer top of casings provided by T&R are listed in Tables 1 and 2. All elevations cited in the following text and illustrations are based on the data as presented to Aquaterra from this survey.

3 Site Geology

3.1 Cross Section A-A'

As shown in Figure 5, the predominant soils observed outcropping along this transect and along the western edge of the site were identified in the field as a red-brown fine sandy silt (ML). The unit ranges in thickness from approximately 5.5 feet at B101 to 3.5 feet at B106. The unit is observed to be prominent along the crest of the ridges on site and mapped at elevations above the 330 feet contour. This is evidenced by boring logs showing the presence of the unit at B101, B107, B108, B109, and B110. The unit has been eroded away at elevations below the 330 feet contour as evidenced by the findings at B102, B103, and B104 (see Figure 5).

As the cross section illustrates, the unit has been extrapolated at B104 above the actual elevation of the boring to depict that the unit was continuous prior to its erosion. At the southern end of the transect (near B106, B107, and B111) a dense purple to gray clay unit underlies the above referenced tan brown clayey silt unit. The dense clay unit is found only at the extreme southern end of the transect and pinches out in a northerly direction as evidenced at B109.

Beneath the dense discontinuous clay unit is a fine to medium grained gray to tan brown interbedded sand classified as SM. The unit varies in thickness along the transect, but appears to be continuous. Immediately below this unit is a dense dark gray and red brown mottled clay that is apparently continuous along the transect in a north-south direction. All sediments lying above the dense clay layer are believed to be members of the Middendorf Formation.

3.2 Cross Section B-B'

As illustrated in Figure 6, at B109, the (ML) silt unit is approximately 4 feet thick and pinches out in a northeasterly direction (downdip). The unit is not identified at elevations below the 330 feet contour and is believed to have eroded at below these elevations, as the cross sections depict. The unit does not out crop at any other boring locations along this transect. Immediately underlying the unit is a tan brown fine sand (SM).

Along the B-B' transect the water table elevation ranges from approximately 8 feet below topographic surface (B109) to 5.5 feet (B102). Note that the elevation of the water table at boring B104 is not representative of ground water conditions depicted at this location on the transect; the boring B104 has been tied back to the transect to provide additional data for illustrating the subsurface geologic conditions. Between B109 and B101, the upper silt and sand unit has been extrapolated to illustrate that the units probably existed at B104 during the Cretaceous Period, but has been eroded since that time. As seen in the cross section, the topographic elevation of B104 has been adjusted to an elevation equivalent to that of its intersection with the transect. It should be noted that in the field at B104 high water table conditions were observed due to topographic elevation changes. Review of the cross section should not be misconstrued or interpreted that high water table conditions occur at that location of transect (see Figure 6).

Below the thin veneer of red brown clayey silt is a thick unit of fine to medium grained tan brown silty sand. Some interbedding of light gray clayey sands occurs within this unit. The continuous unit ranges in thickness from approximately six to seventeen feet. At the western end of the transect, a thick dense gray clay dissects the sand unit and pinches out as observed at B102.

Below the apparently continuous medium grained sand unit is a thin layer of discontinuous dense gray clay underlain by a dissected massive gray clayey silt classified as ML. As observed at B103, the silt unit is over 31 feet in thickness. The silt unit is believed to be underlain by more clay as evidenced at B104 and B103. These sediments are believed to also be members of the Middendorf Formation.

3.3 Cross Section C-C'

Beginning with B105, this transect shows fine to medium grain sand (SC) outcropping and pinching out laterally in southeast direction (see Figure 7). Underlying the unit mapped as a silt (ML) at B111 is a massive dense gray to purple fine sandy clay (CL). As observed at B111 the clay is approximately 22.5 feet thick, but is limited in lateral extent. The highly plastic clay material encountered at this location as well as B107 and B106 would be ideal for use as a bottom liner material; however, its limited extent does not make this a feasible option. The elevation of B111 has been adjusted to an elevation equivalent to that of the intersection with the transect (see Figure 6).

Underlying the thick massive discontinuous clay deposit are the fine to medium and coarse grained sands classified as SM, SW, and SC. The units typical thickness across the site is greater than 20 feet. As evidenced by B108 the unit is underlain by the dense gray to purple clay unit classified as CL. These are also believed to be members of the Middendorf Formation.

3.4 Summary of Geology

Three primary lithologic units have been classified as a result of drilling operations and are depicted in the above referenced cross sections. The units identified and classified consist of members of the Middendorf Formation to include sand (SC, SM, and SW), silt (ML), and clay (CL). During drilling operations significant stratigraphic variation was noted among each of these units depending on horizontal and vertical location within the units. Grain size, percent of secondary minerals, color, and density varied within each unit; however, to simplify the description of the soil types encountered the generic terms have been assigned.

The clay unit depicted in the cross sections consisted of highly plastic clays with varying percentages of silts and sands. The competent clay unit would likely be a suitable bottom liner material; however, due to its limited areal extent and depth (22 to 40 feet deep) would not be feasible to pursue as a liner material. One exception to this is in the southwest corner of the site near B111. A significant deposit of clay exists in this general location. The upper extent of the dense clay unit is just below land surface and is greater than 20 feet thick at this boring location.

Typically, overlying the dense clay unit are various fine to medium and coarse grained sands. The variable grained sands (classified as one lithologic unit) range in thickness from approximately 6 feet to over 25 feet. This unit is observed to outcrop in the lower elevations of the site as well as in drainways where the overlying silt unit has likely been eroded exposing the upper surface of the sands. The availability (extensive areal extent and limited depth) make this an ideal source material for cover material. Within the sand unit interbedded fine grain to medium sands and coarse grain sands exist. Color, grain size, and clay fractions with the sand unit varies significantly across the site.

Immediately overlying the variable grained sands is a thin veneer of fine sandy silt. The thin silt unit is exposed primarily along the upper elevations of the site occurring along the tops of ridges. Due to the materials extremely fine grained texture and moisture contents observed in the field, the unit exhibited plastic behavior. Because of these properties, the unit was not classified in the field as a member of the underlying variable grained sand unit.

4 Site Hydrogeology

4.1 Ground Water Level Measurements

To determine the elevation of the ground water surface, two rounds of measurements were performed. Water level measurements were obtained one day and several days after piezometer construction. Water level measurements were obtained by using an Olympic Well Probe, an electronic water level measurement device. The measurements were obtained by lowering the tape until the analog meter was activated. The reading on the tape corresponding with the casing measuring point was then recorded to the nearest 0.01 foot. The measurements were then used along with the survey data to construct the potentiometric map shown in Figure 8.

4.2 Water Table Conditions

As illustrated by Figure 8, the direction of ground water flow in the surficial aquifer is generally in a southeast to easterly direction. The direction of ground water flow is observed to be directed toward points of discharge or drainage in the lowest elevations on-site. During drilling operations, surface water was observed standing in many areas on the eastern portion of the site below elevation of approximately 295 above sea level. The areas of standing surface water are believed to be areas that ground water has breached the topographic land surface. Both ground water flow and primary site drainage are to the eastward border of the site. It is estimated that the water table elevations observed during the site subsurface investigation are representative of the approximate mean seasonal high water table. However, to effectively estimate the elevation of the mean seasonal high water table it is recommended that frequent piezometer measurements be performed for at least one year.

The nested piezometers PZ-5 and PZ-6 reflect a vertical gradient indicating slight recharging conditions or downward movement from the water table aquifer to the lower semi-confined aquifer. These conditions are representative only in the location of that piezometer nest and are not believed to be representative of ground water conditions topographically lower elevations of the site to the southeast. As previously referenced, surface water standing below elevations of 300 feet above sea level are believed to be ground water discharging or moving upward to breach land surface. To verify this, a nest of piezometers would need to be installed in these lower elevations and water level measurements obtained.

To calculate the horizontal gradient (I_h), the following equation was used :

$$I_h = \frac{h_1 - h_2}{L}$$

Typical horizontal hydraulic gradients across the site range from approximately .02 to .06 feet/foot. These calculated gradients are consistent with the published data from other sites within the sand hills.

To determine the vertical gradient (I_v) between the unconfined water table aquifer and the lower confined aquifer, water level measurements at PZ-5 and PZ-6 were obtained and a calculation was performed. The vertical gradient is expressed as:

$$I_v = \frac{h_1 - h_2}{L}$$

The vertical gradient calculated from the measurements of the shallow and deep piezometers is 0.77 feet/foot downward.

4.3 Hydraulic Conductivity Testing

To determine the hydraulic conductivity (K) of the unconfined water table aquifer, rising head hydraulic or recovery tests were performed at PZ-1, PZ-2, PZ-3, and PZ-4. The hydraulic conductivity tests were performed by first obtaining a static water level (head) measurement and then removing a measured volume of water from the piezometer. Upon removal of the final volume of water, measurements were initiated and performed by recording the recovery of the water level versus time. These numeric values were set as a ratio of H/Ho and plotted logarithmically on the y scale and linearly on the x scale. The recovery data was mathematically reduced by methods prevented by Hvorslev (1951). The data plots and results of the field hydraulic conductivity tests are found in Attachment E. The K values computed are below for the specified piezometer locations. The computations were performed by use of the equation:

$$K_h = \frac{d^2 \ln \frac{2m\,L}{D}}{8LT}, \text{ where } m = 1$$

The hydraulic conductivity values calculated for each specified piezometer location follows. Note that two recovery tests were performed at PZ-1.

PZ-1
$K_1 = 6.02 \times 10^{-4}$ cm/sec
$K_2 = 8.13 \times 10^{-4}$ cm/sec

PZ-2
$K = 2.58 \times 10^{-6}$ cm/sec

PZ-3
$K = 5.54 \times 10^{-7}$ cm/sec

PZ-4
$K = 2.69 \times 10^{-4}$ cm/sec

PZ-1 and PZ-4 are screened across the fine-medium sand unit (SW) and coarse sand (SW). Therefore, as indicated by these computations, the sand units exhibit greater K values than the other piezometers screened across silts and less permeable units. Screen intervals of PZ-2 and PZ-3 penetrate the underlying silt and clay units as shown on the cross-sections and therefore yield lower K values than the piezometers screened across the sands by 2 to 4 orders of magnitude.

5 Geotechnical Laboratory Testing Results

Two Shelby tube samples and two bulk samples from soil borings B109 and B110, respectively, were submitted to GAI CONSULTANTS-NC, Inc. in Raleigh, NC. The samples were tested for:

- undisturbed properties (Shelby Tubes)

  - hydraulic conductivity
  - in-place density
  - natural moisture content
  - grain size distribution
  - Atterberg limits
  - porosity

- disturbed properties (Bulk Samples)

  - Standard Proctor maximum dry density and optimum moisture content
  - remolded hydraulic conductivity
  - grain size distribution
  - remolded density and water content

5.1 Shelby Tube Results

A Shelby tube sample from B109 was collected from the 2 to 5 foot interval. Based on the B109 boring log, the Shelby tube contained approximately 1.5 feet of loose, red brown sand silt (called the ML soil) overlaying 1.5 feet of loose, tan brown silty, fine sand (called the SM soil). The B110 Shelby tube sampled contained a red brown silty, fine sand (called the SM soil).

The results of the two Shelby tube samples are tabulated below:

	B109	B110
Moisture content	12.1%	5.4%
Density, pcf	104.5	117.9
Specific gravity	2.74	2.64
Liquid limit	50	21
Plastic limit	34	NP
Plasticity index	16	NP
Hydraulic conductivity in cm/sec.	2.8×10^{-4}	2.4×10^{-4}
Porosity	38.9%	28.4%
Percent sand	75	78
Percent silt	2	1
Percent clay	23	21

Based on the results, there are two different soils with similar properties. The two soils should be classified as silty sands, SM, based on the grain size distribution. The plasticity index and liquid limit values for the B109 soil and the lack of plastic index and plasticity index properties of B110 indicate that the fines are behaving as silts and not clays.

Both soils (in situ) have hydraulic conductivities (K average 2.6×10^{-4} cm/sec) higher than would be considered reasonably impermeable (general $<1 \times 10^{-6}$ cm/sec). However, both soils have a sufficient percentage of silts in the sands to be compacted into a low hydraulic conductivity liner.

5.2 Bulk Sample Results

A bulk sample was collected from B109 from 0.5 to 1.5 feet below the ground surface in the soil field classified as a loose red brown sandy silt. A bulk sample was collected from B100 from 2 to 6 feet below ground surface in the tan-red brown find sandy silt. The results of the two bulk samples are tabulated below:

	B109	B110
Liquid limit	35	26
Plastic limit	27	20
Plasticity index	8	6
Percent sand	82	73
Percent silt	2	4
Percent clays	16	23
Standard Proctor,pcf (Max. dry density)	115.8	118.0
Standard Proctor Optimum	14%	12%
Porosity	36.6%	29.4

Based on the results, it appears that the bulk soil sample from B110 is very similar to the bulk and Shelby tube samples from B109. The two bulk soil samples, based on grain size distribution and Atterberg limits, are silty sands with little actual clay properties.

Both soils were remolded, compacted, and a hydraulic conductivity test conducted on the remolded samples. The results are tabulated below:

	B109	B110
Remolded Density pcf	113.1	120.2
% Max. Standard Proctor	98%	102%
Remolded water content in pcf	13.4%	12.4%
Remolded hydraulic conductivity in cm/sec	4.3×10^{-7}	4.9×10^{-8}

Based on the results of the remolded testing at 98 percent or greater Standard Proctor, the soils represented by B109 and B110 could be compacted into a layer acceptable for an impermeable liner ($K < 1.0 \times 10^{-6}$ cm/sec). It would appear that a hydraulic conductivity of 1×10^{-6} cm/sec could be obtained from these soils with a compactive effort at approximately 90 percent standard Proctor; however, this would need to be confirmed by collection of samples under field conditions and testing in the laboratory.

6 Conclusions and Recommendations

Based on conventional requirements administered by the DSWM, it is probable that the majority of the site evaluated may be used to some degree for waste disposal purposes if the following criteria are met.

1. Limit the vertical extent of over burden excavation not to encroach within 4 feet of the mean seasonal high water table.

2. Provide a bottom liner material (of unspecified thickness) to meet a design permeability of 1.0×10^{-7} with a deviation factor of plus or minus one order of magnitude.

The subsurface investigation has identified a silty sand (SM) and/or clayey silt (ML) comprising the upper limits of the soil horizon. It is probable that when constructed, the lower limits of the monofill will extend into these units. The silt and clay fraction within this

soil complex vary in lateral and vertical direction across the site. These soils exhibit an in situ hydraulic conductivity on the order of 1.0×10^{-4}. When excavated and recompacted to 98 percent of the standard Proctor maximum dry density and a moisture content of approximately -1 to +3 percent wet of optimum, these soils will exhibit K values three orders of magnitude less. However, it may not be practical or cost effective to achieve this magnitude of hydraulic conductivity for this monofill. Compacting the soils to 90 percent of the standard Proctor maximum dry density should yield hydraulic conductivity on the order of 1.0×10^{-6}.

As determined by mottled soil cuttings from drilling operations and by water levels observed at piezometer locations, water table conditions existing at the site will limit the excavation associated with monofill construction. Anticipated excavation depths could range from 0 feet (below elevations of 290 feet above sea level) to over 7 feet (at elevation greater than 350 feet above sea level). Limiting cuts to depths no greater than this should allow for at least 4 feet of separation from the bottom elevation of the monofill to the mean seasonal high water table. In the vicinity of B104 excavation will be limited to 0.5 feet or less due to extreme high water table conditions at this location. At boring location B103 and B102, excavation should be limited to approximately two feet. A map showing the estimated excavation limits is shown in Figure 9. Above elevations of 340 feet, it is projected that excavation to a depth of six feet may be readily attained across the site. Field conditions during the time of excavation may limit cuts to elevations less than indicated by the map, if high water table conditions exist during the season in which the excavation is performed.

For daily, intermittent, or final cover material the same soils (SM) and (ML) may be used. This material is ideal for this purpose due to its geotechnical properties and availability on-site. Using this material as a daily or intermittent cover material should not require mechanical compaction. Use of the soil as a final cover should require minimal compaction and/or the addition of moisture unless the DSWM otherwise defines a specific permeability requirement for the final cover. For final cover, the material should be placed and compacted to achieve the necessary permeabilities and to provide a uniform two foot cover. A vegetative ground cover of native grasses should be immediately provided to attain a minimum of 75+ percent cover.

Control of storm water run-off during cell construction and operation will likely require the use of a series of lateral drainage ditches, berms and diversions in conjunction with a properly designed sediment basin. Typical natural grades at the site are as great as 5 percent. Due to the high percentage of sand within the soil matrix side slopes of cut ditches should not exceed a maximum angle of 1 foot (horizontal) : 1 foot (vertical). Cut slopes should be provided immediately with a ground cover to restrain accelerated erosion and prevent slope failure. Erosion control matting, such as Excelsior, could be used for velocity control.

The results of the geotechnical laboratory tests indicate that there are several silty sands (SM), comprising the upper 10 feet of the ground surface. The undisturbed hydraulic conductivity values for the sands indicate that the soils are permeable and would readily allow water to infiltrate through the unit. The soils in this uncompacted state would not

meet the normal 1 x 10^{-6} cm/sec or lower hydraulic conductivities associated with impermeable liners.

The remolded geotechnical soil test results indicate that the silt and sand mixture can be compacted into a liner. At 98 percent or greater standard Proctor, the hydraulic conductivities of the silty sands averaged 2.4 x 10^{-7} cm/sec. A lower compactive effort such as 90 percent standard Proctor may still give hydraulic conductivities approaching 1 x 10^{-6} cm/sec or less. It appears that the natural soil moistures are very close to the optimum moisture content and would fall within any soil moisture range established for compaction control.

We recommend that several additional soil borings be placed to depths of 10 feet or less to evaluate the volume of silty sand available for borrow for construction of any natural soil liners. During the boring program, several areas should have bulk soil samples collected for standard Proctors, and then remolded densities and hydraulic conductivity tests performed at 90 percent standard Proctor.

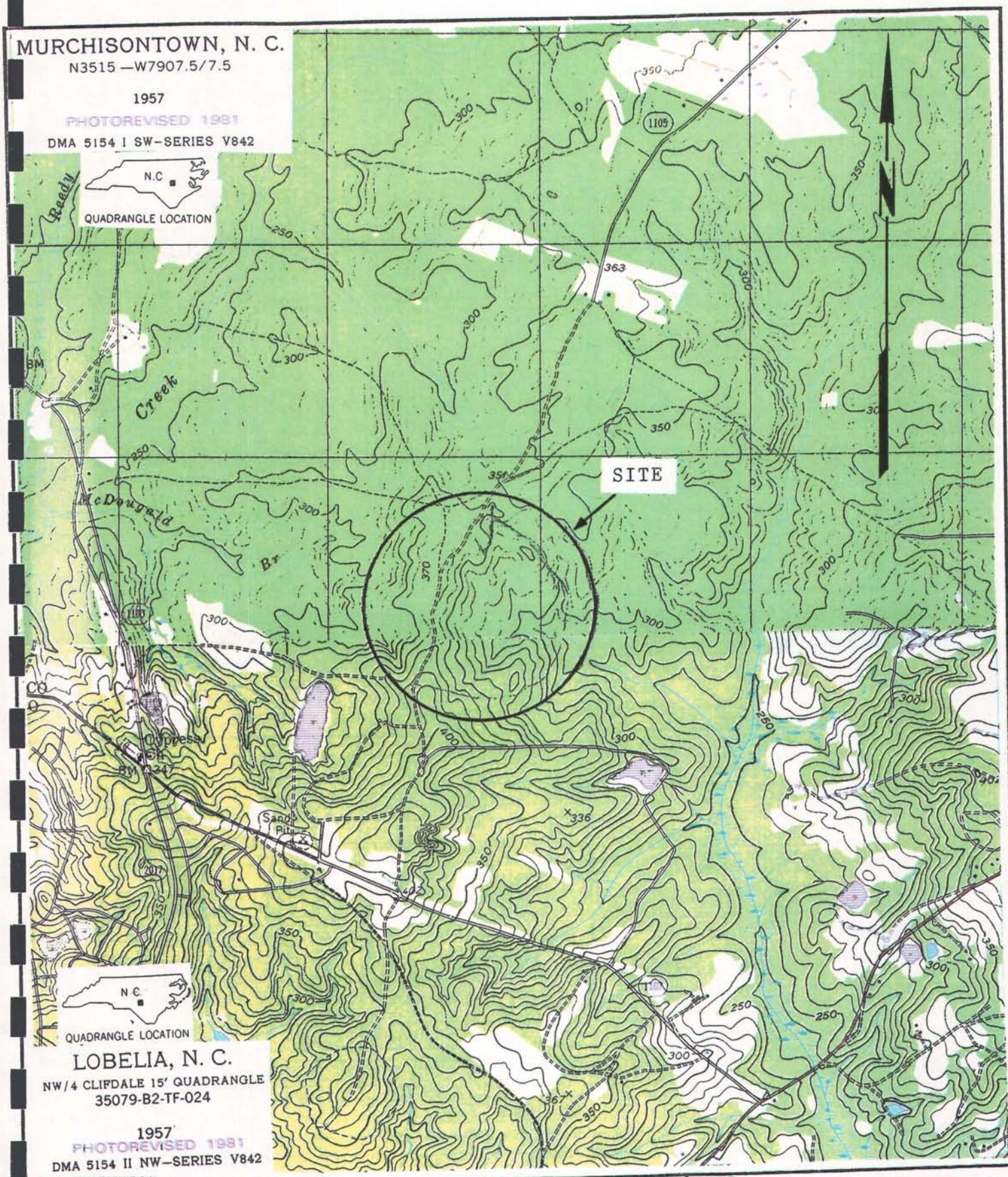
Based on our experience, we do not recommend that these soils be compacted in place. This could result in an incompetent impermeable liner. These soils will need to be excavated and placed over a graded, sloped site in loose lifts of 9 to 12 inches and compacted into dense layers. We recommend a minimum compacted liner thickness of 1 foot. In addition, we recommend that if there will be any vehicular traffic on the liner, a geotextile fabric should be placed on the liner and a 1-foot minimum thick gravel layer placed over the geotextile. The gravel layer would also aid in draining precipitation from the cell minimizing the potential for water to penetrate the liner.

7 Ground Water Sampling and Analysis Plan

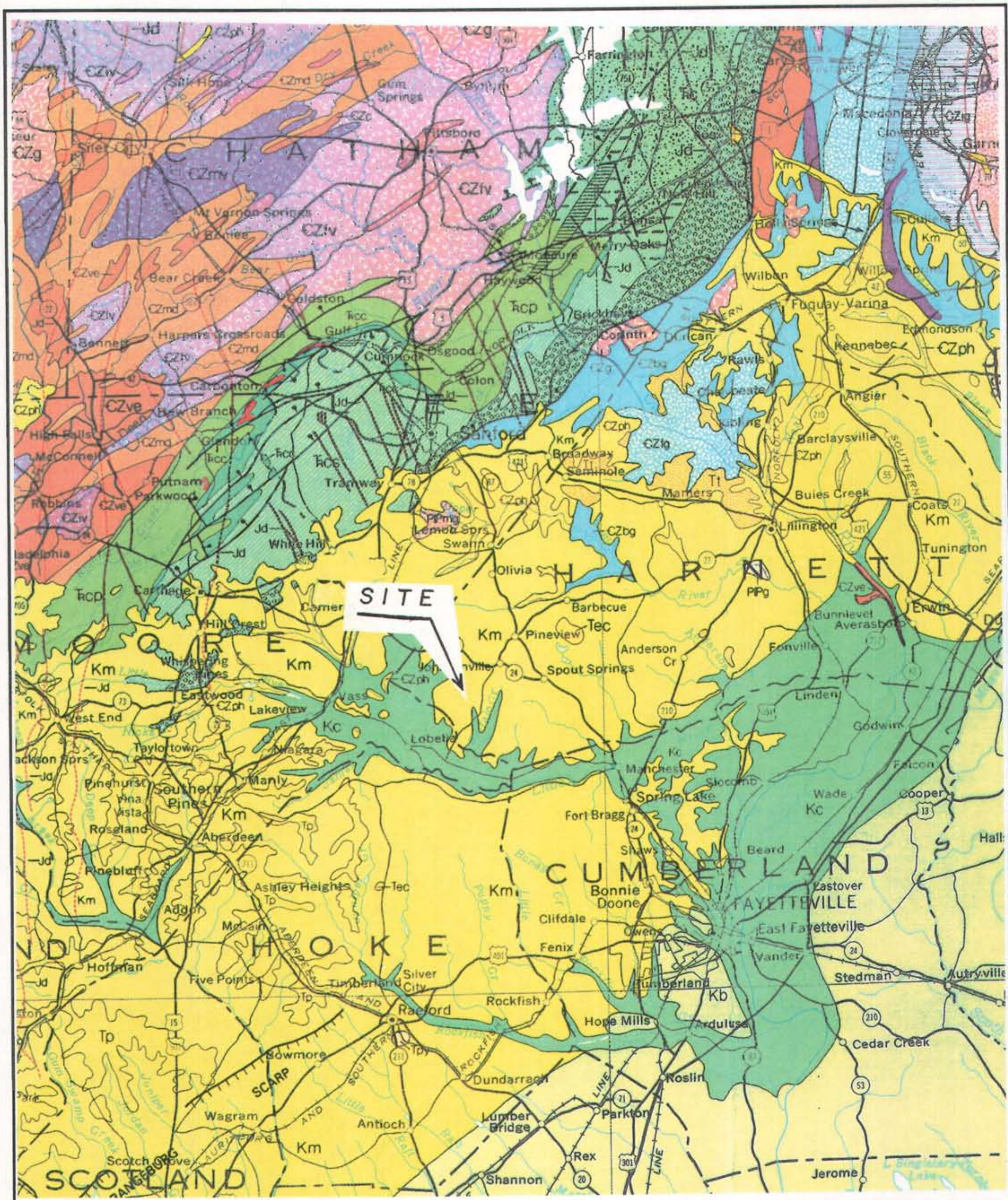
To determine the potential long-term effects from operating the proposed monofill, a ground water monitoring plan is being submitted. A total of four ground water monitoring wells are proposed and should be constructed in accordance with Title 15, NCAC, 2C, Section .0100, well construction standards. One of the proposed wells should be constructed upgradient of the proposed monofill location. The remaining three wells should be constructed hydraulically downgradient of the proposed location.

Discussions with Mr. Terry Dover and Bobby Lutfy of the DSWM indicate that the typical parameters required for sampling at permitted solid waste disposal facilities may not be required at this proposed monofill site. The typical parameters generally required may be waived in this case due to the homogeneous character of the proposed waste stream. Since the DSWM has not yet specified a sampling frequency or parameters to be sampled, these items will not be addressed in the following sampling plan found in Attachment G.

