MSWLF FACILITY SITE STUDY

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WHITE OAK LANDFILL

HAYWOOD COUNTY
NORTH CAROLINA

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

11/4/98

October 1998

Municipal Engineering Services Company, P.A.
Garner and Boone, North Carolina

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Solid Waste
Section

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SECTION 1.0
INTRODUCTION

1.1 Purpose

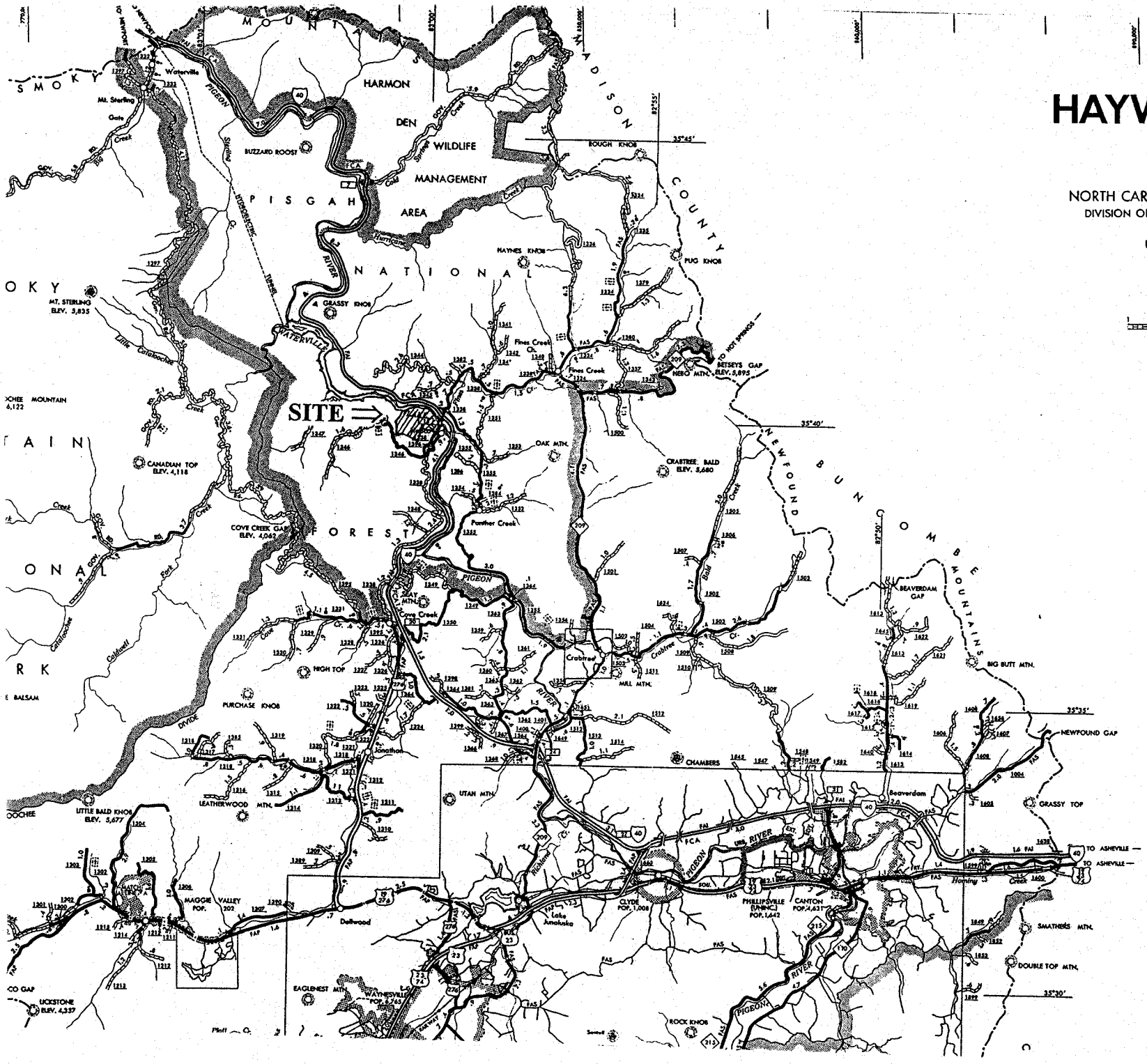
The purpose of this MSWLF Site Study is to demonstrate that the area proposed for development by Haywood County is suitable for lateral expansion of the existing Municipal Solid Waste Landfill Facility according to The North Carolina Administrative Code, Title 15A, Department of Environment, Health, and Natural Resources, Chapter 13, Solid Waste Management, Subchapter 13B-Solid Waste Management Section .1600 Rule .1618.

1.2 Background

Haywood County, North Carolina currently owns and operates one Municipal Solid Waste Landfill Facility. The new Subtitle D Landfill Facility will be located around the existing sanitary landfill site (see Figure 1-1 -- Location Map). Waste currently being disposed in a Regional County Landfill will be disposed in the new Subtitle D Facility.

1.3 General

In accordance with Rule .1618 (c)(5), local government approval of the proposed Subtitle D Landfill Facility has been obtained and is presented in Appendix A. The site of the proposed facility is on the same tract of land in which the existing Haywood County Municipal Solid Waste Landfill lies. The proposed site will have six Phases of Municipal Solid Waste(MSW). The Facility will only accept Municipal Solid Waste which includes but is not limited to Household, Industrial, Construction/Demolition, and Animal Waste. The Facility will not accept any Hazardous or PCB wastes. It is the intent of Haywood County that the first Phase will be completed and ready to receive municipal solid waste generated within Haywood County.



HAYWOOD COUNTY

NORTH CAROLINA

PREPARED BY THE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS—PLANNING AND RESEARCH BRANCH

IN COOPERATION WITH THE

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

SCALE

1 0 1 2 3 4 MILES

0 0.5 1 MILE

SCALE FOR ENLARGEMENTS

10,000 FOOT GRID BASED ON NORTH CAROLINA PLANE COORDINATE SYSTEM

POLYCONIC PROJECTION

FIGURE 1-1

SECTION 2.0
CHARACTERIZATION STUDIES

The proposed facility located around the existing Municipal Solid Waste Landfill Facility, lies on approximately 268.54 acres of land which is located approximately 13 miles northwest of Waynesville. There will be a total of six Phases. Phase 1 will be approximately 10.0 acres in size. Phase 2 will be approximately 4.87 acres in size, Phase 3 will be approximately 7.72 acres in size, Phase 4 will be approximately 13.25 acres in size, Phase 5 will be approximately 13.78 acres in size and Phase 6 will be approximately 19.21 acres in size. The remaining permittable acres will be used for leachate lagoon, borrow areas and buffers.

The most recent (1990) Census information available showed the population of Haywood County at 46,942. The majority (33,488) of Haywood County residents live in unincorporated areas. The landfill is in the White Oak Township and has a population of 305. The census information has the distribution of population by race in Haywood County at 98.0% White, 1.4% Black, 0.4% Indian, 0.1% Asian, 0.1% Hispanic or other race. A disparate impact analysis comparing the racial characteristics of the affected population show that persons protected under Title VI are not being impacted at a disparate rate.

The land use within two (2) miles of the proposed facility is mostly forest with some pastures and residential dwellings. The landfill will not have an adverse impact on the residents of Haywood County since the proposed landfill is located around the existing facility.

2.1 Regional Characterization Study

The Regional Characterization Study describes the area within two (2) miles of the proposed Landfill Facility. There are two public water supply wells located within the two (2) mile perimeter, Fines Creek Methodist Church and Panther Creek Baptist Church. There are no residential subdivisions and no airports or runways. Waste transportation routes consist of interstate 40 and S.R. 1338 (White Oak Road). The amount of waste being disposed of at the Facility will remain at virtually the same rates since the landfill will be accepting wastes from the same area. The amount of traffic, therefore, will not increase due to the construction of the proposed landfill.

2.1.1 Landfill Facility Location

Access to the Proposed Landfill Facility is located off SR 1338 (White Oak Road) in Haywood County, North Carolina, adjacent to the existing landfill facility.

2.1.2 Public Water Supply Wells, Surface Water Intakes and Service Areas

There are two (2) Public Water Supply Wells within a two mile perimeter of the Landfill. All Public Water Supply Wells are listed below and are on the Regional Characterization Map.

1. Fines Creek Methodist Church
2. Panther Creek Baptist Church

2.1.3 Residential Subdivisions

There are no Residential Subdivisions.

2.1.4 Waste Transportation Routes

There are several Waste Transportation Routes. All Waste Transportation Routes are listed below and are highlighted on the Regional Characterization Map.

1. Interstate 40
2. SR 1338 (White Oak Road)

2.1.5 Public Use Airports and Runways

There are no Public Use Airports within the two (2) mile perimeter of the Facility boundary. The closest airport is located just over nine (9) miles north of the Facility.

2.2 Local Characterization Study

The Local Characterization Study describes the area within 2000 feet of the proposed Landfill Facility. The property consists of 268.54 acres, of which 68.84 acres shall be used for Municipal Solid Waste Landfill. The existing land use of the property is forests, existing Municipal Solid Waste Landfill and borrow areas for the existing Landfill Facility. The surrounding property is mostly forest with some pastures and residential dwellings. There are no schools located within the study. There are 36 private residential wells within the 2000 perimeter. The 36 residential wells are located outside the Recharge/Discharge area that the proposed Facility will be located; therefore, there should be no impact to the private wells.

2.2.1 Disposal Site Property and On-Site Easements

The property lines are indicated on the aerial photograph and local area map located on the following pages. The entire property consists of 268.54 acres of land. There are no On-Site Easements.

2.2.2 Existing Land Use and Zoning

The proposed property was previously used for woodland and borrow material by the County. This land is not zoned. A zoning letter is located on the following page.

Board of Commissioners:

Edwin Russell, *Chairman*
William M. Edwards, *Vice Chairman*
Grover L. Bradshaw
Robert Forga
Jack Rice

HAYWOOD COUNTY N.C. 1808

County Manager:
C. Jack Horton

County Attorney:
Leon M. Killian

September 15, 1998

Mr. Wayne Sullivan
Municipal Engineering Services Company, P.A.
P.O. Box 97
Garner, NC 27529

Dear Mr. Sullivan,

The area which is proposed as the site for Haywood County's Subtitle D solid waste landfill expansion is not located within a zoned area.

Haywood County has no countywide zoning at this time.

Please advise me if additional information is needed.

Sincerely,

C. Jack Horton
Haywood County Manager

CJH:bdr

215 North Main Street • Courthouse Annex • Waynesville, North Carolina 28786
(704) 452-6625 FAX (704) 452-6725

2.2.3 Private Residences and Schools

There is no schools located within 2000' of the proposed Landfill Facility. There are 36 private residences within 2000' of the proposed facility.

2.2.4 Potential Sources of Contamination

The existing Municipal Solid Waste Landfill is a potential source of contamination. This is indicated on the Local Area Map.

2.2.5 Potable Wells

There are no well documentation records available. A records research was conducted in the Asheville Regional and Raleigh NCDEHNR offices. All 36 private residences have wells.

2.2.6 Historic Sites

There are six (6) archaeological sites within 2000' of the landfill. A site investigation was conducted, and five sites were discovered. The four prehistoric sites (31HW455, 31HW456, 31HW457, and 31HW458) and two historical sites (31HW459 and 31HW286). The Cultural Resources Report was forwarded to the North Carolina Department of Cultural Resources. All correspondence is located in Appendix D.

2.2.7 Surface Water Drainage Patterns, Watersheds and Floodplains

Surface Water Drainage Patterns: All water flowing on site will eventually either reach groundwater or flow into Pigeon River. Pigeon River and its tributaries bound the site on all sides.

Watersheds: Pigeon River is classified as C. There are no surface water intakes within the two (2) mile perimeter. The Regional and Local Characterization Map indicates the classification. C is classified as aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture.

Floodplains: There is no 100-year flood hazard. The MSWLF units are not located within a 100-year floodplain.

2.2.8 Available Well Records

There are no well records available. An extensive search was conducted at the Asheville Regional and Raleigh NCDEHNR office. Apparently, the wells in this area were constructed before well construction records were kept.

SECTION 3.0
SITE HYDROGEOLOGIC SUMMARY

3.1 Geologic and Hydrologic Setting

The proposed Haywood County MSWLF site lies within the Blue Ridge physiographic province. Surface waters drain primarily to the north toward the Pigeon River (Waterville Lake). The proposed site is currently undeveloped and is largely covered in pine and hardwood forests. The property has historically been used as pasture and farmland, and several abandoned buildings occupy a clearing on the western side of the site.

The regional land surface is characterized by mountainous topography with broad ridge lines and deeply carved valleys. The highest point is at an elevation of 2700 feet above mean sea level (MSL) in the central-southern portion of the property. The lowest area is at 2250 feet above MSL. On-site slopes average 20%, though areas adjacent to drainage features approach 40%.

The site is underlain by Precambrian age basement complexes that consist of metamorphosed plutonic rocks and the Carolina Gneiss. The underlying units are polymetamorphic rocks derived from felsic igneous intrusions (granite and granodiorite) and metasedimentary complexes.

3.2 Site Investigation and Laboratory Tests

Twenty-one borings were installed for the site hydrogeologic study in March through May 1998. Borings were logged in the field by a qualified geologist according to the Unified Soil Classification System. Select samples were sent to a certified geotechnical laboratory for further testing. Laboratory tests were conducted in accordance with ASTM procedures and were used to help properly classify soils and determine hydrologic implications. Tests included Atterberg limits, sieve analysis with hydrometer, triaxial permeability, and specific gravities.

3.3 Synthesis of Site Geology

The subsurface conditions at this site are divided into three hydrogeologically distinct units. The uppermost consist of saprolite defined as *in situ* chemically weathered crystalline rock. By USCS classification, these soils are low plasticity inorganic silts and fine sands and slightly plastic clays. The second unit is a zone of partially weathered rock (PWR). This unit is found as a transition zone between saprolite and bedrock and as zones resistant to weathering suspended in saprolite. The third unit is the underlying fractured gneissic bedrock. Fractures in this unit are the primary conduit for groundwater transport and typically parallel gneissic foliation.

3.4 Synthesis of Hydrogeology

The uppermost aquifer consists of regolith and bedrock. Regolith is inclusive of all unconsolidated material overlying intact bedrock. Infiltration occurs when precipitation reaches the land surface and penetrates the unsaturated soil. Moving laterally and downward, groundwater will ultimately move into bedrock and be transported along interconnected fractures to points of discharge.

No supply wells exist between the proposed landfill and points of discharge along the Pigeon River. The average flow rate for lithologic units at the site is approximately 81 feet/year. Long-term seasonal high is established based on local USGS observation wells, piezometer and monitoring well fluctuation, and seasonal precipitation influences. In consideration of all pertinent factors, 12 feet was added the lowest water level reading from piezometers located on ridges and slopes. Similarly, 8 feet was added to the lowest water level reading from piezometers located in draws. These numbers are considered to provide very conservative estimates for long term groundwater highs and allow for a substantial amount of soil for cut and fill.

A complete synthesis of geologic conditions and hydrogeologic implications is presented in the attached Site Hydrogeologic Study.

3.5 Summary and Conclusions

Data published by the US Geological Survey indicates that the site does not lie near any Holocene age fault. The site is located within a seismic impact zone though no major structural features are located within the site boundaries. Potentiometric surfaces suggest recharge occurs along an upgradient ridge and flows north toward the Pigeon River. Subsurface geology and groundwater conditions are favorable for monitoring potential contaminant leaks from the proposed landfill.

In conclusion, no deterrent was found during the subsurface hydrogeologic investigation to suggest that the site is not suitable for development as a MSWLF.

SECTION 4.0
LOCATION RESTRICTIONS

4.1 Airport Safety

There are no Public Use Airports within five (5) miles of the Landfill Facility. The closest Airport is just over five (9) miles (47,520 ft.) from the site. Two U.S.G.S maps and an Aeronautical map are provided on the following pages.

4.2 Floodplains

There is a 100-year Floodplains located within the property boundary but no within the limits of the proposed landfill facility. A FIRM Flood Insurance Rate Map panel number 370120 0080 B dated July 15, 1984 shows the location of the floodplain in relation to the property line and MSWLF units. The flood map is located on the following page.

4.3 Protected Species and Wetland Delineation

A protected species survey and wetland delineation was conducted in September 1998 for the proposed Haywood County Landfill Facility. The property contains three (3) ecological communities: Fallow Field, Pine-Hardwood Forest, and Mesic Hardwood Forest. The entire property has historically and recently been grazed by cattle.

Information on previous occurrences of protected species near the project area was obtained from the U.S. Fish and Wildlife Service and the North Carolina Natural Heritage Program at the time of the survey. The property contains marginal habitat for one state and federally protected plant along with five state protected plants. The property also contains potential habitat for six state protected animal species, although no state or federally protected species or evidence thereof were observed. It was recommended that surveys be done in May for the state and federally protected small-whorled pogonia and the Alabama least trillium.

A small amount of jurisdictional wetlands found within the proposed landfill area, adjacent to the existing landfill, will be impacted by the lateral expansion. This Palustrine emergent wetland may be partly created by landfill activities, including changes in hydrology and drainage sediments. One spring-fed stream exists in the proposed landfill area, which is a water of the United States, regulated under Section 404 of the Clean Water Act. The location of the wetlands are contained within the Facility Drawings located in Appendix C. A wetlands permit is in process. As soon as the permit is received from the U.S. ARMY CORPS OF ENGINEERS, it will be forwarded. The Nationwide Permit 26 Permit application is located on the following page.

4.4 Fault Areas

The proposed Lined Landfill Facility is not located within 200' of a fault that has had displacement since Holocene time. See Appendix F.

4.5 Seismic Impact Zones

The site is located in a seismic impact zone. See Appendix F.

4.6 Unstable Areas

Based on a visual reconnaissance and the subsurface exploration, no unstable areas, such as poor foundation soils and areas susceptible to mass movement, are present at the site. See Appendix F.

4.7 Cultural Resources

The Cultural Resource survey recorded four (4) prehistoric archaeological sites. Prehistoric sites 31HW455, 31HW456, 31HW457 and 31HW458 do not appear to be potentially eligible for the National Register of Historic Places.

The Cultural Resource survey also recorded two (2) historic sites 31HW459 and 31HW286. Site 31HW459 appears to represent a small farm complex which was utilized until very recently. The site is unlikely to provide significant data concerning the historic period occupation of the area, and is recommended to be determined ineligible for the National Register of Historic Places. Site 31HW286 was initially identified by Brown and Rogers (1990:17-19). The resurvey found nothing that would change the recommendation of Brown and Rogers (1990:21-22). It is recommended that the site be determined ineligible for the National Registry of Historic Places. The facility drawings show the location of each historic site. The Facility Drawings are located in Appendix C. The report is located in Appendix D.

4.8 State Nature and Historic Preserve

There will be no adverse impact to a State Nature and Historic Preserve since there are no State Nature and Historic Preserves within the Proposed Landfill Facility. See Appendix D and E.

4.9 Water Supply Watersheds

Pigeon River and its tributaries are classified as C. There is no surface water intake within 2 miles of the Proposed site.

SECTION 5.0
FACILITY REPORT

5.1 Geologic and Hydrogeologic Summary

PURPOSE AND SCOPE OF STUDY

This study was undertaken to begin defining, with borings and piezometers, the soil and rock types and conditions of the uppermost aquifer regime at the proposed Haywood County MSWLF site. It is drafted to meet the requirements set forth by the North Carolina Department of Environment and Natural Resources in Solid Waste Management Rule 15A NCAC 13B.1623(a).

SITE DESCRIPTION

The proposed Haywood County MSWLF site is located on 268 acres (109 acres of which have site suitability, Law Engineering, 1990) including the existing White Oak Landfill (*Plate 1*). The site is 12 miles north of Waynesville at the Fines Creek Exit (Exit 15) off Interstate 40 almost 9 miles from the North Carolina-Tennessee state line.

The site lies within the Blue Ridge physiographic province characterized by mountainous topography. The site has a total relief of approximately 450 feet. The highest point is at 2700 feet above MSL in the central-southern portion of the property. The lowest area is at an elevation of 2250 feet above mean sea level (MSL). This area is located along the Pigeon River reservoir on the northern property boundary [Walters Dam, located approximately 3.5 miles northwest of the site, was constructed along the Pigeon River for hydroelectric purposes. The resulting reservoir was named Waterville Lake (Walters Lake on older USGS Quadrangles). However, for the purpose of this report, it will be referred to as the Pigeon River]. On site slopes average 20%, though certain areas have considerably higher grades. Slopes that rise from the Pigeon River on the eastern border of the site have grades approaching 42%. Grades as low as 10% are found on shallow slopes between ridgelines in the central and western portion of the site. Three springs occur in the area where the water table intersects the land surface. The resulting waters drain north toward the Pigeon River. The property has historically been used as pasture

and farmland. Several abandoned buildings occupy the clearing on the western side of the site. There are several paths that provide access for light vehicles. A General Site Plan is located on Plate 1.

GEOLOGIC CONSIDERATIONS

The stratigraphy and structure of the southern Appalachian region have been the topic of many investigations and professional papers. In addition to previous observations by Law Engineering and Hatcher, MESCO personnel documented rock types and structure within the vicinity of the proposed landfill site. These observations were used in conjunction with extensive field reconnaissance performed by Hadley and Goldsmith (1963) to construct a geologic map outlining structures and lithologies within and surrounding the proposed site. The derived geologic map and accompanying field notes are presented in Plate 2.

Regional Geology

Regionally the site lies near Ocoee series rocks that include both the older Snowbird Group and younger Great Smoky Group. The site itself overlies the Precambrian age basement complex that consists of metamorphosed plutonic rocks and the Carolina Gneiss (Hadley and Goldsmith, 1963). Both units have experienced various degrees of polymetamorphism in both the Precambrian and Paleozoic where the original structure of the rocks was massively deformed, if not completely destroyed. The plutonic rocks, as described by Hadley and Goldsmith, stratigraphically overlie the Carolina Gneiss and are described as massive, often coarse textured rocks with varying textures and compositions. The composition of these metacrystalline plutonic rocks (orthogneisses) suggests the parent materials were felsic igneous intrusions, namely granite and granodiorite. Though the underlying Carolina Gneiss is similar in texture and appearance, its composition suggests it was derived from very old metasedimentary units (Hadley and Goldsmith, 1963). A nonconformity exists between the plutonic rocks of the basement complex and

the overlying Thunderhead Sandstone that outcrops to the west and south of the site.

Structurally, the site is located very near the Cataloochee Divide Syncline between the kyanite and staurolite isograds. The degree of metamorphism increases to the south-southeast (Hadley and Goldsmith, 1963). The Cataloochee Anticlinorium, located to the northwest of the site, is bounded by the Greenbrier Fault and bisected by the Cold Springs Fault. Located north-northwest of the site are small, high angle reverse faults that roughly parallel the Cold Springs Fault. However, the lateral continuity of these faults is not established across the Pigeon River. Ridgeline orientation typically parallels structural features which trend northeast/southwest.

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

The site lies within a seismic impact zone defined as an area having greater than 10 percent probability that the maximum expected horizontal acceleration expressed as a percentage of the earth's gravitational pull (g) will exceed 0.10g in 250 years (Algermissen, et al, 1990). There are no Holocene faults present within 200 feet of the landfill site (Howard, et al, 1978).

Site Specific Geology

Rock outcrop and core samples support the boundaries outlined by Hadley and Goldsmith (1963). Most of the core samples are layered, coarse-grained gneiss with varied degrees of fracturing and weathering. Some samples display granitic texture and good relict crystalline structure with only slight secondary orientation. Other samples show a typically gneissic texture that is massively foliated with interlayers of biotite mica and coarse-grained plagioclase and quartz. Although changes in texture and composition are observed, the rocks underlying and outcropping within and directly adjacent to the site are classified as preCambrian plutonic basement rocks.

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

Small boulders of fine grained, white sandstone are found on the head of the slope where abandoned borehole P-8 is located. These are likely relicts of the overlying Thunderhead Sandstone. Soils weathered from the sandstone unit are not present in any borehole within the proposed site nor are there any sandstone outcrops within the site boundaries. The reported contact between the Thunderhead Sandstone and the basement complex lies west and south of the site as mapped by Hadley and Goldsmith (1963). The location of this contact was confirmed in the field by MESCO personnel.

FIELD INVESTIGATION

MESCO installed twenty-one borings for the site hydrogeologic study in March through May 1998. Piezometers were installed in all borings that reached the water table and their locations were surveyed by MESCO in accordance with 15A NCAC 13B.1632. Boring B-8 reached neither the surface of intact rock nor the water table and was terminated and abandoned at a depth of 120 feet. Borings were drilled to provide both extended groundwater readings and subsurface data necessary for site characterization. Elevations from both the piezometers and monitoring wells will be used to define the potentiometric surface and groundwater flow characteristics. The locations of all borings and monitoring wells are provided on Plate 1. Water elevations and pertinent bore-hole and monitoring well depths are presented on Table 1.

Under the supervision of a MESCO geologist, Graham and Currie Well Drilling Company installed twenty temporary piezometers (P-1 through P-7, P-9 through P-19, P2-1 and P2-2) using a CME-850 track mounted drill rig. Borings were augered with $4^1/_4$-inch ID hollow stem augers. Those borings extending below auger refusal were enlarged with $6^1/_4$-inch ID hollow stem augers to install a 4" casing for support of overburden soils during coring and/or air hammering. Piezometers screened in rock with two inch diameter PVC (P-1, P-3, P-5, P-6, P-7, P-9, P-17, and P-18) were installed with a $3^3/_8$ inch air hammer. Core samples were taken from six borings (P-1, P-4, P-9, P-14, P-18, and P-19) using a 2 inch diameter core barrel. Borings P-4, P-14, and P-18 were installed with one inch diameter PVC in the core hole. Standard split-barrel samples of subsurface soils were taken at five foot intervals. Standard penetration tests were conducted in conjunction with split-barrel sampling in accordance with ASTM Test Procedure D 1586-84 using a 2-inch OD split-barrel sampler. Shelby tube samples were obtained of select cohesive soils for laboratory classification and *in situ* permeability testing. MESCO conducted slug tests in the field on July 6-8, 1998 to measure hydraulic conductivity of select lithologic units.

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

SUBSURFACE CONDITIONS

Textural distinctions occur throughout the saprolite within the upper aquifer. Even though these variations are indicated on the boring logs, they do not imply the vertical or lateral extent of lithologies. The boring logs are divided into different soil lithologies only to add insight to the type and gradation of soils to be encountered. Divisions on the logs are made based on expected hydrogeologic implications and how such variations are expected to influence the vertical and/or horizontal migration of groundwater.