Figures



PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SITE LOCATION MAP				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: ---	FIGURE: 1	SCALE: 1"=2000'	



AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA	Author: HMT	Drawing: NA	Layers: 0,1	Date: 04-24-91	Title: Geologic Map of South Central NC
	Job No.: R-548	Revision: NA	Figure: 2	Scale: 1"= 500,000'	Project: Harnett County Monofill Johnsonville, North Carolina

CRETACEOUS

Kp — PEEDEE FORMATION — Sand, clayey sand, and clay, greenish gray to olive black, massive, glauconitic, locally fossiliferous and calcareous. Patches of sandy molluscan-mold limestone in upper part

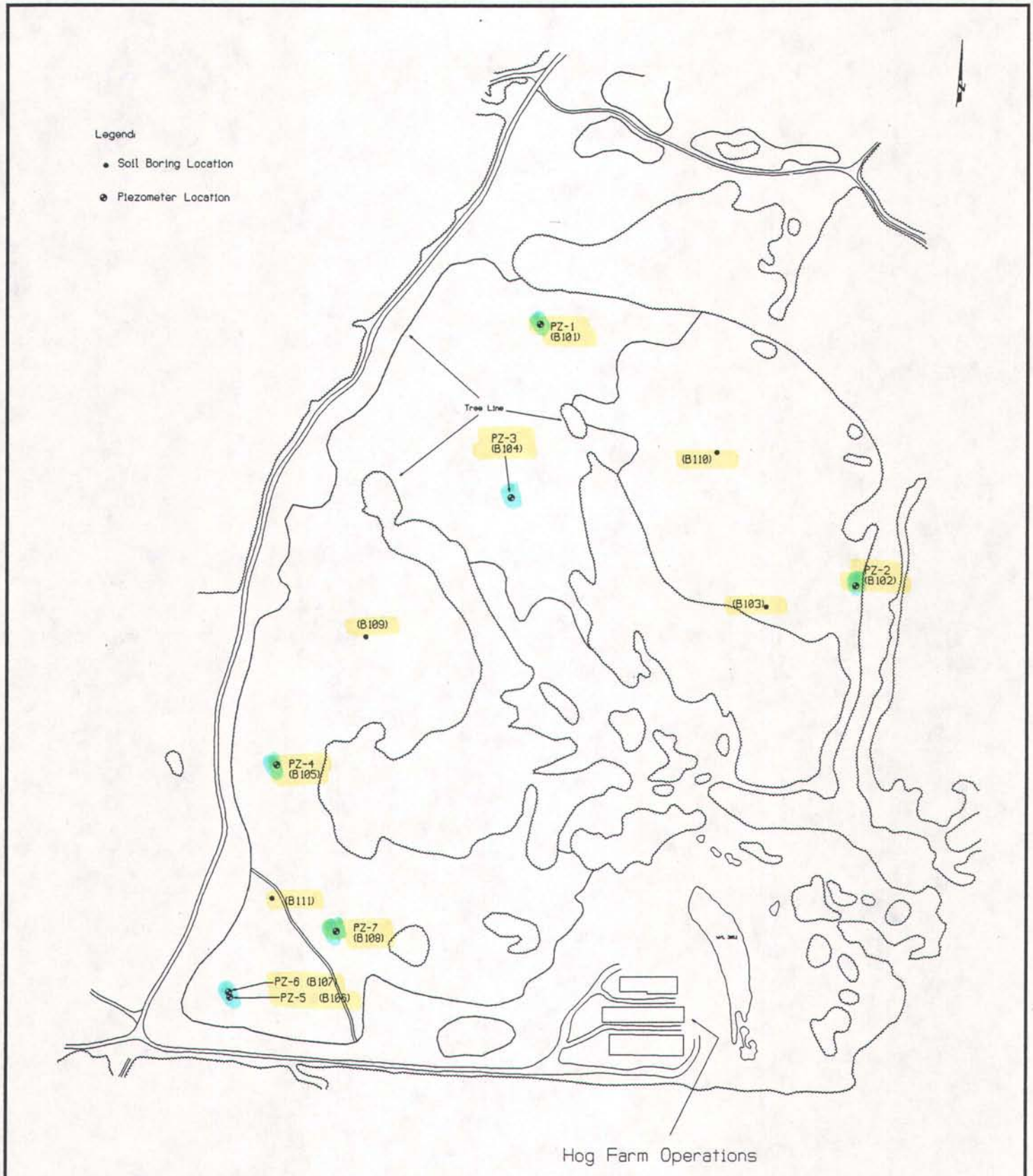
Kb — BLACK CREEK FORMATION — Clay, gray to black, lignitic; contains thin beds and laminae of fine-grained micaceous sand and thick lenses of cross-bedded sand. Glauconitic, fossiliferous clayey sand lenses in upper part

Km — MIDDENDORF FORMATION — Sand, sandstone, and mudstone, gray to pale gray with an orange cast, mottled; clay balls and iron-cemented concretions common, beds laterally discontinous, cross-bedding common

Kc — CAPE FEAR FORMATION — Sandstone and sandy mudstone, yellowish gray to bluish gray, mottled red to yellowish orange, indurated, graded and laterally continuous bedding, blocky clay, faint cross-bedding, feldspar and mica common

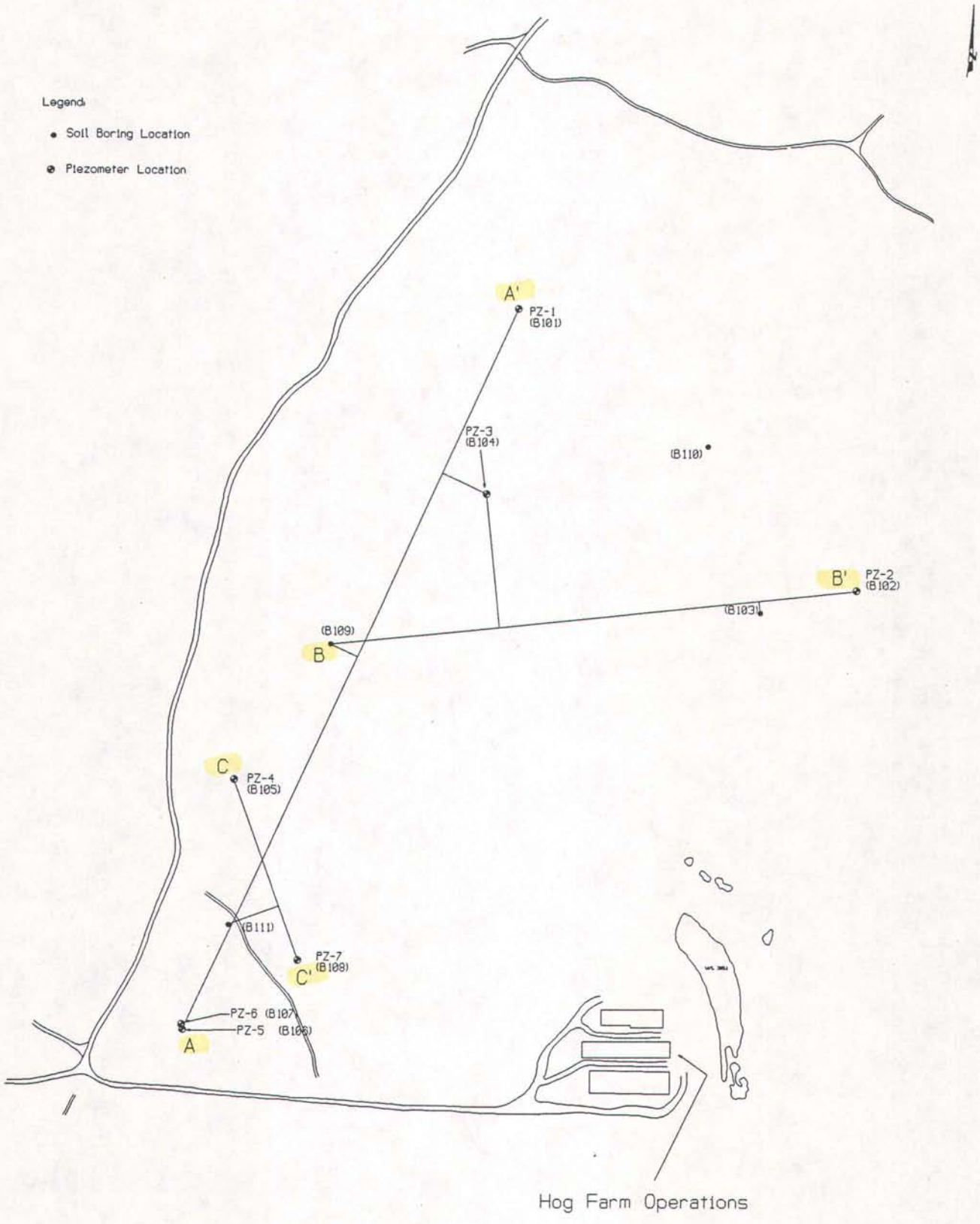
AQUATERRA, INC.
RALEIGH, GREENSBORO, CHARLOTTE
NORTH CAROLINA

Author	Drawing	Layers	Date	Title
HMT	NA	0,1	04-24-91	Geologic Explanation
Job No.	**Revision**	**Figure**	**Scale**	**Project**
R-548	NA	2a	NA	Harnett County Monofill Johnsonville, North Carolina

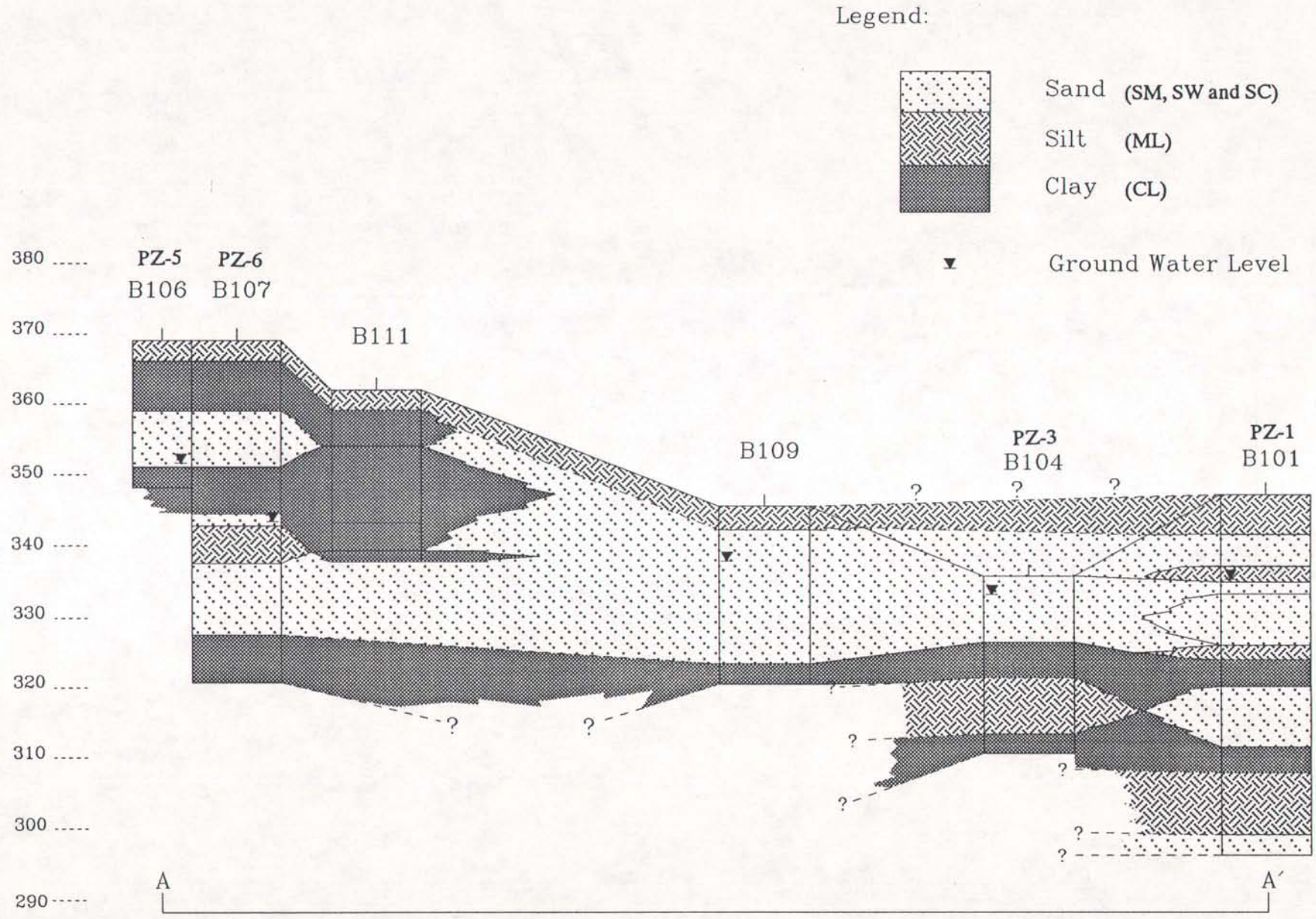


AQUATERRA, INC.
RALEIGH, GREENSBORO, CHARLOTTE
NORTH CAROLINA

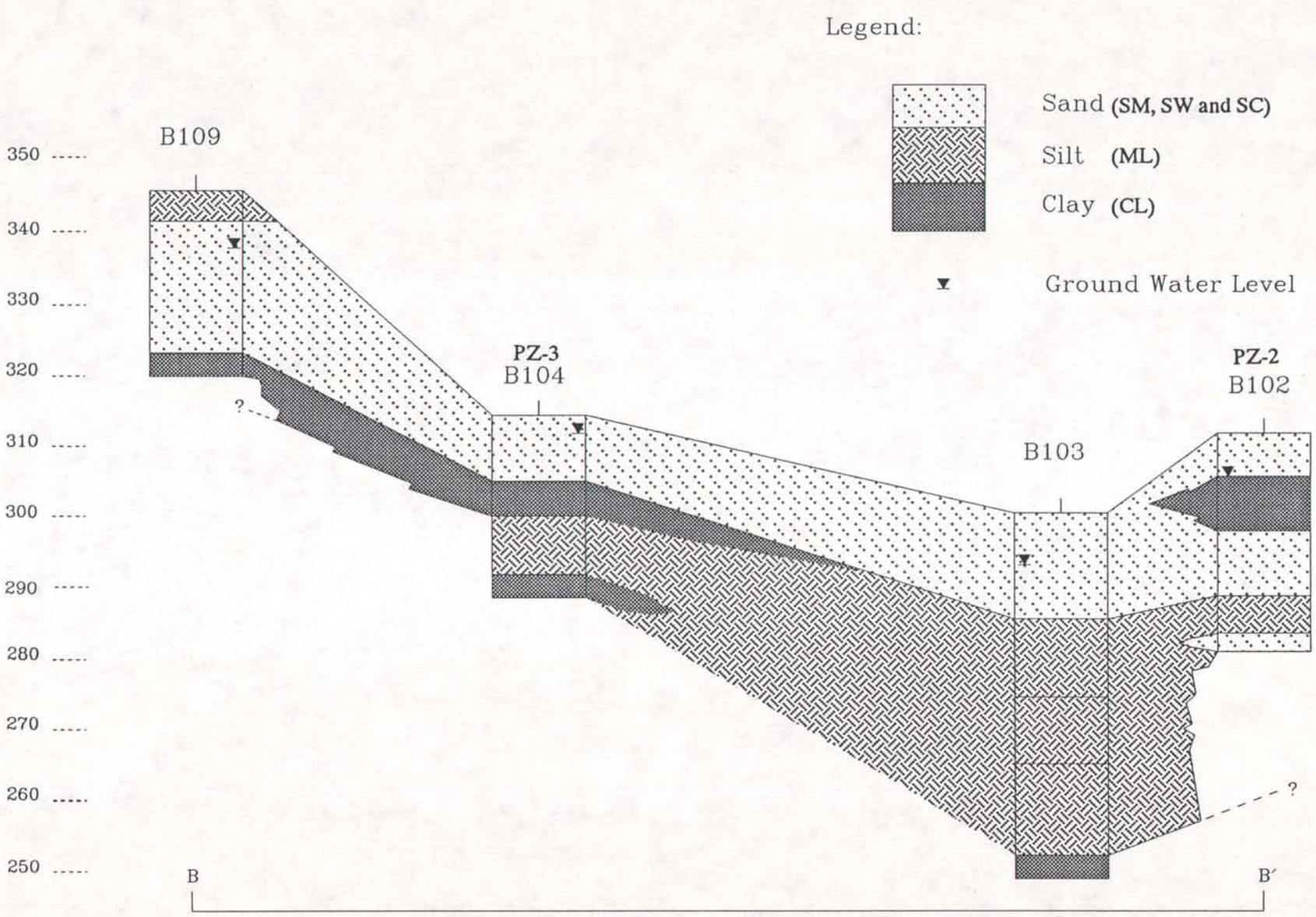
Author	Drawing	Layers	Date	Title
DLG	548-1b	0,1,3,6,8	04-08-91	Piezometer/Boring Location Map
Job No.	**Revision**	**Figure**	**Scale**	**Project**
548	8	3	1" = 400'	Harnett County Monofill Johnsonville, North Carolina



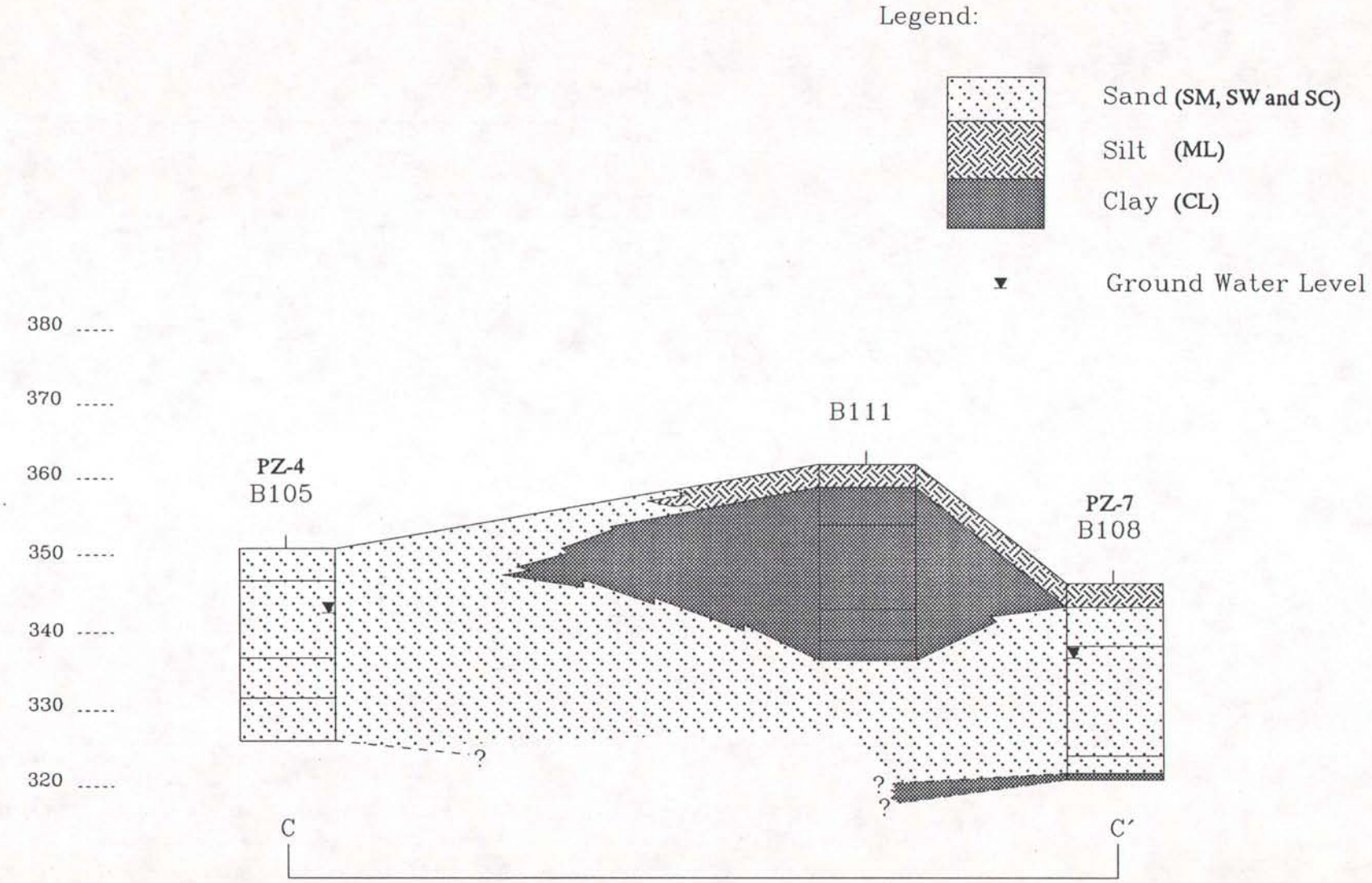
AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA	Author	Drawing	Layers	Date	Title
	DLG	548-1b	0,1,3,10	04-08-91	Cross Section Location Map
	Job No.	Revision	Figure	Scale	Project
	548	8	4	1" = 400'	Harnett County Monofill Johnsonville, North Carolina



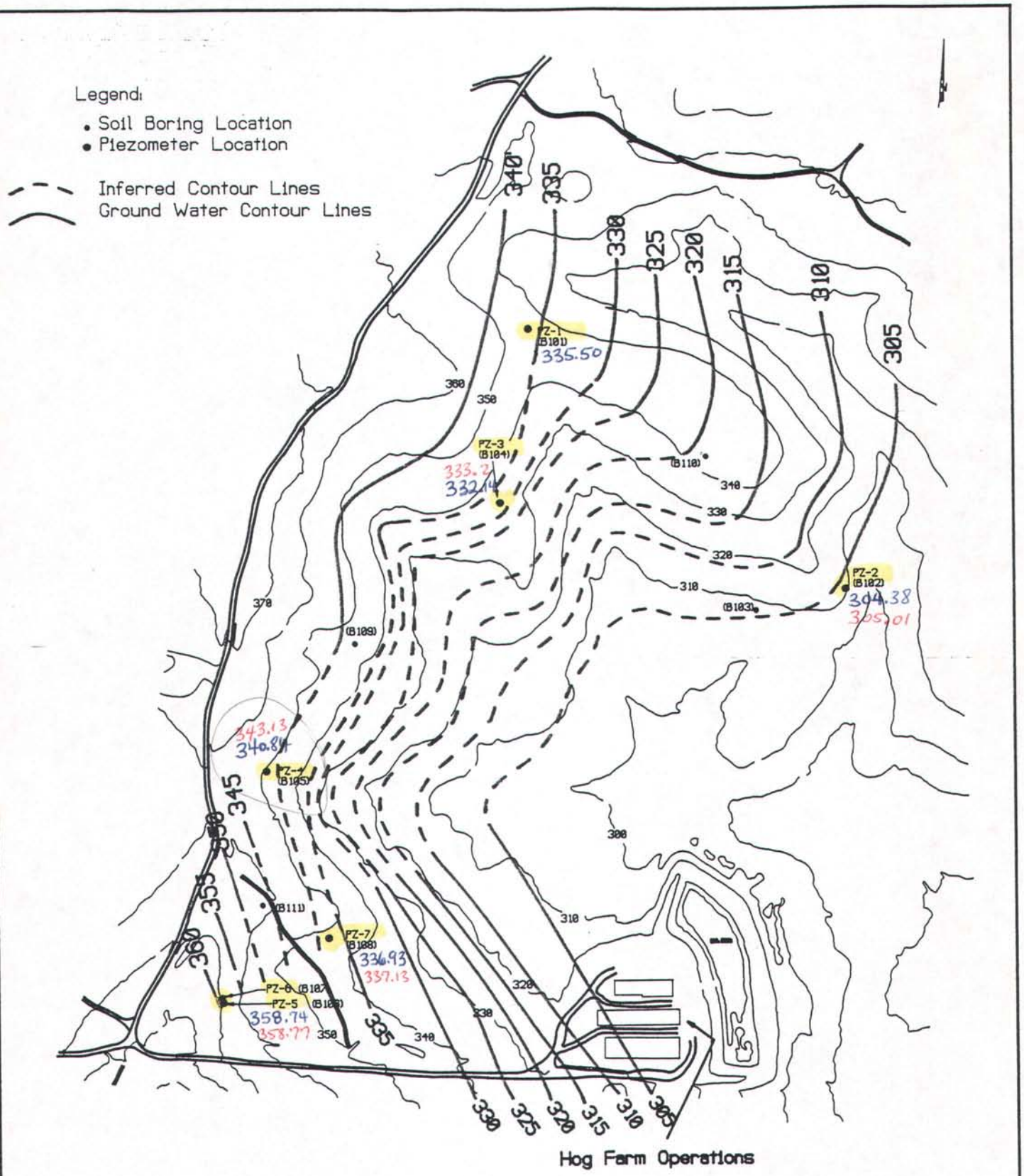
AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA	Author: DLG	Drawing: 548-2a	Layers: 0,1,2	Date: 03-28-91	Title: Geologic Cross Section A – A´
	Report: R-548	Revision: 03-29-91	Figure: 5	Scale: H 1" = 300´ V 1" = 20´	Project: Harnett County Monofill Johnsonville, North Carolina



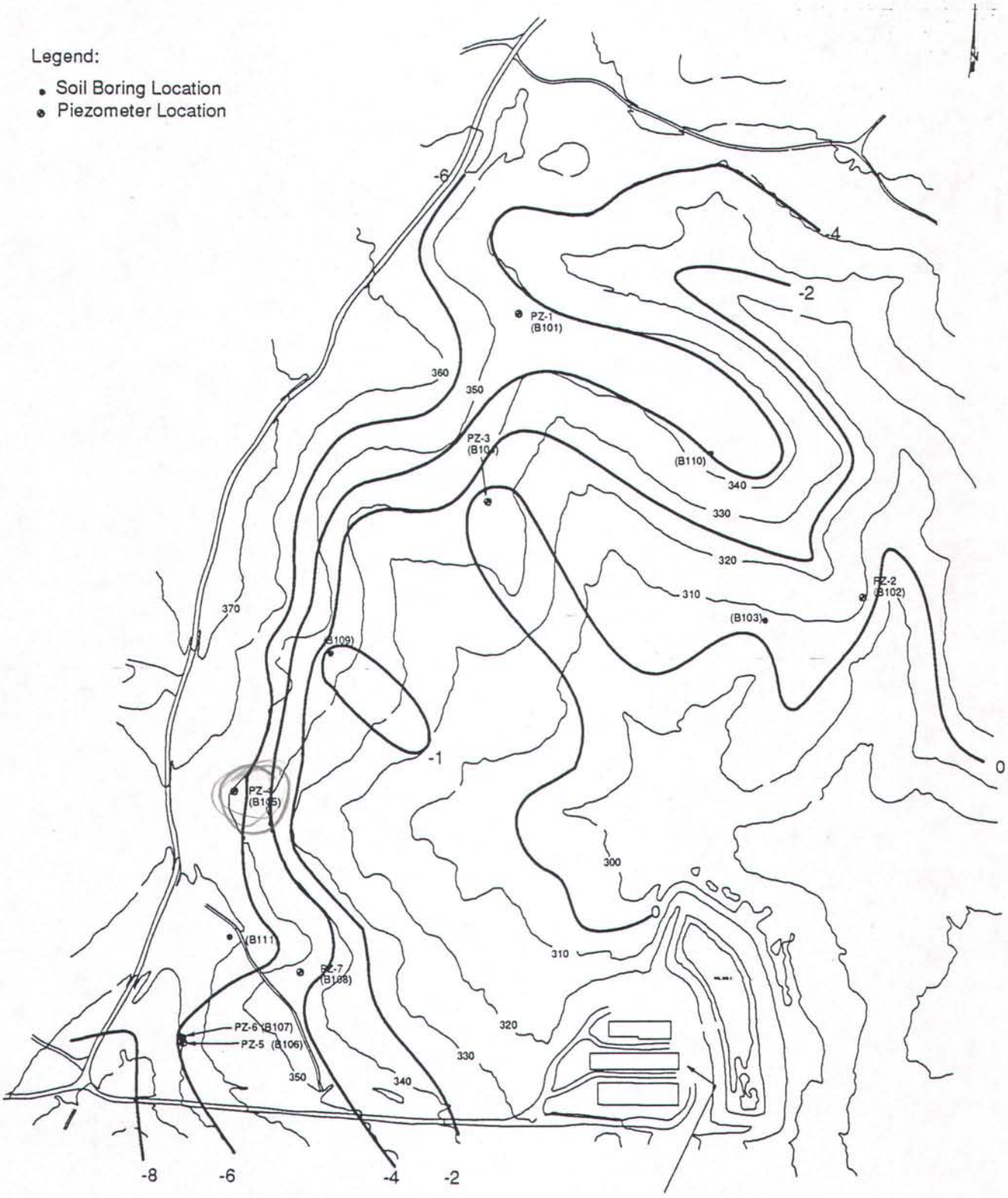
AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA					
Author: DLG	Drawing: 548-2	Layers: 0,1,2	Date: 03-28-91	Title:	Geologic Cross Section B – B′
Report: R-548	Revision: 03-29-91	Figure: 6	Scale: H 1" = 200′ V 1" = 20′	Project:	Harnett County Monofill Johnsonville, North Carolina



AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA				
Author: DLG	Drawing: 548-2b	Layers: 0,1,2	Date: 03-28-91	Title: Geologic Cross Section C – C′
Report: R-548	Revision: 03-29-91	Figure: 7	Scale: H 1" = 100′ V 1" = 20′	Project: Harnett County Monofill Johnsonville, North Carolina



AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA	Author	Drawing	Layers	Date	Title
	DLG	548-1b	8,1,3,5,7,9	04-08-91	Ground Water Potentiometric/Topographic Map
	Job No.	Revision	Figure	Scale	Project
	548	8	8	1" = 400'	Harnett County Monofill Johnsonville, North Carolina



Hog Farm Operations

AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA	Author: DLG	Drawing: 548-1b	Layers: 0,1,3,7,11	Date: 04-08-91	Title: Estimated Limits Of Excavation
	Job No.: 548	Revision: 8	Figure: 9	Scale: 1" = 400'	Project: Harnett County Monofill Johnsonville, North Carolina

Tables

Table 1. Ground Water Elevations–24-Hour Ground Water Measurements.

Well ID	Date Collected	TOC Elevation	Ground Water Depth (ft)	Elevation (ft)
PZ-1	2-7-91	347.50	11.5	336.0
PZ-2	2-8-91	314.33	10.1	304.23
PZ-3	2-13-91	338.77	5.6	333.17
PZ-4	2-13-91	354.18	15.6	338.58
PZ-5	2-14-91	372.23	13.8	358.43
PZ-6*	2-14-91	370.89	28.3	342.59
PZ-7	2-15-91	349.22	12.4	336.82

** deep piezometer*

Aquaterra Job No. 548
R1289-91

Table 2. Ground Water Elevations—7-Day Ground Water Measurements.

Well ID	TOC Elevation	Ground Water Depth (ft)	Elevation (ft)		Δ +
PZ-1	347.50	12.0	335.50	?	?
PZ-2	314.33	9.95	304.38	305.01	0.63
PZ-3	338.77	6.63	332.14	333.2	1.06
PZ-4	354.18	13.34	340.84	343.13	2.29
PZ-5	372.23	13.49	358.74	358.77	0.03
PZ-6*	370.89	26.37	344.52	344.96	0.44
PZ-7	349.22	12.29	336.93	337.13	0.20

** deep piezometer*

Date of ground water measurement for all piezometers was 2-18-91

Aquaterra Job No.
R1289-91

long-term seasonal high water table ?

Attachments

Attachment A

REQUIRED ITEMS IDENTIFIED WITHIN TWO MILES OF PROPOSED SITE'S BOUNDARIES

I. Significant Ground Water Users – Houses assumed to be on private private wells would be major ground water users.

House Locations Within 2-Mile Radius of Site

21 houses located along County Road 1105 in Harnett County
21 housed located along or in the immediate vicinity of County Road 1103 in Harnett County (Also 1 church at the intersection of CR1102 and CR 1107 at Cypress Church)
5 houses located along or in the vicinity of County Road 1104 in Harnett County
51 houses located along or in the vicinity of County Road 1106 in Harnett County
15 houses located along or in the vicinity of County Road 1109 in Harnett County
8 houses located along or in the vicinity of County Road 1108 in Harnett County
7 houses located along or in the vicinity of County Road 1107 in Harnett County
8 houses located along or in the vicinity of County Road 2018 in Moore County
2 houses scattered between County Roads 1105 and 1106 in Harnett County
4 houses scattered between County Roads 1103 and 1105 in Harnett County
17 houses located in what looks like a subdivision on the eastern side of Lake Surf in Moore County

163 Total Houses
1 Church

II. Potential or Existing Sources of Ground Water and Surface Water Pollution

None visible on topo map except possibly farm or agricultural related activities and runnoff from these activities.

III. Water Intakes

1. An unnamed tributary of Buffalo Creek flows in north-south direction approximately 1,500 feet east of site. This unnamed tributary has 2 smaller unnamed tributaries, one of which flows northwest ot southeast directly from site, the other flows northwest to southwest approximately 5,000 feet northeast of site.

2. McDougald Branch flows in east-west direction located approximately 1,000 - 1,500 feet west of site.

3. Cypress Creek flows northeast to southwest, located approximately 6,000 feet northwest of the site, with a small unnamed tributary flowing southeast to northwest approximately 1,000 feet northwest of site.

REQUIRED ITEMS IDENTIFIED WITHIN TWO MILES OF PROPOSED SITE'S BOUNDARIES (cont.)

4. Reedy Branch flows north to south approximately 7,000 feet northwest of site.

5. Big Branch flows north to south approximately 10,000 feet west of site.

6. Deep Branch flows north to south approximately 10,000 feet west of site.

7. Little Creek flows north to south approximately 7,000 feet southwest of site, and it has approximately 5 or 6 small intermittent tributaries.

8. There are numerous ponds within 2-mile radius of site, all of which are unnamed:

   - 1 pond located approximately 750 - 1,000 feet southwest of site.
   - 1 pond located approximately 2,000 feet southeast of site.
   - 1 pond located approximately 4,000 feet west-southwest of site along County Road 1103.
   - 1 pond located approximately 6,000 feet southeast of site on the north side of County Road 1106.
   - 2 small ponds located next to each other 7,000 feet southeast of site on the south side of County Road 1106.
   - 2 ponds located 6,000 feet southwest of site in vicinity of Lake Surf.
   - 1 pond or small lake that is dammed, from which Little Creek originates approximately 7,000 feet southwest of site.
   - 2 ponds located along the unnamed tributary to Buffalo Creek approximately 9,000 feet southeast of site
   - 1 pond located on the north side of County Road 1108 approximately 9,000 feet east of site.
   - 3 ponds located on the east side of County Road 1106 approximately 10,000 feet east-northeast of site.
   - 1 pond located on the west side of County Road 1106 approximately 8,000 feet northeast of site.
   - 1 small pond located along County Road approximately 8,000 feet southeast of site.

   21 Ponds Total, all unnamed

   Lake Surf is located approximately 8,000 feet southwest of site.

IV. No airports or runways within 2 miles of site.

V. One possible subdivision on the Eastern Shore of Lake Surf 8,000 feet southwest of site. The way the roads are constructed, it looks like a subdivision - not many houses plotted on topo map, but photo revision was done 10 years ago; it has probably become more highly developed since then.

Attachment B

State of North Carolina
Department of Environment, Health, and Natural Resources
Fayetteville Regional Office

James G. Martin, Governor

William W. Cobey, Jr., Secretary

DIVISION OF ENVIRONMENTAL MANAGEMENT

February 7, 1991

Tribble & Richardson Consulting
Engineers/Surveyors
4020 West Chase Boulevard
Suite 515
Raleigh, NC 27606

SUBJECT: Well Construction Permit
No. 42-0193-WM-0111
For the Construction of Seven (7)
Monitor Wells Located at the End of
State Road 1105
Johnsonville, Harnett County

To Whom It May Concern:

In accordance with your application received February 5, 1991, we are forwarding herewith Well Construction Permit No. 42-0193-WM-0111, dated February 7, 1991, issued to Tribble and Richardson, Inc. for the construction of seven (7) monitor wells located at the above mentioned location.

This Permit will be effective from the date of its issuance and shall be subject to the conditions and limitations as specified therein.

If any parts, requirements, or limitations contained in this Permit are unacceptable to you, you have the right to an adjudicatory hearing before a hearing officer upon written demand to the Director within 30 days following receipt of this Permit, identifying the specific issues to be contended. Unless such demand is made, this Permit shall be final and binding.

Sincerely,

original signed by

M. J. Noland, P.E.
Regional Supervisor

MJN/cah
Enclosure
cc: Aquaterra
Billy Thomas

Wachovia Building, Suite 714 • Fayetteville, N.C. 28301-5043 • Telephone 919-486-1541 FAX 919-486-0707

NORTH CAROLINA

ENVIRONMENTAL MANAGEMENT COMMISSION

RALEIGH, NORTH CAROLINA

PERMIT FOR THE CONSTRUCTION OF A WELL OR WELL SYSTEM

In accordance with the provisions of Article 7, Chapter 87, North Carolina General Statutes, and other applicable Laws, Rules and Regulations.

PERMISSION IS HEREBY GRANTED TO

Tribble and Richardson Consulting Engineers/Surveyors

FOR THE CONSTRUCTION OF seven (7) monitor wells in the surficial material, and located at the end of State Road 1105 in Johnsonville, Harnett County, in accordance with the application dated February 2, 1991, and in conformity with specifications and supporting data, all of which are filed with the Department of Environment, Health, and Natural Resources and are considered a part of this Permit.

This Permit is for well construction only and does not waive any provisions or requirements of the Water Use Act of 1967 or any other applicable laws or regulations.

Construction of a well under this Permit shall be in compliance with the North Carolina Well Construction Regulations and Standards and any other laws and regulations pertaining to well construction.

This Permit will be effective from the date of its issuance through the duration of this project or as this shall be amended, and shall be subject to other specified conditions, limitations, or exceptions as follows:

1. To receive approval for the construction of any additional monitor/recovery wells at the location described above contact:

   Division of Environmental Management/Groundwater Section
   Suite 714, Wachovia Building
   Fayetteville, NC 28301-5043
   (919) 486-1541

   Copies of construction diagrams for proposed wells and a site plan (map) showing the locations of proposed wells must be provided.

2. Furnish copies of all chemical analyses to the Division of Environmental Management at the above address.

Permit issued this the 7th day of February, 1991.

FOR THE NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

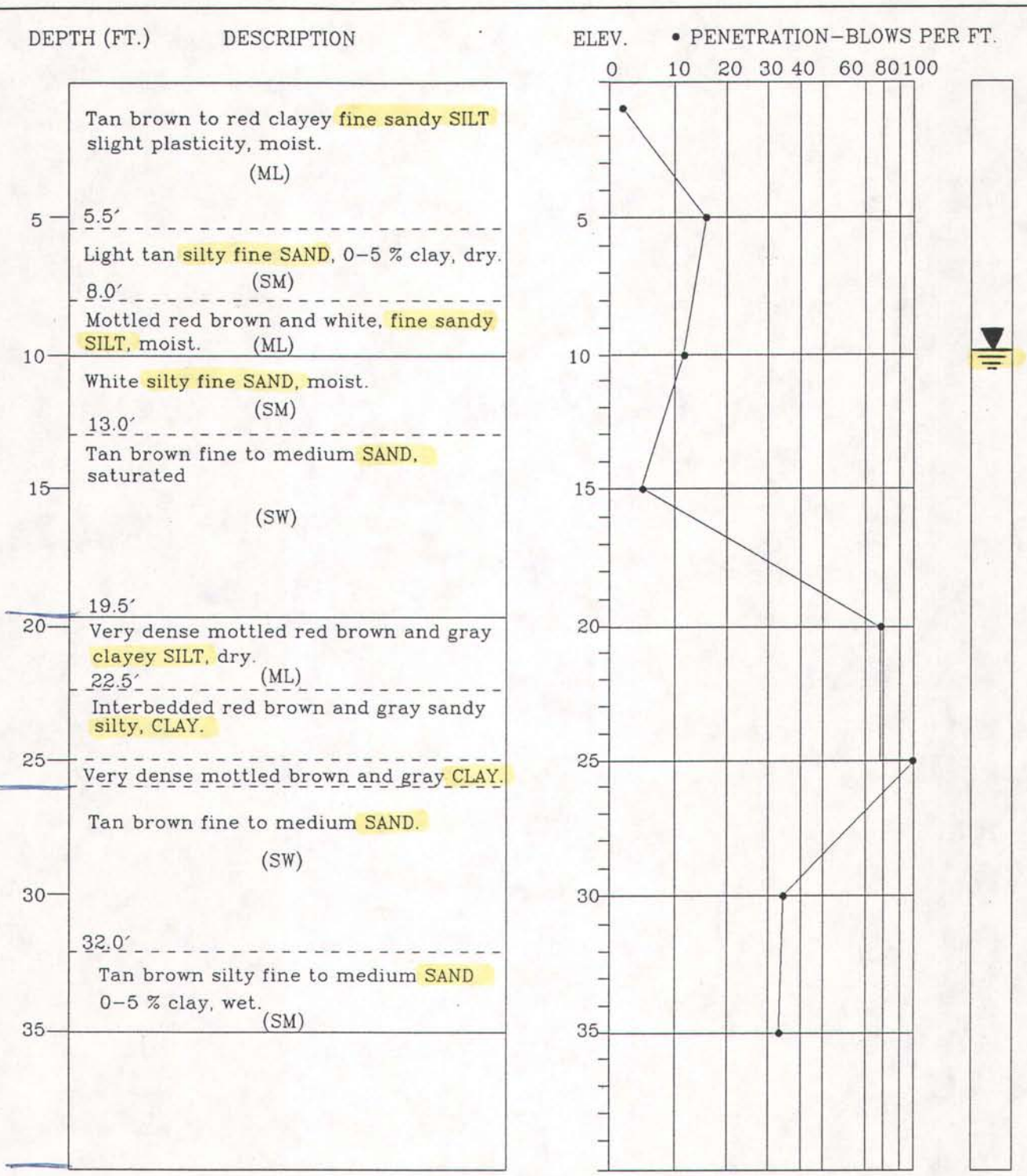
_____

M. J. Noland, Regional Supervisor
DIVISION OF ENVIRONMENTAL MANAGEMENT

By Authority of the Environmental Management Commission

Permit No. 42-0193-WM-0111

Attachment C



TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO.	B101
DATE DRILLED	2/5/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:			
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG			
	JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS

AQUATERRA, INC.
RALEIGH, GREENSBORO, CHARLOTTE
NORTH CAROLINA

DEPTH (FT.) DESCRIPTION

Dense gray to black silty CLAY, moist.
(CL)

38.0′

Dense interbedded brown silt with gray fine sandy SILT, moist.

40

(ML)

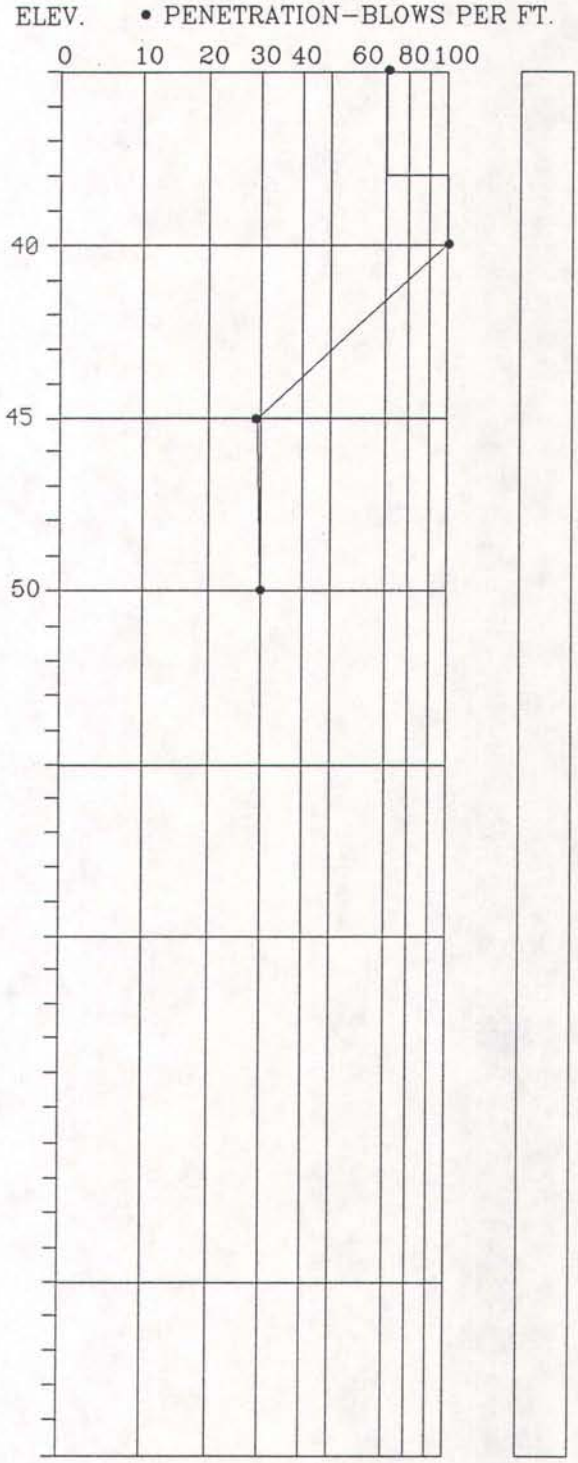
45 — 45.7′

Gray micaceous clayey fine SAND, wet.

(SC)

BOTTOM OF BORING AT 50.5′

NOTE:
TEMPORARY PIEZOMETER PZ−1 INSTALLED IN COMPLETED BORING (see pz−1 well schematic)



BORING AND SAMPLING MEETS ASTM D−1586
CORE DRILLING MEETS ASTM D−2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO.	B101
DATE DRILLED	2/5/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548−SB	FIGURE: NA	APRX.SCALE: NTS	

DEPTH (FT.) DESCRIPTION

ELEV. • PENETRATION–BLOWS PER FT.

0 10 20 30 40 60 80 100

Soft tan brown clayey silty fine SAND, moist.

(SM)

6.0′

Medium dense gray CLAY, with occasional red brown silt lens, moist.

(CH)

14.0′

Loose gray silty fine to medium SAND, wet, with occasionall red brown silt lens.

(SM)

23.0′

Very dense black gray clayey SILT, highly compacted, dry.

(ML)

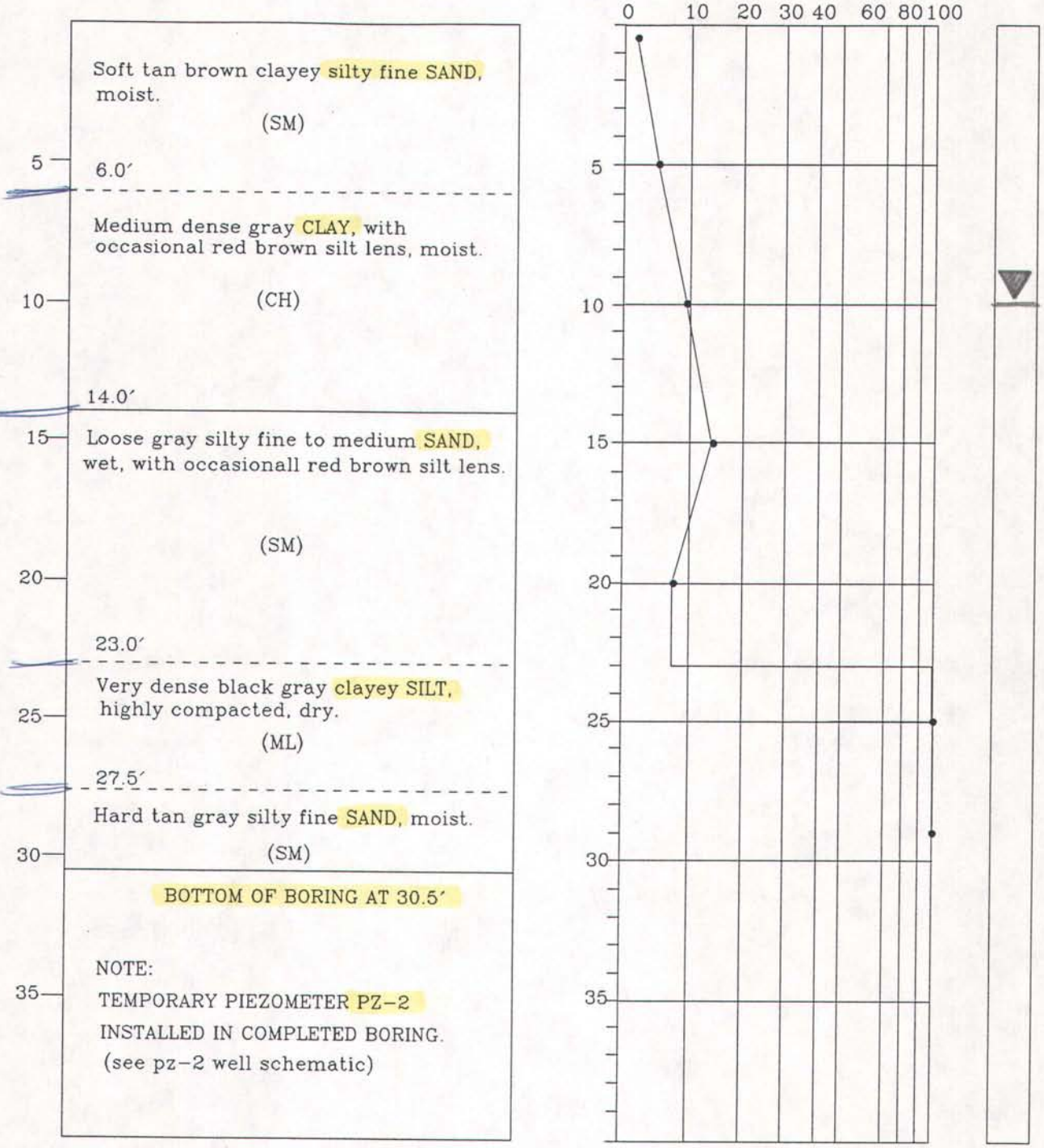
27.5′

Hard tan gray silty fine SAND, moist.

(SM)

BOTTOM OF BORING AT 30.5′

NOTE:
TEMPORARY PIEZOMETER PZ–2
INSTALLED IN COMPLETED BORING.
(see pz–2 well schematic)

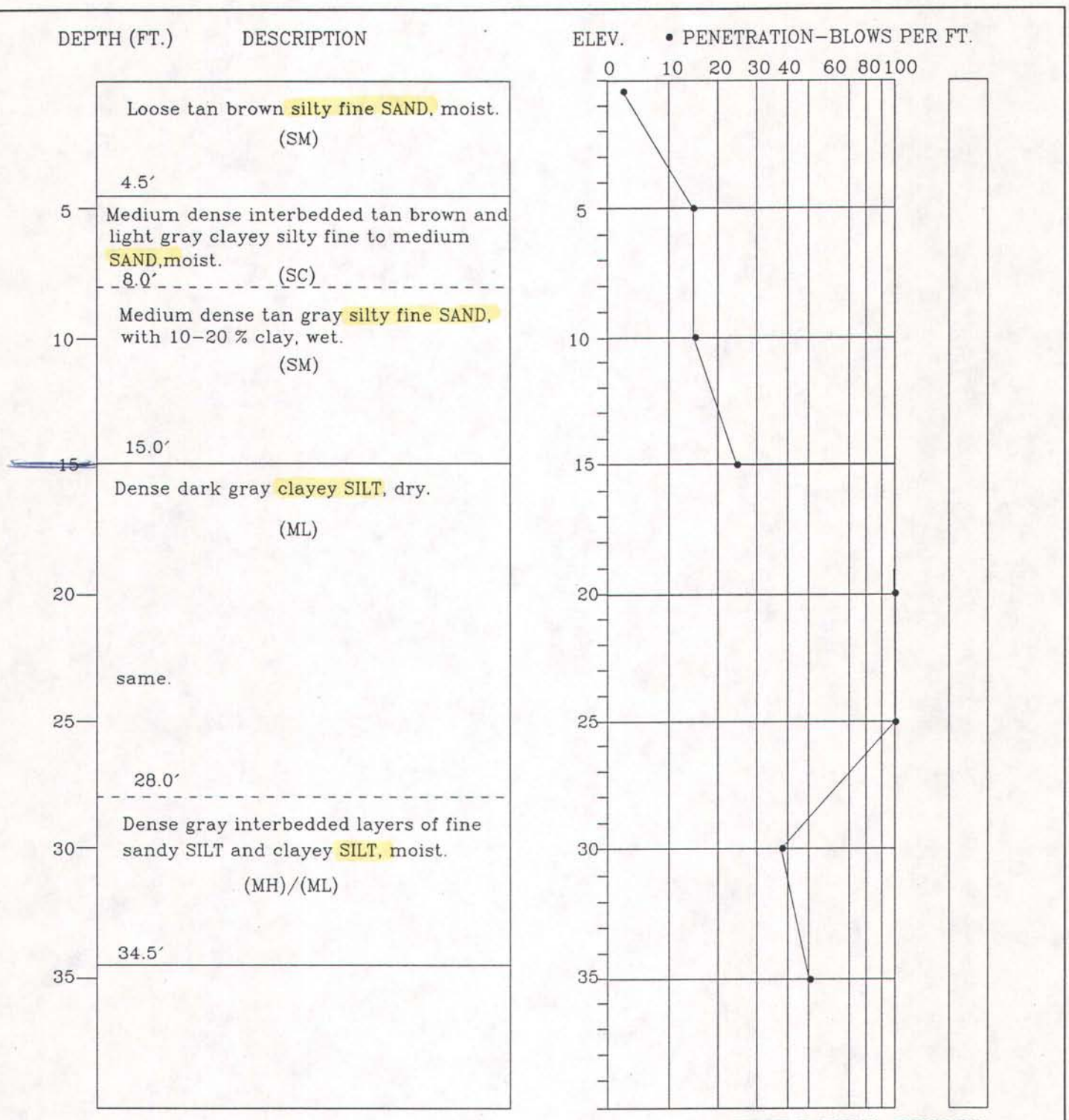


BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO.	B102
DATE DRILLED	2/6/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:			
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG			
JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA



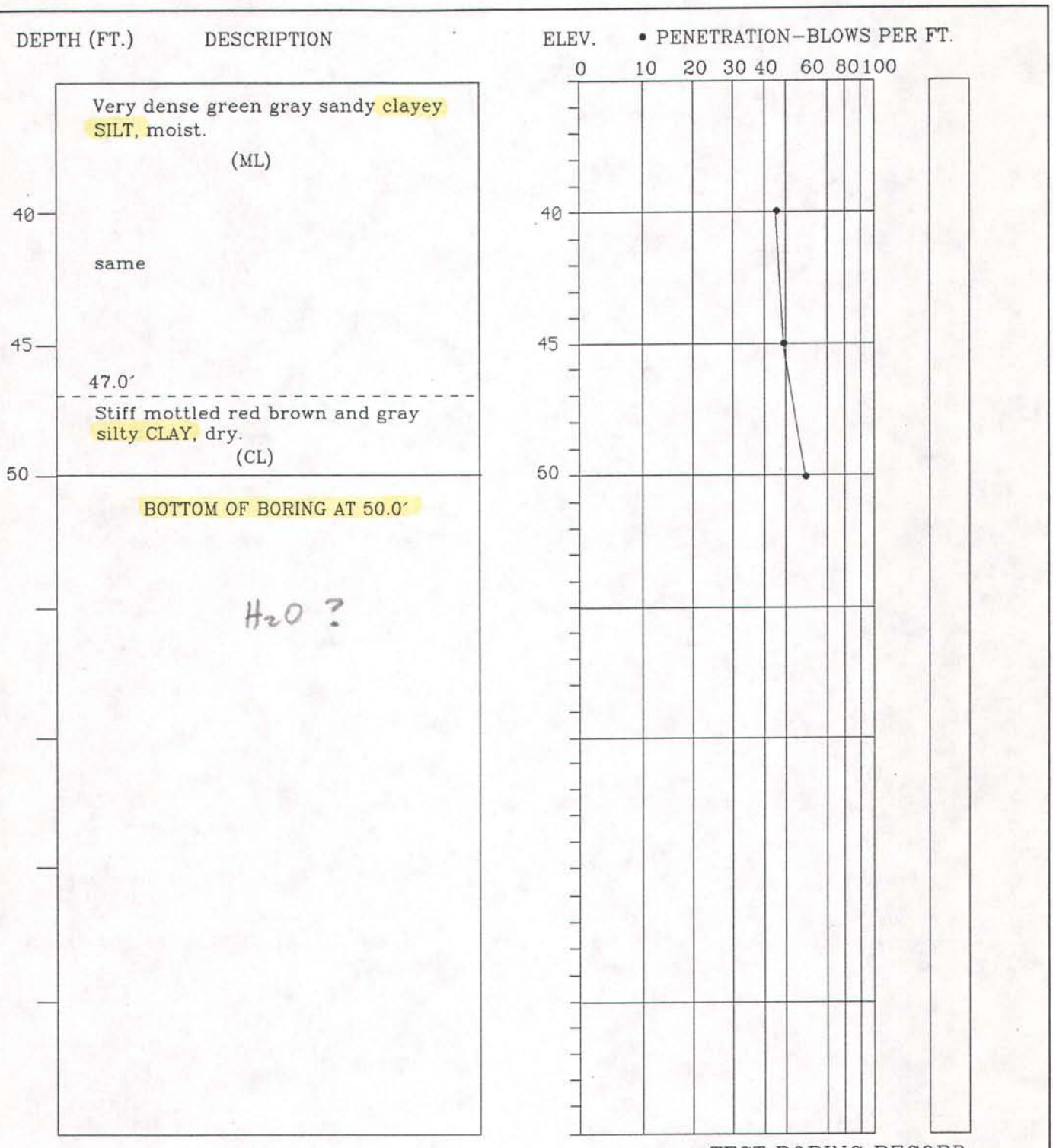
TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO.	B103
DATE DRILLED	2/7/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:			
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG			
JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	

AQUATERRA, INC.
RALEIGH, GREENSBORO, CHARLOTTE
NORTH CAROLINA



TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO.	B103
DATE DRILLED	2/7/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	

DEPTH (FT.) DESCRIPTION

ELEV. • PENETRATION–BLOWS PER FT.

0 10 20 30 40 60 80 100

Loose tan red brown clayey silty fine to medium SAND, wet.

(SM)

9.0′

Very stiff mottled red and gray silty CLAY moist.

(CL)

14.0′

Dense tan gray sandy clayey SILT, with moist.

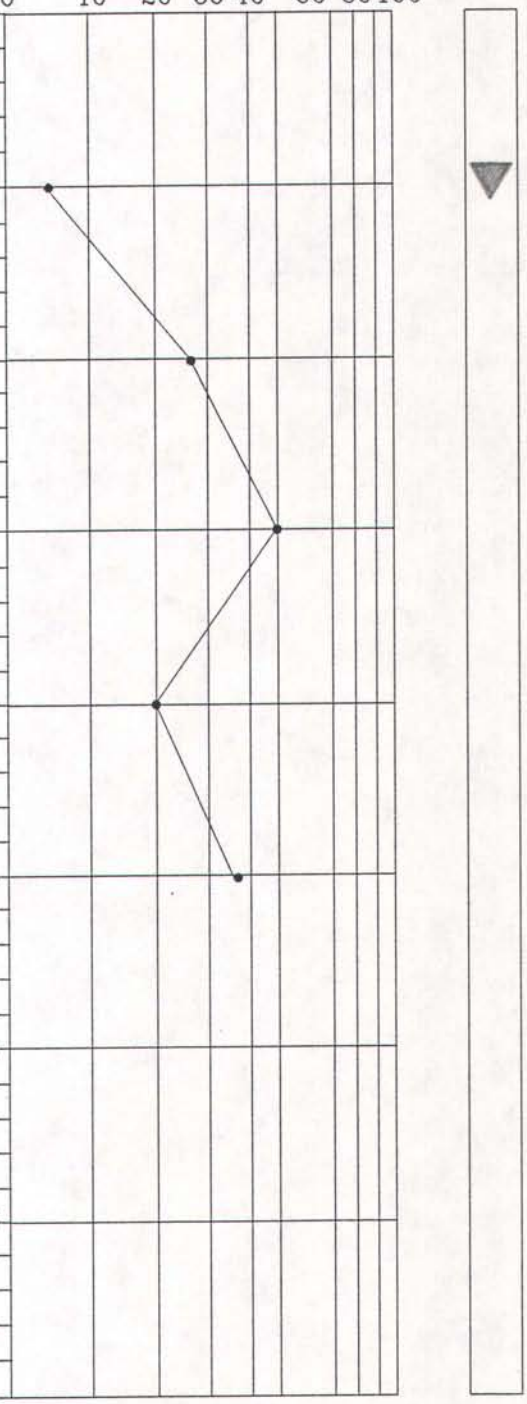
(ML)

23.0′

Dense dark gray silty CLAY, with 10 % fine sand, moist. (CL)

BOTTOM OF BORING AT 25.5′

NOET:
TEMPORARY PIEZOMETER PZ–3
INSTALLED IN COMPLETED BORING.
(see pz–3 well schematic)



TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO.	B104
DATE DRILLED	2/11/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:			
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG			
JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA

DEPTH (FT.) DESCRIPTION

Loose brown silty fine SAND, moist.
(SM)

4.5′

Loose light tan silty fine to medium SAND, moist.
(SM)

14.6′

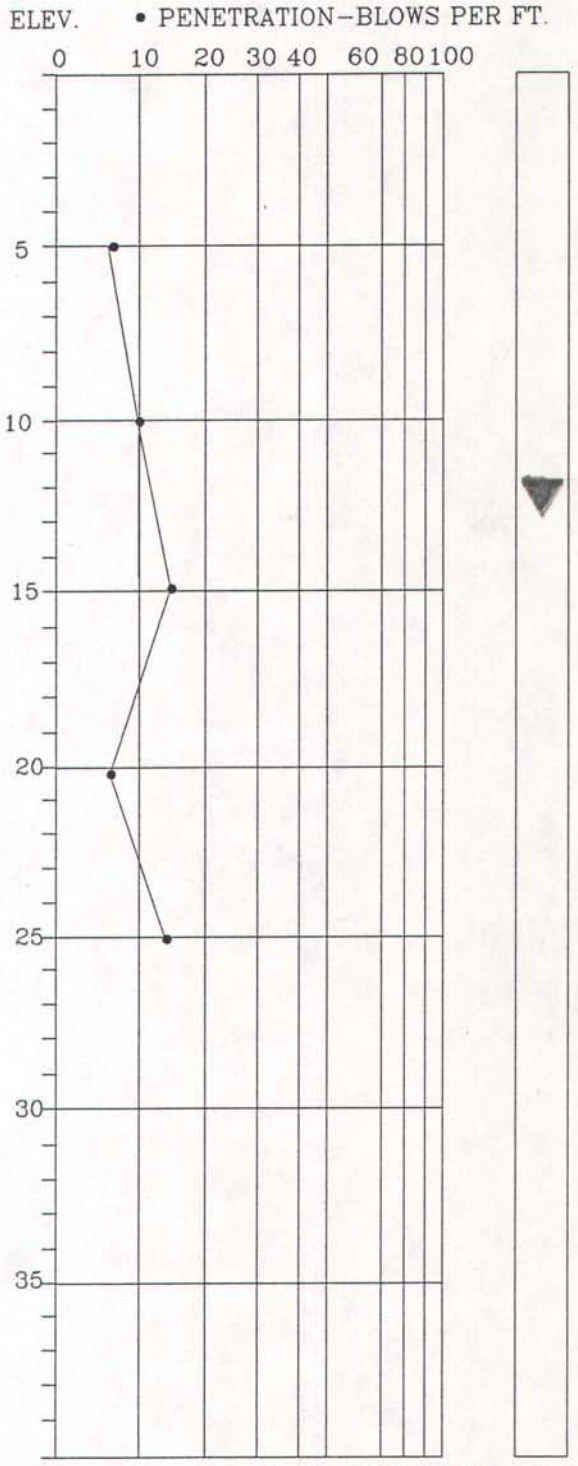
Medium dense medium coarse SAND, saturated. (SW)

15.4′

Red brown silty fine to medium SAND, saturated.
(SM)

BOTTOM OF BORING AT 26.0′

NOTE;
TEMPORARY PIEZOMETER PZ-4 INSTALLED IN COMPLETED BORING (see pz-4 well schematic)



TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO.	B105
DATE DRILLED	2/12/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:			
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG			
	JOB: 548	DRAWING: 548-SB	FIGURE: NA	APRX.SCALE: NTS

AQUATERRA, INC.
RALEIGH, GREENSBORO, CHARLOTTE
NORTH CAROLINA

DEPTH (FT.) DESCRIPTION

ELEV. • PENETRATION–BLOWS PER FT.