The subsurface conditions at this particular site are best divided into three hydrogeologically distinct units. Boundaries for these units are made based on field inspection during installation, visual and laboratory sample analysis, and surrounding subsurface conditions. The uppermost portion of the site consists of saprolite defined as *in situ* chemically weathered crystalline rock. In this zone, a dense soil is found that grades slightly in composition, size, and degree of weathering depending on zonal variations in parent bedrock. Small scale structures are found in the overlying saprolite that, upon visual inspection, are similar to underlying gneissic bedrock. Relict structures include foliations, thin fractures with iron-stains and clay replacement, broken quartz intrusions, phyllitic texture, and weathered crystals. Because the extent of chemical weathering of a rock depends largely upon the ease of access of water to the rock, a thick overburden (saprolite) layer can be an indication that the rock from which is derived is abundantly fractured or has interstices of some type through which water can flow. A

thick saprolite unit which is generally porous although not necessarily very permeable, serves as a reservoir to feed water into fractures (LeGrand and Mundorff, 1952).

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

where is this seen on site

The third distinct unit is the underlying fractured gneissic bedrock. This unit, as previously described, is composed of metacrystalline plutonic rocks. These orthogneisses vary in composition, texture, and structure. Fractures commonly parallel gneissic foliation at approximately 45 to 65 degrees in core sample. The abundance of fractures within bedrock is often dependent on rock type. Strongly metamorphosed rock, such as that underlying the Haywood County Site, develops planes of cleavage owing to the growth of micaceous minerals. Cleavage planes provide openings along which water may enter and flow (LeGrand and Mundorff, 1952). Degree of fracturing is evident in an examination of core recovery (REC) and rock quality designation (RQD) values. The borings on ridgelines and toward the top of slopes (P-1, P-4, P-19) show higher average REC and RQD values. P-1, located on a broad ridgeline, has REC of 96% and RQD of 73%. REC and RQD values from P-4, which is located on a narrow ridge with steep slopes on either side, are 89% and 69% respectively. P-19 is located near the top of the steep slope rising from the Pigeon River. The average REC is 90% and average RQD is 71%. These high

REC's and RQD's are an indication of intact and moderately fractured rock. Such high values can also provide reason for the existence of ridgelines, steep topography, and abundant outcrop in certain areas on-site. Conversely, borings located in valleys and toward the bottom of shallow slopes (P-9, P2-1) display a decrease in REC and RQD values. REC and RQD values from P2-1, located midslope (before previous grading), are 84% and 48% respectively. P-9 is located very near a drainage feature. The average REC is 65% and the average RQD is 21%.

Along with supplying soil sample, standard penetration tests (SPT's) provide information to determine the relative *in situ* density of the saprolite unit. This information, when viewed in conjunction with other subsurface data, can help define weathering patterns and the presence of relict structures. A plot of average bpf versus depth ratio of borings (*Chart 1*) indicates blow counts increase only slightly from ground surface through the majority of the boring. Average standard penetration values of saprolite fall between 10 and 40 blows per foot (bpf). However, toward auger refusal (80% to 100% depth), the standard penetration values increase rapidly. This sudden rise in in-situ densities indicate an extensively and uniformly weathered overburden soil. Variations in the plot might account for zones of resistance such as partially weathered rock and broken quartz veins. ?

Groundwater was initially encountered in all three distinct units. Due to the general absence of subsurface structure that might influence groundwater movement (horizontal displacement, unweathered intrusions, etc.), water elevations are largely a function of overlying topography. Water was initially encountered in saprolite in borings P-10, P-11, P-12, P-13, P-14, and P-16. Groundwater was encountered initially in partially weathered rock in P-2, P-4, P-15, and P-18; and initial water elevations occurred in rock in the remaining borings (P-1, P-3, P-5, P-6, P-7, P-9, P-17, P-19, P2-1, and P2-2). Of these, water in P-6, P2-1, and P2-2 was found just below the soil/rock interface as defined by auger refusal. Once allowed to stabilize after piezometer installation, the head in P-6, P-9, P-10, P-11, P-12, P-13, P-15, P-16, and P-19 increased. Boring P-6 rose to the ?

saprolite portion of the upper aquifer just above the soil/rock interface. Similarly, the head in P-1, P-2, P-4, P-14, and P-18 fell after stabilization. After installation, P-14 fell below the soil/rock interface. The remaining borings (P-3, P-5, P-7, P-17, P2-1, P2-2) stabilized to levels comparable to those recorded while drilling. Stabilized water levels across the site indicate groundwater levels fall within 10 feet above or below the soil/rock interface.

Cross-sections are presented on Plates 5A through 5E. These sections display subsurface soil, rock, and groundwater conditions. The cross-sections show a somewhat uniform rock surface that generally mimics the topography. Bedrock data was not available from all borings, therefore the bedrock surface under and between certain boreholes (B-8, P-10, P-13, P-15) is interpretive. Partially Weathered Rock occurs directly over the bedrock surface in most areas. It is most abundant on ridges and hills where it can be found in thick units on top of the rock surface as well as suspended in the saprolite unit. This is a result of reduced joints and fractures on the resistant hills and ridges. The saprolite remains thick, with larger zones of PWR. In the valleys and draws, saprolite tends to be thin, while the PWR unit often pinches out on either side of the draw.

The estimated long term seasonal high water table is presented on all cross-sections. The seasonal high surface generally occurs in the saprolite or PWR and tends to mimic topographic and bedrock surface contours. Proposed subgrade elevations are also included on the cross-sections to show the four foot separation between the seasonal high water table elevations and subgrade elevations. The general profile presented on Plate 6 shows sections B-B' and D-D' all the way to the river. The water table line shown on these is the single day line. The general profile shows the extreme topographic relief onsite as well as general hydrogeologic conditions. Cross-sections 5A-5E are more detailed and do not extend to the Pigeon River.

Hydraulic conductivities were determined using the Bouwer and Rice (1976) method. This slug test method was developed as a bail-down test; that is, the water level is lowered by bailing so that the water flows from the aquifer into the well (Fetter, 1994). The test is appropriate for water levels that intersect the well screen or those where the water rises above the screened interval. A total of sixteen slug tests provided data to determine the hydraulic conductivities of the three distinct lithologic units comprising the uppermost aquifer.

Slug tests were performed on P-10, P-11, P-12, P-13, and P-16 which are screened in the saprolite portion of the upper aquifer. The average hydraulic conductivity for these wells is 5.54×10^{-5} cm/sec. This average value includes permeability tests run on five Shelby tubes taken from varying zones within the saprolite unit. Slug tests run on P-2 and P-15, which are screened in partially weathered rock, yield an average hydraulic conductivity of 1.05×10^{-5} cm/sec. Borings P-1, P-5, P-6, P-7, P-9, P-17, P-19, P2-1, and P2-2 are screened in fractured gneissic bedrock. The average for this unit is 4.65×10^{-5} cm/sec. A Hydraulic Considerations Table and calculations are included in Appendix B.

LABORATORY TEST RESULTS

Selected soil samples were tested in the laboratory in accordance with ASTM Standards to assist in classification and the estimation of engineering parameters. Laboratory tests included analysis of specific gravity, particle size through sieve analysis and hydrometer, and Atterberg limits. Tests on Shelby tube samples from P-8, P-9, P2-1, and P2-2 determined in-situ hydraulic conductivities. Particle size plotted on textural classification triangles determined effective porosities for the overburden soils. Total and effective porosity values used in calculating flow rates are presented in Table 2. Table 3 summarizes the laboratory results and Appendix B includes all related documentation.

Atterberg limits (ASTM D-4318) were determined for 12 samples representative of variations within the saprolite unit. Liquid Limits ranged from 37% to 55% with an average of 44%. Plastic Limits ranged from 27% to 48% with an average of 35%. Plasticity Index ranged from 0 to 26% with an average of 11%. Test results for natural moisture content indicate an average of 23.6% with a range from 13.4% to 30.4%. By Unified Soil Classification System parameters, these soils are low plasticity inorganic silts and fine sands and slightly plastic clayey silts.

GROUNDWATER CONSIDERATIONS

Regionally, the upper aquifer occurs in regolith overlying fractured crystalline bedrock. Regolith is inclusive of all unconsolidated material that overlies intact bedrock. Most groundwater storage is located in the regolith because it has a higher porosity than fractured bedrock (Heath, 1984). Infiltration occurs when precipitation reaches the land surface and penetrates the unsaturated soil. Water then moves laterally and downward through a temporary saturated zone. Ultimately, water will move into bedrock and be transported along interconnected fractures to points of discharge (Heath, 1984).

Onsite groundwater mainly occurs near the bedrock surface except on the crests of broad ridges underlain by thick saprolite and in deep draws, where the groundwater occurs in the saprolite. Plate 4 provides a single day potentiometric map generated from August 17, 1998 water level elevations. Groundwater flow is toward the main discharge feature, the Pigeon River. Recharge areas occur on the tops of the largest ridges on the property (P-13, P-1, and B-8). Groundwater on the extreme southern portion of the site flows south and southeast from the proposed Phase 1 area.

As discussed above, the hydraulic conductivities for all three distinct units are very comparable. This is evidence to the fact that a change from saprolite or PWR to rock does not greatly affect flow within the aquifer. Groundwater is preferentially flowing

along relict fractures and foliation in the saprolite. Because fractures in core samples and outcrops parallel foliations, foliations are a zone of preferential groundwater flow in both the rock and the saprolite. Major stream traces also follow foliation and joint orientations observed in outcrop.

Groundwater flow rates for each distinct lithology are calculated using permeability and effective porosity data from Table 2 and vertical and horizontal gradients generated from potentiometric data. Saprolite and PWR generally have the lowest flow rates. This is largely because they have a higher effective porosity than Gneiss. For two hydrogeologic units with the similar hydraulic conductivity, flow rate is controlled by effective porosity. In the flow rate equation, effective porosity is inversely proportional to flow rate; the lower the effective porosity, the higher the flow rate. The average flow rate in saprolite is 60.19 ft/yr with a maximum of 229.33 ft/yr and minimum 0.65 ft/yr. The maximum flow rate occurs in P-12 which is located in a draw while the minimum occurs at P-13 located on top of a ridge. Flow rates in PWR average 17.44 ft/yr, with the maximum of 30.80 ft/yr on a slope at P-18. The minimum flow rate (3.32 ft/yr) occurs on a ridge at P-15. Fractured Gneiss contains higher flow rates averaging 165.64 ft/yr. The maximum flow rate for gneiss is 673 ft/yr at P-1 on a ridge. The slowest rates occur on slopes at 1.19 ft/yr in P-19 and 7.60 ft/yr in P-7.

Plate 7 is an aerial photograph showing houses with wells within 2000 feet of the landfill boundary. The nearest supply wells are located just south of the property. The wells are across a groundwater divide which occurs from P-14 to P-13 through TWD-10. Phase 1 limits cross this divide in the southeastern portion of Phase 1. The majority of groundwater under proposed waste cells will flow north toward the Pigeon River and discharge into the River or local streams which feed the river. A minimal amount of groundwater flows toward the supply wells south of the property. This localized southern flow can be easily monitored with monitoring wells. There is also a group of wells west of the site. Based on topography and the location of local streams, groundwater will flow

north to northeast in the area of these wells, that is, groundwater will be flowing from these wells toward the landfill. Supply wells are also located north of the property, however these wells are north of the Pigeon River and will not be affected by groundwater originating in the landfill area.

Local Precipitation

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

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

Observation Well Data

Data from local USGS observation wells were used to track natural fluctuations in the regional water table. NC-40 is the closest currently maintained observation well. It is located approximately 20 miles to the southeast of the site along US 276. The well is 18 feet deep and is screened in saprolite of Precambrian gneiss. This is similar to the saprolite at the White Oak Landfill. The highest water level recorded during the 1997 water year was 2.71 feet below land surface in March. The low occurred in October, 1996 at 6.04 feet below land surface for a difference of 3.33 feet. Observation well NC-40 is a climatic effects well located in a valley. The maximum fluctuation recorded in this well is approximately 4 feet. NC-144 is located in Transylvania County just south of

Haywood County in a moderately sloped area. The well is screened in saprolite of gneiss to 70 feet. The high for the 1997 water year occurred in May 1997 at 25.09 feet below land surface, while the low was 32.88 feet below land surface in November 1996 for a difference of 7.79 feet. Observation well NC-144 is a terrain effects well. The maximum fluctuation observed in NC-144 in one year was 12 feet. All observation well locations and data are provided in Appendix C.

Limited data is available for groundwater fluctuations at the landfill site. Water level elevations are available only since the boring program was completed. Data from the temporary piezometers was obtained during a period when groundwater levels are historically low. Taking into account fluctuations in terrain and climatic effects data provided by the USGS, 12 feet was added to the lowest reading on each piezometer located on a slope or ridge, while 8 feet was added to the lowest reading on piezometers located in valleys and draws. This coincides with USGS data suggesting groundwater levels do not fluctuate as greatly in draws and valleys. The maximum expected fluctuation was added to be conservative for engineering design. The seasonal high estimation is summarized in Table 4, and all calculation and documentation is included in Appendix C.

SITE SUITABILITY

Overall the White Oak Landfill Site is suitable for development as a Subtitle D Municipal Solid Waste Landfill Facility. The majority of the groundwater flows toward a major discharge feature (Pigeon River). Because Haywood County owns the property to this point, the site will be easily monitored. No faults, mines, lithologic contacts, or other geologic features which influence groundwater flow have been located onsite.

CLOSURE

This report was prepared to determine the site suitability of the proposed regional lined landfill and completes the requirements of Rule .1623(a). Geological and hydrological data, information, and conclusions contained here and in reports of surrounding areas indicate no hindrance to developing a landfill at the White Oak Site in Haywood County, NC. The contents of this report discuss our investigations and conclusions of soil, rock, and groundwater conditions at the site. The scope of work is limited solely to the White Oak Landfill Site and is not meant to infer conditions outside of the study area.

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

Respectfully submitted,

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State Climate Office of North Carolina, NC State University.

United States Geological Survey, 1967, Cove Creek Gap 7.5 minute quadrangle.

United States Geological Survey, 1967, Fines Creek 7.5 minute quadrangle.

5.2.2 Disposal Rates

The Proposed Facility will be open for 5.5 days per week. The tonnage per day from the existing landfill was approximately 200 cubic yards (100 tons) of baled waste per day. The average monthly disposal rates will be approximately 6,000 cubic yards (3,210 tons) per month. During the year there is a seasonal increase of approximately 200-300 tons a month due to summer tourism, and a marginal increase during the beginning of the school year and the Holiday Season. The winter months see a decrease of the average monthly tonnage rates. The life of the Facility will depend on Disposal Rates and Compaction, which can vary throughout the life of the Facility. This variance can either increase or decrease the life of the Facility. All calculations are based on current data; but over the life of the facility, the variables will change.

5.2.3 Service Area

The new landfill will accept all waste from Haywood County.

5.2.4 Waste Segregation

The Haywood County Lined Landfill Facility will segregate Municipal Solid Waste, Yard Waste, Land Clearing and Inert Debris, Recyclables, White Goods, and Tires. The Facility will use the current access route from the existing Sanitary Landfill Facility; and the attendant at the existing scale house will direct incoming wastes to their appropriate areas. Waste Segregation will continue to occur at the existing facility, with MSW, C/D, and LCID wastes being the only types of waste being disposed in the new MSWLF units.

5.2.5 Equipment Requirements

Haywood County Lined Landfill Facility will use the following equipment:

1. 355 Rex Compactor.
2. Front-end Loaders.
3. Pans.
4. Dozers.
5. Backhoe.

5.3 Landfill Capacity

The Life Expectancy calculations were calculated for Phases 1-6 of development, with a vertical expansion being included when a Phase is constructed adjacent to the previous Phase. The following calculations assumed a yearly 1 percent (1%) increase in waste disposal. The development of all 6 Phases and their vertical expansion with 4:1 side slopes produces about 69 years of life for the proposed landfill. The following table of data shows a year by year breakdown of the amount of waste disposed of and the volume of space remaining at the end of each year. Figure 1-2 shows a graphic representation of the life expectancy of the landfill with annual increases in waste of 2%, 3%, 4%, and 5%, along with a table of date for each different annual percent increase.

HAYWOOD COUNTY SOLID WASTE

REFUSE/SOIL RATIO 8
DENSITY (LB/CU.YD.) 1000
DAILY TONNAGE = 150
VOLUME AVAILABLE 9,660,761
ANNUAL % INC. = 1.00%

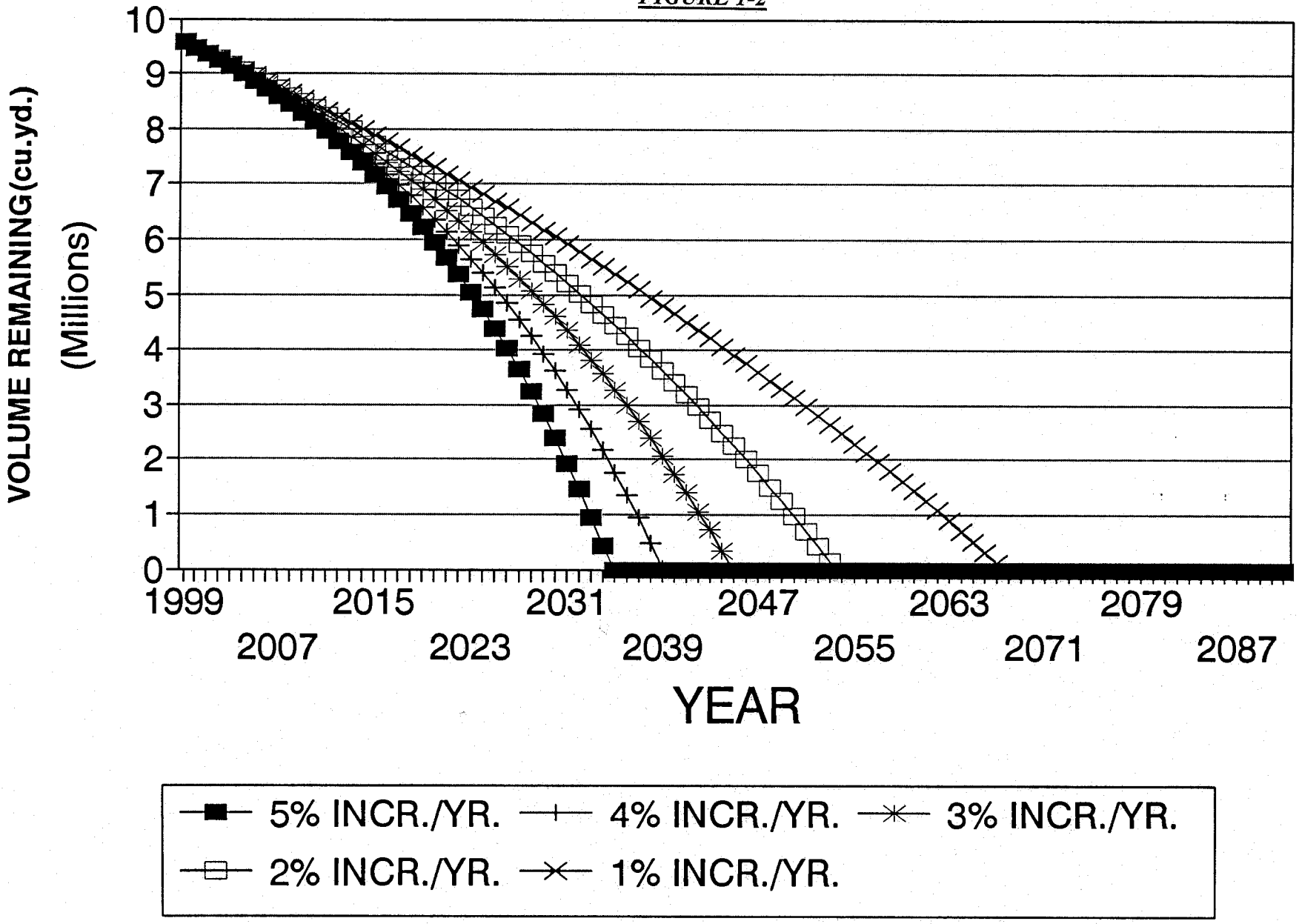
YEAR	TONNAGE(T/YR.)	VOLUME(CU.YD.)	CUMULATIVE VO	VOL.REMAININ
1999	42,900.00	96,525.00	96,525	9,564,236
2000	43,329.00	97,490.25	194,015	9,466,746
2001	43,762.29	98,465.15	292,480	9,368,281
2002	44,199.91	99,449.80	391,930	9,268,831
2003	44,641.91	100,444.30	492,375	9,168,386
2004	45,088.33	101,448.75	593,823	9,066,938
2005	45,539.21	102,463.23	696,286	8,964,475
2006	45,994.61	103,487.86	799,774	8,860,987
2007	46,454.55	104,522.74	904,297	8,756,464
2008	46,919.10	105,567.97	1,009,865	8,650,896
2009	47,388.29	106,623.65	1,116,489	8,544,272
2010	47,862.17	107,689.89	1,224,179	8,436,582
2011	48,340.79	108,766.79	1,332,945	8,327,816
2012	48,824.20	109,854.45	1,442,800	8,217,961
2013	49,312.44	110,953.00	1,553,753	8,107,008
2014	49,805.57	112,062.53	1,665,815	7,994,946
2015	50,303.62	113,183.15	1,778,999	7,881,762
2016	50,806.66	114,314.99	1,893,314	7,767,447
2017	51,314.73	115,458.14	2,008,772	7,651,989
2018	51,827.87	116,612.72	2,125,384	7,535,377
2019	52,346.15	117,778.84	2,243,163	7,417,598
2020	52,869.61	118,956.63	2,362,120	7,298,641
2021	53,398.31	120,146.20	2,482,266	7,178,495
2022	53,932.29	121,347.66	2,603,614	7,057,147
2023	54,471.62	122,561.14	2,726,175	6,934,586
2024	55,016.33	123,786.75	2,849,962	6,810,799
2025	55,566.50	125,024.62	2,974,986	6,685,775
2026	56,122.16	126,274.86	3,101,261	6,559,500
2027	56,683.38	127,537.61	3,228,799	6,431,962
2028	57,250.22	128,812.99	3,357,612	6,303,149
2029	57,822.72	130,101.12	3,487,713	6,173,048
2030	58,400.95	131,402.13	3,619,115	6,041,646
2031	58,984.96	132,716.15	3,751,831	5,908,930

2032	59,574.80	134,043.31	3,885,874	5,774,887
2033	60,170.55	135,383.74	4,021,258	5,639,503
2034	60,772.26	136,737.58	4,157,996	5,502,765
2035	61,379.98	138,104.96	4,296,101	5,364,660
2036	61,993.78	139,486.01	4,435,587	5,225,174
2037	62,613.72	140,880.87	4,576,468	5,084,293
2038	63,239.86	142,289.68	4,718,757	4,942,004
2039	63,872.25	143,712.57	4,862,470	4,798,291
2040	64,510.98	145,149.70	5,007,619	4,653,142
2041	65,156.09	146,601.19	5,154,221	4,506,540
2042	65,807.65	148,067.21	5,302,288	4,358,473
2043	66,465.72	149,547.88	5,451,836	4,208,925
2044	67,130.38	151,043.36	5,602,879	4,057,882
2045	67,801.68	152,553.79	5,755,433	3,905,328
2046	68,479.70	154,079.33	5,909,512	3,751,249
2047	69,164.50	155,620.12	6,065,132	3,595,629
2048	69,856.14	157,176.32	6,222,309	3,438,452
2049	70,554.71	158,748.09	6,381,057	3,279,704
2050	71,260.25	160,335.57	6,541,392	3,119,369
2051	71,972.85	161,938.92	6,703,331	2,957,430
2052	72,692.58	163,558.31	6,866,890	2,793,871
2053	73,419.51	165,193.90	7,032,083	2,628,678
2054	74,153.70	166,845.83	7,198,929	2,461,832
2055	74,895.24	168,514.29	7,367,444	2,293,317
2056	75,644.19	170,199.44	7,537,643	2,123,118
2057	76,400.64	171,901.43	7,709,544	1,951,217
2058	77,164.64	173,620.44	7,883,165	1,777,596
2059	77,936.29	175,356.65	8,058,522	1,602,239
2060	78,715.65	177,110.22	8,235,632	1,425,129
2061	79,502.81	178,881.32	8,414,513	1,246,248
2062	80,297.84	180,670.13	8,595,183	1,065,578
2063	81,100.81	182,476.83	8,777,660	883,101
2064	81,911.82	184,301.60	8,961,962	698,799
2065	82,730.94	186,144.62	9,148,106	512,655
2066	83,558.25	188,006.06	9,336,112	324,649
2067	84,393.83	189,886.12	9,525,998	134,763
2068	85,237.77	191,784.98	9,717,783	0
2069	86,090.15	193,702.83	9,911,486	0
2070	86,951.05	195,639.86	10,107,126	0
2071	87,820.56	197,596.26	10,304,722	0

HAYWOOD COUNTY

SOLID WASTE VOLUME UTILIZED

FIGURE 1-2



HAYWOOD COUNTY SOLID WASTE

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VOLUME AVAILABLE 9,660,761
ANNUAL % INC. = 2.00%

YEAR	TONNAGE(T/YR.)	VOLUME(CU.YD.)	CUMULATIVE VO	VOL.REMAININ
1999	42,900.00	96,525.00	96,525	9,564,236
2000	43,758.00	98,455.50	194,981	9,465,781
2001	44,633.16	100,424.61	295,405	9,365,356
2002	45,525.82	102,433.10	397,838	9,262,923
2003	46,436.34	104,481.76	502,320	9,158,441
2004	47,365.07	106,571.40	608,891	9,051,870
2005	48,312.37	108,702.83	717,594	8,943,167
2006	49,278.62	110,876.88	828,471	8,832,290
2007	50,264.19	113,094.42	941,566	8,719,195
2008	51,269.47	115,356.31	1,056,922	8,603,839
2009	52,294.86	117,663.44	1,174,585	8,486,176
2010	53,340.76	120,016.71	1,294,602	8,366,159
2011	54,407.57	122,417.04	1,417,019	8,243,742
2012	55,495.72	124,865.38	1,541,884	8,118,877
2013	56,605.64	127,362.69	1,669,247	7,991,514
2014	57,737.75	129,909.94	1,799,157	7,861,604
2015	58,892.51	132,508.14	1,931,665	7,729,096
2016	60,070.36	135,158.30	2,066,823	7,593,938
2017	61,271.76	137,861.47	2,204,685	7,456,076
2018	62,497.20	140,618.70	2,345,304	7,315,457
2019	63,747.14	143,431.07	2,488,735	7,172,026
2020	65,022.09	146,299.69	2,635,034	7,025,727
2021	66,322.53	149,225.69	2,784,260	6,876,501
2022	67,648.98	152,210.20	2,936,470	6,724,291
2023	69,001.96	155,254.41	3,091,725	6,569,036
2024	70,382.00	158,359.49	3,250,084	6,410,677
2025	71,789.64	161,526.68	3,411,611	6,249,150
2026	73,225.43	164,757.22	3,576,368	6,084,393
2027	74,689.94	168,052.36	3,744,420	5,916,341
2028	76,183.74	171,413.41	3,915,834	5,744,927
2029	77,707.41	174,841.68	4,090,676	5,570,085
2030	79,261.56	178,338.51	4,269,014	5,391,747
2031	80,846.79	181,905.28	4,450,919	5,209,842