0 10 20 30 40 60 80 100

Tan brown clayey SILT, moist.

3.5′

5 Very stiff mottled purple and gray silty CLAY, with occasional pockets of fine sand, moist.

8.0′ (CL)

10 Medium dense tan gray clayey silty fine SAND, moist.

(SM)

15

17.0′

Very dense gray silty CLAY, dry.

20 (CL)

BOTTOM OF BORING AT 20.5′

NOTE:

25 TEMPORARY PIEZOMETER PZ–5 INSTALLED IN COMPLETED BORING. (see pz–5 well schematic)

30

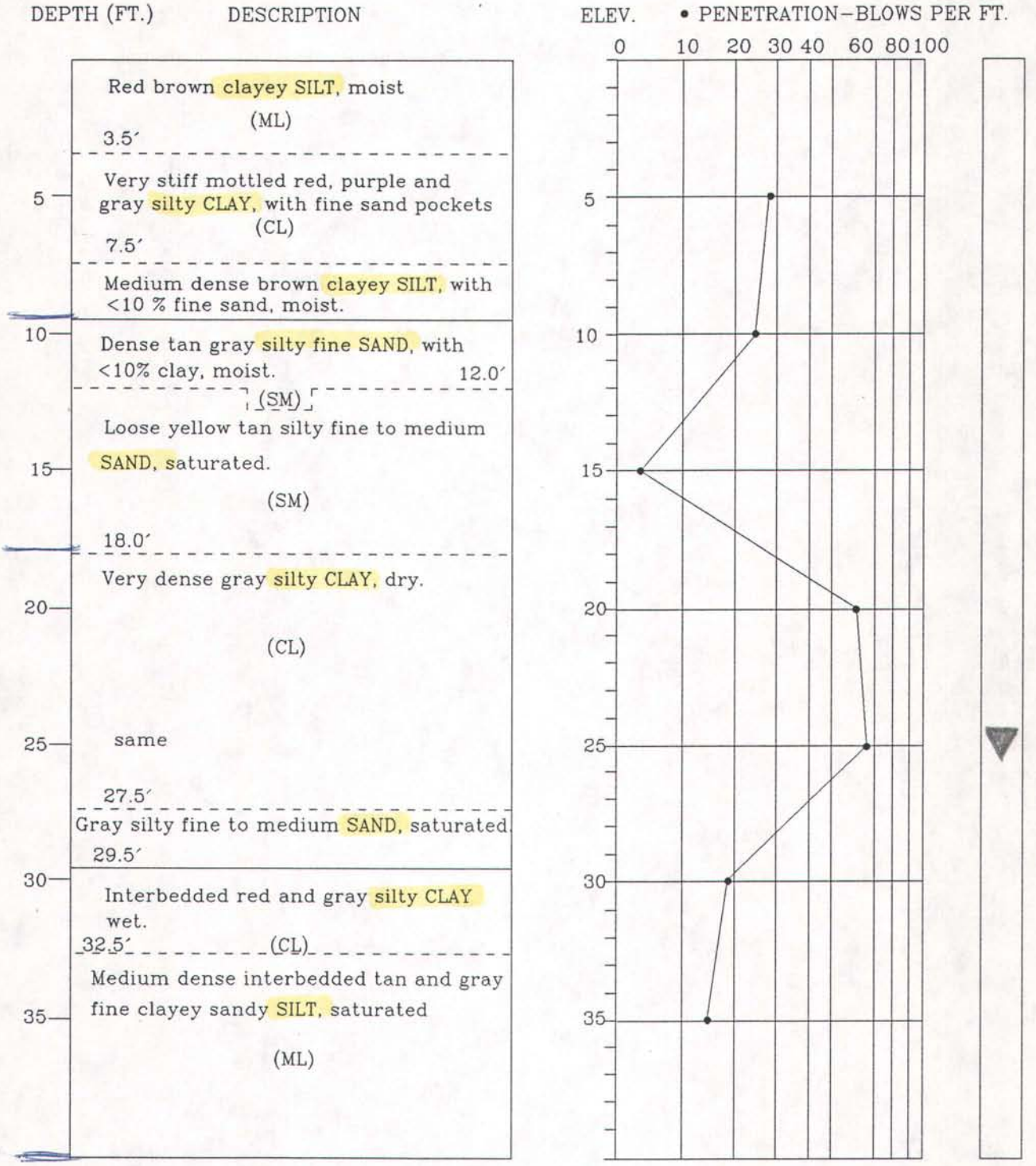
35

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO.	B106
DATE DRILLED	2/12/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	



TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO.	B107
DATE DRILLED	2/13/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	

DEPTH (FT.) DESCRIPTION

ELEV. • PENETRATION–BLOWS PER FT.

0 10 20 30 40 60 80 100

40

41.5′

Medium dense yellow tan silty fine to medium SAND, saturated.
(SM)

Dense brown gray CLAY, moist.
(CH)

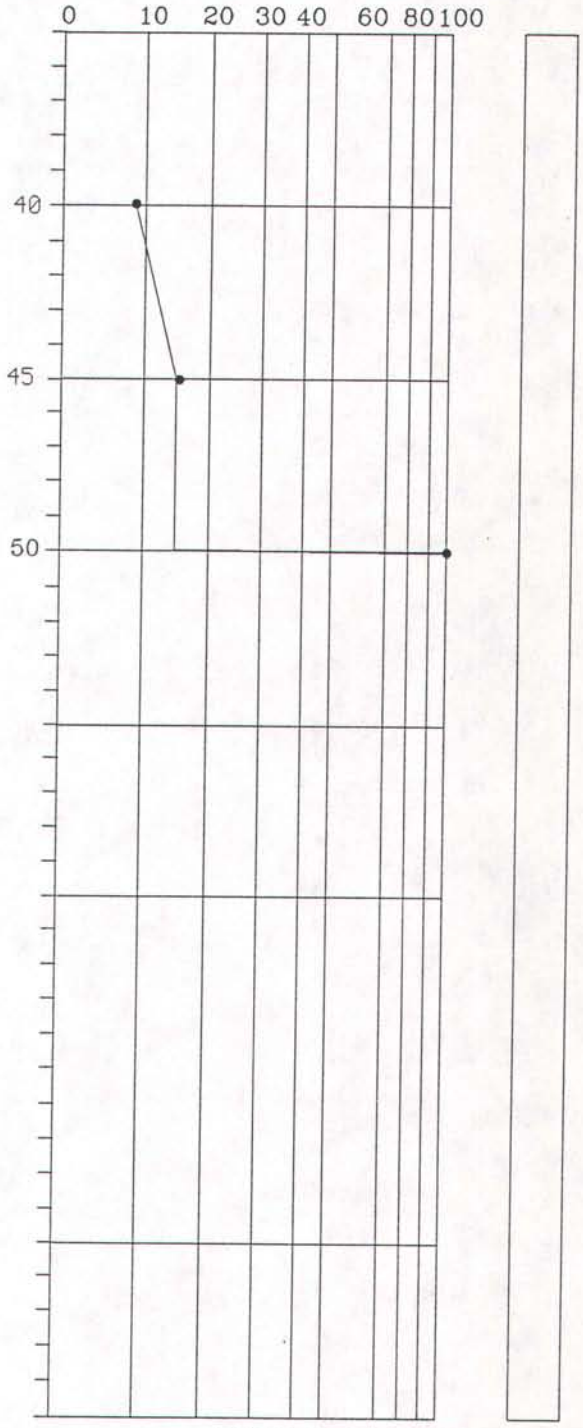
45

Very dense gray silty CLAY, dry.
(CL)

50

BOTTOM OF BORING AT 50.5′

NOTE:
TEMPORARY PIEZOMETER PZ–6
INSTALLED IN COMPLETED BORING
(see pz–6 well schematic)



BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO.	B107
DATE DRILLED	2/13/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	

DEPTH (FT.) DESCRIPTION

ELEV. • PENETRATION–BLOWS PER FT.

0 10 20 30 40 60 80 100

Loose red brown fine sandy SILT, moist. (ML)

3.5′

Loose red brown interbedded silty fine to medium SAND and medium to coarse SAND, moist. (SW)

10.0′

Medium dense red brown silty fine to medium SAND (SM)

saturated at 14.0′

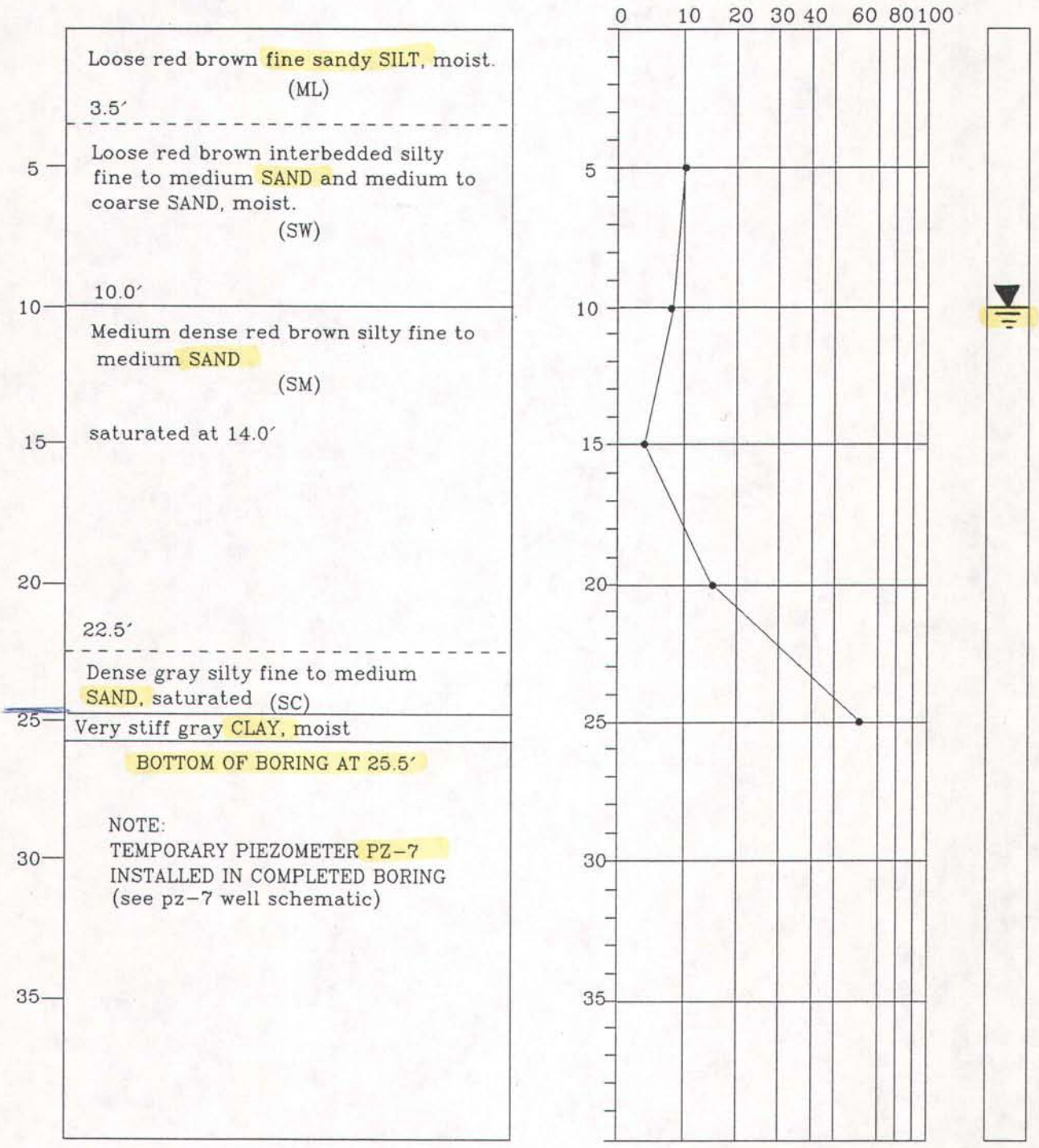
22.5′

Dense gray silty fine to medium SAND, saturated (SC)

Very stiff gray CLAY, moist

BOTTOM OF BORING AT 25.5′

NOTE:
TEMPORARY PIEZOMETER PZ–7 INSTALLED IN COMPLETED BORING (see pz–7 well schematic)



BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO.	B108
DATE DRILLED	2/14/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	

DEPTH (FT.) DESCRIPTION

Loose red brown clayey sandy SILT, moist. (ML)

3.5′

Loose tan brown silty fine SAND, wet

(SM)

saturated at 14.0′

22.0′

Very dense gray CLAY, mottled with red and orange, dry. (CL)

BOTTOM OF BORING AT 25.5′

ELEV. • PENETRATION–BLOWS PER FT.

0 10 20 30 40 60 80 100

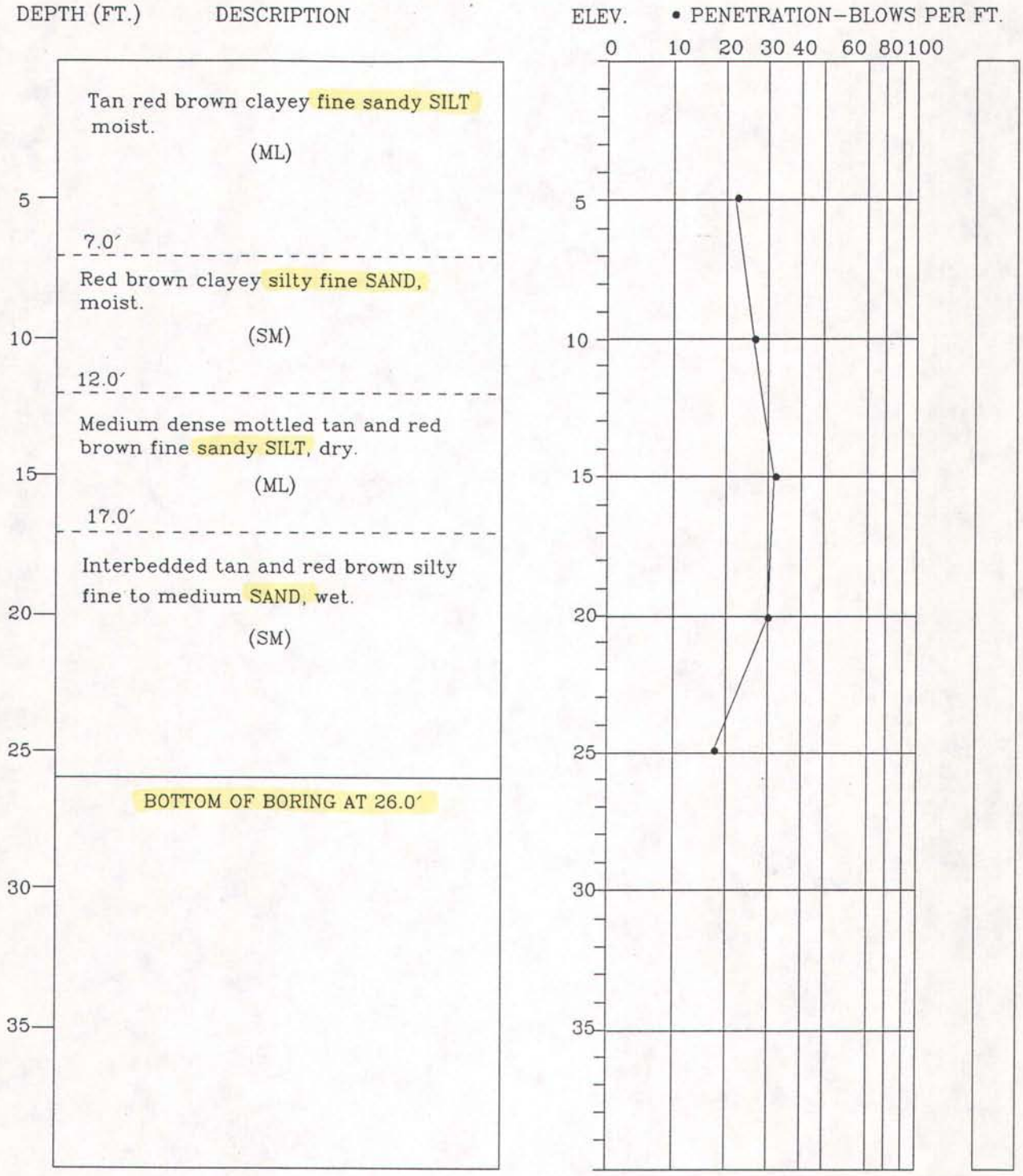
5 10 15 20 25 30 35

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO.	B109
DATE DRILLED	2/14/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:			
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG			
JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA



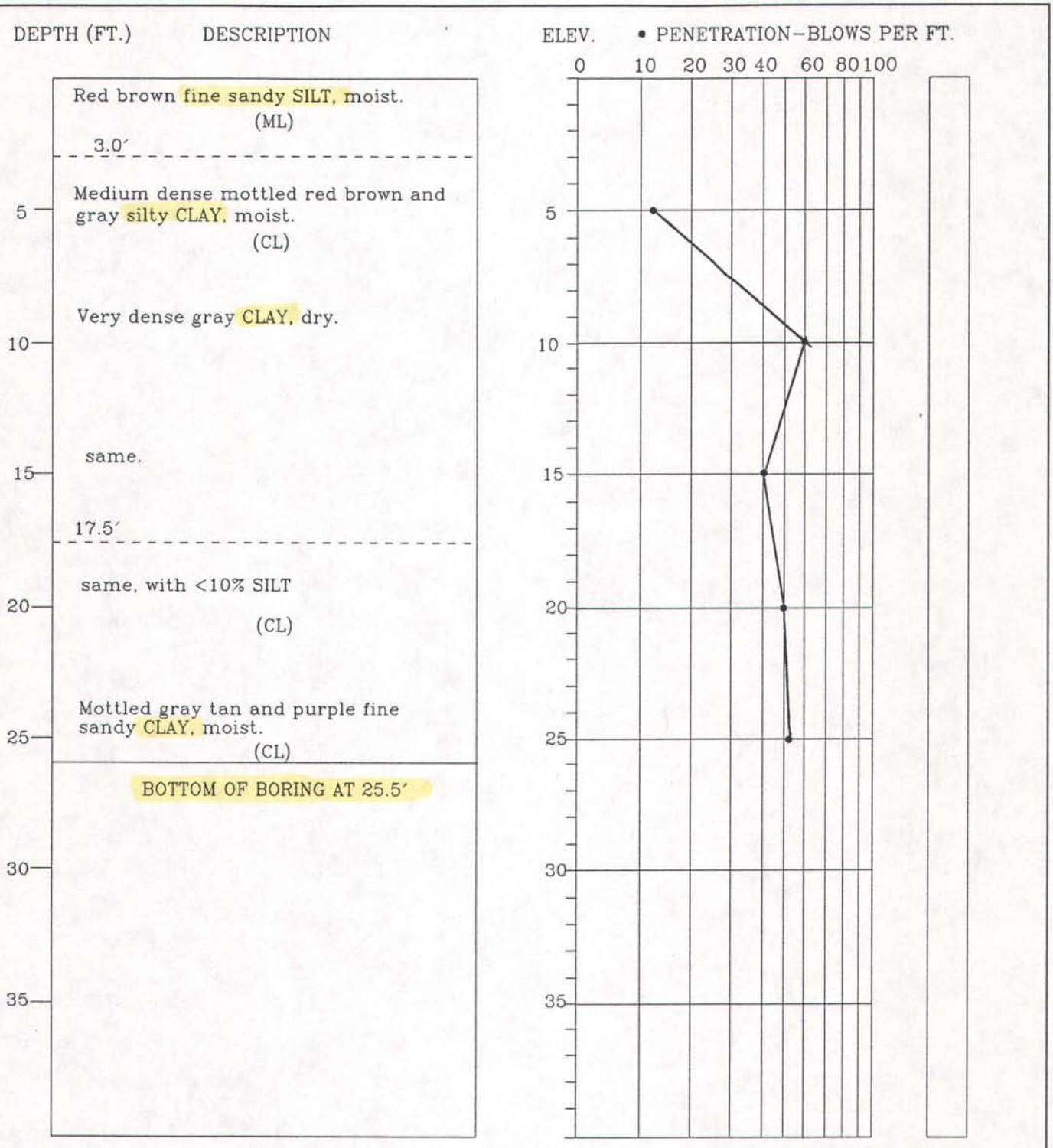
TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO.	B110
DATE DRILLED	2/15/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:			
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG			
JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	

AQUATERRA, INC.
RALEIGH, GREENSBORO, CHARLOTTE
NORTH CAROLINA



BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO.	B111
DATE DRILLED	2/15/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	

AQUATERRA

Environmental Consultants

October 23, 1991

Mr. Richard Wood, P.E.
Tribble & Richardson, Inc.
4020 Westchase Boulevard Suite 515
Raleigh, North Carolina 27607

Reference: Proposed Harnett County Monofill
Johnsonville, North Carolina
Aquaterra Job No. 548

Dear Mr. Wood:

As requested on October 22, 1991, Aquaterra, Inc. is pleased to present an additional copy of our original report and provide additional information regarding boring B110. A revised Test Boring Record for B110 which provides additional detail regarding the soil conditions is also attached to this letter.

As shown in Figure 8 of the report, ground water levels collected on April 8, 1991 for piezometers PZ-1 and PZ-2 and soil conditions in boring B110 were used to construct the ground water contour gradient across the northern portion of the site. Figure 8 shows the ground water level in the vicinity of B110 to be about 22 feet below ground surface.

The Test Boring Record for B110 describes wet soil conditions from 17 to 26 feet below grade. These wet soil conditions do not necessarily indicate that the saturated zone is present at 17 feet below grade. In fact, the field geologist noted that the soil did not become saturated until a depth of 24 feet was reached. Based upon the data collected from the soil samples in B110, Aquaterra concluded the water table depth was appeared to be between 21 and 24 feet. This result was in general agreement with the potentiometric data collected from PZ-1 and PZ-2. Therefore, the contour lines in the vicinity of B110 as shown in Figure 8 are supported by the available data.

Corporate Office
P. O. Box 50328
Raleigh, NC 27650
(919) 859-9987
FAX (919) 859-9930

Charlotte Office
P. O. Box 668107
Charlotte, NC 28266-8107
(704) 525-8680
FAX (704) 527-2792

Greensboro Office
P. O. Box 16241
Greensboro, NC 27416-0241
(919) 273-5003
FAX (919) 271-8138

If we can be of further assistance or if there are any questions, please do not hesitate to call Mr. David L. Duncklee at (919) 859-9987. Aquaterra appreciates being of service to Tribble & Richardson, Inc.

Sincerely,

AQUATERRA, INC.

Harold M. Thurston
Project Geologist

David L. Duncklee, P.G.
Senior Project Manager

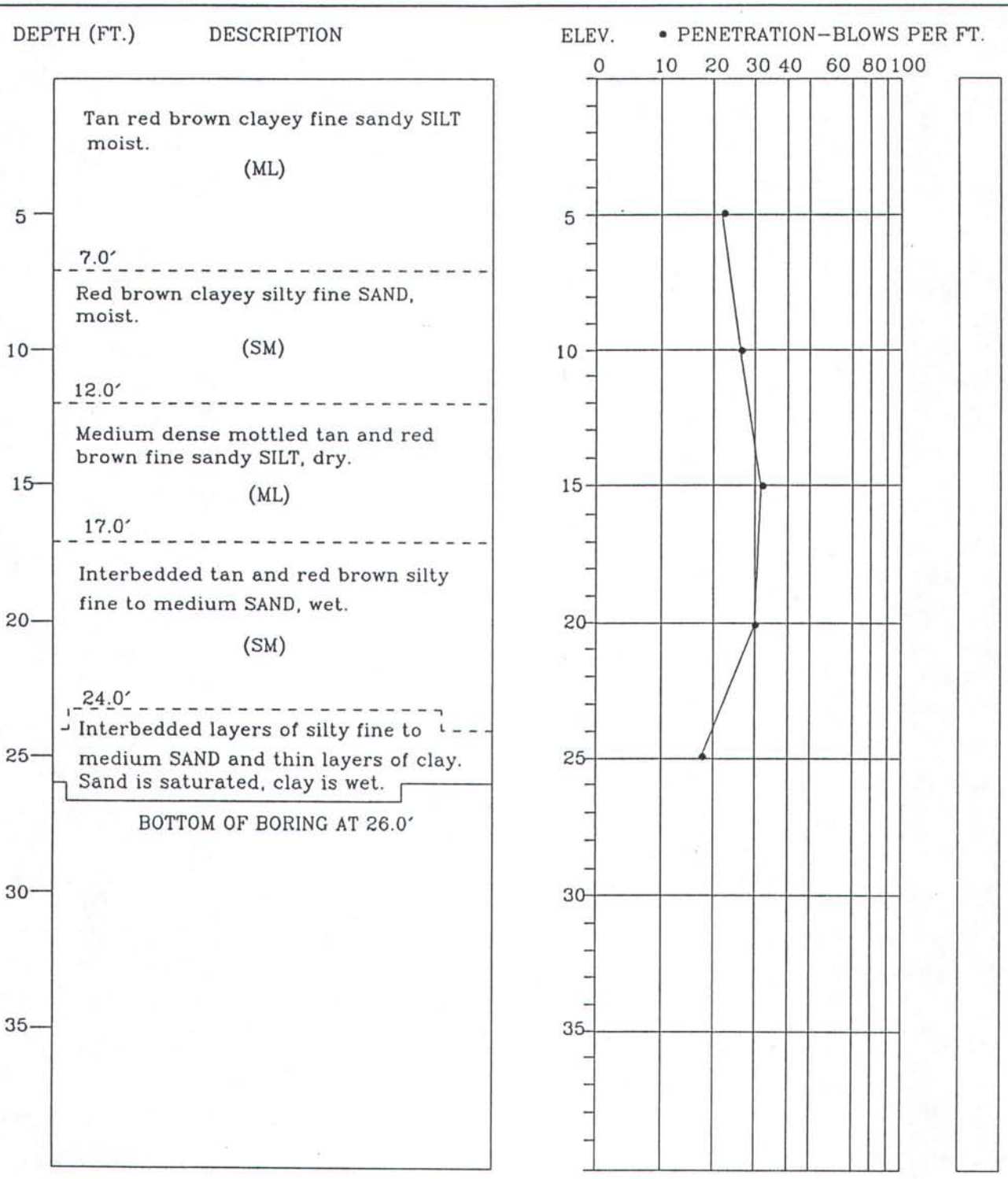
Senior Peer Review:

Bryson D. Trexler, Jr., Ph.D., P.G.
Senior Hydrogeologist

DLD/dld

L:2221-91

AQUATERRA



BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO.	B110
DATE DRILLED	2/15/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	

DEPTH (FT.) DESCRIPTION

Tan red brown clayey fine sandy SILT moist.

(ML)

7.0′

Red brown clayey silty fine SAND, moist.

(SM)

12.0′

Medium dense mottled tan and red brown fine sandy SILT, dry.

(ML)

17.0′

Interbedded tan and red brown silty fine to medium SAND, wet.

(SM)

24.0′

Interbedded layers of silty fine to medium SAND and thin layers of clay. Sand is saturated, clay is wet.

BOTTOM OF BORING AT 26.0′

ELEV. • PENETRATION–BLOWS PER FT.

0 10 20 30 40 60 80 100

5 10 15 20 25 30 35

TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D–1586
CORE DRILLING MEETS ASTM D–2113
PENETRATION IS NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

BORING NO.	B110
DATE DRILLED	2/15/91
JOB NO.	548
GEOLOGIST	H. THURSTON

PROJECT:	TITLE:			
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	SUBSURFACE BORING LOG			
JOB: 548	DRAWING: 548–SB	FIGURE: NA	APRX.SCALE: NTS	AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA

Attachment D

STANDARD ABOVE GRADE 2" PIEZOMETER CONSTRUCTION SCHEMATIC

WELL NUMBER: PZ-1
DATE STARTED: 2/6/91
DATE FINISHED: 2/6/91
GEOLOGIST/ENG: H. THURSTON
REMARKS: TEMPORARY PIEZOMETER

DRILLING METHOD: HOLLOW STEM AUGER
DRILLING FLUIDS: NA
STATIC WATER LEVEL: 10.2 DATE: TOB
OBSERVED BY:

NOTE: STATIC WATER LEVEL MEASURED FROM GROUND SURFACE

WELL CONSTRUCITON MEASUREMENTS REFERENCED TO GROUND SURFACE

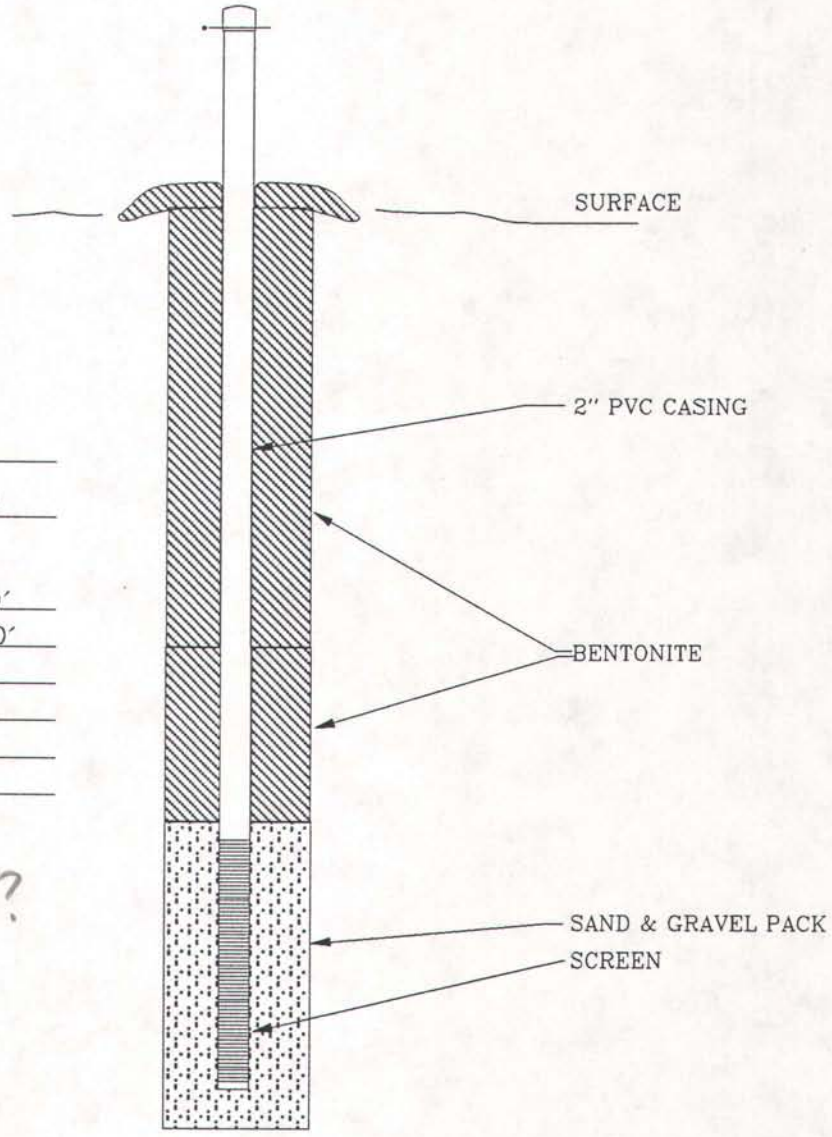
O.D. OF BOREHOLE: 6 1/4"
O.D. OF CASING: 2.0"

PIPE STICKUP: 2.4'
SURFACE ELEVATION: ?
GROUT TYPE: NA
CASING TYPE: PVC
CASING SIZE: 2.0"
DEPTH TO BOTTOM OF CASING 10.0'

DEPTH TO TOP OF BENTONITE GS
DEPTH TO TOP OF SAND PACK 9.0'

DEPTH TO TOP OF SCREEN 10.0'
DEPTH TO BOTTOM OF SCREEN 20.0'
LENGTH OF SCREEN: 10.0'
SCREEN OPENING SIZE: 0.010"
SCREEN TYPE: PVC
SCREEN SIZE: 2.0"

Well Depth = 20.0' } ?
Boring Depth = 50.5'



PROJECT:	TITLE: Well Schematic				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	JOB: 548	DRAWING: 548-WS	FIGURE: ---	SCALE: NTS	AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA

STANDARD ABOVE GRADE 2" PIEZOMETER CONSTRUCTION SCHEMATIC

WELL NUMBER: PZ-2
DATE STARTED: 2/6/91
DATE FINISHED: 2/7/91
GEOLOGIST/ENG. H. THURSTON
REMARKS: TEMPORARY PIEZOMETER
NOTE: STATIC WATER LEVEL MEASURED FROM GROUND SURFACE

DRILLING METHOD: HOLLOW STEM AUGER
DRILLING FLUIDS: NA
STATIC WATER LEVEL: 10 ± DATE:
OBSERVED BY:

WELL CONSTRUCITON MEASUREMENTS REFERENCED TO GROUND SURFACE

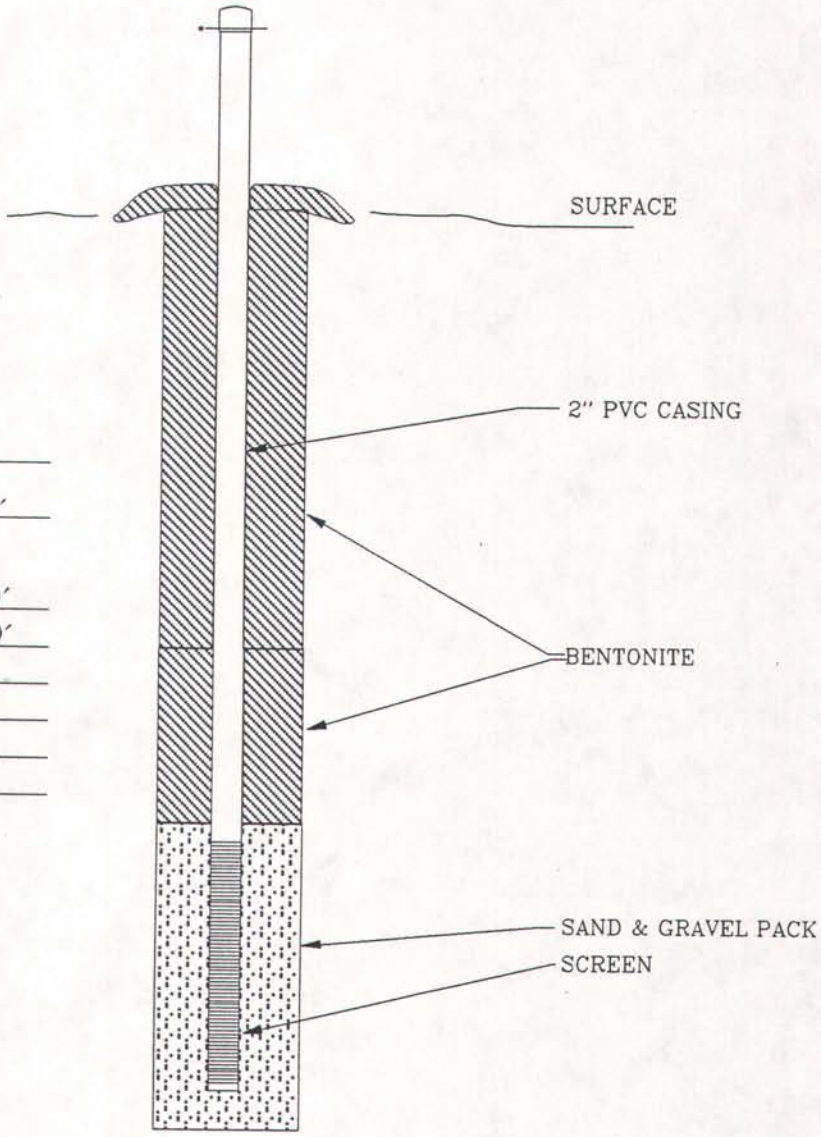
O.D. OF BOREHOLE: 7 1/4"
O.D. OF CASING: 2.0"

PIPE STICKUP: 3.9'
SURFACE ELEVATION: 311.06
GROUT TYPE: NA
CASING TYPE: PVC
CASING SIZE: 2.0"
DEPTH TO BOTTOM OF CASING 19.0'

DEPTH TO TOP OF BENTONITE G.S.
DEPTH TO TOP OF SAND PACK 17.0'

DEPTH TO TOP OF SCREEN 19.0'
DEPTH TO BOTTOM OF SCREEN 29.0'
LENGTH OF SCREEN: 10.0'
SCREEN OPENING SIZE: 0.010"
SCREEN TYPE: PVC
SCREEN SIZE: 2.0"

Well Depth 29.0'
Boring Depth 30.5'



PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	Well Schematic				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548-WS	FIGURE: ---	SCALE: NTS	

STANDARD ABOVE GRADE 2" PIEZOMETER CONSTRUCTION SCHEMATIC

WELL NUMBER: PZ-3
DATE STARTED: 2/12/91
DATE FINISHED: 2/12/91
GEOLOGIST/ENG. H. THURSTON
REMARKS: TEMPORARY PIEZOMETER

DRILLING METHOD: HOLLOW STEM AUGER
DRILLING FLUIDS: NA
STATIC WATER LEVEL: 6 ± DATE: _____
OBSERVED BY: _____

NOTE: STATIC WATER LEVEL MEASURED FROM GROUND SURFACE

WELL CONSTRUCITON MEASUREMENTS REFERENCED TO GROUND SURFACE

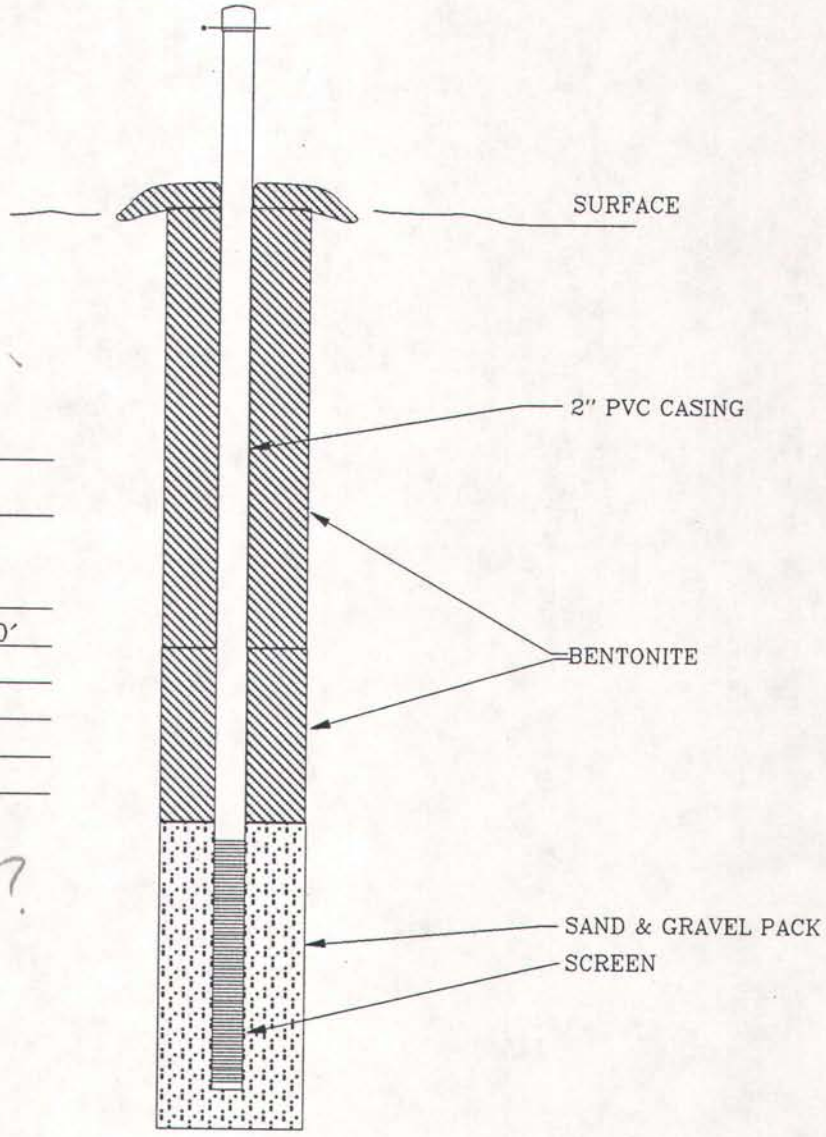
O.D. OF BOREHOLE: 10 1/4"
O.D. OF CASING: 2.0"

PIPE STICKUP: 3.5'
SURFACE ELEVATION: 335.3
GROUT TYPE: NA
CASING TYPE: PVC
CASING SIZE: 2.0"
DEPTH TO BOTTOM OF CASING 14.0'

DEPTH TO TOP OF BENTONITE G.S.
DEPTH TO TOP OF SAND PACK 3.0'

DEPTH TO TOP OF SCREEN 4.0'
DEPTH TO BOTTOM OF SCREEN 14.0'
LENGTH OF SCREEN: 10.0'
SCREEN OPENING SIZE: 0.010"
SCREEN TYPE: PVC
SCREEN SIZE: 2.0"

Well Depth = 14.0' } ?
Boring Depth = 25.5'



PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	Well Schematic				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548-WS	FIGURE: ---	SCALE: NTS	

STANDARD ABOVE GRADE 2" PIEZOMETER CONSTRUCTION SCHEMATIC

WELL NUMBER: PZ-4
DATE STARTED: 2/12/91
DATE FINISHED: 2/12/91
GEOLOGIST/ENG. H. THURSTON
REMARKS: TEMPORARY PIEZOMETER

DRILLING METHOD: HOLLOW STEM AUGER
DRILLING FLUIDS: NA
STATIC WATER LEVEL: 13± DATE: _____
OBSERVED BY: _____

NOTE: STATIC WATER LEVEL MEASURED FROM GROUND SURFACE

WELL CONSTRUCITON MEASUREMENTS REFERENCED TO GROUND SURFACE

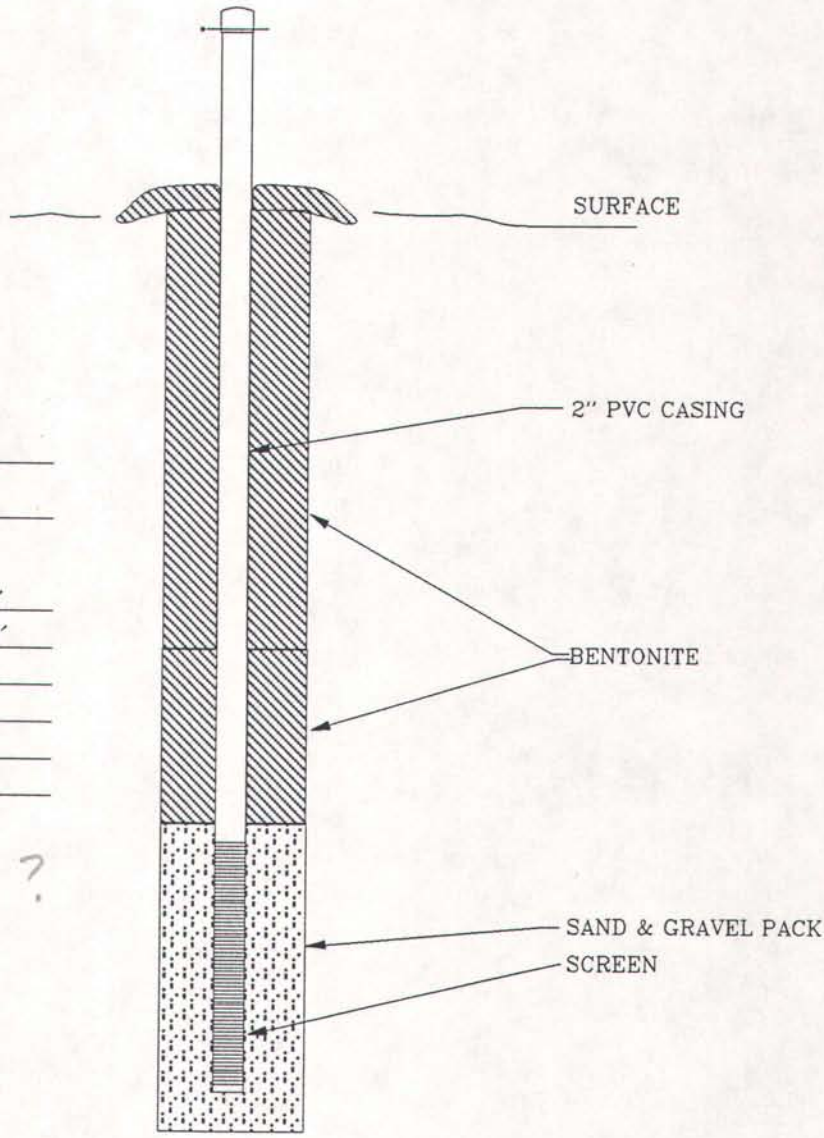
O.D. OF BOREHOLE: 10 1/4"
O.D. OF CASING: 2.0"

PIPE STICKUP: 4.5'
SURFACE ELEVATION: 351.97
GROUT TYPE: NA
CASING TYPE: PVC
CASING SIZE: 2.0"
DEPTH TO BOTTOM OF CASING 10.5'

DEPTH TO TOP OF BENTONITE G.S.
DEPTH TO TOP OF SAND PACK 8.0'

DEPTH TO TOP OF SCREEN 10.5'
DEPTH TO BOTTOM OF SCREEN 20.5'
LENGTH OF SCREEN: 10.0'
SCREEN OPENING SIZE: 0.010"
SCREEN TYPE: PVC
SCREEN SIZE: 2.0"

Well Depth = 20.5' } ?
Boring Depth = 26.0'



PROJECT:	TITLE: Well Schematic				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	JOB: 548	DRAWING: 548-WS	FIGURE: ---	SCALE: NTS	AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA

STANDARD ABOVE GRADE 2" PIEZOMETER CONSTRUCTION SCHEMATIC

WELL NUMBER: PZ-5
DATE STARTED: 2/12/91
DATE FINISHED: 2/13/91
GEOLOGIST/ENG. H. THURSTON
REMARKS: TEMPORARY PIEZOMETER

DRILLING METHOD: HOLLOW STEM AUGER
DRILLING FLUIDS: NA
STATIC WATER LEVEL: 13± DATE:
OBSERVED BY:

NOTE: STATIC WATER LEVEL MEASURED FROM GROUND SURFACE

WELL CONSTRUCITON MEASUREMENTS REFERENCED TO GROUND SURFACE

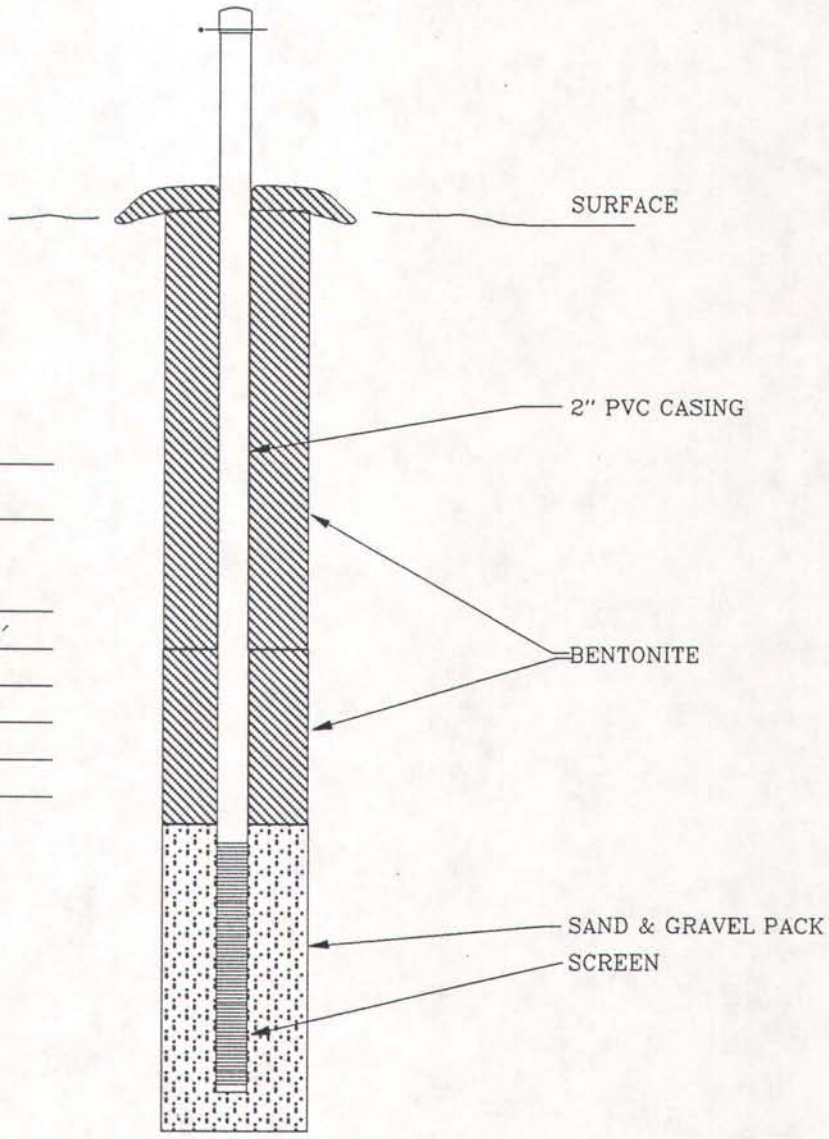
O.D. OF BOREHOLE: 10 1/4"
O.D. OF CASING: 2.0"

PIPE STICKUP: 3.0'
SURFACE ELEVATION: 369.26
GROUT TYPE: NA
CASING TYPE: PVC
CASING SIZE: 2.0"
DEPTH TO BOTTOM OF CASING 9.5'

DEPTH TO TOP OF BENTONITE G.S.
DEPTH TO TOP OF SAND PACK 9.0'

DEPTH TO TOP OF SCREEN 9.5'
DEPTH TO BOTTOM OF SCREEN 19.5'
LENGTH OF SCREEN: 10.0'
SCREEN OPENING SIZE: 0.010"
SCREEN TYPE: PVC
SCREEN SIZE: 2.0"

Well Depth = 19.5'
Boring Depth = 20.5'



PROJECT:	TITLE: Well Schematic				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	JOB: 548	DRAWING: 548-WS	FIGURE: ---	SCALE: NTS	AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA

STANDARD ABOVE GRADE 2" PIEZOMETER CONSTRUCTION SCHEMATIC

WELL NUMBER: PZ-6
DATE STARTED: 2/13/91
DATE FINISHED: 2/13/91
GEOLOGIST/ENG. H. THURSTON
REMARKS: TEMPORARY PIEZOMETER

DRILLING METHOD: HOLLOW STEM AUGER
DRILLING FLUIDS: NA
STATIC WATER LEVEL: 26± DATE: _____
OBSERVED BY: _____

NOTE: STATIC WATER LEVEL MEASURED FROM GROUND SURFACE

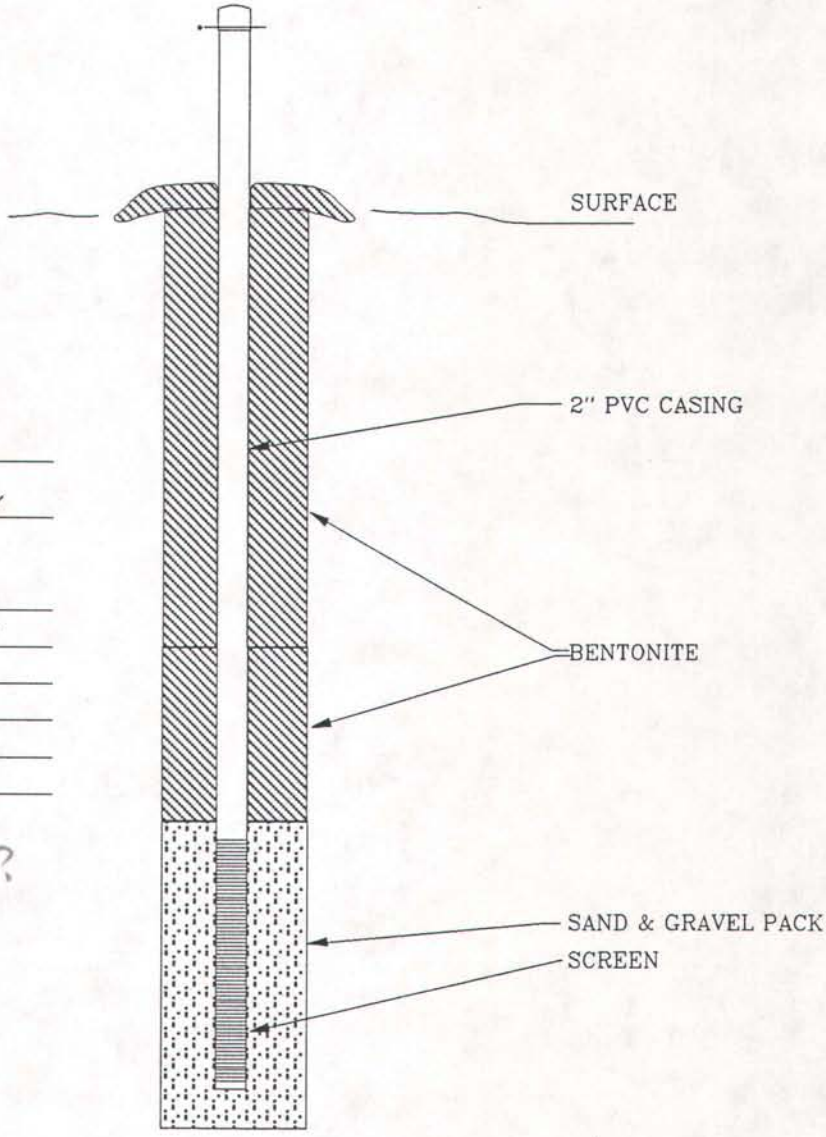
WELL CONSTRUCITON MEASUREMENTS REFERENCED TO GROUND SURFACE

O.D. OF BOREHOLE: 7 1/4"
O.D. OF CASING: 2.0"

PIPE STICKUP: 2.0'
SURFACE ELEVATION: 369.33
GROUT TYPE: NA
CASING TYPE: PVC
CASING SIZE: 2.0"
DEPTH TO BOTTOM OF CASING 28.0'

DEPTH TO TOP OF BENTONITE G.S.
DEPTH TO TOP OF SAND PACK 26.0'

DEPTH TO TOP OF SCREEN 28.0'
DEPTH TO BOTTOM OF SCREEN 38.0'
LENGTH OF SCREEN: 10.0'
SCREEN OPENING SIZE: 0.010"
SCREEN TYPE: PVC
SCREEN SIZE: 2.0"



Well Depth = 38.0 } ?
Boring Depth = 50.5

Nest - Deep Well

PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	Well Schematic				AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA
	JOB: 548	DRAWING: 548-WS	FIGURE: ---	SCALE: NTS	

STANDARD ABOVE GRADE 2" PIEZOMETER CONSTRUCTION SCHEMATIC

WELL NUMBER: PZ-7
DATE STARTED: 2/14/91
DATE FINISHED: 2/14/91
GEOLOGIST/ENG: H. THURSTON
REMARKS: TEMPORARY PIEZOMETER

DRILLING METHOD: HOLLOW STEM AUGER
DRILLING FLUIDS: NA
STATIC WATER LEVEL: 9.9' DATE: TOB
OBSERVED BY: H. THURSTON

NOTE: STATIC WATER LEVEL MEASURED FROM GROUND SURFACE

WELL CONSTRUCITON MEASUREMENTS REFERENCED TO GROUND SURFACE

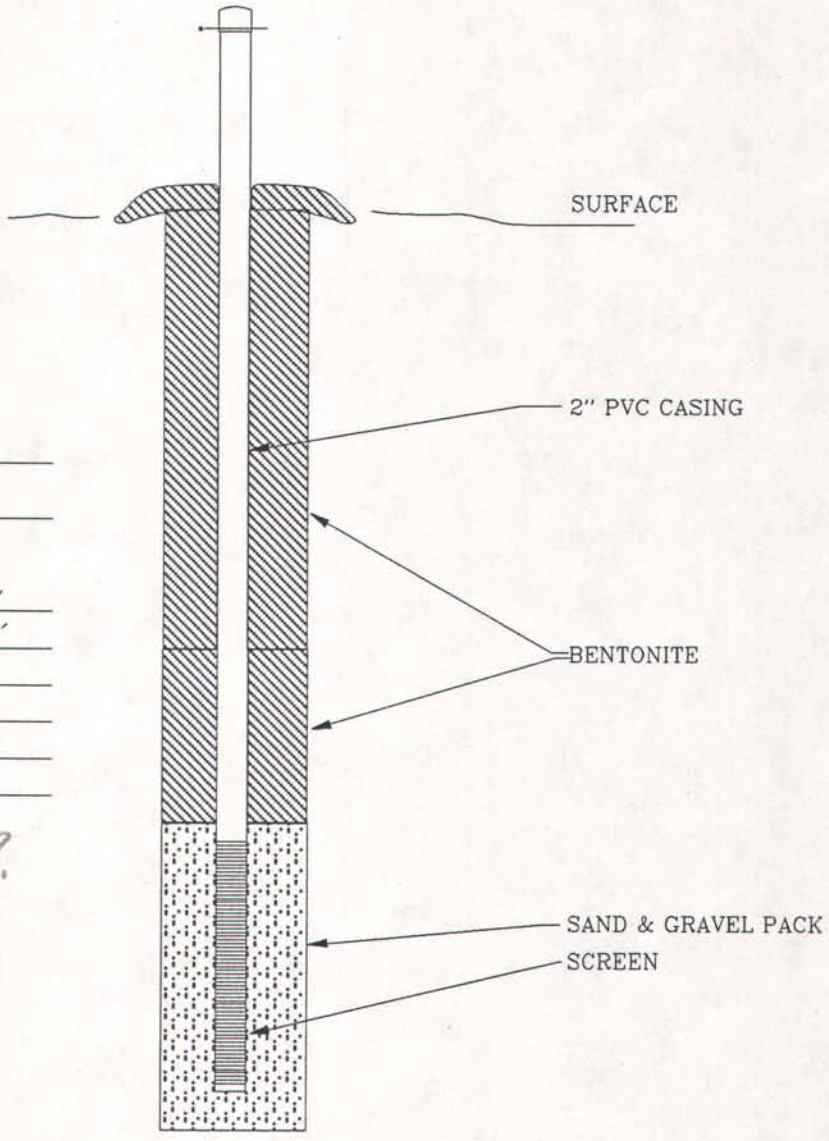
O.D. OF BOREHOLE: 7 1/4"
O.D. OF CASING: 2.0"

PIPE STICKUP: 2.5'
SURFACE ELEVATION: 346.92
GROUT TYPE: NA
CASING TYPE: PVC
CASING SIZE: 2.0"
DEPTH TO BOTTOM OF CASING 9.0'

DEPTH TO TOP OF BENTONITE G.S.
DEPTH TO TOP OF SAND PACK 9.0'

DEPTH TO TOP OF SCREEN 10.0'
DEPTH TO BOTTOM OF SCREEN 20.0'
LENGTH OF SCREEN: 10.0'
SCREEN OPENING SIZE: 0.010"
SCREEN TYPE: PVC
SCREEN SIZE: 2.0"

Well Depth 20.0' } ?
Boring Depth 25.5' }



PROJECT:	TITLE:				
HARNETT COUNTY MONOFILL JOHNSONVILLE, NORTH CAROLINA	Well Schematic				
	JOB: 548	DRAWING: 548-WS	FIGURE: ---	SCALE: NTS	

AQUATERRA, INC.
RALEIGH, GREENSBORO, CHARLOTTE
NORTH CAROLINA

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH NC 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-ENTP. _____

WELL CONSTRUCTION RECORD

PZ-1

DRILLING CONTRACTOR GAI Consultants - NC

DRILLER REGISTRATION NUMBER 446

STATE WELL CONSTRUCTION PERMIT NUMBER 42-0193-WM-0111

1. WELL LOCATION: (Show sketch of the location)
Nearest Town: Johnsville, NC

County: Harnett

(Road, Community, or Subdivision and Lot No.)
Engineers/Surveyors

2. OWNER Tribble and Richardson Consulting

ADDRESS 4020 West Chase Blvd., Suite 515
Street or Route No.

Raleigh NC 27607
City or Town State Zip Code

3. DATE DRILLED 2-6-91 USE OF WELL G.W. Monitoring

4. TOTAL DEPTH 50.5' CUTTINGS COLLECTED _YES X NO

5. DOES WELL REPLACE EXISTING WELL? _YES X NO

6. STATIC WATER LEVEL: 11.5 FT. X above TOP OF CASING
9.1 _below

TOP OF CASING IS 2.4 FT. ABOVE LAND SURFACE

7. YIELD (gpm): NA METHOD OF TEST _____

8. WATER ZONES (depth): 10-50 .5'

9. CHLORINATION: Type NA AMOUNT _____

10. CASING:

	Depth			Wall Thickness Diameter or Weight/Ft.		Material
From	+2.4	To 10.0	Ft.	2.0"	0.154"	PVC
From		To	Ft.			
From		To	Ft.			