HAYWOOD COUNTY SOLID WASTE

2032	82,463.73	185,543.39	4,636,463	5,024,298
2033	84,113.00	189,254.25	4,825,717	4,835,044
2034	85,795.26	193,039.34	5,018,756	4,642,005
2035	87,511.17	196,900.13	5,215,656	4,445,105
2036	89,261.39	200,838.13	5,416,495	4,244,266
2037	91,046.62	204,854.89	5,621,349	4,039,412
2038	92,867.55	208,951.99	5,830,301	3,830,460
2039	94,724.90	213,131.03	6,043,432	3,617,329
2040	96,619.40	217,393.65	6,260,826	3,399,935
2041	98,551.79	221,741.52	6,482,568	3,178,193
2042	100,522.82	226,176.35	6,708,744	2,952,017
2043	102,533.28	230,699.88	6,939,444	2,721,317
2044	104,583.95	235,313.88	7,174,758	2,486,003
2045	106,675.62	240,020.15	7,414,778	2,245,983
2046	108,809.14	244,820.56	7,659,598	2,001,163
2047	110,985.32	249,716.97	7,909,315	1,751,446
2048	113,205.03	254,711.31	8,164,027	1,496,734
2049	115,469.13	259,805.53	8,423,832	1,236,929
2050	117,778.51	265,001.65	8,688,834	971,927
2051	120,134.08	270,301.68	8,959,136	701,625
2052	122,536.76	275,707.71	9,234,843	425,918
2053	124,987.50	281,221.87	9,516,065	144,696
2054	127,487.25	286,846.30	9,802,911	0
2055	130,036.99	292,583.23	10,095,495	0
2056	132,637.73	298,434.89	10,393,930	0
2057	135,290.49	304,403.59	10,698,333	0
2058	137,996.29	310,491.66	11,008,825	0
2059	140,756.22	316,701.50	11,325,526	0
2060	143,571.35	323,035.53	11,648,562	0
2061	146,442.77	329,496.24	11,978,058	0
2062	149,371.63	336,086.16	12,314,144	0
2063	152,359.06	342,807.89	12,656,952	0
2064	155,406.24	349,664.04	13,006,616	0
2065	158,514.37	356,657.32	13,363,274	0
2066	161,684.65	363,790.47	13,727,064	0
2067	164,918.35	371,066.28	14,098,130	0
2068	168,216.71	378,487.61	14,476,618	0
2069	171,581.05	386,057.36	14,862,675	0
2070	175,012.67	393,778.50	15,256,454	0
2071	178,512.92	401,654.07	15,658,108	0

HAYWOOD COUNTY SOLID WASTE

REFUSE/SOIL RATIO 8
DENSITY (LB/CU.YD.) 1000
DAILY TONNAGE = 150
VOLUME AVAILABLE 9,660,761
ANNUAL % INC. = 3.00%

YEAR	TONNAGE(T/YR.)	VOLUME(CU.YD.)	CUMULATIVE VO	VOL.REMAININ
1999	42,900.00	96,525.00	96,525	9,564,236
2000	44,187.00	99,420.75	195,946	9,464,815
2001	45,512.61	102,403.37	298,349	9,362,412
2002	46,877.99	105,475.47	403,825	9,256,936
2003	48,284.33	108,639.74	512,464	9,148,297
2004	49,732.86	111,898.93	624,363	9,036,398
2005	51,224.84	115,255.90	739,619	8,921,142
2006	52,761.59	118,713.57	858,333	8,802,428
2007	54,344.44	122,274.98	980,608	8,680,153
2008	55,974.77	125,943.23	1,106,551	8,554,210
2009	57,654.01	129,721.53	1,236,272	8,424,489
2010	59,383.63	133,613.17	1,369,886	8,290,875
2011	61,165.14	137,621.57	1,507,507	8,153,254
2012	63,000.10	141,750.22	1,649,257	8,011,504
2013	64,890.10	146,002.72	1,795,260	7,865,501
2014	66,836.80	150,382.80	1,945,643	7,715,118
2015	68,841.91	154,894.29	2,100,537	7,560,224
2016	70,907.16	159,541.12	2,260,078	7,400,683
2017	73,034.38	164,327.35	2,424,406	7,236,355
2018	75,225.41	169,257.17	2,593,663	7,067,098
2019	77,482.17	174,334.89	2,767,998	6,892,763
2020	79,806.64	179,564.93	2,947,563	6,713,198
2021	82,200.84	184,951.88	3,132,515	6,528,246
2022	84,666.86	190,500.44	3,323,015	6,337,746
2023	87,206.87	196,215.45	3,519,230	6,141,531
2024	89,823.07	202,101.91	3,721,332	5,939,429
2025	92,517.77	208,164.97	3,929,497	5,731,264
2026	95,293.30	214,409.92	4,143,907	5,516,854
2027	98,152.10	220,842.22	4,364,750	5,296,011
2028	101,096.66	227,467.49	4,592,217	5,068,544
2029	104,129.56	234,291.51	4,826,509	4,834,252
2030	107,253.45	241,320.26	5,067,829	4,592,932
2031	110,471.05	248,559.86	5,316,389	4,344,372

HAYWOOD COUNTY SOLID WASTE

2032	113,785.18	256,016.66	5,572,405	4,088,356
2033	117,198.74	263,697.16	5,836,102	3,824,659
2034	120,714.70	271,608.07	6,107,711	3,553,050
2035	124,336.14	279,756.32	6,387,467	3,273,294
2036	128,066.22	288,149.01	6,675,616	2,985,145
2037	131,908.21	296,793.48	6,972,409	2,688,352
2038	135,865.46	305,697.28	7,278,107	2,382,654
2039	139,941.42	314,868.20	7,592,975	2,067,786
2040	144,139.66	324,314.24	7,917,289	1,743,472
2041	148,463.85	334,043.67	8,251,333	1,409,428
2042	152,917.77	344,064.98	8,595,398	1,065,363
2043	157,505.30	354,386.93	8,949,785	710,976
2044	162,230.46	365,018.54	9,314,803	345,958
2045	167,097.38	375,969.09	9,690,772	0
2046	172,110.30	387,248.17	10,078,020	0
2047	177,273.61	398,865.61	10,476,886	0
2048	182,591.81	410,831.58	10,887,718	0
2049	188,069.57	423,156.53	11,310,874	0
2050	193,711.66	435,851.22	11,746,725	0
2051	199,523.00	448,926.76	12,195,652	0
2052	205,508.70	462,394.56	12,658,047	0
2053	211,673.96	476,266.40	13,134,313	0
2054	218,024.17	490,554.39	13,624,867	0
2055	224,564.90	505,271.02	14,130,139	0
2056	231,301.85	520,429.16	14,650,568	0
2057	238,240.90	536,042.03	15,186,610	0
2058	245,388.13	552,123.29	15,738,733	0
2059	252,749.77	568,686.99	16,307,420	0
2060	260,332.27	585,747.60	16,893,168	0
2061	268,142.23	603,320.03	17,496,488	0
2062	276,186.50	621,419.63	18,117,907	0
2063	284,472.10	640,062.22	18,757,969	0
2064	293,006.26	659,264.08	19,417,234	0
2065	301,796.45	679,042.01	20,096,276	0
2066	310,850.34	699,413.27	20,795,689	0
2067	320,175.85	720,395.66	21,516,084	0
2068	329,781.13	742,007.53	22,258,092	0
2069	339,674.56	764,267.76	23,022,360	0
2070	349,864.80	787,195.79	23,809,556	0
2071	360,360.74	810,811.67	24,620,367	0

HAYWOOD COUNTY SOLID WASTE

REFUSE/SOIL RATIO 8
DENSITY (LB/CU.YD.) 1000
DAILY TONNAGE = 150
VOLUME AVAILABLE 9,660,761
ANNUAL % INC. = 4.00%

YEAR	TONNAGE(T/YR.)	VOLUME(CU.YD.)	CUMULATIVE VO	VOL.REMAININ
1999	42,900.00	96,525.00	96525	9,564,236
2000	44,616.00	100,386.00	196,911	9,463,850
2001	46,400.64	104,401.44	301,312	9,359,449
2002	48,256.67	108,577.50	409,890	9,250,871
2003	50,186.93	112,920.60	522,811	9,137,950
2004	52,194.41	117,437.42	640,248	9,020,513
2005	54,282.19	122,134.92	762,383	8,898,378
2006	56,453.47	127,020.31	889,403	8,771,358
2007	58,711.61	132,101.13	1,021,504	8,639,257
2008	61,060.08	137,385.17	1,158,889	8,501,872
2009	63,502.48	142,880.58	1,301,770	8,358,991
2010	66,042.58	148,595.80	1,450,366	8,210,395
2011	68,684.28	154,539.63	1,604,906	8,055,855
2012	71,431.65	160,721.22	1,765,627	7,895,134
2013	74,288.92	167,150.07	1,932,777	7,727,984
2014	77,260.48	173,836.07	2,106,613	7,554,148
2015	80,350.90	180,789.51	2,287,402	7,373,359
2016	83,564.93	188,021.10	2,475,423	7,185,338
2017	86,907.53	195,541.94	2,670,965	6,989,796
2018	90,383.83	203,363.62	2,874,329	6,786,432
2019	93,999.18	211,498.16	3,085,827	6,574,934
2020	97,759.15	219,958.09	3,305,785	6,354,976
2021	101,669.52	228,756.41	3,534,542	6,126,219
2022	105,736.30	237,906.67	3,772,448	5,888,313
2023	109,965.75	247,422.93	4,019,871	5,640,890
2024	114,364.38	257,319.85	4,277,191	5,383,570
2025	118,938.95	267,612.65	4,544,804	5,115,957
2026	123,696.51	278,317.15	4,823,121	4,837,640
2027	128,644.37	289,449.84	5,112,571	4,548,190
2028	133,790.15	301,027.83	5,413,599	4,247,162
2029	139,141.75	313,068.94	5,726,668	3,934,093
2030	144,707.42	325,591.70	6,052,259	3,608,502
2031	150,495.72	338,615.37	6,390,875	3,269,886

HAYWOOD COUNTY SOLID WASTE

2032	156,515.55	352,159.99	6,743,035	2,917,726
2033	162,776.17	366,246.38	7,109,281	2,551,480
2034	169,287.22	380,896.24	7,490,177	2,170,584
2035	176,058.71	396,132.09	7,886,309	1,774,452
2036	183,101.05	411,977.37	8,298,287	1,362,474
2037	190,425.10	428,456.47	8,726,743	934,018
2038	198,042.10	445,594.73	9,172,338	488,423
2039	205,963.78	463,418.52	9,635,756	25,005
2040	214,202.34	481,955.26	10,117,712	0
2041	222,770.43	501,233.47	10,618,945	0
2042	231,681.25	521,282.81	11,140,228	0
2043	240,948.50	542,134.12	11,682,362	0
2044	250,586.44	563,819.48	12,246,182	0
2045	260,609.89	586,372.26	12,832,554	0
2046	271,034.29	609,827.15	13,442,381	0
2047	281,875.66	634,220.24	14,076,601	0
2048	293,150.69	659,589.05	14,736,190	0
2049	304,876.72	685,972.61	15,422,163	0
2050	317,071.78	713,411.51	16,135,574	0
2051	329,754.66	741,947.97	16,877,522	0
2052	342,944.84	771,625.89	17,649,148	0
2053	356,662.64	802,490.93	18,451,639	0
2054	370,929.14	834,590.57	19,286,230	0
2055	385,766.31	867,974.19	20,154,204	0
2056	401,196.96	902,693.16	21,056,897	0
2057	417,244.84	938,800.88	21,995,698	0
2058	433,934.63	976,352.92	22,972,051	0
2059	451,292.02	1,015,407.04	23,987,458	0
2060	469,343.70	1,056,023.32	25,043,481	0
2061	488,117.44	1,098,264.25	26,141,745	0
2062	507,642.14	1,142,194.82	27,283,940	0
2063	527,947.83	1,187,882.61	28,471,823	0
2064	549,065.74	1,235,397.92	29,707,221	0
2065	571,028.37	1,284,813.83	30,992,035	0
2066	593,869.51	1,336,206.39	32,328,241	0
2067	617,624.29	1,389,654.64	33,717,896	0
2068	642,329.26	1,445,240.83	35,163,137	0
2069	668,022.43	1,503,050.46	36,666,187	0
2070	694,743.32	1,563,172.48	38,229,359	0
2071	722,533.06	1,625,699.38	39,855,059	0

HAYWOOD COUNTY SOLID WASTE

REFUSE/SOIL RATIO 8
DENSITY (LB/CU.YD.) 1000
DAILY TONNAGE = 150
VOLUME AVAILABLE 9,660,761
ANNUAL % INC. = 5.00%

YEAR	YEAR	TONNAGE(T/YR.)	VOLUME(CU.YD.)	CUMULATIVE VO	VOL.REMAININ
1999	1999	42,900.00	96,525.00	96525	9,564,236
2000	2000	45,045.00	101,351.25	197,876	9,462,885
2001	2001	47,297.25	106,418.81	304,295	9,356,466
2002	2002	49,662.11	111,739.75	416,035	9,244,726
2003	2003	52,145.22	117,326.74	533,362	9,127,399
2004	2004	54,752.48	123,193.08	656,555	9,004,206
2005	2005	57,490.10	129,352.73	785,907	8,874,854
2006	2006	60,364.61	135,820.37	921,728	8,739,033
2007	2007	63,382.84	142,611.39	1,064,339	8,596,422
2008	2008	66,551.98	149,741.96	1,214,081	8,446,680
2009	2009	69,879.58	157,229.05	1,371,310	8,289,451
2010	2010	73,373.56	165,090.51	1,536,401	8,124,360
2011	2011	77,042.24	173,345.03	1,709,746	7,951,015
2012	2012	80,894.35	182,012.28	1,891,758	7,769,003
2013	2013	84,939.07	191,112.90	2,082,871	7,577,890
2014	2014	89,186.02	200,668.54	2,283,539	7,377,222
2015	2015	93,645.32	210,701.97	2,494,241	7,166,520
2016	2016	98,327.59	221,237.07	2,715,478	6,945,283
2017	2017	103,243.97	232,298.92	2,947,777	6,712,984
2018	2018	108,406.16	243,913.87	3,191,691	6,469,070
2019	2019	113,826.47	256,109.56	3,447,801	6,212,960
2020	2020	119,517.80	268,915.04	3,716,716	5,944,045
2021	2021	125,493.68	282,360.79	3,999,077	5,661,684
2022	2022	131,768.37	296,478.83	4,295,555	5,365,206
2023	2023	138,356.79	311,302.77	4,606,858	5,053,903
2024	2024	145,274.63	326,867.91	4,933,726	4,727,035
2025	2025	152,538.36	343,211.31	5,276,937	4,383,824
2026	2026	160,165.28	360,371.87	5,637,309	4,023,452
2027	2027	168,173.54	378,390.47	6,015,700	3,645,061
2028	2028	176,582.22	397,309.99	6,413,010	3,247,751
2029	2029	185,411.33	417,175.49	6,830,185	2,830,576
2030	2030	194,681.89	438,034.26	7,268,220	2,392,541
2031	2031	204,415.99	459,935.98	7,728,155	1,932,606

HAYWOOD COUNTY SOLID WASTE

2032	2032	214,636.79	482,932.77	8,211,088	1,449,673
2033	2033	225,368.63	507,079.41	8,718,168	942,593
2034	2034	236,637.06	532,433.38	9,250,601	410,160
2035	2035	248,468.91	559,055.05	9,809,656	0
2036	2036	260,892.36	587,007.81	10,396,664	0
2037	2037	273,936.98	616,358.20	11,013,022	0
2038	2038	287,633.82	647,176.11	11,660,198	0
2039	2039	302,015.52	679,534.91	12,339,733	0
2040	2040	317,116.29	713,511.66	13,053,245	0
2041	2041	332,972.11	749,187.24	13,802,432	0
2042	2042	349,620.71	786,646.60	14,589,079	0
2043	2043	367,101.75	825,978.93	15,415,058	0
2044	2044	385,456.83	867,277.88	16,282,335	0
2045	2045	404,729.68	910,641.77	17,192,977	0
2046	2046	424,966.16	956,173.86	18,149,151	0
2047	2047	446,214.47	1,003,982.55	19,153,134	0
2048	2048	468,525.19	1,054,181.68	20,207,315	0
2049	2049	491,951.45	1,106,890.76	21,314,206	0
2050	2050	516,549.02	1,162,235.30	22,476,441	0
2051	2051	542,376.47	1,220,347.07	23,696,788	0
2052	2052	569,495.30	1,281,364.42	24,978,153	0
2053	2053	597,970.06	1,345,432.64	26,323,585	0
2054	2054	627,868.57	1,412,704.27	27,736,290	0
2055	2055	659,261.99	1,483,339.49	29,219,629	0
2056	2056	692,225.09	1,557,506.46	30,777,136	0
2057	2057	726,836.35	1,635,381.79	32,412,517	0
2058	2058	763,178.17	1,717,150.87	34,129,668	0
2059	2059	801,337.07	1,803,008.42	35,932,677	0
2060	2060	841,403.93	1,893,158.84	37,825,836	0
2061	2061	883,474.13	1,987,816.78	39,813,652	0
2062	2062	927,647.83	2,087,207.62	41,900,860	0
2063	2063	974,030.22	2,191,568.00	44,092,428	0
2064	2064	1,022,731.73	2,301,146.40	46,393,574	0
2065	2065	1,073,868.32	2,416,203.72	48,809,778	0
2066	2066	1,127,561.74	2,537,013.91	51,346,792	0
2067	2067	1,183,939.82	2,663,864.60	54,010,657	0
2068	2068	1,243,136.81	2,797,057.83	56,807,714	0
2069	2069	1,305,293.66	2,936,910.72	59,744,625	0
2070	2070	1,370,558.34	3,083,756.26	62,828,381	0
2071	2071	1,439,086.26	3,237,944.07	66,066,326	0

SOIL CALCULATIONS PHASES 1-6
HAYWOOD COUNTY SOLID WASTE LINED LANDFILL

Soil Available on Site	= 2,666,984 c.y.
Soil Needed for Construction	= 360,007 c.y.
Soil Needed for Daily Cover	= 1,207,595 c.y.
Soil Needed for Closure	= 261,489 c.y.
Total Soil Needed	= 1,829,091 c.y.

*Determined by Softdesk Adcadd Earthworks computer program.

There is an excess of 837,893 cubic yards of soil available on site after construction of the entire Facility. The County should not need to utilize other properties for borrow material. There should be enough borrow material available to complete the project. If the need arises the County can utilize other areas on the property to borrow from.

5.4 Containment and Environmental Control Systems

Haywood County Lined Landfill Facility will be constructed with a Base Liner System consisting of a cohesive soil liner with a permeability no greater than 1.0 x 10^{-7} cm/sec, sixty (60) mil High Density Polyethylene (HDPE) liner, 3' of protective cover, and leachate collection system consisting of leachate trenches and pipes to collect the leachate. The leachate will be gravity fed into a leachate lagoon. The waste will be covered daily with either a synthetic cover and/or on-site soils to control disease vectors. The cap system will consist of twelve inches (12") of bridging material (temporary cover), eighteen inches (18") of soil liner with a permeability no greater than 1.0×10^{-5} cm/sec, forty (40) mil Linear Low Density Polyethylene (LLDPE) flexible membrane liner, drainage layer, and twenty four inches (24") of protective/erosive layer. The cap will contain a gas venting system consisting of a series of washed stone trenches below the soil liner that will be vented through pipes that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

5.5 Special Engineering Features

Haywood County Lined Landfill Facility will have storm water diversion berms within each phase of development. The Facility will consist of six Phases of development. The Facility will be located on approximately 268.54 acres of land with 68.84 acres being used for Municipal Solid Waste Landfill. Phase 1 will be built first and will consist of approximately 10.0 acres. Phase 2 will be constructed approximately fifteen (15) years later and will consist of about 4.87 acres. Phase 3 will be constructed about seven (7) years after Phase 2 and will contain approximately 7.72 acres. Construction of Phase 4 will begin approximately twelve (12) years after Phase 3 and contain about 13.25 acres. Phase 5 will be constructed about twenty (20) years later and contain approximately 13.78 acres. Finally, Phase 6 should be constructed about twenty-one (21) years after Phase 5 and consists of 19.21 acres, giving the Landfill a total life expectancy of one hundred seventeen (117) years. The remaining acreage shall be used for the Leachate Lagoon and Buffer. Storm water coming into contact with solid waste is leachate and will be sent to the leachate lagoon. The leachate will be recirculated and/or treated at the Town of Waynesville Wastewater Treatment Facility.

NOTICE OF PUBLIC HEARING

The Haywood County Board of Commissioners will hold a public hearing on Monday, June 7, 1999 at 9:00 a.m. in the Commissioner's Boardroom of the Haywood County Courthouse Annex regarding the enlargement of the solid waste landfill facility located at White Oak Township, Haywood County, North Carolina. The proposed facility will be enlarged and extended around the existing facility. The facility is operated and managed by Haywood County and serves Haywood County.

The purpose of the hearing will be to inform the public of the proposed enlargement of the County solid waste landfill and receive comments on same.

A copy of the site study is available for public review at the Haywood County Public Library in Waynesville, and the County Manager's Office at the Courthouse Annex.

Persons wishing to be heard at the public hearing are asked to be present. The County Commissioners may adopt reasonable rules governing the conduct of the hearing including (i) fixing the maximum time allotted to each speaker, (ii) providing for the designation of spokesmen for groups of persons supporting or opposing the same positions, (iii) providing for the selection of delegates from groups of persons supporting or opposing the same positions when the number of persons wishing to attend the hearing exceeds the capacity of the hall, and (iv) providing for the maintenance of order and decorum in the conduct of the hearing.

This the 5th day of May 1999.

C. Jack Horton, Clerk to the
Haywood County Board of Commissioners

Published as a Legal Notice on:

May 5, 1999

Asheville Citizen-Times

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BUNCOMBE COUNTY
SS.
NORTH CAROLINA

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This the 5th day of May 1999.

C. Jack Horton,
Clerk to the
Haywood County Board
of Commissioners

May 5, 1999
(9470)

Before the undersigned, a Notary Public of said County and State, duly commissioned, qualified and authorized by law to administer oaths, personally appeared **Ross G. Venning,** who, being first duly sworn, deposes and says: that he (she) is the **Legal Billing Clerk** of **TheAsheville Citizen-Times Company,** engaged in publication of a newspaper known as **The Asheville Citizen-Times**, published, issued, and entered as second class mail in the City of Asheville, in said County and State; that he (she) is authorized to make this affidavit and sworn statement; that the notice or other legal advertisement, a true copy of which is attached hereto, was published in **The Asheville Citizen-Times** on the following dates: **May 5, 1999** And that the said newspaper in which said notice, paper, document or legal advertisement were published were, at the time of each and every publication, a newspaper meeting all of the requirements and qualifications of Section 1-597 of the General Statues of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statues of North Carolina.

This 12th day of May, 1999

Ross G Venning
(Signature of person making affidavit)

Sworn to and subscribed before me the 12th day of May, 1999

Kelly B Allen
(Notary Public)

My Commission expires the 6th day of October 2001.

REGULAR MEETING – JUNE 7, 1999

MEMBERS PRESENT: Commissioners Stevens, Enloe, Ferguson, and Francis

MEMBERS ABSENT: Commissioner Forga

Chairman Stevens called the meeting to order at 9:00 a.m. in the Commissioners Board Room of the Haywood County Courthouse Annex.

Commissioner Francis made a motion to approve the minutes of the May 17, 1999 regular meeting, and the special meetings of May 24, 1999 and May 25, 1999 as presented. Commissioner Enloe seconded the motion and the Board unanimously passed the motion.

Chairman Stevens declared a Public Hearing in session at 9:00 a.m. for the purpose of informing the public of the proposed enlargement of the County solid waste landfill and receive comments on same. County Manager Jack Horton introduced Wayne Sullivan of Municipal Engineering and Rick Honeycutt, Assistant to the County Manager. Mr. Honeycutt cited the statutory requirements for holding such a public hearing and what the Board's action is supposed to accomplish. Mr. Honeycutt stated that as required by the Statutes, notice of the public hearing was duly advertised to be conducted on this date and at this time. Prior to approval of the jurisdictional local government, the Board of County Commissioners, there shall be at least one public hearing to inform the community of the proposed waste management activities as described in the proposed facility plan. Wayne Sullivan explained that the site suitability was conducted to include additional property that the County acquired for the landfill in order to expand the landfill to its largest capability without infringing on areas that are restricted. Wetlands, endangered species, archeological sites, groundwater location, buffer requirements, and affects on minorities were considered in the study. The expansion site is located adjacent to the existing landfill. There is a buffer requirement around the landfill of at least 300'. Adjacent to the river, a buffer of from 400' to 900' has been utilized. In the site some wetlands were found in a bottom that will be affected by Phase I (construction phase) which is less than one-eighth of an acre. A permit has been acquired for disturbing this area. The other area that will be affected several years from now is a springhead that will eventually be piped under the landfill. At that time a permit will be required for this work. Archeological finds included some old buildings that were part of the original farm, but are not the type that will require further study, and may be disturbed when the time comes, many years down the road. Some Indian artifacts were scattered around the site but nothing of significance. The main affect of the site is the requirement of a 500' buffer at a house behind the borrow site. Life expectancy on the overall site of approximately 200 acres is from 35 to 70 years dependent upon growth, with the 35 years representing a 5% growth each year and the 70-year projection reflecting a 1% growth per year. The site suitability study has been at the State for approximately six to seven months for their review. Cell 4, which is connecting on to the current landfill cell, is expected to be completed by the middle of this month. Phase I, the next phase to be constructed and another permit requirement, is scheduled for construction next year. Chairman Stevens opened the floor for public comment. There were no comments from the public. There being no further comments, Chairman Stevens declared the Public Hearing concluded.

REGULAR MEETING – JUNE 7, 1999

MEMBERS PRESENT: Commissioners Stevens, Enloe, Ferguson, and Francis

MEMBERS ABSENT: Commissioner Forga

Chairman Stevens called the meeting to order at 9:00 a.m. in the Commissioners Board Room of the Haywood County Courthouse Annex.

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Commissioner Enloe made a motion to approve the White Oak Landfill site suitability study and report as presented by Wayne Sullivan of Municipal Engineering for enlargement and extension around the existing solid waste landfill. Commissioner Francis seconded the motion and the Board unanimously passed the motion.

CERTIFICATION

I, C. Jack Horton, Clerk to the Board of Commissioners for the County of Haywood, North Carolina, DO HEREBY CERTIFY that the foregoing is a true and complete copy of so much of the proceedings for the Board of Commissioners for said County at a meeting duly called and held June 7, 1999, and that said proceedings are recorded in Minute Book No. 17 of said Board.