11. GROUT:

	Depth			Material	Method
From	0.0	To 9.0	Ft.	Bentonite	Poured
From		To	Ft.		

12. SCREEN:

	Depth			Diameter	Slot Size		Material
From	10.0	To 20.0	Ft.	2.0"	0.010	in.	PVC
From		To	Ft.			in.	
From		To	Ft.			in.	

13. GRAVEL PACK: 41.5' X

	Depth			Size	Material
From	9.0	To 50.5	Ft.	Fine	Sand
From		To	Ft.		

DEPTH From	To	DRILLING LOG Formation Description
0	10.5	Tan brown to red brown fine sandy SILT(ML) mois interbedded with tan sil fine sand at 5.5'
10.5	12.0	White silty fine SAND(SM moist
12.0	19.5	Tan brown fine to medium SAND (SW) saturated
19.5	26.0	Red brown to brown gray clayey SILT (ML)
26.0	31.0	Tan brown fine to medium SAND(SW)
31.0	35.5	Tan brown silty fine to medium SAND(SM)
35.5	39.0	Gray to black silty CLAY (CL) moist

* If additional space is needed use back of form.

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

See Attached Site Location Map

14. REMARKS: Well constructed as temporary piezometer.

I DO HERBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Hamilton Dunn 5/16/91
SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to well owner.

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P. O. BOX 27687 - RALEIGH NC 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-ENTP. _____

WELL CONSTRUCTION RECORD

PZ-2

DRILLING CONTRACTOR GAI Consultants - NC

DRILLER REGISTRATION NUMBER 446

STATE WELL CONSTRUCTION PERMIT NUMBER 42-0193-WM-0111

1. WELL LOCATION: (Show sketch of the location)
Nearest Town: Johnsville, NC

County: Harnett

(Road, Community, or Subdivision and Lot No.)
Engineers/Surveyors

2. OWNER Tribble and Richardson Consulting

ADDRESS 4020 West Chase Blvd., Suite 515
Street or Route No.

Raleigh NC 27607
City or Town State Zip Code

3. DATE DRILLED 2-6, 2-7-91 USE OF WELL G.W. Monitoring

4. TOTAL DEPTH 30.5' CUTTINGS COLLECTED _YES X NO

5. DOES WELL REPLACE EXISTING WELL? _YES X NO

6. STATIC WATER LEVEL: 10.1 FT. _above TOP OF CASING
6.2 X below

TOP OF CASING IS 3.9 FT. ABOVE LAND SURFACE

7. YIELD (gpm): NA METHOD OF TEST _____

8. WATER ZONES (depth): 17-30.5'

9. CHLORINATION: Type NA AMOUNT _____

10. CASING:

	Depth		Wall Thickness Diameter or Weight/Ft.		Material
From	+3.9	To 17.0 Ft.	2"	0.154"	PVC
From	_____	To _____ Ft.	_____	_____	_____
From	_____	To _____ Ft.	_____	_____	_____

11. GROUT:

	Depth		Material	Method
From	0.0	To 17.0 Ft.	Bentonite	Poured
From	_____	To _____ Ft.	_____	_____

12. SCREEN:

	Depth		Diameter	Slot Size	Material
From	17.0	To 27.0 Ft.	2"	0.01 in.	PVC
From	_____	To _____ Ft.	_____	_____ in.	_____
From	_____	To _____ Ft.	_____	_____ in.	_____

13. GRAVEL PACK: 13.5

	Depth		Size	Material
From	17.0	To 30.5 Ft.	Fine	SAND
From	_____	To _____ Ft.	_____	_____

14. REMARKS: Well constructed as temporary piezometer

DEPTH From	To	DRILLING LOG Formation Description
0.0	6.0'	Tan brown silty fine SAN
		(SC) some clay, red brow
		mottling 4.0-6.0'.
6.0-	14.0	Gray CLAY (CH), with
		occasional red brown sil
		moist.
14.0-	23.0'	Red brown to gray silty
		fine to medium SAND (SM)
		wet.
23.0-	26.0'	Black gray SILT (ML), dr
26.0-	28.0'	Red brown silty CLAY (CL
28.0-	30.5'	Tan gray silty fine SAN
		(SM), moist.

If additional space is needed use back of form.

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

See attached site location map

I DO HERBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

[signature] 5/16/91

SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to well owner.

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH NC 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-ENTP. _____

WELL CONSTRUCTION RECORD

PZ-3

DRILLING CONTRACTOR GAI Consultants - NC

DRILLER REGISTRATION NUMBER 446

STATE WELL CONSTRUCTION PERMIT NUMBER 42-0193-WM-0111

1. WELL LOCATION: (Show sketch of the location)
Nearest Town: Johnsville, NC

County: Harnett

(Road, Community, or Subdivision and Lot No.)
Engineers/Surveyors

2. OWNER Tribble and Richardson Consulting

ADDRESS 4020 West Chase Blvd., Suite 515
Street or Route No.

Raleigh NC 27607
City or Town State Zip Code

3. DATE DRILLED 2-12-91 USE OF WELL GW Monitor

4. TOTAL DEPTH 25.5 CUTTINGS COLLECTED _YES X NO

5. DOES WELL REPLACE EXISTING WELL? _YES X_NO

6. STATIC WATER LEVEL: 5.6 FT. _above TOP OF CASING
2.1 X below

TOP OF CASING IS 3.5 FT. ABOVE LAND SURFACE

7. YIELD (gpm): NA METHOD OF TEST _____

8. WATER ZONES (depth): 4.0'-25.5'

9. CHLORINATION: Type NA AMOUNT _____

10. CASING:

	Depth			Wall Thickness Diameter or Weight/Ft.		Material
From	3.5	To 4.0	Ft.	2"	0.154"	PVC
From		To	Ft.			
From		To	Ft.			

11. GROUT:

	Depth			Material	Method
From	0.0	To 3.0	Ft.	Bentonite	Poured
From		To	Ft.		

12. SCREEN:

	Depth			Diameter	Slot Size		Material
From	4.0'	To 14.0	Ft.	2"	0.01	in.	PVC
From		To	Ft.			in.	
From		To	Ft.			in.	

13. GRAVEL PACK: 22.5 X

	Depth					
From	3.0	To 25.5	Ft.	Fine	Sand	
From		To	Ft.			

DEPTH From	To	DRILLING LOG Formation Description
0.0	3.5	Medium brown fine to medium sandy SILT (ML), moist.
3.5	9.0	Tan to red brown silty fine to medium SAND (SM) wet.
9.0	14.0	Mottled red and gray sil CLAY (CL), moist.
14.0	23.5	Tan to gray clayey SILT (ML) dry, becomes moist 18.5'.
23.5	25.5	Dark gray silty CLAY (CL moist.

If additional space is needed use back of form.

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

See attached site location map.

14. REMARKS: Well constructed as temporary piezometer

I DO HERBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

[signature] 5/16/91

SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to well owner.

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH NC 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-ENTP. _____

WELL CONSTRUCTION RECORD

PZ-4

DRILLING CONTRACTOR GAI Consultants - NC

DRILLER REGISTRATION NUMBER 446

STATE WELL CONSTRUCTION PERMIT NUMBER 42-0193-WM-0111

1. WELL LOCATION: (Show sketch of the location)
Nearest Town: Johnsville, NC

County: Harnett

(Road, Community, or Subdivision and Lot No.)

2. OWNER Engineers/Surveyors Tribble and Richardson Consulting
ADDRESS 4020 West Chase Blvd., Suite 515
Street or Route No.
Raleigh NC 27607
City or Town State Zip Code

3. DATE DRILLED 2-12-91 USE OF WELL GW Moinitor
4. TOTAL DEPTH 26.0' CUTTINGS COLLECTED _YES xNO
5. DOES WELL REPLACE EXISTING WELL? _YES x NO
6. STATIC WATER LEVEL: 15.6' FT. _above TOP OF CASING
11.1 _below
TOP OF CASING IS 4.5' FT. ABOVE LAND SURFACE
7. YIELD (gpm): NA METHOD OF TEST _____
8. WATER ZONES (depth): 10.5-26.0'

9. CHLORINATION: Type NA AMOUNT _____

10. CASING:

	Depth		Wall Thickness Diameter or Weight/Ft.		Material
From	+4.5 To	10.5 Ft.	2"	0.154"	PVC
From	_____ To	_____ Ft.	_____	_____	_____
From	_____ To	_____ Ft.	_____	_____	_____

11. GROUT:

	Depth		Material	Method
From	0.0 To	8.0 Ft.	Bentonite	Pour
From	_____ To	_____ Ft.	_____	_____

12. SCREEN:

	Depth		Diameter	Slot Size	Material
From	10.5' To	20.5' Ft.	2"	0.01" in.	PVC
From	_____ To	_____ Ft.	_____	_____ in.	_____
From	_____ To	_____ Ft.	_____	_____ in.	_____

13. GRAVEL PACK: 18 X

	Depth		Size	Material
From	8.0 To	26.0 Ft.	Fine	Sand
From	_____ To	_____ Ft.	_____	_____

DEPTH From	To	DRILLING LOG Formation Description
0.0'	-20.0'	Brown to light brown silty fine to medium SAND (SM) interbedded with medium brown mediu to coarse SAND (SW) fro 14.5-15.5' and 19.0-19. saturated at 14.0'.
20.0'	-25.5'	Interbedded red brown a white silty fine SAND (SM) saturated. Sand becomes medium to coars at 25.0'.
25.5	-26.0'	Interbedded tan, white and gray clayey, silty fine SAND (SC) saturate

If additional space is needed use back of form.

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

See attached site location map.

14. REMARKS: Well constructed as temporary piezometer.

I DO HERBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

[signature] 5/16/91
SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to well owner.

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH NC 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-ENTP. _____

WELL CONSTRUCTION RECORD

PZ-5

DRILLING CONTRACTOR GAI Consultants - NC

DRILLER REGISTRATION NUMBER 446

STATE WELL CONSTRUCTION PERMIT NUMBER 42-0193-WM-0111

1. WELL LOCATION: (Show sketch of the location)
Nearest Town: Johnsville, NC

County: Harnett

(Road, Community, or Subdivision and Lot No.)
Engineers/Surveyors

2. OWNER Tribble and Richardson Consulting
ADDRESS 4020 West Chase Blvd., Suite 515
Street or Route No.
Raleigh NC 27607
City or Town State Zip Code

3. DATE DRILLED 2-12, 2-13-91 USE OF WELL GW Monitor
4. TOTAL DEPTH 20.5' CUTTINGS COLLECTED _YES X NO
5. DOES WELL REPLACE EXISTING WELL? _YES X NO
6. STATIC WATER LEVEL: 16.5 FT. _above TOP OF CASING
13.5 X below
TOP OF CASING IS 3.0 FT. ABOVE LAND SURFACE
7. YIELD (gpm): NA METHOD OF TEST _____
8. WATER ZONES (depth): 9.5-19.5'

9. CHLORINATION: Type NA AMOUNT _____

10. CASING:

	Depth		Diameter or Weight/Ft.	Wall Thickness	Material
From	+3.0 To	9.5 Ft.	2"	0.154"	PVC
From	_____ To	_____ Ft.	_____	_____	_____
From	_____ To	_____ Ft.	_____	_____	_____

11. GROUT:

	Depth		Material	Method
From	0.0 To	9.0 Ft.	Bentonite	Pour
From	_____ To	_____ Ft.	_____	_____

12. SCREEN:

	Depth		Diameter	Slot Size	Material
From	9.5 To	19.5 Ft.	2"	0.01 in.	PVC
From	_____ To	_____ Ft.	_____	_____ in.	_____
From	_____ To	_____ Ft.	_____	_____ in.	_____

13. GRAVEL PACK: 11.5

	Depth		Size	Material
From	9.0 To	20.5 Ft.	Fine	Sand
From	_____ To	_____ Ft.	_____	_____

DEPTH From	To	DRILLING LOG Formation Description
0.0	3.5'	Tan-brown clayey SILT (ML moist.
3.5	7.0'	Purple and gray silty CLAY (CL) with pockets of fine sand, moist.
7.0	17.0'	Tan-gray silty fine to medium SAND (SM) saturated at 13.5'.
17.0	20.5'	Gray silty CLAY (CL) dry.

If additional space is needed use back of form.

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

See attached site location map.

14. REMARKS: Well constructed as temporary piezometer.

I DO HERBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

Hamilton Dunn 5/16/91
SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to well owner.

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH NC 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. 2 GW-ENTP. _____

WELL CONSTRUCTION RECORD

PZ-6

DRILLING CONTRACTOR GAI Consultants - NC

DRILLER REGISTRATION NUMBER 446

STATE WELL CONSTRUCTION PERMIT NUMBER 42-0193-WM-0111

1. WELL LOCATION: (Show sketch of the location)
Nearest Town: Johnsville, NC

County: Harnett

(Road, Community, or Subdivision and Lot No.)
Engineers/Surveyors

2. OWNER Tribble and Richardson Consulting

ADDRESS 4020 West Chase Blvd., Suite 515
Street or Route No.

Raleigh NC 27607
City or Town State Zip Code

3. DATE DRILLED 2-13-91 USE OF WELL GW Monitor

4. TOTAL DEPTH 50.5' CUTTINGS COLLECTED _YES X NO

5. DOES WELL REPLACE EXISTING WELL? _YES X NO

6. STATIC WATER LEVEL: 28.3 FT. _above TOP OF CASING
26.3 X below

TOP OF CASING IS 2.0 FT. ABOVE LAND SURFACE

7. YIELD (gpm): NA METHOD OF TEST _____

8. WATER ZONES (depth): 28.0-50.5'

9. CHLORINATION: Type NA AMOUNT _____

10. CASING:

	Depth			Wall Thickness Diameter or Weight/Ft.		Material
From	+2.0	To	28.0 Ft.	2.0"	0.154"	PVC
From	_____	To	_____ Ft.	_____	_____	_____
From	_____	To	_____ Ft.	_____	_____	_____

11. GROUT:

	Depth			Material	Method
From	0.0	To	26.0 Ft.	Bentonite	Poured
From	_____	To	_____ Ft.	_____	_____

12. SCREEN:

	Depth			Diameter	Slot Size	Material
From	28.0	To	38.0 Ft.	2.0"	0.010 in.	PVC
From	_____	To	_____ Ft.	_____	_____ in.	_____
From	_____	To	_____ Ft.	_____	_____ in.	_____

13. GRAVEL PACK: 24.5

	Depth			Size	Material
From	26.0	To	50.5 Ft.	Fine	Sand
From	_____	To	_____ Ft.	_____	_____

DRILLING LOG

DEPTH From	To	Formation Description
0.0-7.5'		Mottled red, purple and gray silty CLAY (CL) with fine sand pockets, moist dry.
7.5-9.5'		Light brown clayey SILT (M moist
9.5-18.0'		Tan gray to yellow tan silty fine to medium SAND (SM) moist to saturated @ 13.5'.
18.0-31.5'		Gray to red gray silty CLAY (CL) dry to saturate @ 26.5-28.5'.
31.5-38.5'		Tan and gray fine sandy SILT (ML) saturated.
38.5-41.5'		Yellow tan silty fine to medium SAND (SM) saturated.

* If additional space is needed use back of form.

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

See attached site location map.

14. REMARKS: Well constructed as temporary piezometer.

I DO HERBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

[signature] 5/16/91

SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to well owner.

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH NC 27611, PHONE (919) 733-5083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-ENTP. _____

WELL CONSTRUCTION RECORD

PZ-7

DRILLING CONTRACTOR GAI Consultants - NC

DRILLER REGISTRATION NUMBER 446

STATE WELL CONSTRUCTION PERMIT NUMBER 42-0193-WM-0111

1. WELL LOCATION: (Show sketch of the location)
Nearest Town: Johnsville, NC

County: Harnett

(Road, Community, or Subdivision and Lot No.)

2. OWNER Engineers/Surveyors
Tribble and Richardson Consulting
ADDRESS 4020 West Chase Blvd., Suite 515
Street or Route No.
Raleigh NC 27607
City or Town State Zip Code

3. DATE DRILLED 2-14-91 USE OF WELL GW Monitor
4. TOTAL DEPTH 25.5' CUTTINGS COLLECTED _YES X NO
5. DOES WELL REPLACE EXISTING WELL? _YES XNO
6. STATIC WATER LEVEL: 12.4 FT. _above TOP OF CASING
9.9 X_below
TOP OF CASING IS 2.5 FT. ABOVE LAND SURFACE
7. YIELD (gpm): NA METHOD OF TEST _____
8. WATER ZONES (depth): 10-25.5'

9. CHLORINATION: Type NA AMOUNT _____

10. CASING:

	Depth			Wall Thickness Diameter or Weight/Ft.		Material
From	+2.5	To 9.0	Ft.	2.0"	0.154"	PVC
From		To	Ft.			
From		To	Ft.			

11. GROUT:

	Depth			Material	Method
From	0.0	To 9.0	Ft.	Bentonite	Pour
From		To	Ft.		

12. SCREEN:

	Depth			Diameter	Slot Size		Material
From	10.0	To 20.0	Ft.	2.0"	0.010	in.	PVC
From		To	Ft.			in.	
From		To	Ft.			in.	

13. GRAVEL PACK: 16.5

	Depth			Size	Material
From	9.0	To 25.5	Ft.	Fine	Sand
From		To	Ft.		

DEPTH From	To	DRILLING LOG Formation Description
0.0	3.5'	Red brown fine sandy SILT (ML)
3.5	10.0'	Red brown-tan silty fine to coarse SAND (SW) moist
10.0	18.5'	Red brown silty fine to medium SAND (SM) saturate at 14.0'
18.5	22.5'	Tan and brown medium to coarse SAND (SW) saturate
22.5	24.5'	Gray silty medium to fine SAND (SC) some clay, saturated.
24.5	25.5'	Gray CLAY (CH) moist.

If additional space is needed use back of form.

LOCATION SKETCH

(Show direction and distance from at least two State Roads, or other map reference points)

See attached site location map.

14. REMARKS: Well constructed as temporary piezometer.

I DO HERBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

[signature] 5/16/91
SIGNATURE OF CONTRACTOR OR AGENT DATE

Submit original to Division of Environmental Management and copy to well owner.

Attachment E

DRAWDOWN TEST

Well Number: PZ-1 Location: Harnett County Monofill
Top of Casing (TOC) Elevation: 347.50 Date: 2/18/91
Ground Surface Elevation: 345.12 Time: 11:30
Casing Diameter: 2" Computed By: H. Thurston
Borehole Diameter: 10 1/4" Assisted By:
Screen Depth: 10.0" Persons Observing:
Reference Point: T.O.C. Static from TOC: 12.0'

Evacuation Method: Bailing Amount of Water Removed: 8 bails (2 gals.)

Recover Data

Elapsed Time	Ground Water Depth	H	H/H_o
0	12.37	0.37	1.00
15 sec.	12.30	0.30	0.81
30 sec.	12.20	0.20	0.54
60 sec.	12.10	0.10	0.27
90 sec.	12.08	0.08	0.22
2 min.	12.05	0.05	0.14
3 min.	12.03	0.03	0.08
4 min.	12.02	0.02	0.05
5 min.	12.02	0.02	0.05
6 min.	12.01	0.01	0.03
7 min.	12.01	0.01	0.03
8 min.	12.00	0.00	0.00
TEST #2	8 Bails Out		
0	12.35	0.35	1.00
15 sec.	12.25	0.25	0.71
30 sec.	12.13	0.13	0.37
60 sec.	12.09	0.09	0.26
90 sec.	12.05	0.05	0.14
2 min.	12.04	0.04	0.11
3 min.	12.04	0.04	0.11
4 min.	12.02	0.02	0.06
5 min.	12.015	0.015	0.04
6 min.	12.01	0.01	0.03
7 min.	12.01	0.01	0.03
8 min.	12.00	0.00	0.00

Well Number: PZ-1 (test 1) Date: 3/20/91

Computed By: Harold Thurston

Casing diameter	d	=	5.08 (cm)
Borehole diameter	D	=	26.04 (cm)
Length of hydraulic interval	L	=	316.38 (cm)
Time lag at 0.37 H/H_o	T	=	054 (seconds)

$$k_h = \frac{d^2 \ln \frac{2mL}{D}}{8LT} \qquad m = 1$$

Note: This equation is valid only for a typical monitoring well situation. If the situation differs significantly consult Foundation Engineering Handbook, Winterkorn & Fang, pp. 29-35.

Note: $m = k_{horizontal}/k_{vertical}$ Assume $k_h = k_v = 1$

$$k_h = (5.08)^2 \ln \frac{2(1)(316.38)}{26.04} / 8 (316.38) (054)$$

$$k_h = 25.81 (3.19) / 136{,}676.16$$

$$k_h = 6.02 \times 10^{-4} \text{ cm/sec}$$

1cm/sec = 2834.64 ft/day

k_h = 1.71 ft/day

Well Number: PZ-1 (test 2) Date: 3/20/91

Computed By: Harold Thurston

Casing diameter	d	=	5.08 (cm)
Borehole diameter	D	=	26.04 (cm)
Length of hydraulic interval	L	=	316.38 (cm)
Time lag at 0.37 H/H_o	T	=	040 (seconds)

$$k_h = \frac{d^2 \ln \frac{2mL}{D}}{8LT} \qquad m = 1$$

Note: This equation is valid only for a typical monitoring well situation. If the situation differs significantly consult Foundation Engineering Handbook, Winterkorn & Fang, pp. 29-35.

Note: $m = {}^{k_{horizontal}}/_{k_{vertical}}$ Assume $k_h = k_v = 1$

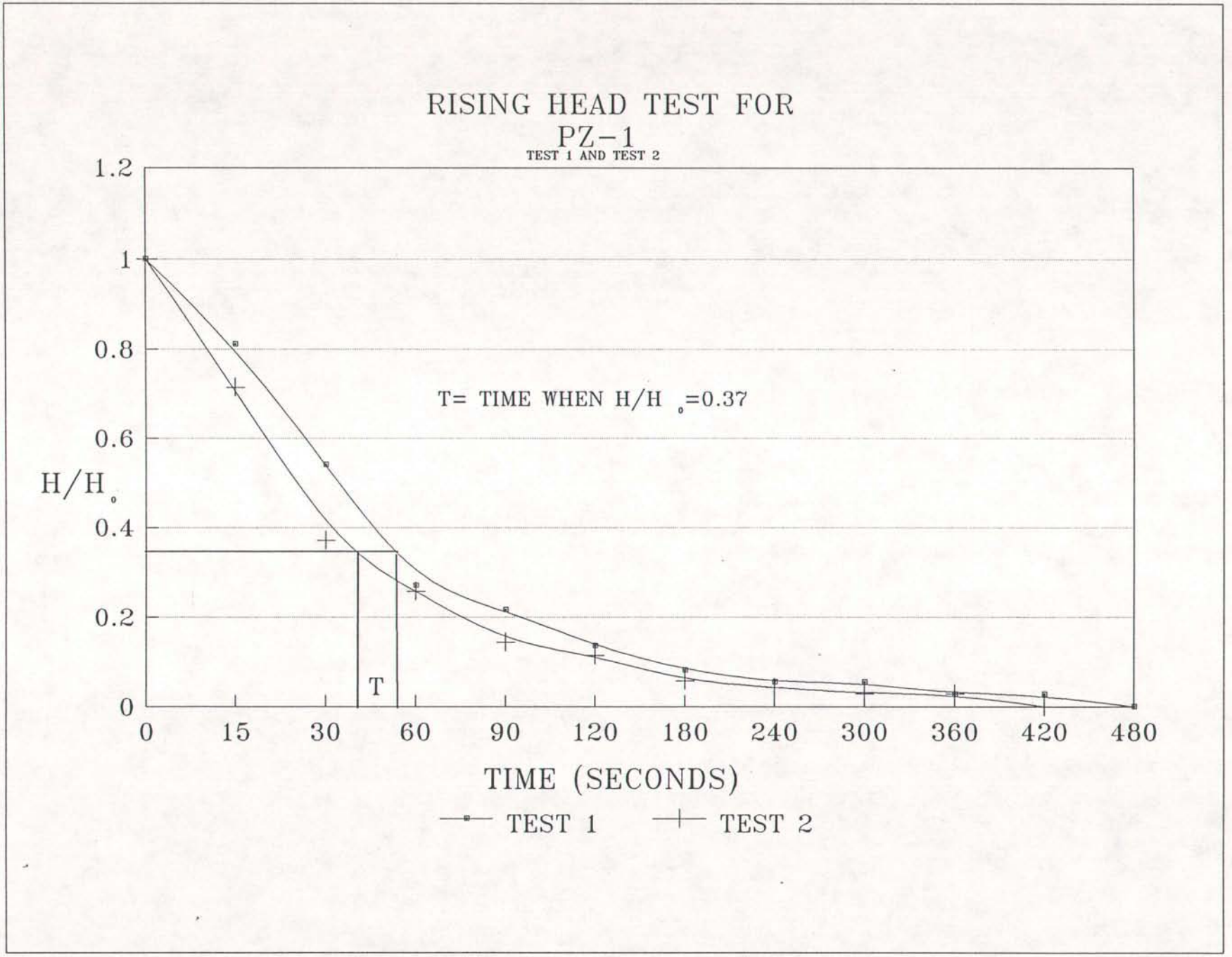
$$k_h = (5.08)^2 \ln \frac{2(1)(316.38)}{26.04} / 8 (316.38) (040)$$

$$k_h = 25.81 (3.19) / 101{,}241.6$$

$k_h = 8.13 \times 10^{-4}$ cm/sec

1cm/sec = 2834.64 ft/day

$k_h = 2.30$ ft/day


RISING HEAD TEST FOR
PZ-1
TEST 1 AND TEST 2
1.2
1
0.8
0.6
0.4
0.2
0
H/H
T= TIME WHEN H/H =0.37
T
0
15
30
60
90
120
180
240
300
360
420
480
TIME (SECONDS)
TEST 1
TEST 2

DRAWDOWN TEST

Well Number: PZ-2 Location: Harnett County Monofill

Top of Casing (TOC) Elevation: 314.33 Date: 2/18/91

Ground Surface Elevation: 311.06 Time: 1:00

Casing Diameter: 2" Computed By: H. Thurston

Borehole Diameter: 7 1/4" Assisted By:

Screen Depth: 19.0" Persons Observing:

Reference Point: T.O.C. Static from TOC: 9.95'

Evacuation Method: Bailing

Amount of Water Removed: 8 bails (2 gals.)

Recover Data

Elapsed Time	Ground Water Depth	H	H/H_o
0	21.37	11.42	1.000
15 sec.	21.30	11.35	0.994
30 sec.	21.13	11.18	0.978
60 sec.	21.10	11.15	0.976
90 sec.	21.02	11.07	0.969
2 min.	20.97	11.02	0.965
3 min.	20.91	10.96	0.959
4 min.	20.88	10.93	0.957
5 min.	20.82	10.87	0.951
6 min.	20.76	10.81	0.947
7 min.	20.73	10.78	0.944
8 min.	20.67	10.72	0.939
9 min.	20.63	10.68	0.935
10 min.	20.55	10.60	0.928
15 min.	20.31	10.36	0.907
20 min.	20.19	10.24	0.897
25 min.	20.09	10.14	0.888
30 min.	19.93	9.98	0.874
45 min.	19.30	9.35	0.819

Well Number: PZ-2 Date: 3/21/91

Computed By: Harold Thurston

Casing diameter	d	=	5.08 (cm)
Borehole diameter	D	=	18.42 (cm)
Length of hydraulic interval	L	=	365.76 (cm)
Time lag at 0.37 H/H_o	T	=	1.26×10^4 (seconds)

$$k_h = \frac{d^2 \ln \frac{2mL}{D}}{8LT} \qquad m = 1$$

Note: This equation is valid only for a typical monitoring well situation. If the situation differs significantly consult Foundation Engineering Handbook, Winterkorn & Fang, pp. 29-35.

Note: $m = k_{horizontal}/k_{vertical}$ Assume $k_h = k_v = 1$

$$k_h = (5.08)^2 \ln \frac{2(1)(365.76)}{18.42} / 8 (365.76) (1.26 \times 10^4)$$

$$k_h = 25.81 (3.68) / 3.687 \times 10^7$$

$k_h = 2.58 \times 10^{-6}$ cm/sec

1cm/sec = 2834.64 ft/day

$k_h = 0.007$ ft/day

AQUATERRA
Aquaterra, Inc. • P.O. Box 50328 • Raleigh, NC 27650

JOB NO. 5-715
SHEET NO.
DATE 3/26/91

JOB NAME Harnett County Landfill
COMPUTED BY H Thurston
SUBJECT T vs Log (T) Calculations
CHECKED BY

PZ-2

Slope = -5.0×10^{-5}

Using

$y = mx + b$

where

$y = 0.37$

$m = -5.0 \times 10^{-5}$

$b = 1$

$x = T = ?$

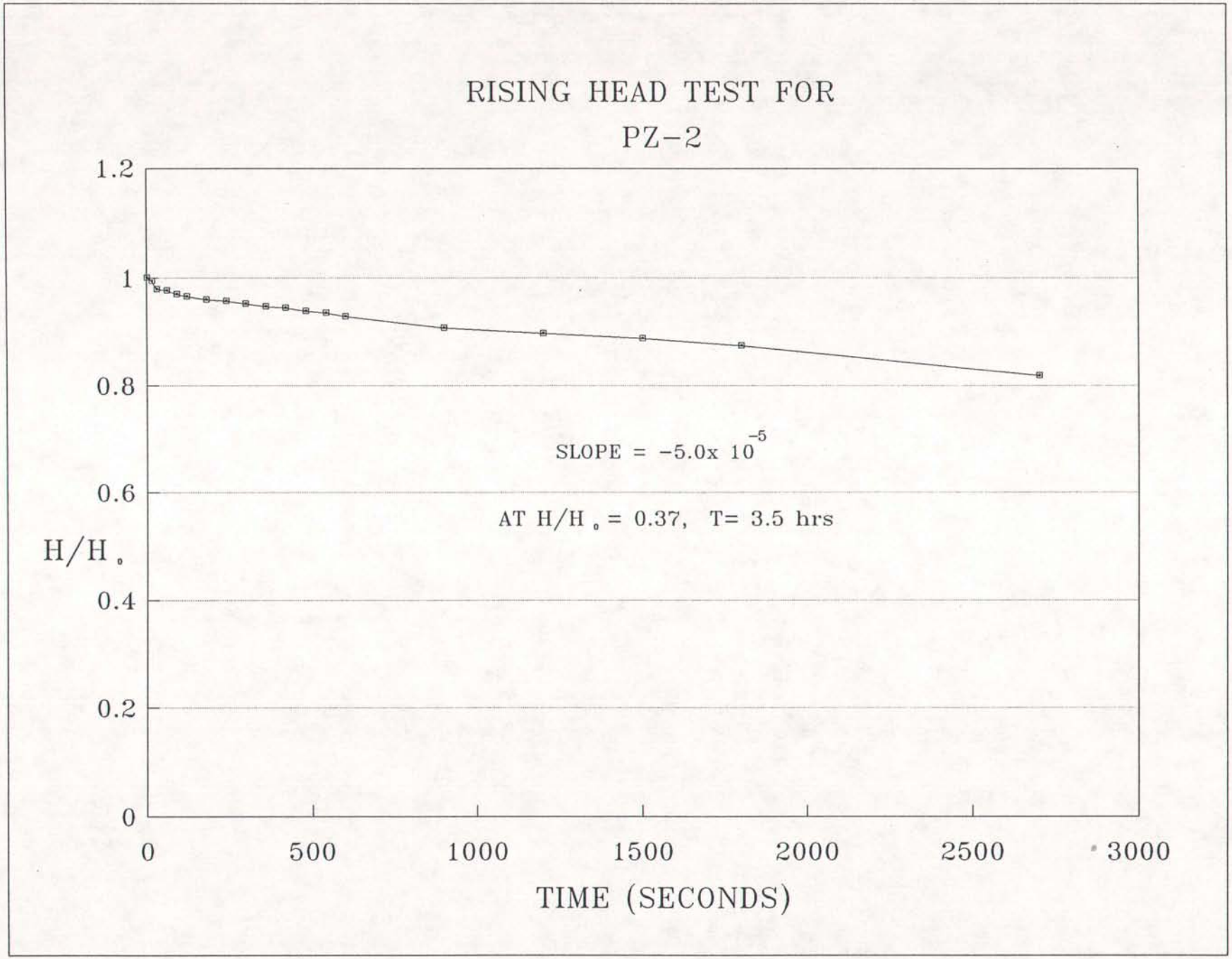
$$x = \frac{y - b}{m}$$

$$x = \frac{0.37 - 1}{-5.0 \times 10^{-5}}$$

$x = 1.26 \times 10^4$ seconds

$x = 3.5$ hrs.