WITNESS my hand and the common seal of said County, this the 21st day of June 1999.

Clerk to the Board of Commissioners,
Haywood County

TRC

PHASE I CULTURAL RESOURCE SURVEY OF THE PROPOSED HAYWOOD COUNTY LANDFILL EXPANSION SITE, HAYWOOD COUNTY, NORTH CAROLINA

July 1998

PHASE I CULTURAL RESOURCE SURVEY OF THE PROPOSED HAYWOOD COUNTY LANDFILL EXPANSION SITE, HAYWOOD COUNTY, NORTH CAROLINA

Prepared for:

Municipal Engineering Services Company, P.A.
P.O. Box 97
Garner, NC 27529

Prepared by:

TRC GARROW ASSOCIATES INC.
6340 Quadrangle Drive, Suite 200
Chapel Hill, NC 27514

Project #24698

Christopher T. Espenshade
Christopher T. Espenshade,
Principal Investigator

Authored by Patrick H. Garrow

July 1998

ABSTRACT/MANAGEMENT SUMMARY

TRC conducted an intensive cultural resource survey of an approximately 75 acre tract at the headwaters of Waterville Lake on the south bank of the Pigeon River in Haywood County, North Carolina. The survey tract included approximately 60 acres of new property and approximately 15 acres of the existing landfill property. The tract is located immediately west of and adjacent to the existing landfill site, which in turn is north of White Oak Road and west of Lower Fines Creek Road. Lower Fines Creek Road intersects I-40 across the Pigeon River from the east end of the existing landfill site. The entire survey area is referred to here as the expansion tract. The proposed expansion tract, as well as the existing landfill property, is located entirely in the uplands. The expansion tract includes a patchwork of forests and fallow fields.

The survey targeted potentially habitable areas, defined as landforms larger than 10 x 10 m with less than a 10° slope. Shovel tests were placed in all potentially habitable areas, and surface survey was also conducted. The tests were excavated into subsoil.

The survey identified five previously unidentified archaeological sites and revisited one site that had been delineated by an earlier study. Four of the newly identified sites are prehistoric, while the other two date to the historic period. Only one of the prehistoric sites contained temporally diagnostic artifacts, and that site dates to the Early Archaic period. Both historic sites date to the early twentieth century. None of the sites are recommended as eligible or potentially eligible for listing on the National Register of Historic Places.

ACKNOWLEDGMENTS

We would like to acknowledge the assistance of Mr. Wayne Sullivan, Project Manager at Municipal Engineering, who provided background information on the project and handled project coordination with our Chapel Hill office.

Chris Espenshade directed the field and laboratory phases of this project. The field assistant for the project was Scott McLear, and Thomas P. Garrow conducted the artifact analysis. Paul Webb provided project management and logistical support. The project graphics were prepared by Vince Macek. Editorial assistance was provided by Dan Dolensky.

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I. INTRODUCTION

This document presents the results of an intensive cultural resources survey of an approximately 75 acre tract immediately west of and adjacent to the existing Haywood County Landfill in Haywood County, North Carolina. The survey of this property was conducted May 7–9, 1998, by TRC Garrow Associates, Inc., on behalf of Municipal Engineering Services Company. The project was directed by Christopher T. Espenshade, with assistance in the field by Scott McLear.

The survey tract is located in the Appalachian Summit region (Figure 1) of extreme western North Carolina. It is located at the headwaters of Waterville Lake on the south bank of the Pigeon River. The tract is located to the west of the existing landfill, which in turn is north of White Oak Road and west of Lower Fines Creek Road. Lower Fines Creek Road intersects I-40 across the Pigeon River from the east end of the existing landfill site.

The survey included 15 acres that was studied by Brown and Rogers (1990) during their investigation of the 108 acre tract that now contains the Haywood County Landfill (Figure 2). That 15 acre strip, located on the western edge of the existing landfill property, was included in the current survey at the request of the North Carolina Office of State Archaeology. The remaining 60 acres of the study property is located to the west and south of the 15 acre strip (see Figure 2) and had not been previously investigated.

The survey resulted in the identification of five archaeological sites and redefined the boundaries of one previously recorded site. Four of the newly identified sites are prehistoric and the other two date to the historic period. One of the prehistoric sites contained diagnostic artifacts and dated to the Early Archaic period, while both historic sites dated to the early twentieth century. None of the sites are considered eligible for the National Register of Historic Places.

This report is organized in the following manner. Chapter II contains background information on the environment of the area. Chapter III provides background information on the prehistory and history of the area as well as on previous archaeological investigations in the vicinity. Chapter IV discusses the research methods. Chapter V details the results of the research, and Chapter VI contains recommendations concerning the identified cultural resources. Appendix 1 contains copies of state site forms for the 14 identified sites, and the resumes of the Principal Investigator and the report author are provided in Appendix 2.

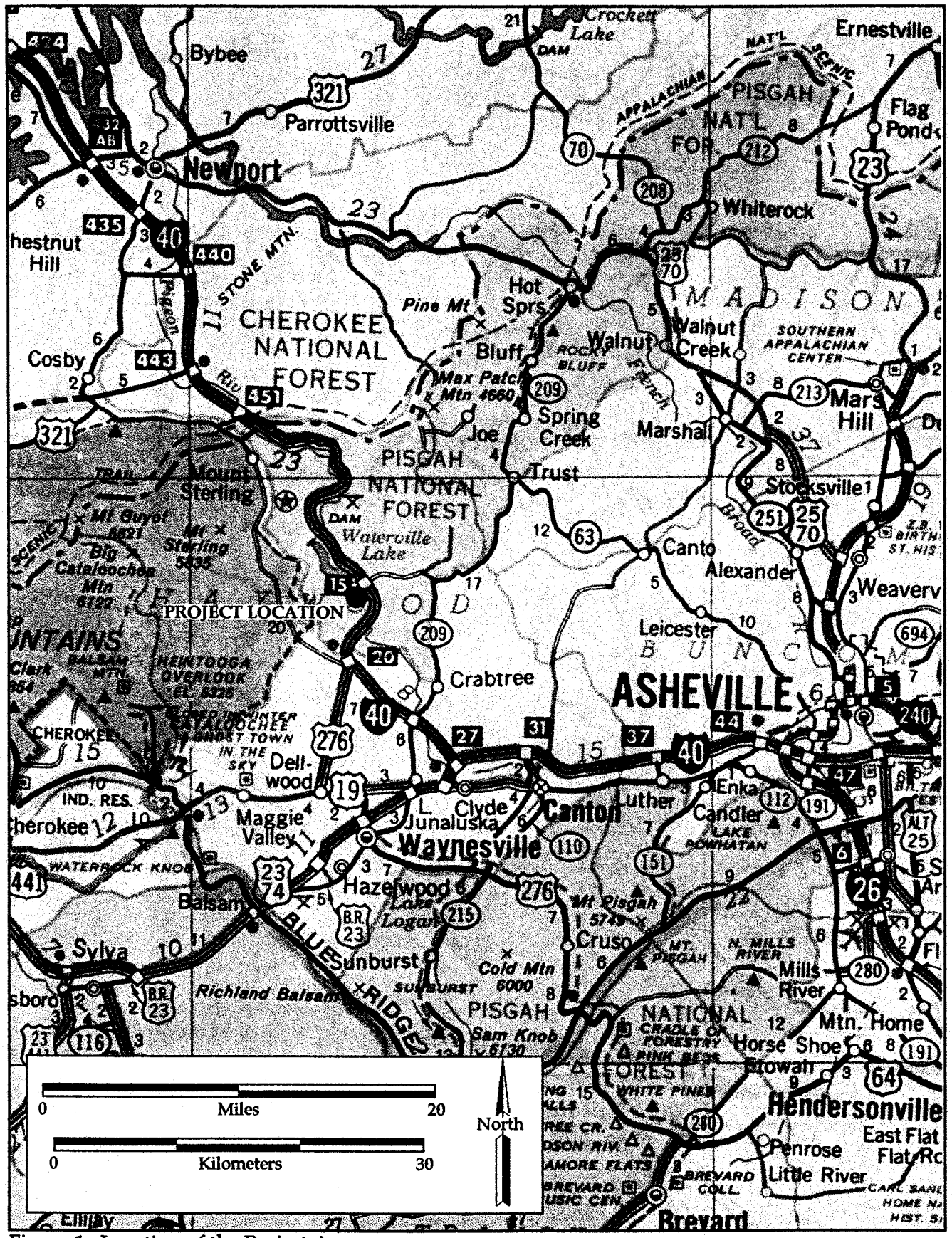

Figure 1. Location of the Project Area.

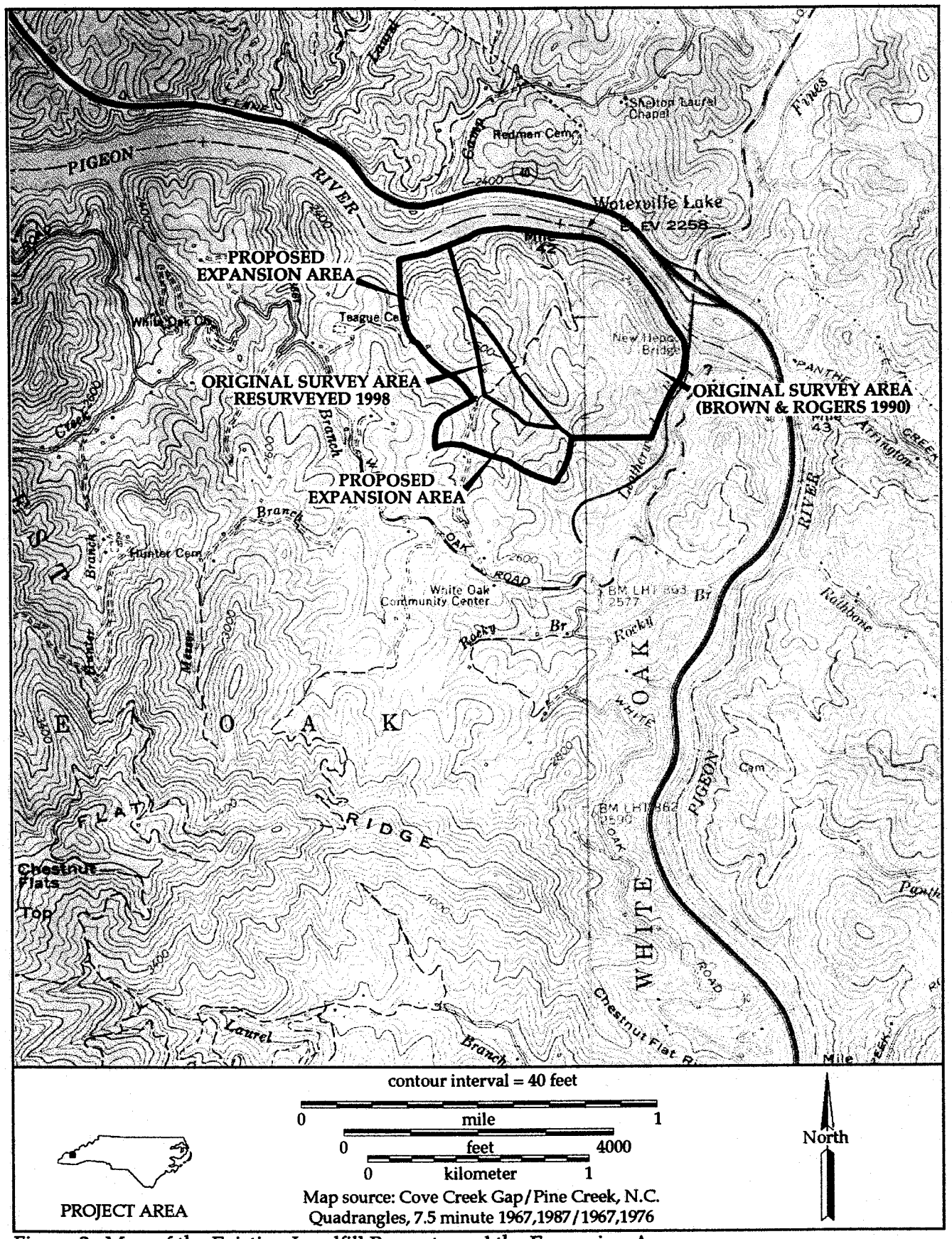

Figure 2. Map of the Existing Landfill Property and the Expansion Area.

II. ENVIRONMENTAL SETTING

PROJECT SETTING

The proposed landfill site is located in western Haywood County, North Carolina, in the headwaters of Waterville Lake on the Pigeon River (see Figure 2). The entire tract is located in the uplands to the south of the Pigeon River. Rocky Branch flows into the Pigeon River to the east of the existing landfill site. An unnamed tributary of the Pigeon drains much of the landfill expansion area. Elevations on the tract range from less than 2,280 feet above mean sea level (AMSL) along the river to over 2,640 feet AMSL in the uplands. The property is covered by a patchwork of forests and fallow fields.

PHYSIOGRAPHY AND HYDROLOGY

Haywood County is located in the Appalachian Summit region of extreme western North Carolina. The county's topography is marked by rugged mountain ranges broken by narrow valleys. The elevations in Haywood County range from 1,400 feet AMSL to 5,000 feet AMSL.

The survey area is located in the Unakas mountain chain, which forms the western boundary of the Appalachian Summit. The eastern boundary is marked by the Blue Ridge chain (Fenneman 1938). The survey area is located between White Oak Mountain to the west and Little Pine Mountain and Hurricane Mountain to the east.

Most of Haywood County (as well as the rest of western North Carolina) is drained by tributaries of the Tennessee River system. The project area is drained by the Pigeon River and its tributaries and is bounded by the river on the north. The Pigeon River flows north into Tennessee, where it joins the Nolichucky and French Broad rivers in the headwaters of Douglas Lake. The combined rivers become the French Broad, which flows generally west to where it joins the Holston River east of Knoxville to form the Tennessee River.

The Pigeon River lies in a deeply entrenched valley that cuts through the Appalachian Summit. The floodplains of the Pigeon, where they exist at all, tend to be extremely narrow. Wide floodplains are present on tributaries such as Fines Creek, to the northeast and east of the study area, but are lacking on the study tract.

GEOLOGY

The entire survey vicinity is underlain by metamorphic rocks. Northwestern Haywood County is underlain by granite gneiss; quartzite, slate, and arkose of the Snowbird Formation; and graywacke sandstone, conglomerate, and slate lumped together as Great Smoky conglomerate. Limestone formations are absent, leaving quartzites and perhaps quartz as local lithic raw materials (Hatcher 1974, as cited in Newkirk et al. 1976:5). Mineral resources suitable for exploitation on any scale are apparently absent in the area.

SOILS

Brown and Rogers (1990:7–8) characterized the soils of the project area (following Goldston et al. 1954) as including Ramsey loam, severely eroded steep phase (30–60 percent slope); Ramsey stony loam, very steep phase (60+ percent slope); Ramsey loam, eroded steep phase

(unspecified slope); Ramsey loam, eroded hilly phase (unspecified slope); Ramsey loam, very steep phase (60+ percent slope); Halewood clay loam, severely eroded steep phase (30–60 percent slopes); Halewood loam, eroded steep phase (30–60 percent slopes); Stony rough land, including Porters and Ramsey materials (30–60 percent slope); Tate silt loam, hilly phase (15–30 percent slope); and rough gullied land, Porters and Ramsey materials (7–30 percent slope). All of the soil types listed by Brown and Rogers are subject to erosion, and severe erosion in most cases. None of the soil types would have been attractive to Native Americans for cultivation and would have had marginal utility for historic cultivation.

CLIMATE

The climate of Haywood County is temperate, characterized by cool, relatively short summers and cool but relatively mild winters. The mean summer temperature in valley settings is 70°F, with winter temperatures averaging 39°F. The climate of the county varies by setting, with higher elevations experiencing lower temperatures year-round (Goldston et al. 1954:6, as cited in Brown and Rogers 1990:4).

FLORA

Prior to Euro-American settlement, Haywood County was covered by a mixed hardwood forest. The trees that composed the hardwood forest varied somewhat with elevation, but doubtless included chestnut, oak, maple, poplar, locusts, hickory, and chinquapin; they were accompanied by a host of understory plants. The virgin forests of the area were lost to logging in the late nineteenth and early twentieth centuries and have been replaced by second- or third-growth hardwoods and pines.

The study property is now nearly surrounded by units of the Pisgah National Forest, which are almost uniformly forested. Small fields that have lain fallow for at least a couple of seasons since they were last cultivated are present in the 75 acres surveyed under the current project.

FAUNA

The upland and floodplain forests in the vicinity would have supported a substantial and diverse fauna. Ecological analysis in the southern portion of the Appalachian Summit indicates that white-tailed deer (*Odocoileus virginianus*) would have inhabited the forests at a rate of about 400 head per 10 square miles (Dorwin 1975), although densities likely varied seasonally and in conjunction with the local topography and vegetation. A variety of other mammalian species were also common, including raccoons and opossums. Black bears (*Ursus americanus*) were present in densities of about 5 per 10 square miles, and elks (*Cervus elaphus*) may have been present during some intervals when human populations were low (Dorwin 1975). Avian species of possible economic importance would have included turkey (*Meleagris gallopavo*) as well as smaller species, and the rivers and streams would have harbored a variety of fish and other freshwater animal resources.

III. CULTURAL BACKGROUND

This chapter summarizes the prehistory and history of the Appalachian Summit region. Much of the cultural sequence for the project area is based on Coe's (1964) pioneering investigations of the prehistoric cultures of North Carolina. The later prehistory of western North Carolina has been refined by a number of researchers, including Dickens (1976), Keel (1976), and various contributors to Mathis and Crow (1983) and Moore (1986). This synthesis draws heavily upon those sources, as well as overviews prepared for previous research in this portion of western North Carolina (Webb et al. 1993).

Information on the historic period Native American occupation of the area was derived from a number of sources, including Cashion (1970), Mooney (1900), McLoughlin et al. (1984), and Riggs (1988). Information on the Euro-American settlement of the area was obtained from a number of regional and local histories, including Farlow et al. (1993) and Allen (1935).

PREHISTORIC CONTEXT

The prehistory of the project area can be divided into four basic time/cultural periods. These periods—Paleoindian, Archaic, Woodland, and Mississippian—relate to both social and technological changes. Several authors (e.g., Dickens 1976:10; Keel 1976:18) divide some or all of these periods into phases, some of which overlap in time and name but vary in precise definition.

Paleoindian Period (ca. 12,000–8000 B.C.)

The Paleoindian period represents the earliest documented human occupation of the Southeast. Key diagnostic artifacts of this period are fluted and unfluted lanceolate projectile points; other typical artifacts include such formal flake tools as endscrapers, gravers, retouched blades, and burins (Gardner 1979). Paleoindian materials have been recovered predominantly from surface sites. For example, almost all of the approximately 405 fluted points found in North Carolina have come from surface contexts (Anderson 1990). As a result, few data are available concerning Paleoindian subsistence or social organization in the region. The hunting of late Pleistocene megafauna, specifically mammoth, mastodon, and other now-extinct species, is inferred based on evidence from other regions, but direct evidence for Paleoindian use of animals of any kind is rare in the Southeast. In addition to big-game hunting, Paleoindian populations probably relied extensively on other animal and plant foods (Meltzer and Smith 1986; Purrington 1983).

Paleoindian populations are believed to have been highly mobile, and settlements are thought to have included small temporary camps and less common base camps that were occupied by loosely organized bands. Paleoindians selected high-quality lithic materials for tools, and many Paleoindian sites are linked to important source areas. The high degree of curation in the tool assemblage (and the low frequency of clearly diagnostic artifacts) causes problems in the recognition of Paleoindian assemblages. Keel (1976:17) suggests that the earlier Clovis phase (pre-9000 B.C.) populations may have been confined to south of an east-west line at the latitude of Asheville because of permafrost to the north. The later Paleoindian phase appears to include Dalton (Goodyear 1982) and perhaps Hardaway (Ward 1983) points and related cultures.

Population density during the Paleoindian period is often thought to have been fairly low, although the presence of large numbers of late Paleoindian sites elsewhere in the South,

coupled with evidence of increasing territoriality, indicates that populations may have increased substantially toward the end of the period (Gunn and Brown 1982). Climate and vegetation were changing rapidly at that time, as the continental ice sheets retreated to the north. Initial Paleoindian groups probably encountered a mixed coniferous forest/parkland vegetational mosaic, which was gradually replaced by northern hardwoods (summarized in Claggett and Cable 1982). The retreat of the glaciers coincided with a marked rise in sea level, which resulted in the flooding of large areas of the Coastal Plain.

Archaic Period (ca. 8000–1000 B.C.)

The Archaic period began with the onset of Holocene, post-glacial climatic conditions in the east and has been subdivided into three subperiods, the Early, Middle, and Late Archaic. Diagnostic projectile points form the primary criteria used to identify and date distinct Archaic period manifestations. As a whole, the Archaic may be seen as a relatively long and successful foraging adaptation, with subsistence based on hunting, fishing, and the collection of wild plant resources. The period is also marked by a general increase in the density and dispersal of archaeological remains. Group size gradually increased during this period, culminating in relatively large populations. By the end of the period, the basic framework for subsequent periods had been established.

Early Archaic (ca. 8000–6000 B.C.) During the Early Archaic, mixed coniferous forests were replaced by mixed hardwood communities dominated by oak, hemlock, beech, and maple (Claggett and Cable 1982:212). A modern faunal assemblage was in place following the extinction of the Pleistocene megafauna. Diagnostic markers of the Early Archaic period in western North Carolina include Palmer and Kirk projectile points of the Corner Notched tradition (ca. 7800–7000 B.C.) and bifurcate-based points such as the St. Albans, LeCroy, and Kanawha types (ca. 7000–6000 B.C.). Low regional population densities, coupled with a continued high degree of group mobility, are inferred for this period, although the nature of both land use patterns and strategies for technological organization remains the subject of discussion (Claggett and Cable 1982). The only temporally diagnostic prehistoric artifacts found during this survey date to this period.

Middle Archaic (ca. 6000–4000 B.C.). During the Middle Archaic, the cool, moist conditions of the early Holocene gave way to the warmer, drier climate of the mid-Holocene Hypsithermal interval. Extensive estuarine marshes and riverine swamps began to emerge in coastal regions as sea level ceased its post-Pleistocene rise at 3000 B.C. The northern hardwoods vegetational matrix present in those regions was replaced by an oak-hickory forest, which was in turn replaced by a southern hardwoods-pine forest characterized by the species occupying the region today (Claggett and Cable 1982:212–216; Delcourt and Delcourt 1983; Delcourt and Delcourt 1985). Subsistence economies became increasingly diversified, and the first use of estuarine shellfish resources and possibly anadromous fish may have begun at this time. Exactly how the Hypsithermal affected the higher altitudes of western North Carolina is unclear. Possibly the general trend toward a warmer, drier climate may have been reversed in such areas due to the nature of local weather patterns (Gunn and Wilson 1993:21–25).

Archaeologically, the transition from the Early Archaic to the Middle Archaic is characterized by the appearance of stemmed rather than notched projectile points and an increased incidence of groundstone tools, including atlatl weights, axes, and grinding implements. The Middle Archaic witnessed the first substantial occupation in the Great Smoky Mountains and adjacent regions (Bass 1977:109). Three subperiods within this period are recognized in Piedmont North Carolina. These are identified by the presence of Stanly Stemmed (ca. 6000–5000 B.C.), Morrow Mountain I and II (ca. 5000–4200 B.C.), and Guilford Lanceolate (ca. 4200–3500 B.C.) projectile points, following the classic Archaic sequence first identified by Coe (1964). Morrow Mountain

sites are frequently encountered in the uplands of western North Carolina (e.g., Purrington 1981a), although the Great Smoky Mountains appear to mark the western extent of the distribution of Guilford points (Bass 1977; Dorwin 1975).

Late Archaic (ca. 4000–1000 B.C.). During the Late Archaic period, population levels appear to have risen markedly. Sites occur in a wide range of environmental zones, although most major settlements are found in riverine or estuarine settings (Bass 1977; Ward 1983; White 1982). The existence of formal residential base camps occupied seasonally or longer is inferred, together with a range of smaller resource exploitation sites such as hunting, fishing, or plant collecting stations (Claggett and Cable 1982; Mathis 1979; Ward 1983). In addition, many sites from this period contain evidence of prepared floors, post molds from structures, and features such as storage pits, all of which indicate a more sedentary lifestyle than is suggested for earlier periods (Simmons and Steen 1987:7). Grinding implements, polished stone tools, and carved soapstone bowls become fairly common, suggesting the increased use of plant resources, and accompanying changes in subsistence strategies and cooking technologies. Although regional evidence is minimal, the first experiments with horticulture probably occurred at this time, with the cultivation of plants such as sunflower (*Helianthus* sp.) and *Chenopodium* (Cowan 1985; Ford 1981; Smith 1989).

The Late Archaic has been divided into a series of subperiods or phases, identified primarily by the presence of diagnostic projectile points. Terminal Middle Archaic/initial Late Archaic occupations (ca. 4200–3500 B.C.) are marked by Guilford Lanceolate (Coe 1964:43–44) points, characterized by long, narrow, thick blades and straight, rounded, or concave bases. Contemporaneous with or slightly later than that type are side-notched and corner-notched stemmed forms, variously described as Halifax in eastern North Carolina (Coe 1964; Oliver 1985) and MALA (which are somewhat larger than the Halifax type) in South Carolina (Sassaman 1985). The distinctive Savannah River Stemmed type, a large, broad-bladed, square-stemmed point, appears ca. 3000 B.C. and lasts to ca. 1500 B.C.

The terminal Archaic/initial Woodland occupation, ca. 1500–500 B.C., is identified with smaller stemmed point forms such as Small Savannah River and Gypsy Stemmed (Oliver 1985). A reduction in the size of these stemmed forms, on the average, is clearly indicated over the course of the Late Archaic/Early Woodland in the region (Oliver 1981, 1985). Soapstone vessels are in use at this time in some areas, and near the end of this interval pottery appears (Sassaman 1993). Stallings Island fiber-tempered ceramics were manufactured as early as 500 B.C. (Anderson et al. 1982; Trinkley 1990). Late Archaic subsistence and settlement strategies, with the addition of pottery, seem to have continued.

Woodland Period (ca. 1000 B.C.–A.D. 1000)

The Woodland period began about 1000 B.C. and continued until the appearance of the Mississippian adaptation around A.D. 1000. Across the Eastern Woodlands the period is marked by the appearance of widespread pottery use, a greatly increased role for horticulture in subsistence economies, and an elaboration of mortuary ceremonialism, including the appearance of burial mounds (Griffin 1967:180).

In the greater Southeast, the Woodland period began with a gradual transition from the Late Archaic. Although this transition period is not well understood, Woodland occupations appear to be marked by increasing sedentariness and improvements in food storage and preparation technologies. Subsistence strategies represent a continuation of earlier hunter-forager ways, but with an increased reliance on the cultivation of native plants (Yarnell and Black 1985). Religious life, as evidenced by increased ceremonialism and the development of burial mounds, seems to have become more complex during the Woodland period. Large triangular projectile points are

diagnostic of the Woodland period. Ceramics became more refined and regional differentiation of wares, particularly with respect to temper, paste, and surface decoration, became evident during the period.

Early Woodland (ca. 1000–400 B.C.). Initial Woodland occupations are thought to reflect a relatively unchanged continuation of preceding Late Archaic lifeways but are characterized by widespread introduction of ceramics. The earliest pottery in the Appalachian Summit region is termed the Swannanoa series. Swannanoa ceramics are usually tempered with sand, grit, or limestone and have fabric-impressed, cord-marked, simple-stamped, or check-stamped surfaces. Subsequent pottery, dating to the Early/Middle Woodland period transition, is assigned to the Pigeon series. Pigeon ceramics are usually grit-tempered, with check-stamped, simple-stamped, complicated-stamped, plain, or brushed surfaces (Keel 1976:256–266).

Site density appears to have increased considerably in some areas during this period, and a settlement pattern characterized by relatively permanent riverine base camps and interior specialized-resource exploitation camps is inferred (Mathis 1979; Ward 1983). But despite these changes, some areas in the Appalachian Summit appear to have continued with the Archaic way of life well into the Woodland period. In the upper Hiwassee Valley of North Carolina, for example, no Early Woodland equivalent appears to have existed (Dorwin 1975).

Middle Woodland (ca. 400 B.C.–A.D. 800). The Middle Woodland period is characterized by an intensification of long-distance trade throughout the Eastern Woodlands. Evidence for direct participation of local groups in the classic Hopewell exchange network remains minimal, although the small amounts of distinctive Hopewell ceramic and lithic artifacts at western North Carolina sites indicates that some trade did occur (Keel 1976:118–122). Horticulture is thought to have become increasingly important, as evidenced at the Harshaw Bottom site, where evidence of cultivation of little barley and maygrass was found (Robinson 1989). Bass (1977:81) reports that 40 percent of the Middle Woodland sites in his sample were located above the valley in coves and on benches, however, indicating that other resources remained important. Numerous large and small sites have been found dating to this period, suggesting periodic aggregation and dispersion, or some kind of settlement dichotomy based on villages or base camps and specialized resource extraction stations.

Diagnostic Middle Woodland artifacts in the Appalachian Summit include Connestee series wares, which are generally thin, sand-tempered wares often decorated with simple-stamped or brushed surfaces. Common vessel forms include conical or footed jars and bowls (Keel 1976:247–255). Connestee ceramics were common at the Harshaw Bottom site, excavated by Robinson (1989), in the Hiwassee Valley, where they were accompanied by smaller numbers of Swift Creek complicated-stamped sherds.

Late Woodland (ca. A.D. 800–1000). The Late Woodland period in much of the Southeast saw the emergence of sedentary village life based on intensive maize (*Zea mays*) horticulture, and the development of complex tribal and chiefdom-level political forms. In the Appalachian Summit, the Late Woodland is all but invisible, raising still unanswered questions about its character there (Moore 1986:74–75). A similar lack of distinctive Late Woodland components has been described in northern Georgia (Rudolph 1991). Part of the problem may be the lack of specific diagnostics useful for unequivocally identifying sites of this period, but it is also possible that the Summit region was only lightly populated during this time.

Mississippian Period (ca. A.D. 1000–1540)

The Mississippian period in the Southeast is marked primarily by the increasing intensification of maize horticulture, the establishment of increasingly hierarchical social structures and

settlement systems, and an increase in ceremonialism expressed architecturally in the construction of flat-topped substructure mounds. Increasing evidence exists that territorial boundaries between chiefdoms were closely maintained during the Mississippian period, although individual chiefdoms rose and fell in cyclical patterns. Studies of relations between native chiefdoms and Spanish expeditions suggest that some type of supra-chiefdom level organization was maintained through a system in which paramount chiefs traveled from fief to fief, displaying royal powers and prerogative and receiving gifts and tribute from subservient chiefdoms (Smith and Hally 1992).

In western North Carolina, the Pisgah phase (ca. A.D. 1000–1450) comprised the early centuries of the Mississippian period (Dickens 1976:13–14). Pisgah series ceramics are generally tempered with sand, or occasionally grit, shell, or steatite. The most common surface treatment is rectilinear complicated stamping, which occurs on over 80 percent of Pisgah sherds from western North Carolina (Dickens 1976:172). Other, less common surface treatments include curvilinear complicated stamping and check stamping. Common vessel forms include conical and globular jars and a variety of bowls. Although maize and other crops were an important source of food, analyses of floral and faunal remains document the persistence of wild resources as a major component of the diet.

The Pisgah phase was followed by the Qualla phase, which represents the final centuries of Native American autonomy in the region. Although elements of the material culture, belief systems, place names, and social structure of the prehistoric societies lingered into the eighteenth century and in some cases to the present day, this period largely reflects the massive changes brought about by the European intrusion into the area. Consequently, this part of the Native American occupation of the region is discussed below as part of the historic background.

HISTORIC CONTEXT

Protohistoric and Early Historic Period Native American Occupation

The first Euro-American intrusion into western North Carolina took place in 1540, when Hernando de Soto's expedition passed through the area. Several different reconstructions of de Soto's route have been proposed, with some scholars (e.g. Swanton 1985:201–202) suggesting that the expedition crossed the Cherokee country by way of the Hiwassee River valley. A more recent reconstruction (Hudson et al. 1984) suggests that de Soto passed to the north of the study property, however, crossing the Blue Ridge at Swannanoa Gap and continuing along the French Broad River into Tennessee. A similar route was apparently followed by the expeditions of Juan Pardo, a later Spanish explorer who traversed much of the same area in 1567–1568 (Hudson 1990:27–46).

Whatever the precise routes of these explorers, it is clear that the ancestral Cherokee's first encounter with Europeans occurred in the mid-sixteenth century. These encounters were to have dramatic effects. The introduction of European diseases to which the native populations had little resistance caused a major reduction in Native American population levels and extensive changes in political organization. Elsewhere in the Southeast, the fragmentation and reformation of political groups resulted in a general decrease in social complexity and the total disappearance of some prehistoric societies (Smith 1987). Although the Cherokee underwent substantial disruption, they managed to retain control of their homeland.

The historic period Cherokee occupation of western North Carolina is known archaeologically as the Qualla phase (ca. A.D. 1450–1838). The material culture of the early Qualla phase largely represents a continuation of the earlier Pisgah phase pattern, although ceramic attributes show influences from the more southern Lamar style (Dickens 1976:84). Qualla ceramics are generally

grit-tempered. The most common surface treatment is curvilinear complicated stamping, although plain, burnished, check-stamped, cord-marked, and corncob ceramics were also present. Common vessel forms included carinated bowls, small bowls, and jars. The late Qualla phase (ca. A.D. 1650–1838) is marked by the increasing appearance of European goods, including ceramics, at Cherokee sites, as well as shifts towards more European-style architecture. The Qualla subsistence base was mixed and included cultivation of maize, beans, and other foods as well as wild plant gathering, hunting, and fishing (Dickens 1976:14–15).

The Garden Creek sites, located on a 100 acre tract two miles upstream from Canton on the Pigeon River in Haywood County, demonstrated the transition from Pisgah to Qualla to Historic Cherokee. That cluster of five sites also proved critical to explicating the Woodland sequence of the Appalachian Summit (Keel 1976:65–158).

During most of the eighteenth century, the Cherokee were concentrated in towns and villages scattered throughout much of present-day western North Carolina, eastern Tennessee, and portions of Georgia and South Carolina. The towns in the general project region were known as the Valley Towns. The Middle Towns were located to the east, the Lower Towns to the southeast, and the Overhill Towns to the west, across the mountains in present-day Tennessee (Smith 1979). Although the late eighteenth century witnessed by a general shift to a more dispersed settlement pattern (Dickens 1976:15), some nucleated settlements remained in the region into the nineteenth century.

The eighteenth century was marked by the continuous arrival of Europeans and the resulting loss of Cherokee lands. With the signing of the Treaty of Hopewell in 1785, the Cherokee lost their remaining lands east of the Blue Ridge (Mooney 1900:61–62). A subsequent treaty in 1791 resulted in additional cessions, but failed to stop Euro-American incursions into Cherokee territory and the resulting conflicts (Mooney 1900:68–77). Treaties signed in 1798, 1817, and 1819 ceded still more land to the U.S. government. After the 1819 treaty, the Cherokee retained only a restricted area in extreme southwest North Carolina, southeast Tennessee, northwest Georgia, and northeast Alabama. The present project area lies at the extreme north of those lands.

The project area apparently lacked Cherokee settlements by 1776, when the Rutherford expedition followed a trail along the Pigeon River through Haywood County and into Tennessee. Haywood County was opened to settlement by treaties negotiated between 1783 and 1798, and many of the early settlers received land grants as Revolutionary War veterans (Farlow et al. 1993:9).

The early nineteenth century witnessed the increasing acculturation of many of the Cherokee due to increased contact and intermarriage with white traders and settlers. Many Cherokee resisted changes to their traditional lifestyles, however. Most accounts by contemporary observers, as well as data from the 1835 Cherokee census, indicate that the Cherokee population of western North Carolina was strongly traditionalist and contained the highest proportion of full-bloods to be found in the nation (McLoughlin and Cosner 1984:224–225).

The Treaty of New Echota, which was signed in 1835, set in motion the forced removal of most of the remaining Cherokee to lands in present-day Oklahoma (Mooney 1900:123–133). The cruelty of this march, known as the "Trail of Tears," has been well-documented. Prior to the removal the Cherokee were gathered at a number of stockades or forts (Cashion 1970).

Despite the Treaty of New Echota, some Cherokee remained in their former lands. Some 1,000 Cherokee living along the Oconaluftee River remained in North Carolina, having become citizens of the state. Others in the town of Cheoah also were allowed to remain in the East. These groups became the nucleus of the Eastern Band of Cherokee (King 1979). Since the removal period they have resided primarily in the area of the present-day Qualla Reservation,

to the southwest of the project area, although small outlying populations have resided elsewhere in the region.

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Euro-American Settlement

The early settlers of the Haywood County were mainly Scotch-Irish and English, with smaller numbers of Germans and others. The main migration came south from Pennsylvania through North Carolina or west from South Carolina, although some settlers moved east from Tennessee and Kentucky (Farlow et al. 1993:10).

Haywood County, named after John Haywood, the State Treasurer of North Carolina, was established by an act of the North Carolina legislature in 1808. Robert Love, a prominent citizen, was instrumental in the formation of the county, as well as in selecting the name Waynesville for the county seat. Waynesville was named for Revolutionary War general "Mad" Anthony Wayne. Waynesville soon boasted a courthouse, jail, and three taverns, and by 1810 also had 21 distilleries that produced 4,300 gallons of liquor. The production of liquor in such large quantities appears to have been in response to the poor transportation systems of the day, and allowed farmers to turn grain into cash crops for sale outside the area (Farlow et al. 1993:11–12).

The settlers of the western, mountainous part of Haywood County were small subsistence farmers. Farlow et al. (1993:11) described those settlers in the following manner:

> In the coves distant from Waynesville, the requirements of county of precinct government would be nominally honored. However, families that had arrived with little more than they could carry, and who could buy little or no land, preferred to live off the land without interference from "organized" society. They helped their neighbors and responded to government's call on occasion, but mostly they worked their small acreage, developed their stock, and hunted and fished to supplement their food supply. As long as wood was plentiful and the land was fertile, hogs and other livestock could be marked and allowed to roam free. Mast (nuts of all kinds), particularly from the chestnut trees, was plentiful; a family could not only survive but begin to get ahead in such circumstances.

The earliest known settlers in the vicinity of the study tract took land along what was then Twelve Mile and is now Fine Creek. David Russell acquired large tracts there by 1796, as did Hughey Rogers. John Penland and John Ray expanded their holding to include Fines Creek soon after, and the four owned most of what is now Fines Creek Township during that early period (Allen 1935:37).

Haywood County included all of what is now southwestern North Carolina until 1828. Macon County was split out in 1828, which was subsequently subdivided to create Cherokee County in 1839 and Swain County in 1871. Cherokee County was further subdivided into Clay County in 1861 and Graham County in 1872. Jackson County was created by lands taken from Macon and Haywood counties in 1851, and in turn provided the lands for Transylvania County in 1861 and Swain County in 1871 (Farlow et al. 1993:12).

Haywood County had only 313 slaves in 1860, owned by 63 slave owners. Only seven planters had more than 10 slaves, and nearly half only had one or two. Haywood County provided 1,000 soldiers for the Confederate Army, of whom 20 percent died from disease or wounds. There was only one military action in the county during the war, when Col. Kirk's raiders burned the county jail and the home of Col. Love, a Confederate officer, in 1865. The war clearly caused financial hardships for some in Haywood County, but was probably felt somewhat less by the subsistence farmers in the mountainous parts of the county (Farlow et al. 1993:12–13).

The township system was created in the county after the war to replace the antebellum voting precincts. Fines Creek and Jonathan Creek townships were created in the vicinity of the project area in 1877, and Jonathan Creek was subdivided to create White Oak in 1895 (Farlow et al. 1993:13).

The most significant event of the immediate postbellum period was the arrival of the railroad. The Western North Carolina Railroad was extended west to Asheville in 1880 and reached Waynesville by 1884. The impact of the railroad can be measured by the fact that the grateful citizens of Haywood County changed the name of Canton to Buford after the president of the railroad, and Lower Pigeon to Clyde after the chief engineer. Buford was eventually changed back to Canton, but the name Clyde has continued to be used to this day. The railroad network was extended in the 1890s, and the local lines became part of the Southern Railway Company. The growth of the railroad gave the citizens of the county a market for their products and opened the region to tourists, who still account for much of the annual income in the region (Farlow et al. 1993:14).

Timbering became the leading industry in Haywood County by the 1890s. Tanning and furniture industries became important in the area at that time. The Champion Coated Paper Company organized the Champion Fibre Company in 1905, and built a plant in Canton between 1905 and 1908. The Champion plant grew and has dominated the economy of Canton and Haywood County throughout the twentieth century (Farlow et al. 1993:16).

Telephone and electrical services developed slowly in Haywood County during the early twentieth century. The White Sulphur Springs Hotel had limited phone service by 1894. That service was gradually expanded to form the Waynesville Telephone Company, which had two long distance lines by 1908. The Waynesville Telephone Company was bought by the Asheville telephone Company in 1916 and was acquired by Southern Bell in 1923 (Farlow et al. 1993:15).

Electrical service began in Waynesville in 1900 with public lighting powered by batteries. The Killian's Woolen Mill generated electricity for its machinery through a combination of steam and water power soon after that time and sold the excess to Waynesville and the White Sulphur Springs Hotel. A power plant was then constructed on the Pigeon River for the newly formed Haywood Electric Power Company, which was sold to Carolina Power and Light Company in 1929 when they finished the Walters Dam to create Waltersville Lake on the Pigeon (Farlow et al. 1993:15).

The Great Depression had a devastating effect on the developing economy of Haywood County. The Great Smoky Mountains Park was authorized by Congress in 1924, but acquisition of the lands for the park did not begin until 1930. The park was established by 1935 through funding by the state governments of North Carolina and Tennessee and significant private contributions. President Roosevelt dedicated the park at a ceremony at Newfound Gap in 1940. The creation of the park and the acquisition of other lands by the National Forest Service displaced many Haywood County citizens from their homes and removed a major percentage of the land in the county from the tax roles. The positive effects of the park have outweighed the negatives, however, as it became the cornerstone for the vital tourist industry that continues to generate many jobs and significant tax revenue (Farlow et al. 1993:15, 17–18).

The lands immediately surrounding the project area are in private hands, but most of northern Haywood County is in the Pisgah National Forest. The community of White Oak still survives, and homes are scattered along White Oak Road and Fines Creek Road. Allen (1935:193) described White Oak in 1931 in the following manner:

> White Oak is in the northern part of the county on the left bank of the Pigeon River. It was erected as a township in 1895 from Jonathan. In 1900 it had a population of 345, and in 1930, its population was 300. The taxable valuation of all property was $142,702.
>
> The principal farm products are corn, wheat, and tobacco. In the lower section of the township, there is considerable activity in cattle raising.
>
> Lower White Oak, in 1926, was put into the Fines Creek Special School Taxing District, thus giving the pupils of that part of the county access to one of the county's five standard high schools. A small one teacher school is maintained on the White Oak side of the river for the benefit of the primary children. Children in the upper part of the township are now [1931] transported to Rock Hill to school.

Interstate 40 was built adjacent to the project area in 1968, linking Asheville to Knoxville and ending the isolation of White Oak from the outside world. The economy of Haywood County has continued to diversify up to the 1990s, and is currently based on a foundation of industry and tourism (Farlow et al. 1993:19–20).

PREVIOUS ARCHAEOLOGICAL RESEARCH

Archaeological research has been conducted in western North Carolina for over a century, and most trends in the history of North American archaeology are reflected in work in the region. This section traces the history of the regional research, with special emphasis on the work in the immediate project vicinity and the rest of Haywood County.

As early as the 1880s, workers from the Valentine Museum in Richmond, Virginia, investigated several mound sites in the region, including the Peachtree Mound, located in Cherokee County on the Hiwassee River upstream of Murphy, and the Garden Creek Mound Number 2, located near Canton in Haywood County (Dickens 1976:7; Keel 1976:71–74; Thomas 1891:153). The museum's work was primarily oriented to recovering artifacts, although in some cases their observations have been useful in addressing present-day research questions (e.g., Dickens 1976:91).

Also in the 1880s, researchers from the Smithsonian Institution's Bureau of Ethnology excavated sites in Buncombe and Henderson counties as part of their investigations into the origin of the Mound Builders (Thomas 1894). That research was instrumental in demonstrating that the mounds in western North Carolina and elsewhere had in fact been built by ancestors of the Native Americans, and were not the products of a mysterious, vanished race.

Early twentieth century work in western North Carolina continued to focus on mound explorations. Between 1915 and 1919, George Heye and associates excavated at the Garden Creek site in Haywood County as well as others in the Cherokee area (Harrington 1922; Heye 1919; Heye et al. 1918). Although this work was designed to gather artifacts for Heye's Museum of the American Indian in New York, it did provide some data on the antiquity of the Cherokee in the region (Dickens 1976:7–8). Subsequent work in 1933–1934 by the Smithsonian at the Peachtree Mound and Village on the Hiwassee River in Cherokee County was also designed to investigate the relationship between the Cherokee and prehistoric cultures in the area (Setzler and Jennings 1941).

The 1940s and 1950s witnessed relatively little research in the Appalachian Summit region. Plans to excavate sites in the area using Works Project Administration (WPA) crews, as had been done elsewhere in the Southeast, were terminated with the outbreak of World War II. Intensive, systematic work in the Appalachian Summit region did not begin until 1964, when the University of North Carolina instituted the Cherokee Archaeological Project. This project lasted until 1971 and included large-scale surveys as well as excavations of late prehistoric and historic Cherokee sites (Purrington 1983:98–99). Data from this project have been reported in several theses, dissertations, and other publications (e.g., Dickens 1976; Egloff 1967; Keel 1976) and provide much of the background information on the Appalachian Summit region.

Beginning in the 1970s, the establishment of federal cultural resources legislation and management procedures resulted in an increasing number of archaeological projects in the Haywood County area. Many of those projects (e.g., Purrington 1981b; Snedeker 1989; Webb 1990) were surveys on National Forest lands in the uplands.

One previous archaeological survey has been conducted in the vicinity of the project area. That project, reported by Brown and Rogers in 1990, investigated the existing landfill prior to construction, and included coverage of a strip approximately 15 acres in extent that was resurveyed during the current project. They employed a combination of pedestrian survey, rake backs, and shovel tests to cover the property, and surveyed along north-south transects placed 20–30 m apart. The Brown and Rogers study covered approximately 108 acres and identified two archaeological sites (Brown and Rogers 1990: 17–19).

Site 31HW286* (Project Site 89-007-1) was found on the western side of the 1990 study area, within the approximately 15 acre strip resurveyed during the current investigation. That site was described as follows:

> This site is located in the area of a cleared tobacco field. The field is westward sloping and lies on the south side of a knoll upon which a large barn currently stands. The field is approximately bisected in a north-south direction by a graded roadway to the barn. In the portion of the field above the barn a single fragment of brown glazed stoneware and part of a quartz PPK were recovered. Subsurface tests in this upper field were sterile. The estimated site size is 2840 sq. m.
>
> Surface finds in the lower field consisted of part of a chert PPk, part of a quartz PPK, three small chert flakes, two chalcedony fragments, two eroded fragments of grit tempered aboriginal ceramics, one eroded fragment of limestone tempered aboriginal ceramic, one fragment of whiteware, and fragments of clear glass, blue glass, and milk glass.
>
> Shovel tests around the perimeter of the barn were negative. Shovel tests were attempted in the dirt floor of the barn, but the soil was too compacted. The structural elements of the barn were hewn, but specific dating based on these or other elements could not be made. The barn is believed to be associated with an abandoned house located approximately 150 m west and outside the study area.
>
> The site does not appear to be eligible for National Register status, and no further work is recommended. [Brown and Rogers 1990]

Site 31HW286** (Project Site 89-007-2), which was identified on the northern portion of their study tract, was described as follows:

> The remains of a structure are located on the east side of the conjunction of a small drainage and larger stream. Only a portion of the floor of the structure remains; the roof

trusses rest on the ground beside the structure. Floor joists only are present for part of the floor. Some of these have been burned, but the fire appears to have been peripheral to the structure. The remaining solid flooring consists of random width planks; some are up to 18 inches wide, and all are fully 1 in thick. The sills are hewn and rest on log piers. Both galvanized wire nails and cut nails were present. No evidence of the location of the chimney was observed.

Modern trash was scattered about near the structural remains. Subsurface testing revealed recent artifacts such as clear window glass; a piece of tire tread; various fragments of plastics, including a child's toy and phonograph record; pieces of cloth fabric, including women's hosiery; leather pieces, including shoe soles; metal fragments, including nails, hooks, part of a zipper, wire, and unidentified pieces; various ceramics of recent origin. There was room west of the structure for only one shovel test before encountering the stream. The test was negative. Two shovel tests north of the structure were positive; one test east of the structure was positive. Two tests south of the structure were negative.

Approximately 60 ft north of these structural remains a rock pile was noted. The base of the rock pile appeared to be intentionally stacked, while the top of it was a random distribution of rocks and brick fragments. Some of the rocks appear to have been exposed to fire. It is felt that the rockpile is associated with the structure and may represent the clearing of the chimney fall from it. The site size, then, is approximately 1441 sq. ft. Subsurface tests in this area were sterile. On the surface and in the adjacent stream whiteware, transfer ware, and a fragment of hand-painted ceramic were recovered, along with both clear and brown glass bottle and jar fragments; a marble, white, green, and blue milk glass, and some brick fragments. None of the artifacts is especially sensitive temporally. The hand-painted ware was manufactured by the Blue Ridge pottery, which places it from the 1930s to the present. All other artifacts are indicative of very recent origin. It appears, therefore, that the house was occupied over time, but perhaps only transiently. No evidence of cultivation was apparent nearby, and it seems likely, in the view of the area's history of cattle-raising, that the house was for the tenant caretaker of the livestock.

These structural remains do not appear eligible for inclusion on the National Register of Historic Places, and no further archaeological work is recommended. [Brown and Rogers 1990:17–19]

IV. RESEARCH DESIGN AND METHODS

The primary goal of the survey was to systematically gather data on cultural resources present in the survey tract. In addition, the field data were combined with information obtained in the background research to address research questions concerning the nature of the prehistoric and historic period occupation of the area. This chapter provides information on the research questions addressed by the project as well as the research methods employed.

RESEARCH DESIGN

The research questions addressed in this study were based on general questions outlined by Claggett (1985:36–37) as those that should be minimally investigated during survey studies, but were tailored to the specific regional concerns. These questions include the following:

> What are the known and predictable archaeological site densities for the study area? How do the site densities encountered compare with those identified by Brown and Rogers (1990) on the adjacent tract?
>
> Are there recognizable patterns to the distribution of sites in the study area? How does the distribution of sites compare with those noted by other projects?
>
> What cultural and natural factors have affected site preservation on the survey tract? Do modern environmental factors of topography or soils serve as adequate predictors of prehistoric site selection?

RESEARCH METHODS

Specific research methods were utilized for the background studies, field research, and analysis and reporting stages of the project. The methods used in each stage of research are outlined below.

Background Research

Background data on the environment, prehistory, and history of the tract and region, as well as on other archaeological investigations in the area, were obtained from previously published environmental, archaeological, and historical studies. Agencies and repositories contacted for relevant data included the North Carolina Office of State Archaeology, the North Carolina State Archives, and the TRC libraries in Atlanta and Chapel Hill.

Field Investigations

The field survey was conducted by a crew of two, consisting of the Principal Investigator and a field assistant. As specified in the proposal, the fieldwork included the intensive survey of all portions of the tract that possessed slopes of less than 10° that did not exhibit evidence of extensive prior disturbance. The fieldwork included a combination of surface survey and subsurface shovel testing. The surface survey consisted of visual inspection of areas exhibiting less than 25 percent ground cover and lacking indications of alluvial or colluvial soil deposition. Surface inspection was useful in the scattered fallow fields across the tract. Shovel testing was

restricted to landforms 10 x 10 m or larger that exhibited less than 10° slope and less than 25 percent ground surface visibility.

Most of the survey tract was inspected using pedestrian survey. Each shovel test was excavated through the A horizon (if present) and at least 5–10 cm into the subsoil.

Each shovel test was assigned a sequential number, and the walls and bottom of each shovel test were inspected for artifacts, features, and other indications of an archaeological site. The soil removed was screened through 1/4 inch mesh hardware cloth to insure uniform and thorough artifact recovery. Each shovel test was described by depth, stratigraphy, artifact recovery, soil texture, and Munsell color on shovel test forms. Any artifacts recovered were placed in a labeled Zip-Loc plastic bag.

When evidence of an archaeological site was encountered, a series of steps were followed to insure uniform site recordation. In those instances in which the ground surface visibility was above 25 percent, surface inspection was used to determine the surface limits of the artifact distribution. One or more shovel tests were then excavated to gather information on artifact density and site stratigraphy. In locations where surface visibility was less than 25 percent, shovel tests were excavated across the site area at 10–30 m intervals in order to identify the site boundaries and gather data on density and stratigraphy.

A detailed sketch map of each site was made, showing the location of all shovel tests in relation to structural or other cultural features as well as features of the natural environment. Black and white prints and color slides of each site were taken, and a variety of observations were recorded in the field notebook.