T = 1.26×10^4 seconds ⇒ 3.5 hrs.


RISING HEAD TEST FOR
PZ-2
1.2
1
0.8
0.6
0.4
0.2
0
H/H ₀
SLOPE = -5.0x 10⁻⁵
AT H/H ₀ = 0.37, T= 3.5 hrs
0
500
1000
1500
2000
2500
3000
TIME (SECONDS)

DRAWDOWN TEST

Well Number: PZ-3 Location: Harnett County Monofill
Top of Casing (TOC) Elevation: 338.77 Date: 2/18/91
Ground Surface Elevation: 335.30 Time: 2:00
Casing Diameter: 2" Computed By: H. Thurston
Borehole Diameter: 10 1/4" Assisted By:
Screen Depth: 4.0" Persons Observing:
Reference Point: T.O.C. Static from TOC: 6.63'
Evacuation Method: Bailing
Amount of Water Removed: 8 bails - 2 gals.

Recover Data

Elapsed Time	Ground Water Depth	H	H/H_o
0	9.00	2.37	1.000
15 sec.	8.93	2.30	0.970
30 sec.	8.88	2.25	0.949
60 sec.	8.84	2.21	0.932
90 sec.	8.83	2.20	0.928
2 min.	8.83	2.20	0.928
3 min.	8.82	2.19	0.924
4 min.	8.82	2.19	0.924
5 min.	8.81	2.18	0.919
6 min.	8.80	2.17	0.916
7 min.	8.79	2.16	0.911
8 min.	8.78	2.15	0.907
9 min.	8.78	2.15	0.907
10 min.	8.78	2.15	0.907
11 min.	8.78	2.15	0.907
12 min.	8.78	2.15	0.907
13 min.	8.78	2.15	0.907
14 min.	8.78	2.15	0.907
15 min.	8.78	2.15	0.907
20 min.	8.78	2.15	0.907
25 min.	8.77	2.14	0.903
30 min.	8.77	2.14	0.903
45 min.	8.76	2.13	0.899

Well Number: PZ-3 Date: 3/26/91

Computed By: Harold Thurston

Casing diameter	d	=	5.08 (cm)
Borehole diameter	D	=	26.04 (cm)
Length of hydraulic interval	L	=	330.40 (cm)
Time lag at 0.37 H/H_o	T	=	5.68×10^4 (seconds)

$$k_h = \frac{d^2 \ln \frac{2mL}{D}}{8LT} \qquad m = 1$$

Note: This equation is valid only for a typical monitoring well situation. If the situation differs significantly consult Foundation Engineering Handbook, Winterkorn & Fang, pp. 29-35.

Note: $m = k_{horizontal}/k_{vertical}$ Assume $k_h = k_v = 1$

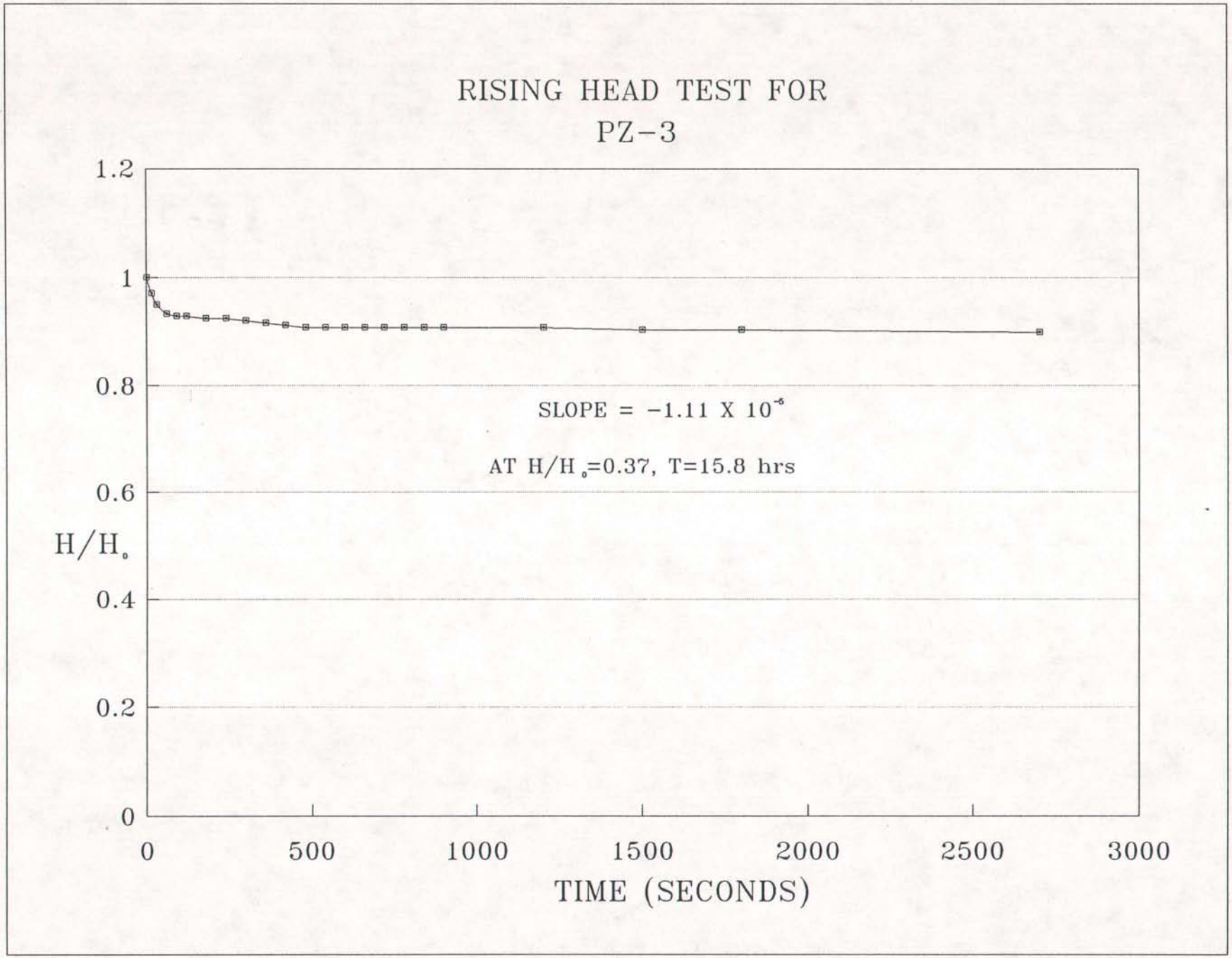
$$k_h = (5.08)^2 \ln \frac{2(1)(330.40)}{26.04} / 8 (330.40) (5.68 \times 10^4)$$

$$k_h = 25.81 (3.23) / 150{,}345{,}216.0$$

$k_h = 5.54 \times 10^{-7}$ cm/sec

1cm/sec = 2834.64 ft/day

$k_h = 0.002$ ft/day


RISING HEAD TEST FOR
PZ-3
1.2
1
0.8
0.6
0.4
0.2
0
H/H$_o$
SLOPE = −1.11 X 10^{-5}
AT H/H$_o$=0.37, T=15.8 hrs
0
500
1000
1500
2000
2500
3000
TIME (SECONDS)

DRAWDOWN TEST

Well Number: PZ-4 Location: Harnett County Monofill

Top of Casing (TOC) Elevation: 354.18 Date: 2/18/91

Ground Surface Elevation: 351.97 Time: 3:00

Casing Diameter: 2" Computed By: H. Thurston

Borehole Diameter: 10 1/4" Assisted By: _____

Screen Depth: 10.5" Persons Observing: _____

Reference Point: T.O.C. Static from TOC: 13.34'

Evacuation Method: Bailing

Amount of Water Removed: 8 bails - 2 gals.

Recover Data

Elapsed Time	Ground Water Depth	H	H/H_o
0	13.51	0.17	1.0000
15 sec.	13.47	0.13	0.7647
30 sec.	13.45	0.11	0.6471
60 sec.	13.43	0.09	0.5294
90 sec.	13.41	0.07	0.4118
2 min.	13.39	0.05	0.2941
3 min.	13.38	0.04	0.2353
4 min.	13.36	0.02	0.1176
5 min.	13.36	0.02	0.1176
6 min.	13.35	0.01	0.0588
7 min.	13.34	0.00	0.0000
8 min.	13.34	0.00	0.0000

Well Number: PZ-4 Date: 3/26/91

Computed By: Harold Thurston

Casing diameter	d	=	5.08 (cm)
Borehole diameter	D	=	26.04 (cm)
Length of hydraulic interval	L	=	381.0 (cm)
Time lag at 0.37 H/H_o	T	=	106.4 (seconds)

$$k_h = \frac{d^2 \ln \frac{2mL}{D}}{8LT} \qquad m = 1$$

Note: This equation is valid only for a typical monitoring well situation. If the situation differs significantly consult Foundation Engineering Handbook, Winterkorn & Fang, pp. 29-35.

Note: $m = {}^{k_{horizontal}}/_{k_{vertical}}$ Assume $k_h = k_v = 1$

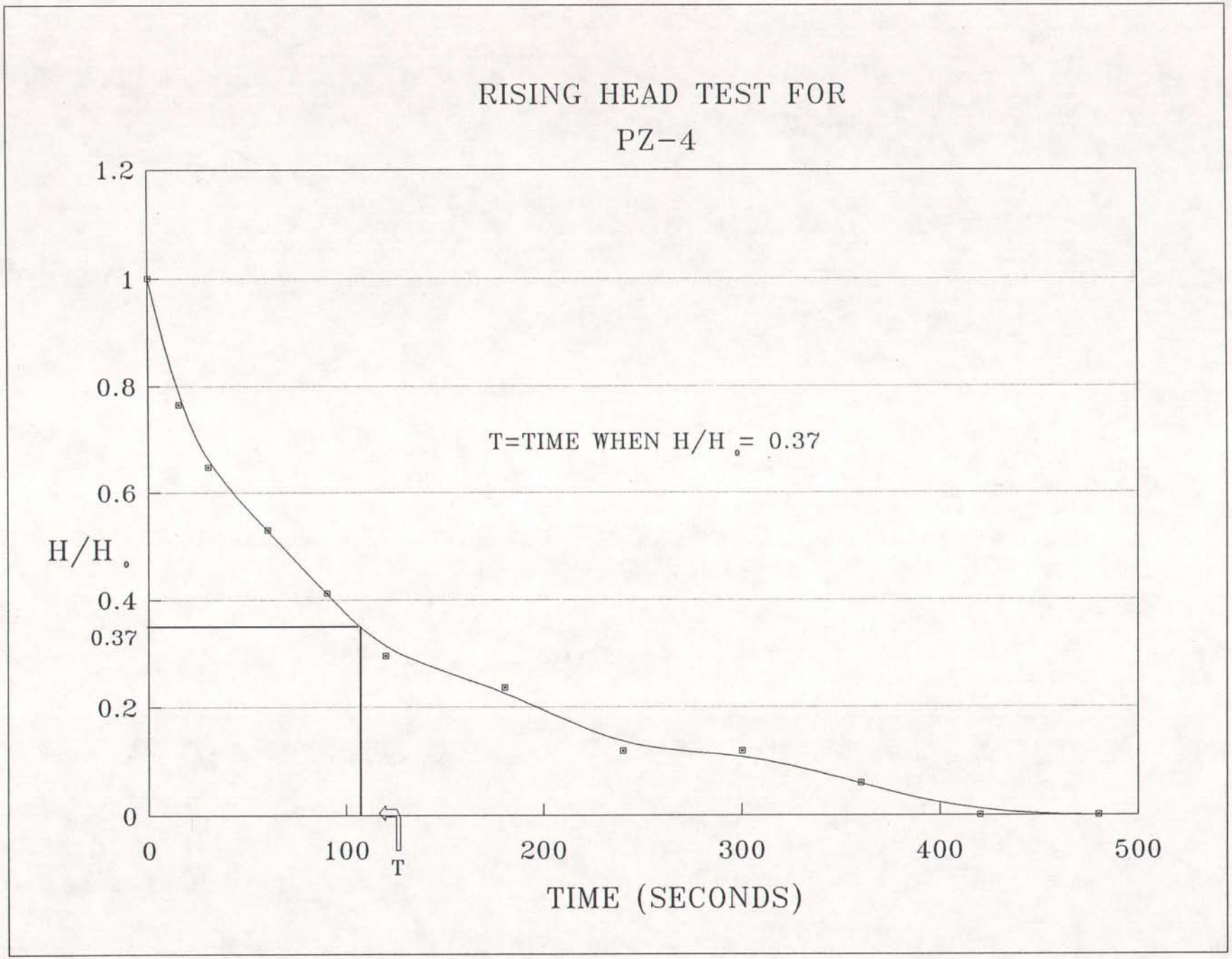
$$k_h = (5.08)^2 \ln \frac{2(1)(381.0)}{26.04} / 8 (381.0) (106.4)$$

$$k_h = 25.81 (3.38) / 324{,}307.2$$

$$k_h = 2.69 \times 10^{-4} \text{ cm/sec}$$

1cm/sec = 2834.64 ft/day

$k_h = 0.76$ ft/day


RISING HEAD TEST FOR
PZ-4
T=TIME WHEN H/H ₀ = 0.37
H/H ₀
1.2
1
0.8
0.6
0.4
0.37
0.2
0
0
100
T
200
300
400
500
TIME (SECONDS)

Attachment F

LETTER OF TRANSMITTAL

GAI CONSULTANTS-NC, INC.
4000 Blue Ridge Road, Suite 500
Raleigh, North Carolina 27512

Phone: (919) 783-4783
Fax: (919) 783-0241

TO: Aquaterra, Inc.
Post Office Box 50328
Raleigh, North Carolina 27650

Date: 3-1-91	Project No: 91109.05
Attention:	Mr. Harold Thurston
Re:	Harnett County Project
	B109 and B110A
	Shelby Tube and Bulk Samples

GENTLEMEN:

WE ARE SENDING YOU X Attached __Under separate cover __Plans

__Shop Drawings __Specifications __Reports X Results

Copies	Description	Drawing No.	Date
1	Lab Result Summary Table		
2	Grain size Analyses (4 curves)		

THIS MATERIAL IS SENT:

__For approval __For your information X For your use

X As requested __For review and comment _____

REMARKS _____

COPY TO _____ SIGNED Wendell W Park

LETTER OF TRANSMITTAL

GAI CONSULTANTS-NC, INC.
4000 Blue Ridge Road, Suite 500
Raleigh, North Carolina 27612

Phone: (919) 783-4783
Fax: (919) 783-0241

Date: 4-3-91	Project No: 91109.05

TO: Aquaterra, Inc.
Post Office Box 50328
Raleigh, North Carolina 27650

Attention: Mr. Harold Thurston

Re: Harnett County Project
B109 and 110A
Proctor Curves

GENTLEMEN:

WE ARE SENDING YOU X Attached ___ Under separate cover

___ Shop Drawings ___ Plans ___ Specifications ___ Reports X Results

Copies	Description	Drawing No.	Dated
1 ea	Moisture-Density Relationships (2 curves)		2-21-91

THIS MATERIAL IS SENT:

___ For approval X For your information ___ For your use

X As requested ___ For review and comment _____

REMARKS _____

COPY TO _____ SIGNED Gary J. Lamb

LABORATORY TEST RESULTS

HARNETT COUNTY, NORTH CAROLINA

	B109 (Shelby tube)	B109 (Bulk)	B110A (Shelby tube)	B110A (Bulk)
Natural Moisture Content, %	12.1	-	5.4	-
In-Place Density, pcf	104.5	-	117.9	-
Specific Gravity	2.74	2.86	2.64	2.73
Liquid Limit	50	35	21	26
Plastic Limit	34	27	NP	20
Plasticity Index	16	8	NP	6
Percent Sand	75	82	78	73
Percent Silt	2	2	1	4
Percent Clay	23	16	21	23
Standard Proctor Maximum Dry Density, pcf	-	115.8	-	118.0
Standard Proctor Optimum Moisture Content, %	-	14.0	-	12.0
Undisturbed Permeability, cm/sec	2.8×10^{-4}	-	2.4×10^{-4}	-
Porosity, %	38.9	36.6	28.4	29.4
Remolded Permeability, cm/sec	-	4.3×10^{-7}	-	4.9×10^{-8}
Remolded Density, pcf	-	113.1	-	120.2
Remolded Water Content, %	-	13.4	-	12.4

gai CONSULTANTS-NC
RALEIGH

4000 Blue Ridge Road, Suite 500
Raleigh, NC 27612
919/783-4783
FAX: 919/783-0241

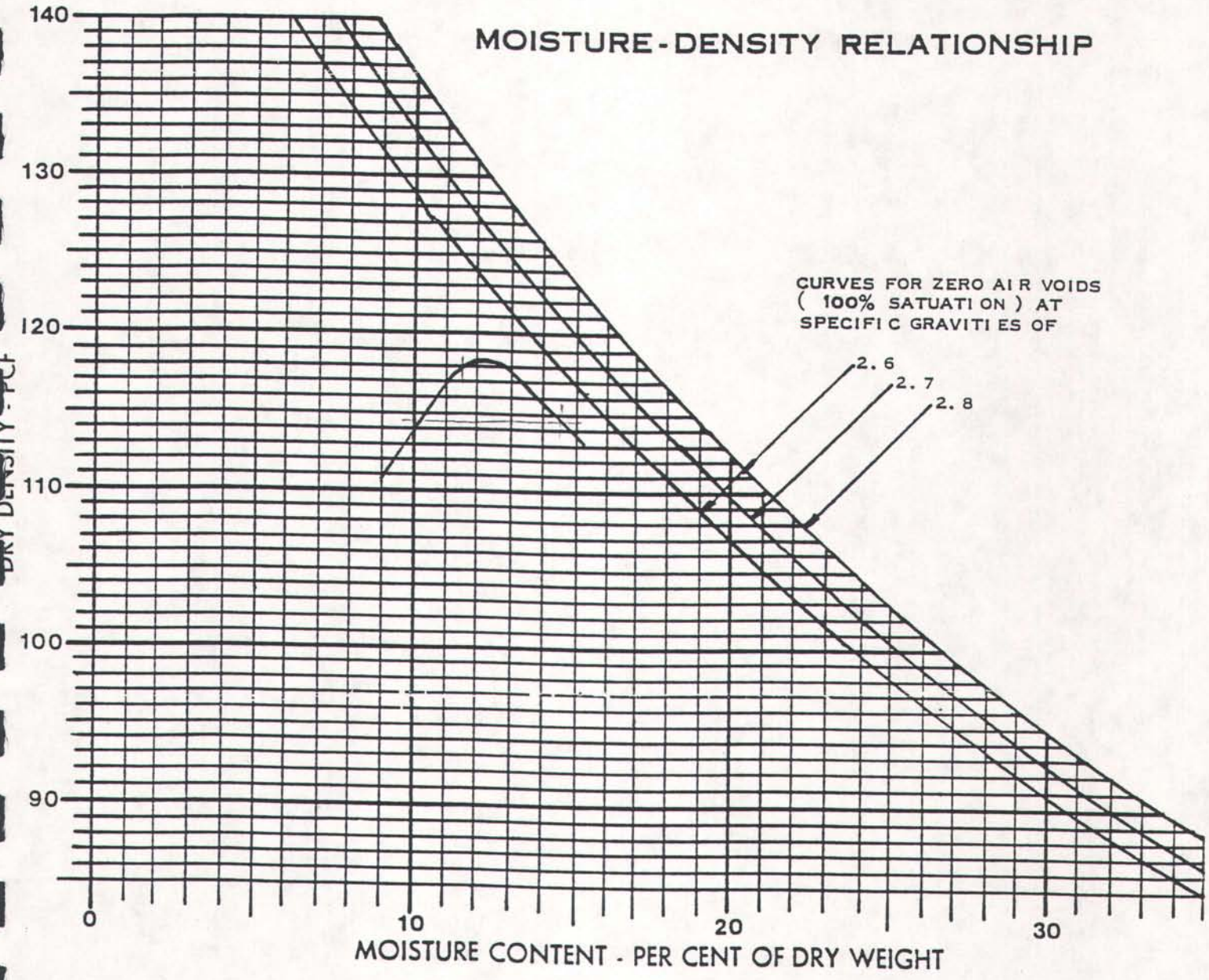
client: Aquaterra

project: Harnett County

date: 2-21-91

job number: 91109.05

MOISTURE-DENSITY RELATIONSHIP



MOISTURE DENSITY RELATION	METHOD OF TEST	MAX DRY DENSITY PCF	OPTIMUM MOISTURE CONT. %	SOIL DESCRIPTION
2	ASTM D698 Method A	118.0	12.0	Orange Silty Sand B110 A 2'-4'

SUBMITTED BY: Gary J. Lamberger

gai CONSULTANTS-NC
RALEIGH

4000 Blue Ridge Road, Suite 500
Raleigh, NC 27612
919/783-4783
FAX: 919/783-0241

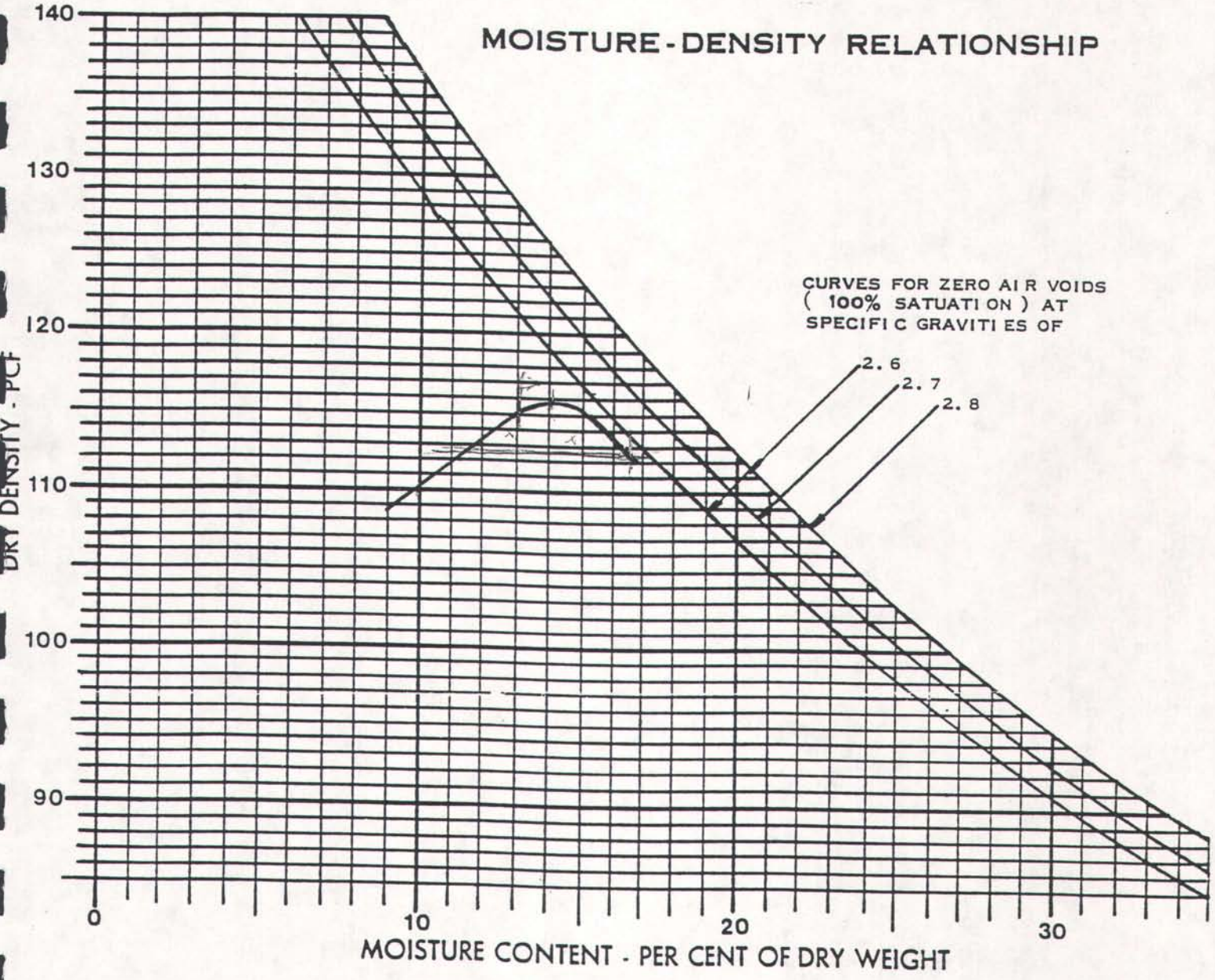
client: Aquaterra

project: Harnett County

date: 2-21-91

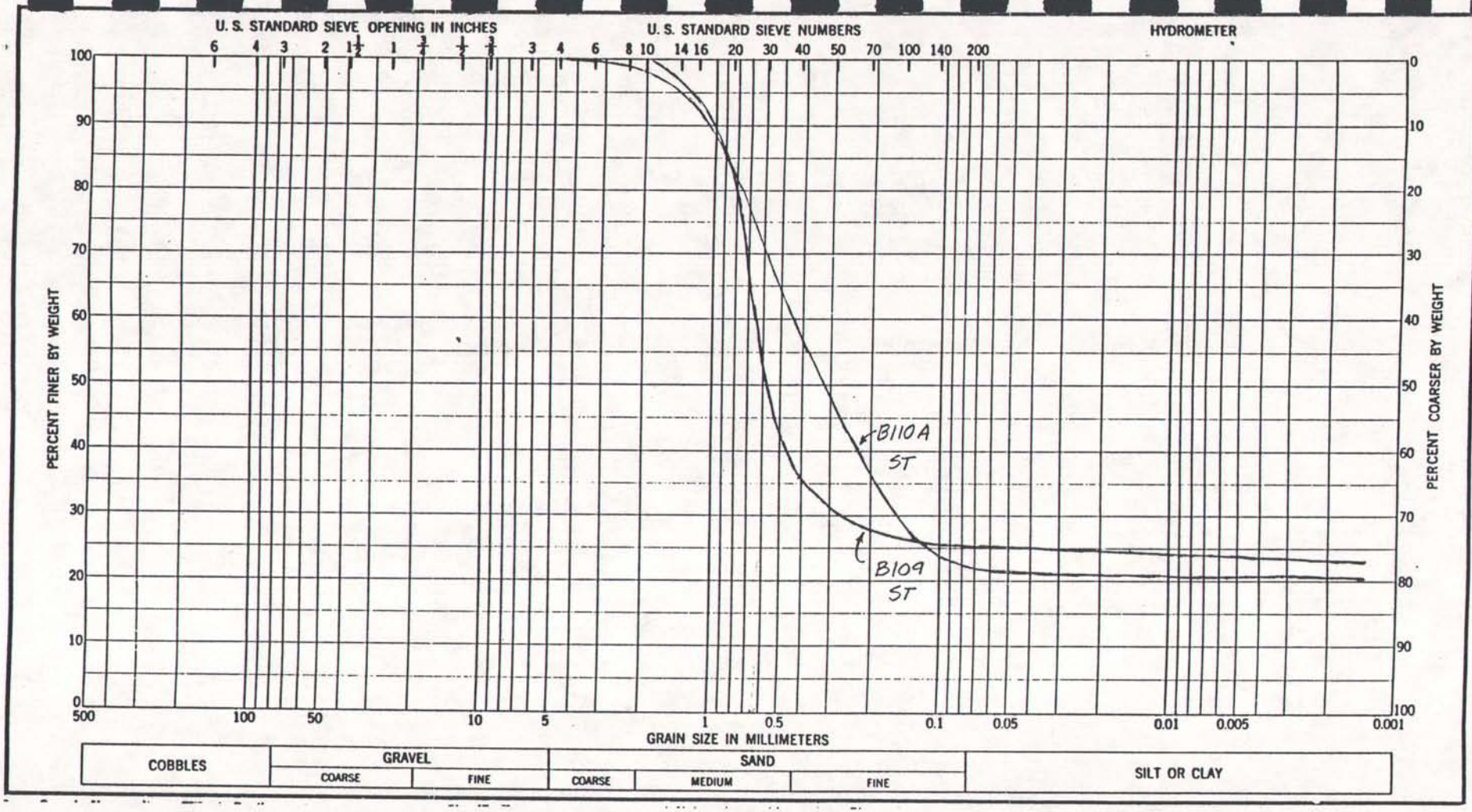
job number: 91109.05

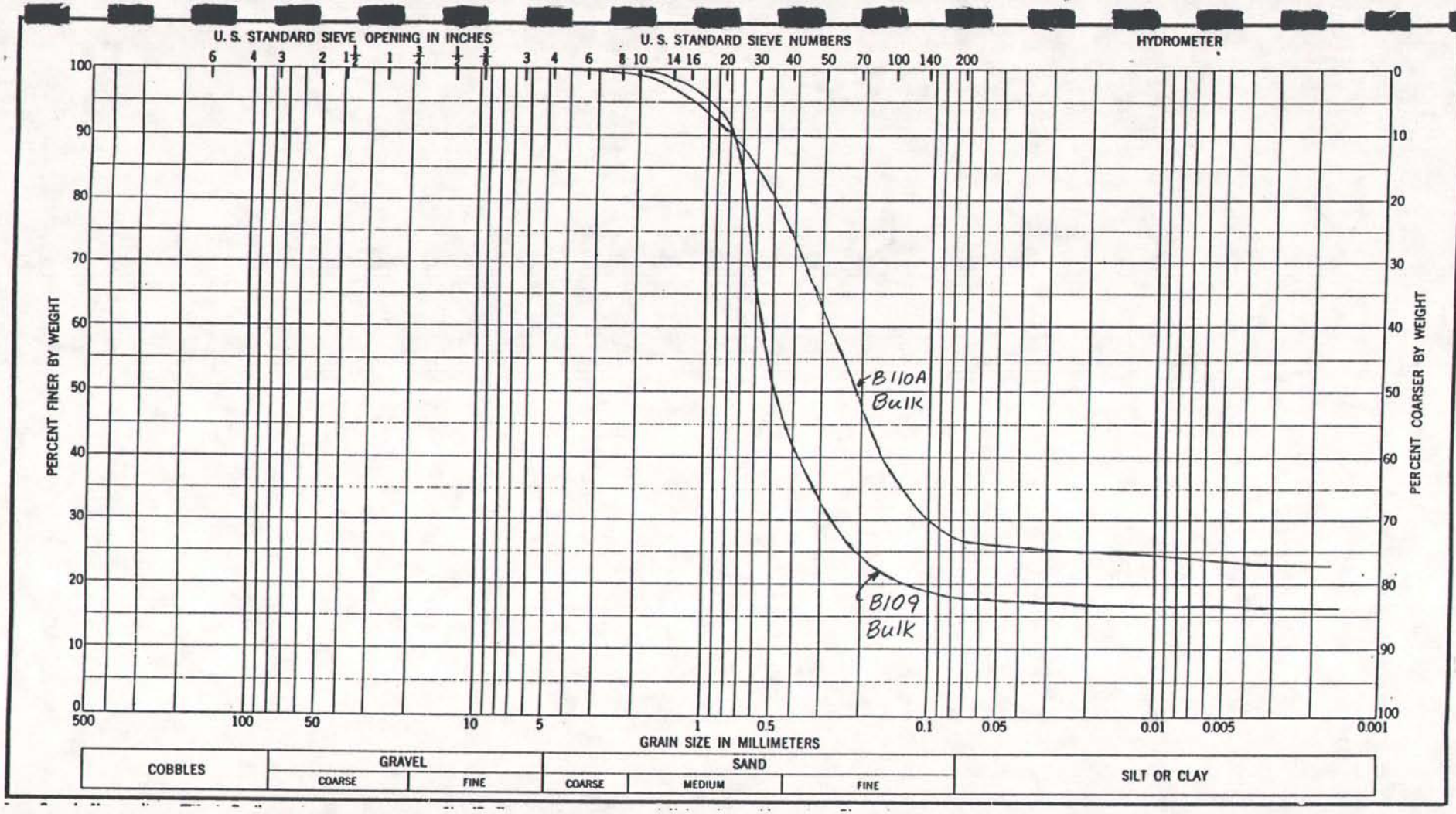
MOISTURE-DENSITY RELATIONSHIP



MOISTURE DENSITY RELATION	METHOD OF TEST	MAX DRY DENSITY PCF	OPTIMUM MOISTURE CONT. %	SOIL DESCRIPTION
1	ASTM D698 Method A	115.8	14.0	Brown Silty Sand B109 6"-1.5'