Artifact Analysis

Following the fieldwork, all artifacts were returned to TRC's Atlanta facility for cleaning and analysis. Initially, the artifacts were washed and dried so that they could be further processed and analyzed. The artifacts then were classified and cataloged, and the collection from each site was analyzed to determine the prehistoric or historic components present and the range of raw materials and activities represented. The vertical and horizontal distributions of the artifacts from each site were studied so that the nature and extent of the site could be better understood. State site numbers for each site were obtained from the Office of State Archaeology, and a North Carolina State Archaeological Site Form was completed for each site identified by the survey.

Curation

No curation facility has yet been designated for the artifacts and records generated by the project. Following completion of the research, a facility will be chosen in consultation with the client and the Office of State Archaeology.

V. RESULTS OF INVESTIGATIONS

This chapter presents the results of the intensive archaeological survey and associated research. An initial section presents the results of the field survey and contains data on all archaeological sites located. Subsequent sections draw on the fieldwork and the background research to address the research questions outlined in Chapter IV.

ARCHAEOLOGICAL SITES IDENTIFIED

The intensive archaeological survey of the proposed exchange tract located five archaeological sites: four prehistoric sites and one historic site. One additional historic site that was first identified and described by Brown and Rogers (1990:17–19) was resurveyed. The location of each site is shown in Figure 3, and specific information on the sites is provided in the following site descriptions. Summary recommendations concerning the potential eligibility of the sites for the National Register are provided in the site descriptions, and more detailed comments concerning site eligibility and the potential for future research are given in Chapter VI of this report.

The site descriptions are presented into two groups, by component. The four Native American sites are described first, followed by the two historic sites.

31HW455

Components:	Unknown prehistoric
Area:	ca. 100 m^2
Landform:	Upland ridge
Elevation:	2,668 feet
Slope:	0 percent

This Native American site is located on a very small knoll top in the central area of the expansion property (Figures 3 and 4). The closest water source appears to be an unnamed tributary of the Pigeon River approximately 305 m to the west. The Pigeon River is approximately 425 m north of the site. The terrain drops off steeply in all directions from the small knoll top that contains 31HW455. The surrounding area is vegetated with mixed hardwoods, but an area cleared to access a geotechnical test station provided 100 percent ground surface visibility on portions of the top of the knoll.

The artifacts that defined this site consisted of a flake fragment of Ridge and Valley chert and a piece of quartz shatter. Both artifacts were recovered from the surface. Shovel Test 26 was placed north of the disturbed portion of the knoll top (see Figure 4) and revealed subsoil at 15 cm. The shovel test was sterile.

Site 31HW455 is an ephemeral site that has been disturbed by erosion and by use of the knoll top as a geotechnical test site. The artifacts that were found were probably dropped there by hunters in some unknown prehistoric period who were simply refitting or making tools while taking advantage of the knoll top's excellent view of the surrounding area. Site 31HW455 clearly does not have the potential to yield significant data upon additional investigation, and is recommended as ineligible for listing on the National Register of Historic Places.

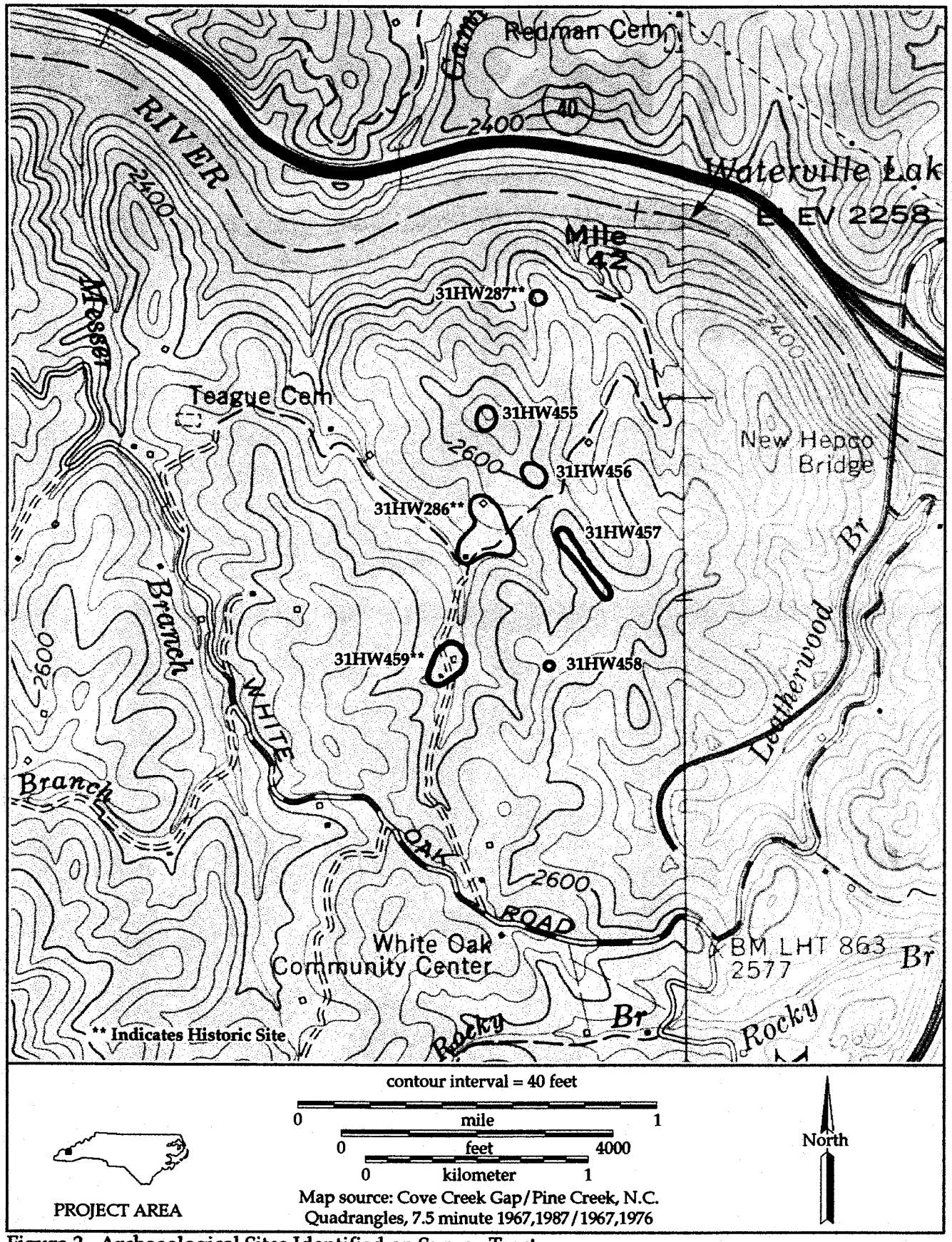

Figure 3. Archaeological Sites Identified on Survey Tract.

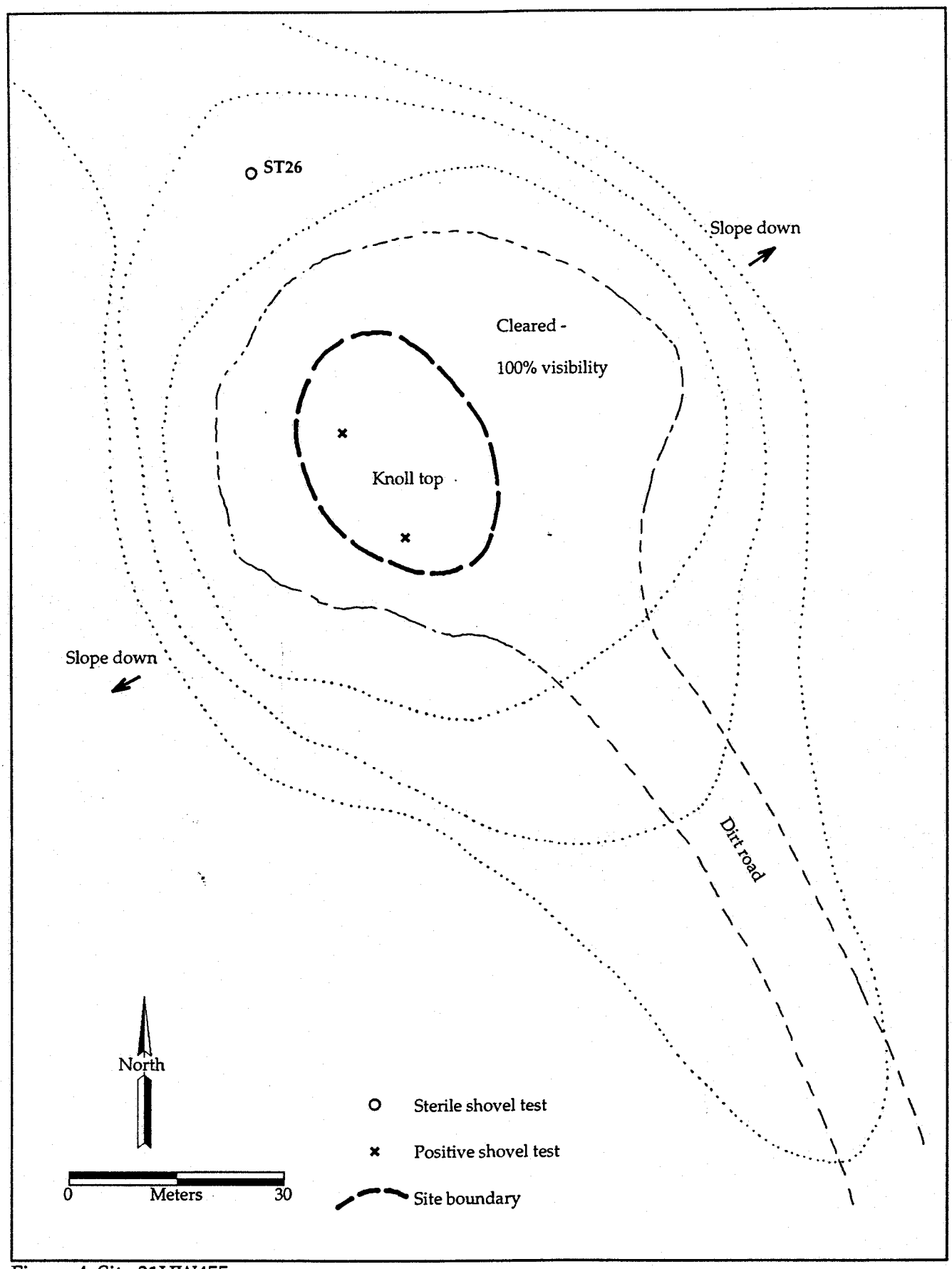

Figure 4. Site 31HW455.

31HW456

Components:	Unknown prehistoric
Area:	ca. 700 m^2
Landform:	Upland ridge
Elevation:	2,598–2,616 feet
Slope:	ca. 20 percent

This prehistoric site is situated in the central part of the survey tract on an upland ridge trending southeast-northwest (see Figure 3). The closest apparent water supply is an unnamed tributary of the Pigeon River approximately 300 m to the west. A gully that provides wet weather drainage is located approximately 70 m to the east. The Pigeon River is over 560 m to the north.

This site is located on fairly steep terrain (ca. 20 percent slope). Ground surface exposure was provided by a dirt road that extends through the long axis (north to north-northwest) of the site (Figure 5). A second dirt road runs roughly east-west to the south of the site. The site is, with the exception of the road, covered by a hardwood forest.

All of the artifacts found on this site were recovered from the surface. Those artifacts include a nondiagnostic biface fragment of quartz, two unspecialized flakes of orthoquartzite, and one flake fragment of orthoquartzite. Three shovel tests placed north and south of the proposed site limits were sterile and demonstrated that only 3–5 cm of topsoil remained over subsoil in that area.

This ephemeral upland artifact scatter has been severely impacted by erosion and other disturbances. There is little chance that it contains intact artifact concentrations or features, and it is unlikely that it can yield substantial additional data concerning the prehistoric occupation of the area. Consequently, we recommend 31HW456 as ineligible for the National Register of Historic Places.

31HW457

Components:	Early Archaic
Area:	ca. 2,675 m^2
Landform:	Upland ridge
Elevation:	2,616–2,624 feet
Slope:	0–15 percent

This long (146 m), narrow (18 m) prehistoric site is situated in the central part of the survey tract on an upland ridge trending southeast-northwest (see Figure 3). The site was originally thought to consist of two discrete sites, but closer investigation revealed that a light surface scatter extended over the entire landform. The closest apparent water source is an unnamed tributary of the Pigeon River approximately 425 m to the west. The Pigeon River is located approximately 730 m to the north.

The site is located on a gently to moderately sloping ridge top. Ground surface exposure was provided by a freshly cut dirt road that runs through the center of the site on its long axis. (Figures 6 and 7). The site outside the boundaries of the road is covered by a hardwood forest.

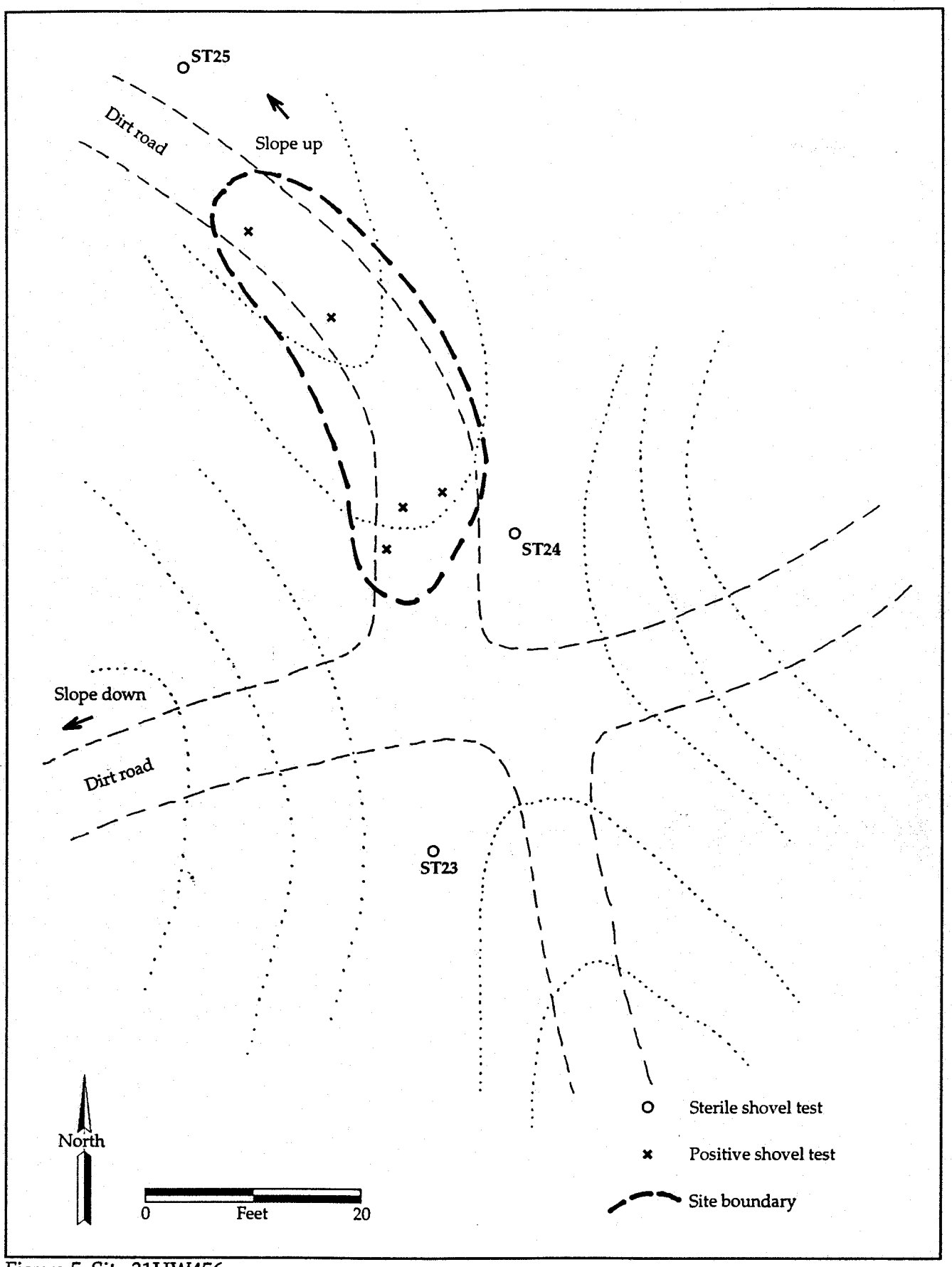

Figure 5. Site 31HW456.

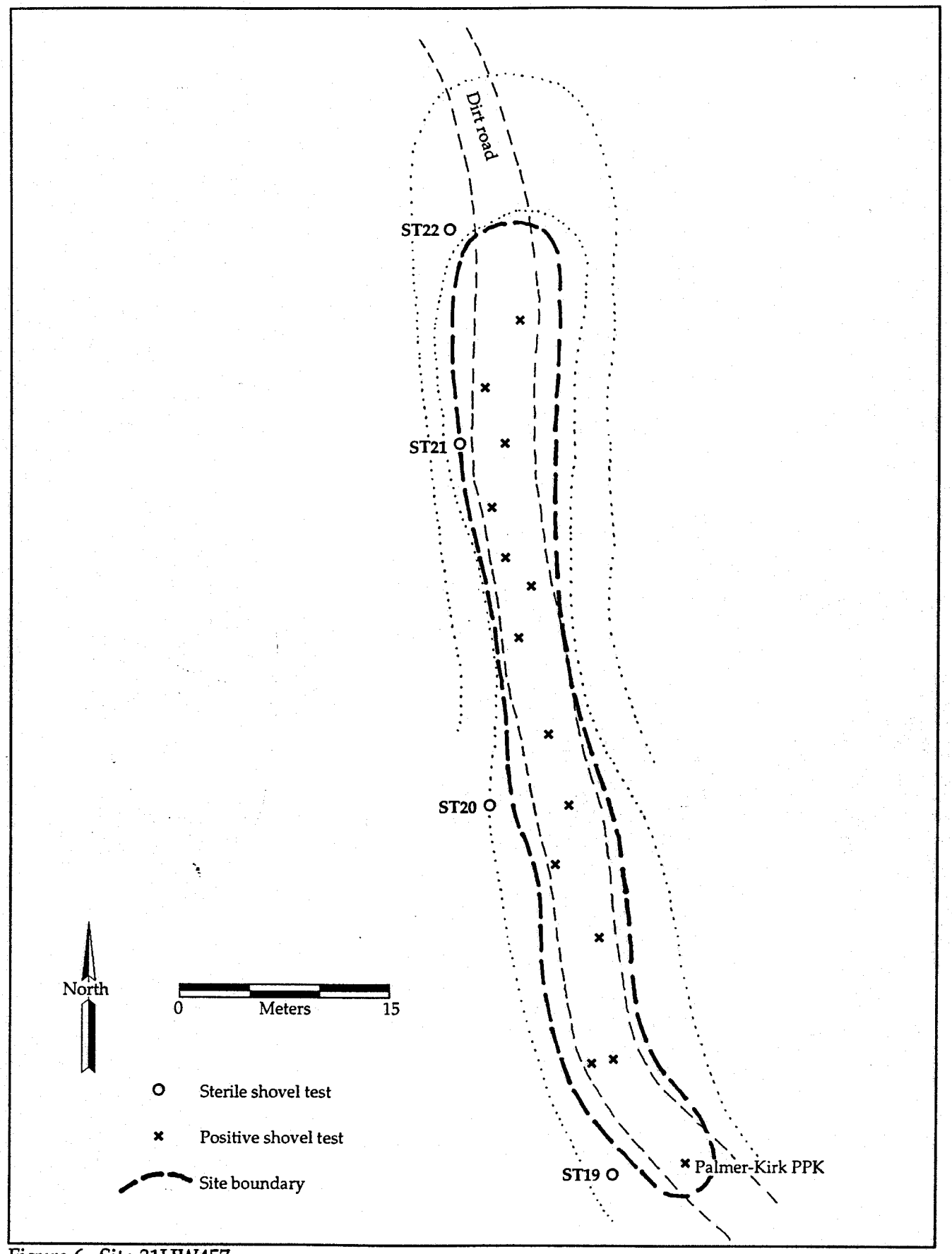

Figure 6. Site 31HW457.

Figure 7. Site 31HW457, View to the North.

All of the artifacts recovered from 31HW457 were found on the surface (Table 1). Two diagnostic artifacts were collected from this site; both are Palmer/Kirk projectile points, one complete and one fragmentary, made of Ridge and Valley chert.

Four shovel tests (STs 19–22) were placed adjacent to the road that runs through the site. All for shovel tests were sterile. The depth to subsoil in those tests was 5–6 cm.

Table 1. Artifacts from Site 31HW457.

Quantity	Description	Raw Material
1	Palmer/Kirk PPK	Ridge & Valley chert
1	Palmer/Kirk PPK fragment	Ridge & Valley chert
2	Unspecialized flake	quartz
2	Unspecialized flake	orthoquartzite
8	Flake fragment	orthoquartzite
6	Flake fragment	quartz
1	Thinning flake	Ridge & Valley chert
1	Thinning flake	quartz
3	Thinning flake	orthoquartzite
4	Shatter	quartz
1	Shatter	orthoquartzite
1	Unidentified white body ceramic	NA
31		

This upland artifact scatter has been severely impacted by erosion and other disturbances. Although a number of artifacts were recovered from the surface, there is little chance that it contains intact artifact concentrations or features. It is unlikely that site 31HW457 can provide substantial additional data concerning the prehistoric occupation of the area, and we recommend that it be determined ineligible for the National Register of Historic Places.

31HW458

Component: Unknown prehistoric
Area: ca. 1 m^2
Landform: Upland ridge
Elevation: 2,650 feet
Slope: 0 percent

This prehistoric isolated find is situated on the western flank of a very narrow knoll top (see Figure 3). The knoll has been altered by construction of a road, and 80 percent surface visibility was available. The area around the disturbances is under a hardwood forest canopy.

One unspecialized quartz flake was recovered from the surface (Figure 8). Shovel Test 18 was placed near the center of the knoll top and revealed 5 cm of topsoil over subsoil. The shovel test was sterile.

This site is represented by an isolated prehistoric artifact in an eroded upland setting. There is little chance that intact artifact concentrations or features are present or that the site can provide substantial additional data concerning the prehistoric occupation of the area. Consequently, we recommend 31HW458 be determined ineligible for the National Register of Historic Places.

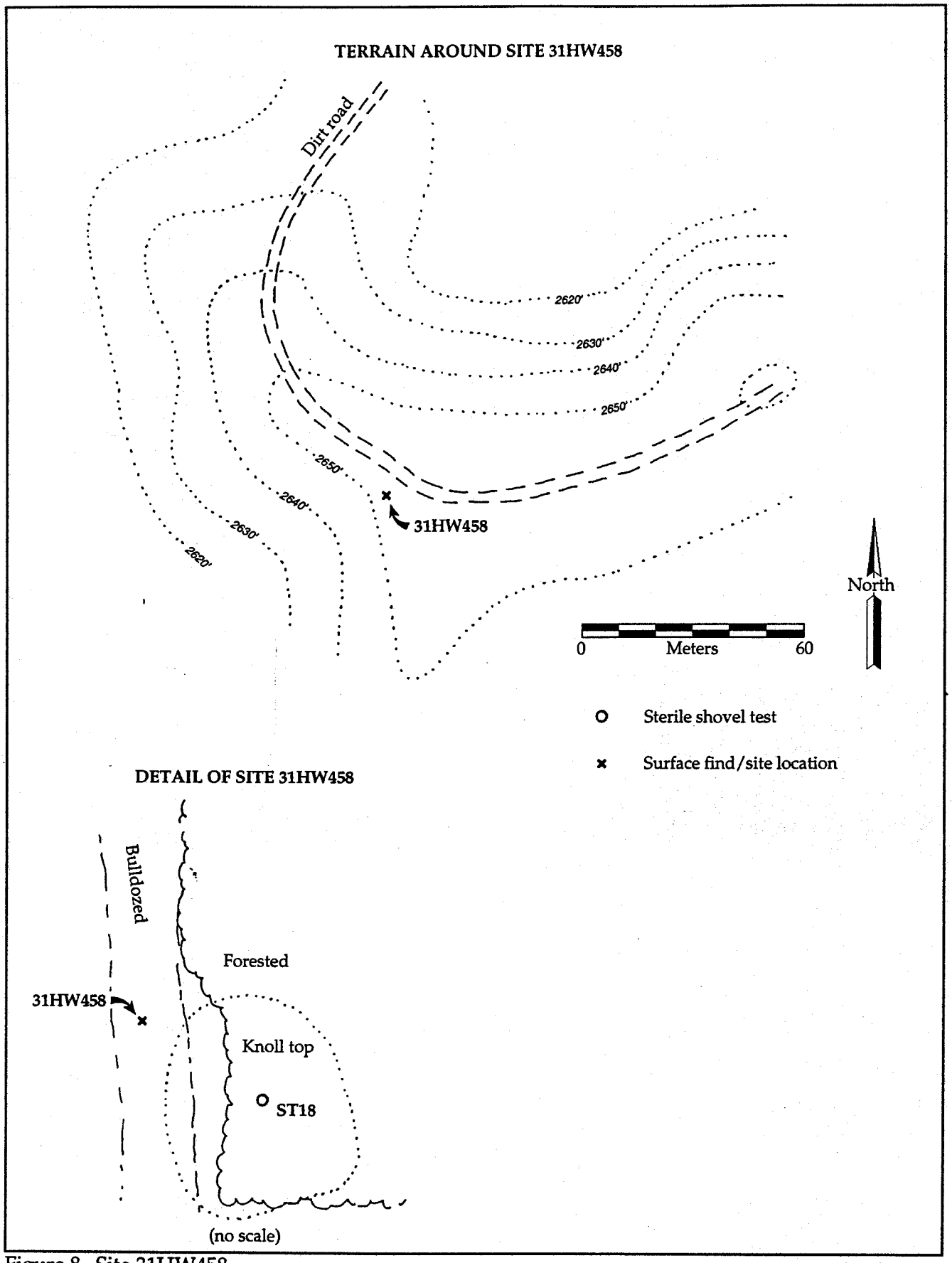

Figure 8. Site 31HW458.

31HW459**

Component:	Historic cemetery - twentieth century
Area:	ca. 56,568 ft^2
Landform:	Uplands and floodplain
Elevation:	ca. 2,540–2,568 feet
Slope:	0–25 percent

Site 31HW459** was identified on the western edge of the proposed expansion area (see Figure 3). The site consists of structural ruins and an artifact scatter placed on both sides of a north-south dirt road (Figure 9). An unnamed tributary of the Pigeon River runs through this site. The residence (Figure 10) is a deteriorated board and batten structure that was built with wire nails and sawn lumber. The house has a tin roof and rests on wooden piers. The main section of the house measures approximately 15 x 30 feet. The house has been expanded by a shed addition on the north side and by a shed room on the south. A covered porch extends over the entire front of the house and part of the south side. It appears that the house was originally built as a two-room structure.