SUBMITTED BY: Gary J. Lamb


U. S. STANDARD SIEVE OPENING IN INCHES
6 4 3 2 1½ 1 ¾ ½ ⅜
U. S. STANDARD SIEVE NUMBERS
3 4 6 8 10 14 16 20 30 40 50 70 100 140 200
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
100 90 80 70 60 50 40 30 20 10 0
0 10 20 30 40 50 60 70 80 90 100
B110A ST
B109 ST
500 100 50 10 5 1 0.5 0.1 0.05 0.01 0.005 0.001
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY


U. S. STANDARD SIEVE OPENING IN INCHES
6 4 3 2 1½ 1 ¾ ½ ⅜
U. S. STANDARD SIEVE NUMBERS
3 4 6 8 10 14 16 20 30 40 50 70 100 140 200
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
100 90 80 70 60 50 40 30 20 10 0
B110A Bulk
B109 Bulk
500 100 50 10 5 1 0.5 0.1 0.05 0.01 0.005 0.001
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY

Attachment G

Attachment G
Groundwater Sampling and Analysis Plan

1 Introduction

3 or 4

The following sampling and analysis plan has been developed to assess ground water conditions at the Harnett County Monofill site. To assess long-term impacts from operation of the monofill four ground water monitoring wells are proposed. One monitoring well will be placed hydraulically upgradient of fill areas to determine ambient ground water conditions. Three monitoring wells will be emplaced downgradient of the fill areas (see Figure 1 and Attachment G). The proposed location of the monitoring wells have been determined based on the best available information provided by T&R as to the actual location and design of the monofill operation. These locations may be modified as necessary depending on the final design of the monofill.

The specifications and details for obtaining water level measurements, purging, sample collection, and preservation are contained in the following text. Specific parameters for sample collection and sampling frequency have not been specified in this document since the Division of Solid Waste Management (DSWM) has not provided or determined that requirement.

2 Review of Sampling Plan

Prior to beginning the water level measurements, purging or monitoring well sampling, the Groundwater Sampling and Analysis Plan will be reviewed by the sampling team and site manager. The team and site manager will develop a daily schedule as to which monitoring wells will be sampled and which samples will be duplicated. The correct number of sample containers will be secured and labeled prior to each field session.

3 Ground Water Sampling

3.1 General

Monitoring wells will be utilized to characterize potential ground water contamination, determine extent (~~both vertical and~~ horizontal) of contamination, identify migration of hazardous substances and assess adverse effects or risks, if any, associated with the presence of identified contaminants at the site.

All monitoring wells will be installed to meet the requirements of the North Carolina Department of Environment, Health and Natural Resources, Division of Environmental Management, and will comply with Title 15, NCAC, Section .0100, Well Construction Regulations. Each well will be surveyed to establish the vertical elevation relative to a fixed reference datum. Each well will be provided with a protective outer casing and lock to prevent inadvertent entry into the well. Wells will be constructed in general accordance with the detail provided in Figure 2 and Attachment G.

3.2 Water Level Measurements

Prior to well purging or sampling, water level measurements to the nearest 0.01 feet will be performed on all wells. Water level measurements should first be obtained from monitoring wells exhibiting the lowest concentrations of contaminants and should proceed to those wells exhibiting increasing concentrations. The equipment required follows:

3.2.1 Required Equipment/Materials

1. Electronic water level measurements device (Olympic Well Probe by Actat Corporation or equivalent)
2. Phosphate-free soap
3. Deionized water in rinse container
4. Measuring tape in increments of 0.01 feet (Lufkin Engineering Tape or equivalent)
5. Paper towels for use in laboratory such as Kim Wipes or equivalent
6. Scrub brushes
7. Isopropyl alcohol

3.2.2 Procedure for Water Level Measurement

Following is the procedure for obtaining measurements:

1. Unlock well and remove well cap.
2. Rinse water level sensing probe and electrical cable with deionized water.
3. Activate sensing device.
4. Dry off level probe and electrical cable as it is lowered into the well.
5. Lower measuring cable into the well until the sensing device lights up or sounds. Raise the cable up slowly and mark the location of the cable with respect to the top of the well casing when the sensor lights up or sounds.
6. Measure the distance from the top of casing mark to the nearest increment on the cable of the measuring tape to the nearest 0.01 foot. The cable is divided into 5-foot increments. Red/black markings are placed every five feet, white 20 feet, red every 50 feet and green every 100 feet. Measure to the closest mark and add the value to the interval of the marking if the marking was above the top of the casing to obtain the desired distance.
7. Record distances in the field log book to the nearest 0.01 foot.
8. Note any unusual conditions of the well.
9. Relock well.

3.2.3 Decontamination of Water Level Probe

Following the measurement of the water levels, the electric probe and first few feet of cable are scrubbed in a phosphate-free, low-residue laboratory soap and then rinsed with distilled water and dried by a laboratory grade paper towel such as Kim Wipe or equivalent.

3.3 *Purging*

Following well construction and development, ground water samples will be obtained from each monitoring well to satisfy the sampling requirements by the DSWM ~~pending closure at the site.~~ After construction and development, the wells will be allowed to reach a state of equilibrium before being sampled; a period of 1 to 2 weeks from the time of development will be allotted for equilibrium to be attained. Prior to sampling, the static head will be measured (to within .01 feet). Procedures for measuring water levels are discussed in Section 3.2.

Well purging will be accomplished by use of either:

- an electrical submersible stainless steel pump;
- a stainless steel air lift pump;
- a peristaltic pump; or
- a dedicated Teflon bailer.

A minimum of three well volumes will be removed from each monitoring well prior to sampling. Wells constructed in low hydraulic conductivity silts and clays will be gently purged so not to disturb the silts and clays and produce a turbid ground water sample. When using a Teflon dedicated bailer for purging, the bailer will be lowered gently into the water column and purging from the upper portion of the column will occur.

Ph, specific conductance, and temperature will be measured after removal of each well volume and sampling will not occur until three consecutive measurements for these parameters stabilize to no greater deviation than 10%. Each field parameter measurement will be recorded in the field log.

3.3 *Disposal of Purge Water*

All water purged from the monitoring wells will be containerized in 55 drums onsite, labeled, dated and marked with the samplers name. Purge water will not remain on-site for a period of greater than 90 days.

A composite sample of the purge water will be collected upon completion of sampling and analyzed for the parameters of concern. Based on the analytical results, purge water will be disposed of in an approved manner and will be documented in the field log.

3.4 *Decontamination of Pumps*

In the event non-dedicated electric submersible or air lift pumps are utilized instead of dedicated bailers for purging, then decontamination will occur as follows:

3.4.1 Required Equipment/Materials

The materials required for field decontamination are:

1. phosphate-free detergent;
2. deionized water supply;
3. tap water supply; or distilled water
4. spray bottles;
5. storage rack;
6. aluminum foil;
7. vinyl/latex gloves;
8. safety glasses or goggles;
9. scrub brushes;
10. isopropyl alcohol; and
11. plastic sheeting

3.4.2 Procedure for Decontamination of Pumps

The method for decontaminating field equipment used in well purging is as follows:

1. Put on a new of vinyl gloves and safety glasses.
2. Clean the exterior pump and column ~~or bailer~~ with a phosphate-free detergent and tap water.
3. Rinse with tap water until all suds are removed.
4. Attach the tubing or column to the pump.
5. Fill an upright 2 to 5 gallon or larger tank if necessary to the fill line with a phosphate-free soap and tap water.
6. Lower the pump into the cleaning solution. Start the pump and pump a minimum of one gallon of soap and water through the pump and column.
7. Fill the upright tank with tap water.
8. Submerge the pump into the tap water and pump water through the tubing and pump until all suds are removed.
9. Fill the upright tank with deionized water.
10. Put the pump in the tank and rinse 2 gallons of deionized water through the pump and hose.
11. Disconnect the pump and tubing and wrap the pump with aluminum foil, shiny side out.
12. If a purge pump shows evidence of an oil and grease coating or other substance, demonstrate an organic odor or high OVA reading, then the pump will be disassembled and cleaned using isopropyl alcohol in addition to the phosphate-free detergent.

3.5 Decontamination of Bailers

Dedicated Teflon bailers will likely be utilized for the purpose of purging and sampling. Bailers will be properly etched and identified, wrapped in aluminum foil and sealed in a polyethylene bag at the laboratory. Therefore, field decontamination of dedicated bailers should not be necessary. ~~In the event it is necessary to decon bailers in the field, the following procedure will be utilized~~:

Field Cleaning

3.5.1 Required Equipment/Materials

The materials required for ~~field~~ decontamination are:

1. phosphate free detergent
2. tap water supply
3. deionized water or distilled
4. nitric acid (10%)
5. isopropyl alcohol
6. stainless steel 3 gallon pail
7. scrub brushes
8. safety glasses or goggles
9. vinyl/latex gloves

3.5.2 Procedure for Decontamination of Bailers

All Teflon bailers will be decontaminated by the following procedure:

1. Put on new vinyl gloves and safety glasses.
2. Using a bristle brush, scrub the bailer with soap (Alconox or other phosphate equivalent) and tap water wash.
3. Rinse the bailer using tap water rinse.
4. Rinse the bailer using a 10% nitric acid wash.
5. Rinse the bailer using a distilled water rinse.
6. Rinse the bailer using an Isopropyl alcohol wash.
7. Rinse the bailer twice using a distilled water rinse.
8. Air dry and wrap the decontaminated bailer in aluminum foil with shiny side out.

3.6 Sampling Procedure

A dedicated Teflon bailer will likely be used for purging and subsequent sampling of each well. Each bailer will be provided with proper identification. Should a second round of samples be needed, the same numbered Teflon bailer will be used for the same well. As stated in Section 3.5, bailers will be decontaminated in a laboratory environment and shipped to the site for sampling. The bailers will be etched with proper identification, wrapped in aluminum foil and sealed in plastic. The following sections discuss the equipment necessary and details of sampling.

3.6.1 Required Equipment/Materials:

The following equipment/materials will be utilized for sampling of monitoring wells:

1. safety glasses
2. vinyl gloves
3. Teflon bailer
4. nylon rope
5. field log book
6. sample bottles

7. pH/conductivity meter/thermometer
8. ice chest and ice, and/or transpaks chilled to 4°C
9. labels and permanent marking pen
10. knife
11. plastic sheeting

3.6.2 Procedure for Collection of Ground Water Samples

Ground water samples will be collected per the following procedure:

1. Check the recommended container list to determine the type and size of container to be used for sample collection. A list of required sample containers is found in Attachment A.

2. Label sample containers using adhesive labels and/or tags cover the labels with one layer of transparent tape. Include the following information:

   - Well name
   - Sample identification number
   - Date and time of sample
   - Preservatives used (if required)
   - Sample container
   - Type of container
   - Special requirements (such as zero headspace)
   - Sampler's name and signature

3. Place 5' x 5' plastic sheeting (with hole in center) over well casing and lower to ground surface to prevent bailer cord from contacting the ground during sampling.

4. Put on a pair of new vinyl gloves.

5. Follow the sample preservation list if needed and add the recommended preservative to each sample container. If using a Transpak from the laboratory, preservatives will be prepackaged by the laboratory.

6. Tie a new piece of nylon cord to the top end of the bailer which has been removed from the aluminum foil.

7. Measure and cut off sufficient length of nylon cord so that the bailer can reach the water. Secure bailer cord to the well casing and/or on the sampler's wrist. Coil bailer cord to prevent contact with the ground.

8. Lower the bailer down into the well slowly until the water is reached, fill with water and bring up to the surface. Note: dropping the bailer into the well causes excessive aeration and in a silt or clay aquifer increases the concentration of suspended solids in the ground water.

9. Check the pH, specific conductivity, and temperature after removal of each volume of purge water. Be sure that each parameter has adequately stabilized prior to sampling.

10. Carefully fill the sample bottles in the appropriate order with a minimum of disturbance to the sampled water. Do not shake the bailer when filling the bottles. Sample should be collected in the order of volatilization sensitivity specified in Section 3.7.

11. Samples collected for analysis of volatile organic compounds must be collected in glass bottles with a Teflon coated septum top. The samples must be collected with zero headspace in order to prevent volatilization. Samples must never be filtered in the field.

12. Record in the field log the ground water, pH and specific conductance, temperature immediately after sampling.

13. Relock the well.

14. Record the following information in the field log book:

    - identification of well
    - sample withdrawal equipment
    - date and time of collection
    - parameter sampling sequence
    - types of sample containers used
    - sample identification number
    - preservatives used
    - parameters requested for analysis
    - field analysis of data and method
    - field observations on sampling event
    - name of collector(s)

15. Complete a chain-of-custody form to include all the samples collected. Insure that the person who receives the samples signs the chain-of-custody form and is aware of the actions to be taken with the samples.

16. Untie nylon rope from well casing and Teflon bailer and discard as disposable. Insert bailer in aluminum foil tube and return to laboratory for decontamination.

17. Place chain-of-custody seal on each sample bottle and pack bottles into cooler to prevent breakage during transport. Chill sample bottles to approximately 4° C during transport to the laboratory.

18. Place a chain-of-custody seal on each cooler or transpak to assure sample integrity during transport.

3.7 Order of Sample Collection

Samples should be collected in the order of volatilization sensitivity. The recommended order of sample collection for common parameters are as follows. The order for sample collection is from first to last.

- volatile organics (VOA)
- purgeable organic carbon (POC)
- purgeable organic halides (POX)
- total organic halides (TOX)
- total organic carbon (TOC)
- extractable organics
- total metals
- dissolved metals
- phenols
- cyanide
- sulfate and chloride
- turbidity
- nitrate and ammonia
- radionuclides

4 Quality Assurance Program

4.1 Introduction

A quality assurance (QA) program should be in effect to assure valid analytical data. The analytical laboratory QC will be in the form of their own QA/QC program and the SW-846 methods.

The QA programs used for water, ground water and surface water, soil and waste will consist of different duplicate and split samples, field blank and travel blanks as required by the DSWM. The definition of each of these terms follows.

Duplicate samples are defined as multiple samples that are identical. These samples must be collected at the same time, from exactly the same location, using the same sampling apparatus. Also, these samples should be collected in identical containers that have been similarly prepared and filled to the same volume. Duplicate samples are preserved and handled in identical fashion.

Field blanks are defined as distilled and deionized, analyte free water that is collected, containerized, treated (if preservatives are used) and handled in the same manner as the samples. The field blanks can be indicators of any contamination that may have occurred in transport or in the laboratory.

Finally, split samples are not planned for the program unless: requested by DSWM, the analytical laboratory results become suspect, or the presence of the unexpected contaminants appear. A split sample is an aliquot of a collected sample that will be analyzed by a different method or another qualified laboratory to verify the original data.

4.2 Sample Blanks

Sampling and analysis of both surface water and ground water will follow the same QA program. The program will consist of duplicate samples (generally one or ten percent times the total samples to be collected), field blanks (generally one or ten percent times the total samples to be collected) and a travel blank (one travel blank per sampling event).

4.2.1 Travel Blanks

If the concentration in the travel blank is less than the detection limit, no action will be taken. If the concentration in the travel blank is greater than the detection limit the analytical laboratory will be required to produce their reagent blank analysis. If it is demonstrated that the contamination is from the laboratory environment or equipment, the reagent blank concentration will be subtracted from the sample values.

If the reagent blanks are found to be clean within acceptable laboratory practice and that the contamination is present in the travel blanks, the sample stations will be resampled and analyzed for the constituents in question.

4.2.2 Field Blanks

The analytical results for the field blanks will be reviewed after the travel blanks. If the field blanks are clean, the travel blanks are contaminated and the laboratory reagent blanks are clean, contamination probably occurred during transport or storage. If the field blanks are contaminated and the travel blanks are clean, the samples will be recollected and analyzed. If the field blanks and travel blanks are clean, the field sampling techniques, equipment decontamination, preservation techniques and atmospheric contamination are not problems.

4.2.3 Duplicate Samples

Duplicate sample results will be used as an indicator of laboratory precision in the method used to analyze the sample. The following formula will be used to initially review the duplicate samples. the formula is:

$$\frac{(X_1 - X_2)}{(X_1 - X_2)/2}(100\%) \leq 15\%$$

where: X_1 = initial observation
X_2 = duplicate observation

If the duplicate sample exceeds the 15 percent, used for the initial screening, then the sample constituents will each be reviewed using the SW-846 procedure for Method 8240 constituents. Table 7 reproduced from SW-846 Test Methods for Evaluating Solid Waste, Volume IB: Laboratory Manual Physical/Chemical methods, Chapter Four - Organic Analytes, Section 4.3.2, third edition, contains the review procedure and the equations found for single analysts precision.

For example, if a sample and its duplicate contained 12 ug/L and 10 ug/L of 1,1,1-trichloroethane, then using the initial screening equation

$$\frac{(X_1 - X_2)}{\left(\frac{X_1 + X_2}{2}\right)} (100\%) \quad \frac{12 - 10}{\left(\frac{12 + 10}{2}\right)} (100\%) = 18.18\%$$

the duplicate sample exceeds the 15 percent. However, the equation from Table 7 for single analysts precision is

$$S_r' = (0.12\,X - 0.15)\ \text{ug/L}$$

$$\text{where } X = \left(\frac{X_1 + X_2}{2}\right) = \frac{12 + 10}{2} = 11\ \text{ug/L}$$

$$\text{therefore, } S_r' = (0.12(11) - 0.15)\ \text{ug/L} = 1.17\ \text{ug/L}$$

The acceptable range for the sample and duplicate to fall in is then defined by

$$X - S_r' \text{ and } X + S_r'$$

or $(11 - 1.17)$ ug/L and $(11 + 1.17)$ ug/L

or 9.83 ug/L and 12.17 ug/L

Since both the sample and duplicate values, 12 ug/L and 10 ug/L, fall in between the ends of the range, the laboratory precision is adequate.

If the duplicate samples exceed the range for laboratory precision, then duplicates splits will be run between the first laboratory and a certified second laboratory. If both laboratories exceed the precision S' calculated from the equations summarized in Table 7, then it will have been determined that, for the particular constituents in this well, the precision is not achievable. If the second and first laboratory meet the overall precision on the split, it will be determined that the first laboratory's precision was not acceptable for the first round of samples.

7

STANDARD ABOVE GRADE 2" PIEZOMETER CONSTRUCTION SCHEMATIC

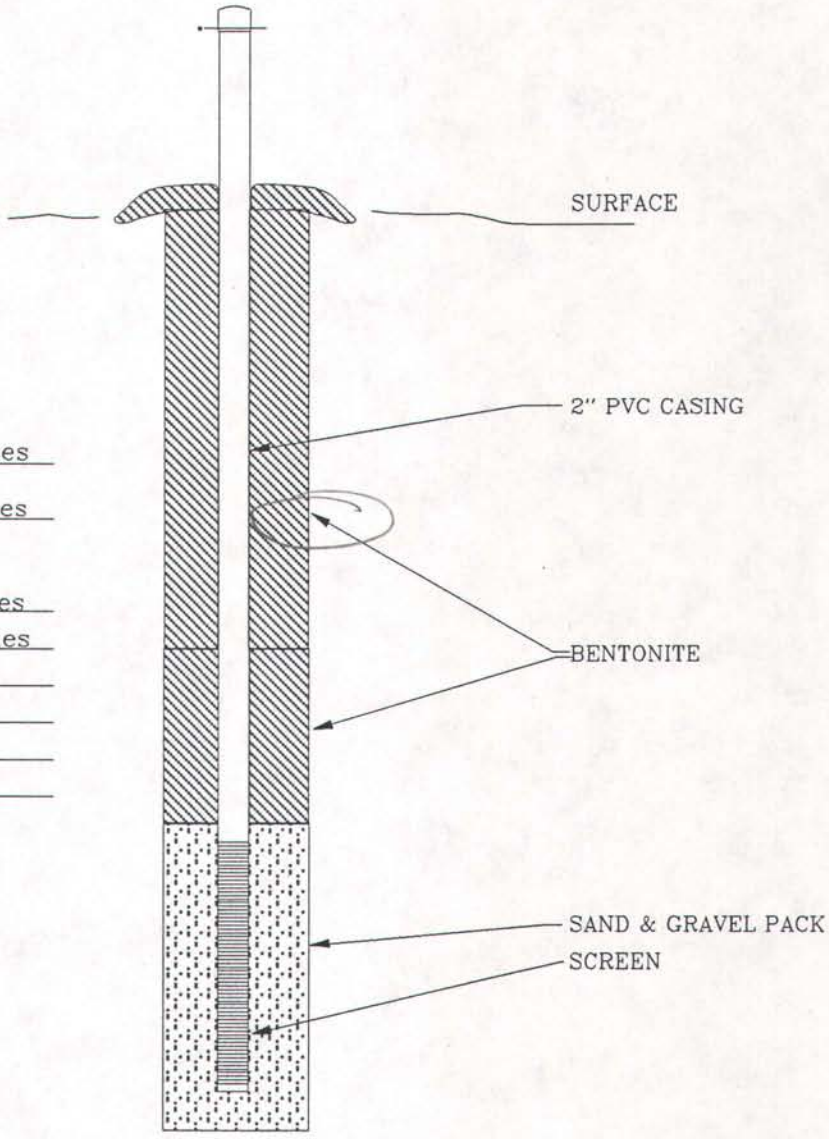
WELL NUMBER: _____ DRILLING METHOD: HOLLOW STEM AUGER
DATE STARTED: _____ DRILLING FLUIDS: _____
DATE FINISHED: _____ STATIC WATER LEVEL: _____ DATE:
GEOLOGIST/ENG _____ OBSERVED BY: _____
REMARKS: _____

O.D. OF BOREHOLE: 6 1/4"
O.D. OF CASING: 2.0"

PIPE STICKUP: 2.0'
SURFACE ELEVATION: _____
GROUT TYPE: Type I portland
CASING TYPE: PVC
CASING SIZE: 2.0"
DEPTH TO BOTTOM
OF CASING varies

DEPTH TO TOP OF BENTONITE varies
DEPTH TO TOP OF SAND PACK varies

DEPTH TO TOP OF SCREEN varies
DEPTH TO BOTTOM OF SCREEN varies
LENGTH OF SCREEN: 10.0'
SCREEN OPENING SIZE: 0.010"
SCREEN TYPE: PVC
SCREEN SIZE: 2.0"



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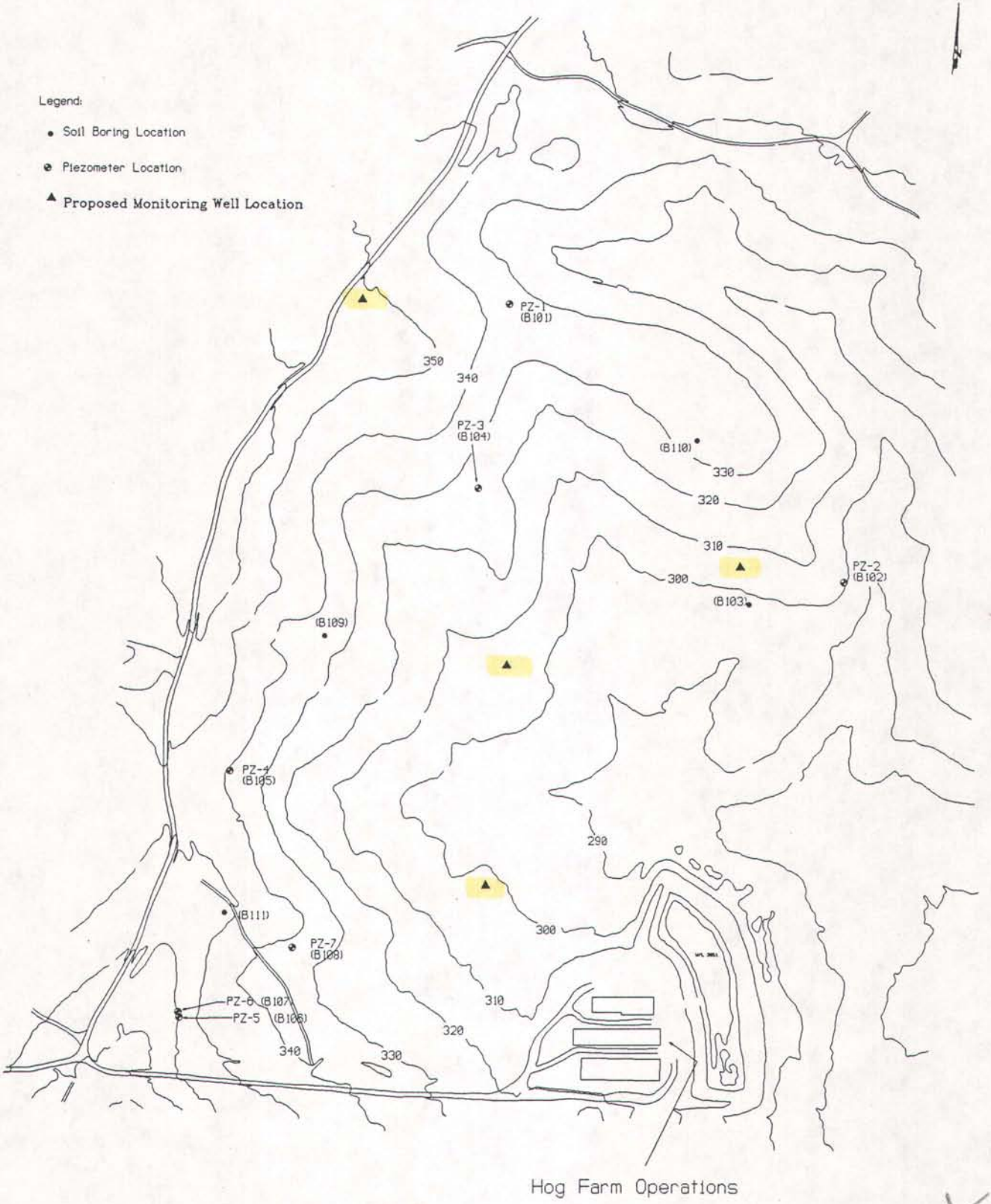

AQUATERRA, INC. RALEIGH, GREENSBORO, CHARLOTTE NORTH CAROLINA	Author	Drawing	Layers	Date	Title
	DLG	548-1b	0,1,3,7,12	04-08-91	Proposed Monitoring Well Location Map
	Job No.	Revision	Figure	Scale	Project
	548	8	1	1" = 400'	Harnett County Monofill Johnsonville, North Carolina

Drawing

"Under Seperate Cover"