A 10 x 10 foot shed is located immediately north of and adjacent to the residence (see Figures 9 and 10). The shed was of frame construction with a tin roof. The function of the shed was not determined during the survey.

The ruins of a barn stand across the road from the residence and shed (see Figures 9 and 10). The barn was constructed of square, hand-hewn logs and has a tin roof. The barn, a single pen structure with a loft, now lies in ruins.

Eight shovel tests, numbered 27–33, were excavated at this site to gather more information about its content and state of preservation. Shovel Test 27, located close to the stream that runs through the site, was excavated through 35 cm of brown loam above a rocky clay subsoil. The shovel tests to the east of the road encountered subsoil at an average depth of 30 cm, but all tests on that side of the road were sterile. The shovel tests to the west of the road were all quite shallow, and each extended less than 10 cm to subsoil.

Shovel Test 33 yielded the only artifacts collected from the site: two milk glass canning seal sherds, one shard of amber bottle glass, one plain clear table glass shard, one plastic child-proof cap, one piece of indeterminate plastic, one piece of unidentified leather, two shards of clear bottle glass, one shard of light green plate window glass, and two sherds of plain white ironstone. Shovel Test 33 was excavated in front of the abandoned residence and doubtless contained primary deposits from that household.

Site 31HW459** appears to date entirely to the twentieth century. That attribution is based on the use of wire nails to pin together the residence. Although the presence of an earlier structure at the site cannot be entirely dismissed because of the presence of the log barn, it is likely, based on the total evidence from the site, that no earlier occupation is present. The log barn was in an advanced state of deterioration at the time of the survey, but close inspection of the timbers indicated that they had most likely been salvaged from another structure. The barn, then, could date to the same period as the other buildings, namely the twentieth century.

Site 31HW459** appears to represent a small farm complex that was constructed in the twentieth century and utilized until very recently. This site is unlikely to provide significant data concerning the historic period occupation of the area, and we recommend that it be determined ineligible for the National Register of Historic Places.

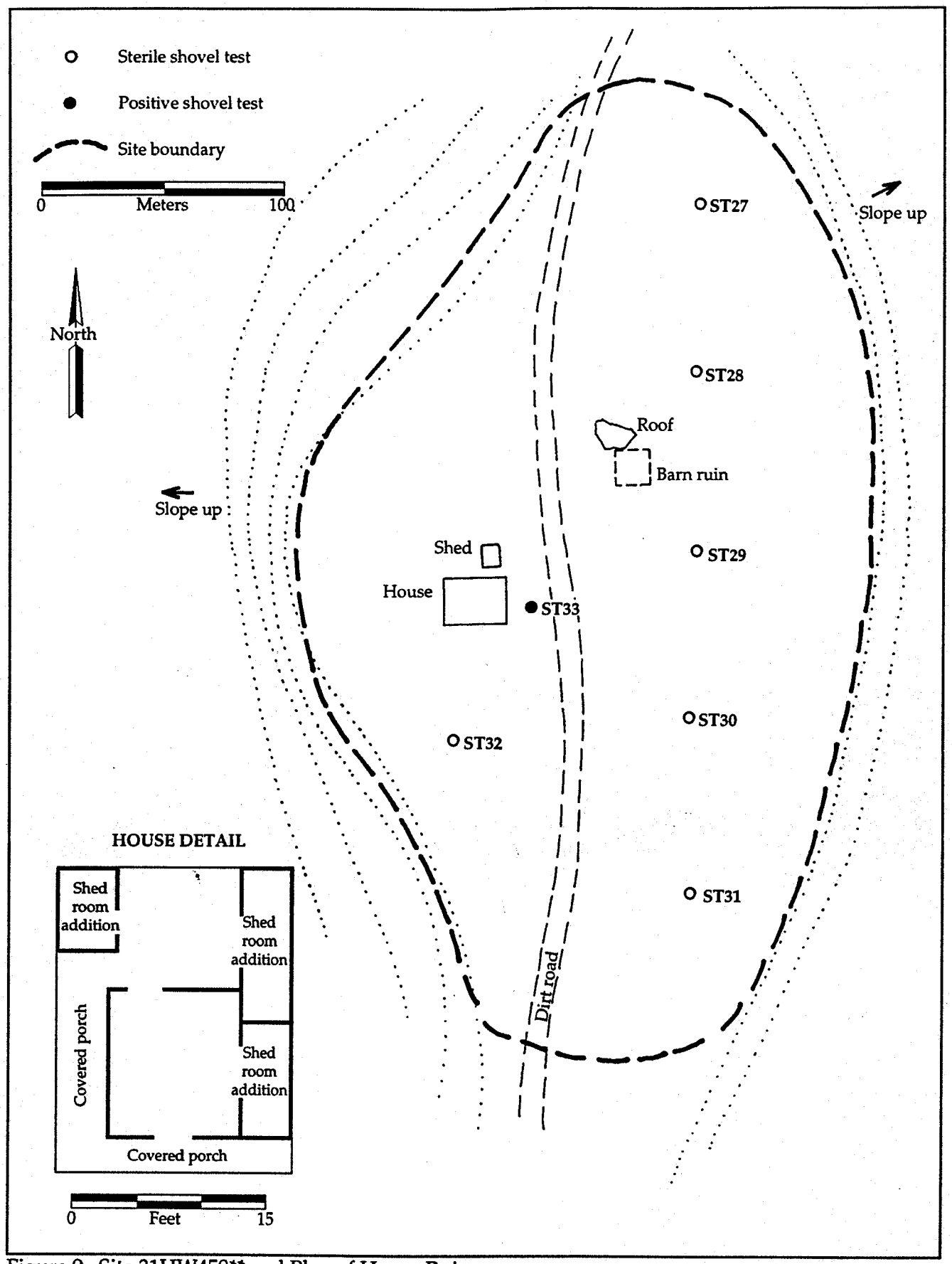

Figure 9. Site 31HW459** and Plan of House Ruin.

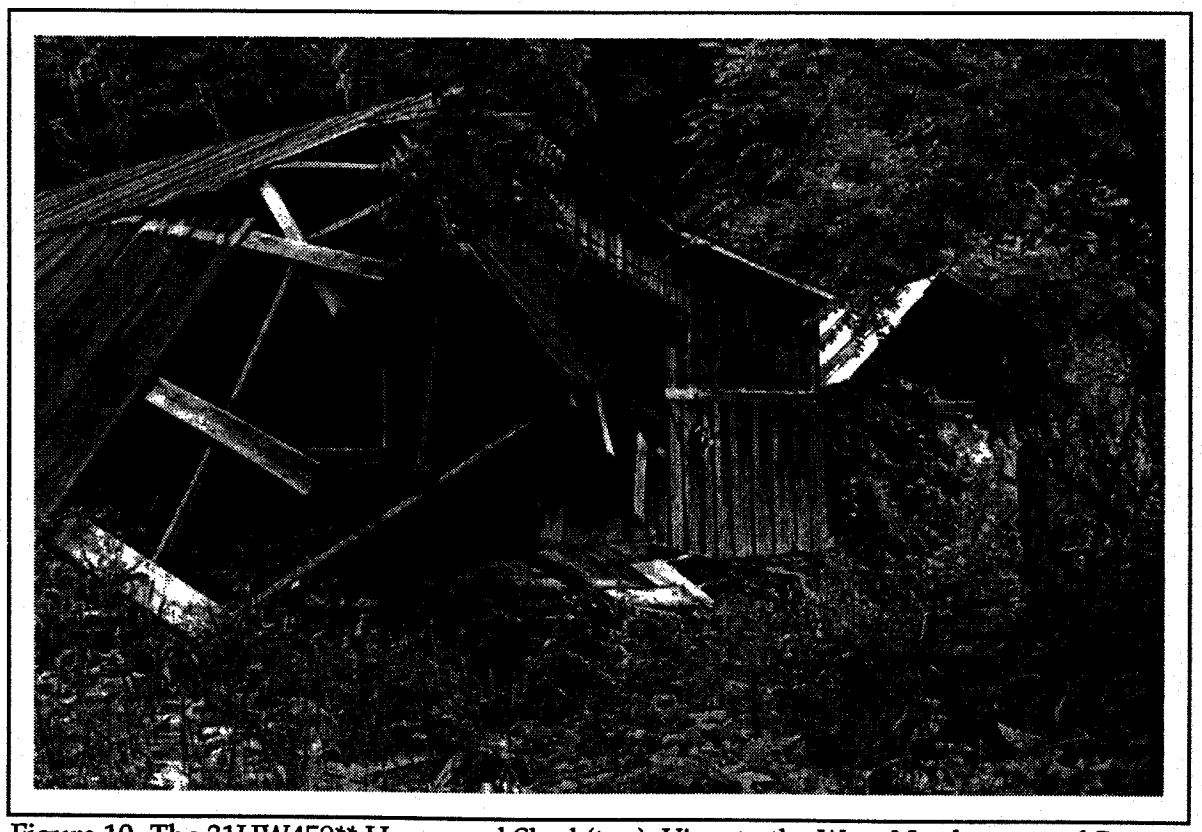

Figure 10. The 31HW459** House and Shed (top), View to the West-Northwest and Barn (bottom), View to the Northeast.

31HW286**

Component:	Historic twentieth century
Area:	ca. 180,00 ft^2
Landform:	Uplands
Elevation:	2,500–2,570 feet
Slope:	0–25 percent

Site 31HW286** was initially identified by Brown and Rogers (1990:17–19). That site was revisited during the current survey because structures linked to their defined site were present in the landfill expansion area. The purpose of the resurvey was to determine the new boundaries of the site and determine the site's eligibility status. As previously discussed in this report, 31HW286** as defined by the earlier survey included both historic and prehistoric components. The historic component is of interest to the present survey, however, as that is the component that extends into the expansion area (see Figure 3).

The current survey added two buildings to this site and extended the site boundaries to the west (Figure 11). One of the structures proved to have been a residence that was of frame construction with sawn clapboard siding (Figures 12–13). The residence had a brick chimney on each end and a tin roof.

The second structure was a storage shed and root cellar located to the east of the residence and immediately facing the road (see Figure 11). The cellar was dug into the hillside, and the downhill facade consists of a lower story of brick and rock and an upper story of frame. The frame portion is constructed of sawn lumber and pinned together with wire nails (Figure 14). The storage building has a tin roof.

Shovel Tests 34 and 35 were placed adjacent to the newly identified structures. Subsoil was encountered at 6 cm. Shovel Test 35, placed by the storage building, was sterile, but two clear bottle glass shards and a shard of light green plate window glass were recovered from Shovel Test 34. The only other artifacts collected during the resurvey were two sherds of plain white ironstone, which were surface finds.

The resurvey of 31HW286** has expanded the site's boundaries and defined the core of that twentieth century farmstead. The resurvey found nothing that would change the recommendation of Brown and Rogers (1990:21–22). The prehistoric component of this site is clearly quite sparse, and no additional prehistoric artifacts were found in the current survey. The historic component dates to the twentieth century. The entire site has been subjected to severe erosion, and it is unlikely that deposits are present that could be used to address significant local or regional research questions. For those reasons, we recommend that the site be considered ineligible for the National Register of Historic Places.

RESEARCH RESULTS

Native American Occupation of the Survey Tract

The intensive survey of the proposed landfill tract located four Native American sites and one historic site, and revisited a second historic site. In the following discussion, the site density in the project area is compared with densities encountered in previous surveys in the somewhat more well-studied Hiwassee River drainage at the southern end of the Appalachian Summit. Summary data are also provided on the relationship between site components and site locations and on lithic raw material preferences evidenced at the project sites.

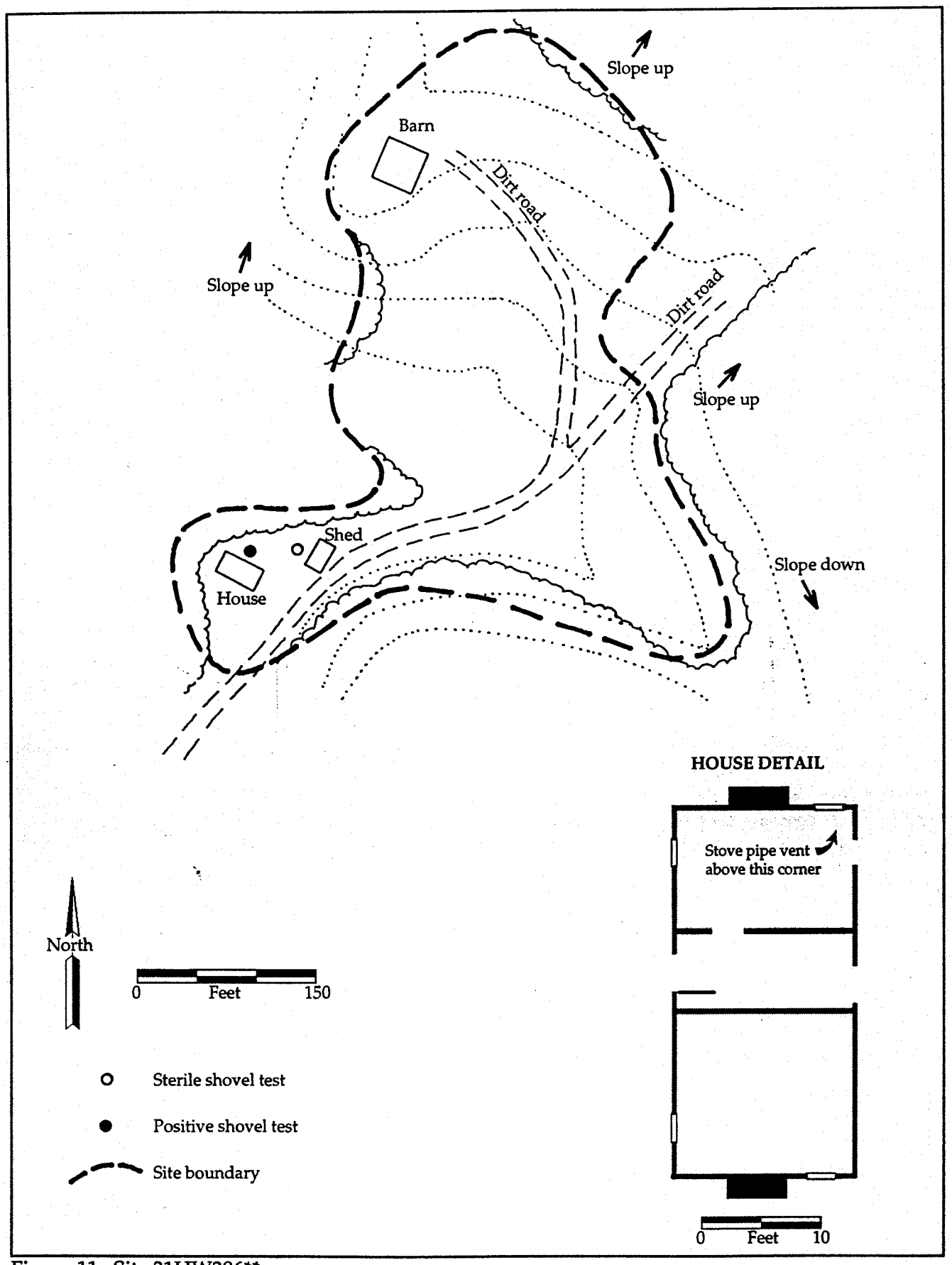

Figure 11. Site 31HW286**.

Figure 12. The Front of the 31HW286** Residence, View to the West-Northwest.

Figure 13. One of the End Chimneys on the 31HW286**
Residence, View to the West-Southwest.

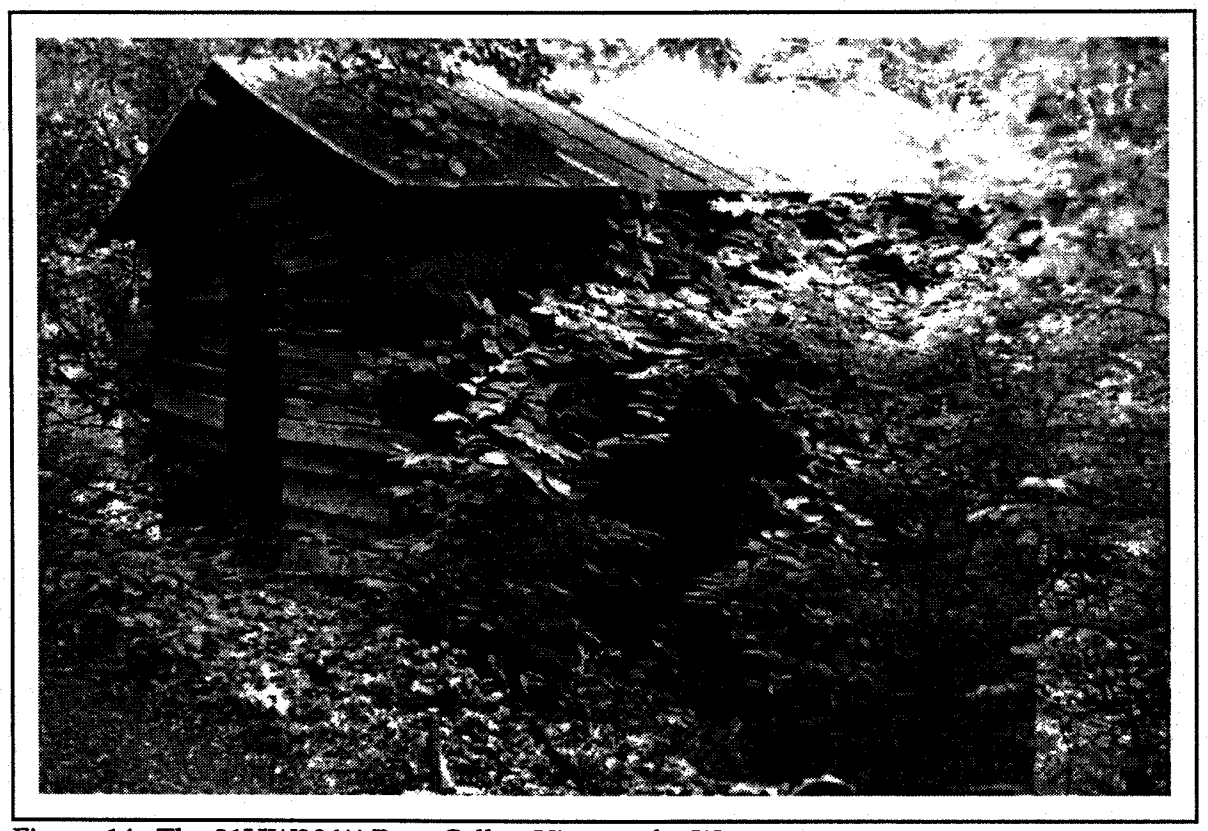

Figure 14. The 31HW286** Root Cellar, View to the West.

Comparative Site Densities. Comparative data on site densities for projects in the Hiwassee River drainage are provided by Abbott (1994:10–11). Six previous studies (Rogers 1984a, 1984b, 1985; Ross 1979; Ward 1977; Wetmore and Rogers 1987) that included a variety of environmental zones produced site densities ranging from 0 (no sites in a survey area) to 1 site per 13.0 acres, with an average density of 1 site per 39.3 acres. Those figures apparently include both prehistoric and historic sites and are not broken down by site type or environmental zone. In reporting his survey in the Hiwassee Valley east of Murphy, Abbott (1994) broke down site density by four environmental zones: recent alluvium, old alluvium, colluvium, and upland residuum. Overall site density per acre (including both prehistoric and historic sites) varied considerably by zone. The highest densities were found on colluvial fans (1 site per 9.81 acres), recent alluvium (1 site per 9.94 acres), and old alluvium (1 site per 13.08 acres). A much lower density (1 site per 59.33 acres) was found on upland residuum (Abbott 1994:100).

All of the archaeological sites (prehistoric and historic) sites identified within the Haywood County Landfill are best characterized as upland sites. The combined Brown and Rogers (1990) survey and the current effort identified a total of seven archaeological sites within approximately 168 acres. The resulting density of 1 site per 24 acres is much greater than the 1 site per 59.33 acres noted by Abbott (1994:100) for upland sites in the Hiwassee River drainage.

While it is clear that a variety of factors besides actual occupation density affect site discovery and resulting figures of site density (cf. McManamon 1984), the difference in the density of sites in the uplands of the Hiwassee River drainage and the study area still requires an explanation. It is most likely that the elevated site density noted on the study property was a result of the topography and hydrology of the area. The Pigeon River has likely served as an important transportation route for thousands of years, and the trails that parallel the Pigeon could have been known and used quite early. The project area would have then served as a camping and/or hunting area for small bands transiting the Smoky Mountains to the east and west.

Lithic Raw Material Use. The Brown and Rogers (1990:19) survey collected seven chipped stone artifacts. Those artifacts included one chert PPK, one quartz PPK, three chert flakes, and two chalcedony flakes. No further descriptions are provided for those raw materials. The current survey recovered 37 lithic artifacts, of which four (10.8 percent) were Ridge and Valley chert, 16 (43.2 percent) were quartz, and 17 (46 percent) were orthoquartzite. The percentage of chert noted during the resurvey compares favorably with the 12.9 percent occurrence of Ridge and Valley chert (Table 2) noted during the survey of a landfill site by Webb (1994:53) in Cherokee

Table 2. Lithic Raw Material Types at Native American Sites, Cherokee County.

			Raw Material Count				
Site	**Location**	**Component(s)**	**Chert**	**Quartz**	**Qtzite**	**Oqtzite**	**Total**
31CE593	Floodplain	Qualla	0	0	0	0	0
31CE594	Uplands	Unknown	1	10	0	0	11
31CE596	Uplands	M. Archaic?	0	47	4	4	55
31CE597	Uplands	M. Archaic?	0	1	0	0	1
31CE599	Uplands	Qualla	16	10	5	1	32
31CE600	Uplands	Unknown	0	7	1	0	8
31CE601	Floodplain	Unknown	0	3	0	0	3
31CE602	Floodplain	Qualla(?)	0	2	3	0	5
31CE603	Uplands	Unknown	0	17	0	0	17
31CE604	Floodplain	Connestee, Qualla(?)	0	2	1	0	3
31CE605	Floodplain	Qualla	2	1	0	0	3
31CE606	Floodplain	Qualla(?)	0	8	0	1	9
Total			**19**	**108**	**14**	**6**	**147**

County to the south. The percentages of quartz and orthoquartzite noted on the expansion area of the Haywood County Landfill vary significantly from those noted on the Cherokee County sites, however, and probably reflects variation in locally available lithic raw materials between the two areas.

Environmental Changes and Site Preservation. The possible role of environmental changes in affecting present-day site distributions on the survey tract must be addressed. The upland ridges on the survey tract are severely eroded. Consequently, the perceived pattern of site distribution in the uplands probably does not reflect the pattern that existed prior to the widespread erosion. Even where artifacts were found in the uplands, the sites were severely eroded and the present artifact density likely does not reflect that originally present.

The Historic Period Native American and Euro-American Occupation

Historic Cherokee Occupation of the Project Vicinity. Survey revealed no evidence that the project area had ever contained Cherokee settlement. Cherokees undoubtedly used the trails along the Pigeon River drainage but apparently left no discernible traces on the study property.

Euro-American Occupation of the Project Area. The study area was settled by Euro-Americans by at least the twentieth century, and more level areas were apparently cultivated. At least two twentieth century farmsteads were present that continued to be occupied until the last few years. No attempt was made to trace the land titles of the survey tract.

Settlement of the project area probably came soon after the White Oak township was split off from the Jonathan township. The residents of the study property appear to have been subsistence-level farmers who probably produced small stands of tobacco as their major cash crop.

VI. SUMMARY AND RECOMMENDATIONS

The intensive cultural resources survey of the proposed Haywood County Landfill expansion and the resurvey of a portion of the existing landfill tract identified five archaeological sites, including four prehistoric Native American sites and one twentieth century Euro-American site. Also, one historic site first identified by Brown and Rogers (1990:17–19) was resurveyed. TRC's recommendations concerning the eligibility of those sites for the National Register of Historic Places have been provided in the previous chapter. The following discussion amplifies those recommendations.

NATIVE AMERICAN SITE RECOMMENDATIONS

The four Native American sites are all recommended as ineligible for the National Register of Historic Places. One of those sites dates to the Early Archaic period; the other three failed to produce temporally diagnostic artifacts. None of these sites is likely to contain significant artifact concentrations or undisturbed cultural deposits or features. We conclude that no additional work is necessary at those sites and recommend that they be determined ineligible for the National Register of Historic Places.

HISTORIC SITE RECOMMENDATIONS

The two historic period sites identified or revisited during the intensive survey consist of twentieth century farmstead sites. Neither site is recommended eligible for the National Register of Historic Places, due to their age and the absence of demonstrated archaeological deposits that could yield information important to better understanding the history of the local area or region.

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APPENDIX 1

NORTH CAROLINA STATE SITE FORMS

NORTH CAROLINA ARCHAEOLOGICAL SITE FORM
OFFICE OF STATE ARCHAEOLOGY / DIVISION OF ARCHIVES AND HISTORY

1. STATE SITE NUMBER: **31HW455**

2. SITE NAME(S): **none**

3. OTHER SITE NUMBER:

4. INSTITUTION ASSIGNING: **TRC Garrow Associates Inc.**

5. PROJECT SITE NUMBER: **TRC-1**

6. SITE COMPONENT: **Unknown Prehistoric**

7. QUAD MAP: **Cove Creek, NC** CODE:

8. UTM ZONE: **17** NORTHING: **3948 580** EASTING: **318 450**

9. COUNTY: **Haywood** DATE RECORDED: **7/7/98**

RECORDED BY: **Christopher T. Espenshade**

PROJECT NAME: **Haywood County Landfill Expansion**

11. RESULT OF COMPLIANCE PROJECT: **Yes**

12. ER/CH/GRANT#:

13. CODING DATE: CODED BY:

DIRECTIONS TO SITE: see attached masp

>>> ATTACH USGS OR OTHER DETAILED SITE MAP <<<

14-18. OSA RESERVED CODES

14. NATIONAL REGISTER STATUS:
1. DETERMINED ELIGIBLE
2. PLACED ON STUDY LIST
3. APPROVED FOR NOMINATION BY SPRC
4. CURRENTLY LISTED ON NRHP
5. REMOVE FROM NRHP
6. NOT ELIGIBLE AFTER EVALUATION
7. UNASSESSED
8. NC ARCHAEOLOGICAL RECORDING PROGRAM

14.a. NATIONAL REGISTER CRITERION:
a. SIGNIFICANT UNDER CRITERION A.
b. SIGNIFICANT UNDER CRITERION B.
c. SIGNIFICANT UNDER CRITERION C.
d. SIGNIFICANT UNDER CRITERION D.

15. TYPE OF FORM: **11 - ARCHAEOLOGICAL SITE FORM VI**

16. RECORDER'S STATUS:
1. NCAC MEMBER
2. AMATEUR
3. UNKNOWN
4. OTHER
5. STUDENT

17. FORM RELIABILITY:
1. CODING COMPLETE
2. CODING INCOMPLETE
3. CODING UNRELIABLE

18. LOCATION RELIABILITY:
1. ACCURATE
2. WITHIN 100M RADIUS
3. UNRELIABLE
4. UNKNOWN LOCATION
5. WITHIN 500M RADIUS
6. WITHIN 1KM RADIUS

19. RESEARCH POTENTIAL:

20. POTENTIAL IMPACTS ARTIFICIAL: **Destruction**

21. POTENTIAL IMPACTS ENVIRONMENTAL:

22. EXPLANATION OF IMPACTS: Within the expansion area of a landfill

23. RECOMMENDATIONS: **ineligible**

24. EXPLAIN RECOMMENDATIONS: site is heavily eroded and lacks significant deposits

25. DATE ON REGISTER

26. EXCAVATION DATE:

27. INSTITUTION EXCAVATING:

CODE:

28. EXCAVATION RESULTS:

29. PERCENT DESTROYED:

30. DATE DESTROYED:

31. CAUSES OF DESTRUCTION:

ENVIRONMENTAL INFORMATION

32. TOPOGRAPHIC SITUATION: Upland Ridge

33. ELEVATION:FT. **2,668 ft AMSL**

34. SLOPE PERCENT: **0**

35. SLOPE FACE DIRECTION:

36. SOIL COMPOSITION: 15 cm topsoil over subsoil

37. SCS SOIL TYPE CODE:

SERIES NAME: **undetermined**

ASSOCIATION: undetermined

38. MODERN VEGETATION site area cleared, surrounded by mixed hardwoods

39. DISTANCE TO WATER: (METERS) 305 40. (YARDS) 300

41. TYPE OF NEAREST PERMANENT WATER: unnamed creek

42. STREAM RANK: 2

43. DRAINAGE BASIN: Pigeon

SITE EVALUATION AND CONDITION

44. SITE CONDITION NATURAL: heavily eroded

45. SITE CONDITION ARTIFICIAL: some recent bulldozing for a geotech test

46. GROUND VISIBILITY: 100 percent

47. COLLECTION MADE: surface

48. COLLECTION STRATEGY: total

49. AREA COVERED SQUARE METERS: 100 sq. m

50. SUBSURFACE TESTING: one adjacent STP

51. SUBSURFACE TESTING METHODS: judgmentally placed STP

52. SUBSURFACE TEST RESULTS: sterile

53. SITE SIZE: 10 x 10 m

PREHISTORIC SITE INFORMATION

54. PREHISTORIC COMPONENTS: unknown prehistoric

55. PREHISTORIC SITE FUNCTION: temporary camp?

56. MIDDEN: absent

57. FAUNAL/ETHNO BOTANICAL REMAINS: absent

58. FEATURE DESCRIPTION: absent

59. TOOL TYPES: none 60. FREQUENCIES:

61. LITHICS: flake frag., quartz shatter

62. PREHISTORIC - MISCELLANEOUS ITEMS/SAMPLES: none

63. CERAMIC TEMPER 1 64. SURFACE TREATMENT 1

65. CERAMIC TEMPER 2

66. SURFACE TREATMENT 2

67. CERAMIC TEMPER 3

68. SURFACE TREATMENT 3

HISTORIC SITE INFORMATION

69. PERIOD OF OCCUPATION BEGIN: **NA**

70. PERIOD OF OCCUPATION END:

71. REFINED DATE FROM:

72. REFINED DATE TO:

73. HISTORIC CULTURAL AFFILIATIONS:

74. HISTORIC SITE DEFINITION:

75. HISTORIC REMAINS DESCRIPTION:

76. MAIN STRUCTURE FUNCTION:

77. NUMBER OF OUTBUILDINGS:

78. OUTBUILDING DISTANCE:

79. OUTBUILDINGS FUNCTION:

80. OUTBUILDING DESCRIPTION:

81. KITCHEN GROUP:

82. ARCHITECTURAL GROUP:

83. ARMS GROUP:

84. MILITARY OBJECTS:

85. CLOTHING GROUP:

86. PERSONAL GROUP:

87. TOBACCO PIPE GROUP:

88. ACTIVITIES GROUP:

89. HISTORIC MISC:

90. DATEABLE CERAMICS:

ADDITIONAL SITE INFORMATION

91. ARTIFACT INVENTORY: **1 chert R&V flake frag, 1 quartz shatter**

92. CURATION FACILITY: **To be Determined**

93. ACCESSION NUMBER(S):

94. ACCESSION DATE(S):

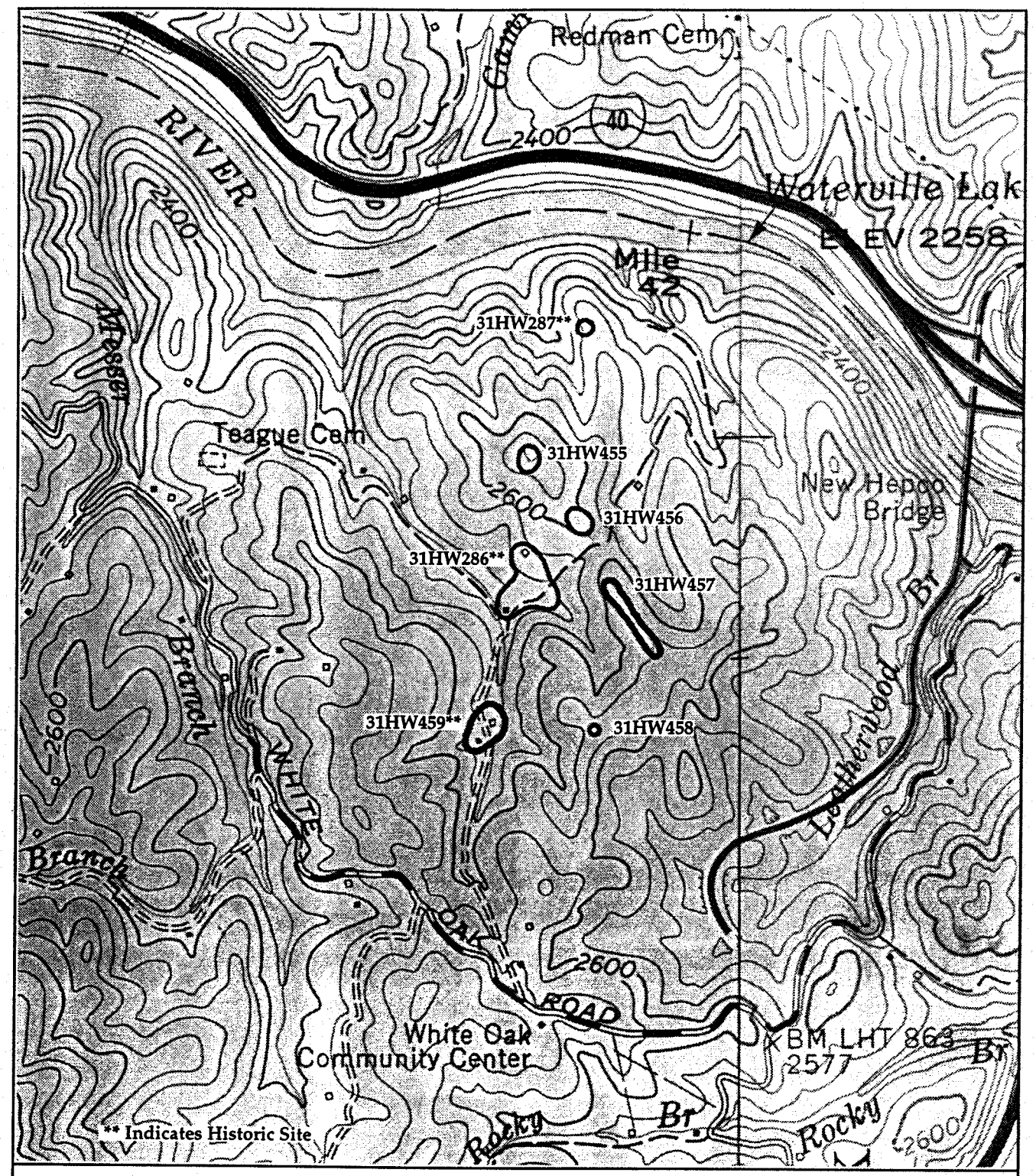
95. OTHER CURATION FACILITY:

96. OTHER ACCESSION NUMBER(S):

97. OWNER/TENANT INFORMATION:

98. BIBLIOGRAPHIC REFERENCE #'S **Patrick H. Garrow, 1998, *Phase I Cultural Resource Survey of the Proposed Haywood County Landfill Expansion Site, Haywood County, North Carolina.* TRC Garrow Associates Inc., Atlanta. Submitted to Municipal Engineers, Garner, N.C.**

99. COMMENTS/NOTES:



contour interval = 40 feet

0 mile 1

0 feet 4000

0 kilometer 1

North

PROJECT AREA

Map source: Cove Creek Gap/Pine Creek, N.C. Quadrangles, 7.5 minute 1967,1987/1967,1976

NORTH CAROLINA ARCHAEOLOGICAL SITE FORM
OFFICE OF STATE ARCHAEOLOGY / DIVISION OF ARCHIVES AND HISTORY

1. STATE SITE NUMBER: **31HW456**

2. SITE NAME(S):

3. OTHER SITE NUMBER:

4. INSTITUTION ASSIGNING: **TRC Garrow Associates, Inc.**

5. PROJECT SITE NUMBER: **TRC-2**

6. SITE COMPONENT: **Unknown Prehistoric**

7. QUAD MAP: **Cove Creek, NC** CODE:

8. UTM ZONE: **17** NORTHING: **3948 400** EASTING: **318 580**

9. COUNTY: **Haywood** DATE RECORDED: **7/8/98**

RECORDED BY: **Christopher T. Espenshade**

PROJECT NAME: **Haywood County Landfill Expansion**

11. RESULT OF COMPLIANCE PROJECT: **Yes**

12. ER/CH/GRANT#:

13. CODING DATE: CODED BY:

DIRECTIONS TO SITE: See attached map

>>> ATTACH USGS OR OTHER DETAILED SITE MAP <<<

14-18. OSA RESERVED CODES

14. NATIONAL REGISTER STATUS:
1. DETERMINED ELIGIBLE
2. PLACED ON STUDY LIST
3. APPROVED FOR NOMINATION BY SPRC
4. CURRENTLY LISTED ON NRHP
5. REMOVE FROM NRHP
6. NOT ELIGIBLE AFTER EVALUATION
7. UNASSESSED
8. NC ARCHAEOLOGICAL RECORDING PROGRAM

14.a. NATIONAL REGISTER CRITERION:
a. SIGNIFICANT UNDER CRITERION A.
b. SIGNIFICANT UNDER CRITERION B.
c. SIGNIFICANT UNDER CRITERION C.
d. SIGNIFICANT UNDER CRITERION D.

15. TYPE OF FORM: **11 - ARCHAEOLOGICAL SITE FORM VI**

16. RECORDER'S STATUS:
1. NCAC MEMBER
2. AMATEUR
3. UNKNOWN
4. OTHER
5. STUDENT

17. FORM RELIABILITY:
1. CODING COMPLETE
2. CODING INCOMPLETE
3. CODING UNRELIABLE

18. LOCATION RELIABILITY:
1. ACCURATE
2. WITHIN 100M RADIUS
3. UNRELIABLE
4. UNKNOWN LOCATION
5. WITHIN 500M RADIUS
6. WITHIN 1KM RADIUS

19. RESEARCH POTENTIAL:

20. POTENTIAL IMPACTS ARTIFICIAL: **Destruction**

21. POTENTIAL IMPACTS ENVIRONMENTAL:

22. EXPLANATION OF IMPACTS: Within the expansion area of a landfill

23. RECOMMENDATIONS: **ineligible**

24. EXPLAIN RECOMMENDATIONS: **site is heavily eroded and lacks significant deposits**

25. DATE ON REGISTER

26. EXCAVATION DATE:

27. INSTITUTION EXCAVATING:

CODE:

28. EXCAVATION RESULTS:

29. PERCENT DESTROYED:

30. DATE DESTROYED:

31. CAUSES OF DESTRUCTION:

ENVIRONMENTAL INFORMATION

32. TOPOGRAPHIC SITUATION: Upland Ridge

33. ELEVATION:FT. **2,598-2,616 ft AMSL**

34. SLOPE PERCENT: **ca. 20 percent**

35. SLOPE FACE DIRECTION: southeast

36. SOIL COMPOSITION: 3-5 cm of topsoil over subsoil

37. SCS SOIL TYPE CODE:

SERIES NAME: **undetermined**

ASSOCIATION: undetermined

38. MODERN VEGETATION hardwood forest

39. DISTANCE TO WATER: (METERS) 300 40. (YARDS) 274

41. TYPE OF NEAREST PERMANENT WATER: unnamed creek

42. STREAM RANK: 2

43. DRAINAGE BASIN: Pigeon

SITE EVALUATION AND CONDITION

44. SITE CONDITION NATURAL: heavily eroded

45. SITE CONDITION ARTIFICIAL: disturbed by dirt road

46. GROUND VISIBILITY: %0-100%

47. COLLECTION MADE: surface

48. COLLECTION STRATEGY: total

49. AREA COVERED SQUARE METERS: 700 sq m

50. SUBSURFACE TESTING: 3 adjacent STPs

51. SUBSURFACE TESTING METHODS: judgmentally placed STPs

52. SUBSURFACE TEST RESULTS: sterile

53. SITE SIZE: 46 x 15 m

PREHISTORIC SITE INFORMATION

54. PREHISTORIC COMPONENTS: unknown prehistoric

55. PREHISTORIC SITE FUNCTION: temporary camp?

56. MIDDEN: absent

57. FAUNAL/ETHNO BOTANICAL REMAINS: absent

58. FEATURE DESCRIPTION: absent

59. TOOL TYPES: none 60. FREQUENCIES:

61. LITHICS: undiagnostic biface and flakes

62. PREHISTORIC - MISCELLANEOUS ITEMS/SAMPLES: none

63. CERAMIC TEMPER 1 64. SURFACE TREATMENT 1

65. CERAMIC TEMPER 2

66. SURFACE TREATMENT 2

67. CERAMIC TEMPER 3

68. SURFACE TREATMENT 3

HISTORIC SITE INFORMATION

69. PERIOD OF OCCUPATION BEGIN:

70. PERIOD OF OCCUPATION END:

71. REFINED DATE FROM:

72. REFINED DATE TO:

73. HISTORIC CULTURAL AFFILIATIONS:

74. HISTORIC SITE DEFINITION:

75. HISTORIC REMAINS DESCRIPTION:

76. MAIN STRUCTURE FUNCTION:

77. NUMBER OF OUTBUILDINGS:

78. OUTBUILDING DISTANCE:

79. OUTBUILDINGS FUNCTION:

80. OUTBUILDING DESCRIPTION:

81. KITCHEN GROUP:

82. ARCHITECTURAL GROUP:

83. ARMS GROUP:

84. MILITARY OBJECTS:

85. CLOTHING GROUP:

86. PERSONAL GROUP:

87. TOBACCO PIPE GROUP:

88. ACTIVITIES GROUP:

89. HISTORIC MISC:

90. DATEABLE CERAMICS:

ADDITIONAL SITE INFORMATION

91. ARTIFACT INVENTORY: **1 nondiagnostic quartz biface frag., 2 unspecialized orthoquartzite flakes, one orthoquartzite flake frag.**

92. CURATION FACILITY: **To be determined**

93. ACCESSION NUMBER(S):

94. ACCESSION DATE(S):

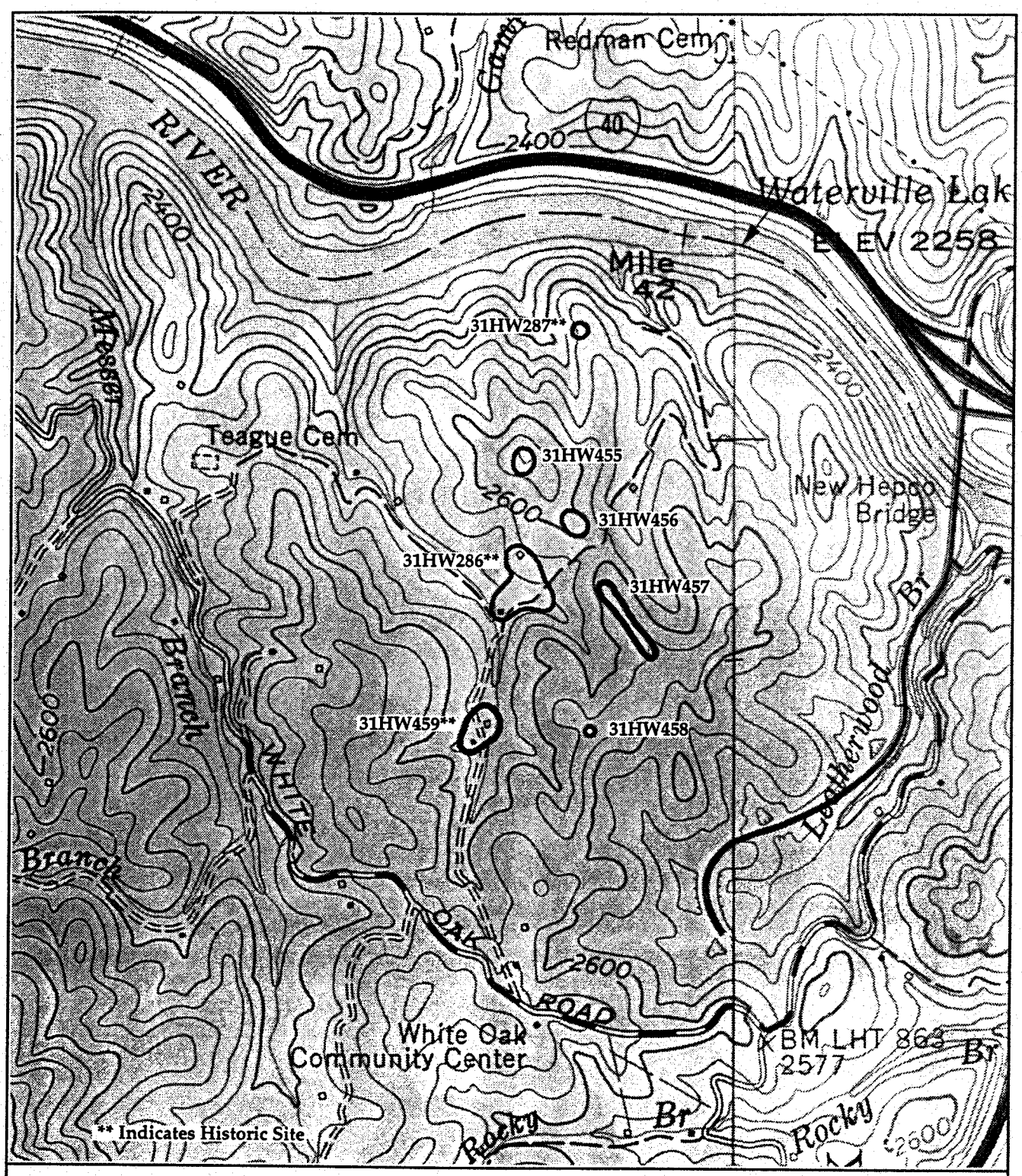
95. OTHER CURATION FACILITY:

96. OTHER ACCESSION NUMBER(S):

97. OWNER/TENANT INFORMATION:

98. BIBLIOGRAPHIC REFERENCE #'S **Patrick H. Garrow, 1998, *Phase I Cultural Resource Survey of the Proposed Haywood County Landfill Expansion Site, Haywood County, North Carolina.* TRC Garrow Associates Inc., Atlanta. Submitted to Municipal Engineers, Garner, N.C.**

99. COMMENTS/NOTES:



contour interval = 40 feet

0 mile 1

0 feet 4000

0 kilometer 1

North

PROJECT AREA

Map source: Cove Creek Gap/Pine Creek, N.C. Quadrangles, 7.5 minute 1967,1987/1967,1976

NORTH CAROLINA ARCHAEOLOGICAL SITE FORM
OFFICE OF STATE ARCHAEOLOGY / DIVISION OF ARCHIVES AND HISTORY

1. STATE SITE NUMBER: 31HW457

2. SITE NAME(S): none

3. OTHER SITE NUMBER:

4. INSTITUTION ASSIGNING: TRC Garrow Associates Inc.

5. PROJECT SITE NUMBER: TRC 3-4

6. SITE COMPONENT: Early Archaic Prehistoric

7. QUAD MAP: Cove Creek, NC CODE:

8. UTM ZONE: 17 NORTHING: 3948 240 EASTING: 318 660

9. COUNTY: Haywood DATE RECORDED: 7/8/98

RECORDED BY: Christopher T. Espenshade

PROJECT NAME: Haywood County Landfill Expansion

11. RESULT OF COMPLIANCE PROJECT: Yes

12. ER/CH/GRANT#:

13. CODING DATE: CODED BY:

DIRECTIONS TO SITE: see attached map

>>> ATTACH USGS OR OTHER DETAILED SITE MAP <<<

14-18. OSA RESERVED CODES

14. NATIONAL REGISTER STATUS:
1. DETERMINED ELIGIBLE
2. PLACED ON STUDY LIST
3. APPROVED FOR NOMINATION BY SPRC
4. CURRENTLY LISTED ON NRHP
5. REMOVE FROM NRHP
6. NOT ELIGIBLE AFTER EVALUATION
7. UNASSESSED
8. NC ARCHAEOLOGICAL RECORDING PROGRAM

14.a. NATIONAL REGISTER CRITERION:
a. SIGNIFICANT UNDER CRITERION A.
b. SIGNIFICANT UNDER CRITERION B.
c. SIGNIFICANT UNDER CRITERION C.
d. SIGNIFICANT UNDER CRITERION D.

15. TYPE OF FORM: 11 - ARCHAEOLOGICAL SITE FORM VI

16. RECORDER'S STATUS:
1. NCAC MEMBER
2. AMATEUR
3. UNKNOWN
4. OTHER
5. STUDENT

17. FORM RELIABILITY:
1. CODING COMPLETE
2. CODING INCOMPLETE
3. CODING UNRELIABLE

18. LOCATION RELIABILITY:
1. ACCURATE
2. WITHIN 100M RADIUS
3. UNRELIABLE
4. UNKNOWN LOCATION
5. WITHIN 500M RADIUS
6. WITHIN 1KM RADIUS

19. RESEARCH POTENTIAL:

20. POTENTIAL IMPACTS ARTIFICIAL: **Destruction**

21. POTENTIAL IMPACTS ENVIRONMENTAL:

22. EXPLANATION OF IMPACTS: Within the expansion area of a landfill

23. RECOMMENDATIONS: **ineligible**

24. EXPLAIN RECOMMENDATIONS: **site is heavily eroded and lacks significant deposit**

25. DATE ON REGISTER

26. EXCAVATION DATE:

27. INSTITUTION EXCAVATING:

CODE:

28. EXCAVATION RESULTS:

29. PERCENT DESTROYED:

30. DATE DESTROYED:

31. CAUSES OF DESTRUCTION:

ENVIRONMENTAL INFORMATION

32. TOPOGRAPHIC SITUATION: Upland Ridge

33. ELEVATION:FT. **2,616-2,624 ft AMSL**

34. SLOPE PERCENT: **0-15%**

35. SLOPE FACE DIRECTION:

36. SOIL COMPOSITION: 6 cm of topsoil over subsoil

37. SCS SOIL TYPE CODE:

SERIES NAME: **undetermined**

ASSOCIATION: undetermined

38. MODERN VEGETATION hardwood forest surrounding open dirt road

39. DISTANCE TO WATER: **(METERS) 425** 40. **(YARDS) 389**

41. TYPE OF NEAREST PERMANENT WATER: **unnamed stream**

42. STREAM RANK: **2**

43. DRAINAGE BASIN: **Pigeon**

SITE EVALUATION AND CONDITION

44. SITE CONDITION NATURAL: **heavily eroded**

45. SITE CONDITION ARTIFICIAL: **disturbed by dirt road**

46. GROUND VISIBILITY: **%0-100%**

47. COLLECTION MADE: **surface**

48. COLLECTION STRATEGY: **total**

49. AREA COVERED SQUARE METERS: **2,675 sq m**

50. SUBSURFACE TESTING: **4 adjacent STPs**

51. SUBSURFACE TESTING METHODS: **judgmentally placed STPs**

52. SUBSURFACE TEST RESULTS: **sterile**

53. SITE SIZE:

PREHISTORIC SITE INFORMATION

54. PREHISTORIC COMPONENTS: **Early Archaic**

55. PREHISTORIC SITE FUNCTION: **temporary camp?**

56. MIDDEN: **absent**

57. FAUNAL/ETHNO BOTANICAL REMAINS: **absent**

58. FEATURE DESCRIPTION: **absent**

59. TOOL TYPES: **two PPKs** 60. FREQUENCIES:

61. LITHICS: **PPKs, flakes, shatter**

62. PREHISTORIC - MISCELLANEOUS ITEMS/SAMPLES: **none**

63. CERAMIC TEMPER 1 64. SURFACE TREATMENT 1

65. CERAMIC TEMPER 2

66. SURFACE TREATMENT 2

67. CERAMIC TEMPER 3

68. SURFACE TREATMENT 3

HISTORIC SITE INFORMATION

69. PERIOD OF OCCUPATION BEGIN: **single artifact, inconsequential**

70. PERIOD OF OCCUPATION END:

71. REFINED DATE FROM:

72. REFINED DATE TO:

73. HISTORIC CULTURAL AFFILIATIONS:

74. HISTORIC SITE DEFINITION:

75. HISTORIC REMAINS DESCRIPTION:

76. MAIN STRUCTURE FUNCTION:

77. NUMBER OF OUTBUILDINGS:

78. OUTBUILDING DISTANCE:

79. OUTBUILDINGS FUNCTION:

80. OUTBUILDING DESCRIPTION:

81. KITCHEN GROUP: **1 ceramic**

82. ARCHITECTURAL GROUP:

83. ARMS GROUP:

84. MILITARY OBJECTS:

85. CLOTHING GROUP:

86. PERSONAL GROUP:

87. TOBACCO PIPE GROUP:

88. ACTIVITIES GROUP:

89. HISTORIC MISC:

90. DATEABLE CERAMICS:

ADDITIONAL SITE INFORMATION

91. ARTIFACT INVENTORY: **1 Palmer/Kirk PPK, R&V chert, 1 Palmer/Kirk PPK frag., R&V chert, 2 quartz unspecialized flakes, 2 orthoquartzite unspecialized flakes, 8 orthoquartzite flake fragments, 6 quartz flake fragments, 1 R&V thinning flake. 1 quartz thinning flake, 3 orthoquartzite thinning flake, 4 quartz shatter, 1 orthoquartzite shatter, 1 unidentified white body ceramic (historic)**

92. CURATION FACILITY: **To be Determined**

93. ACCESSION NUMBER(S):

94. ACCESSION DATE(S):

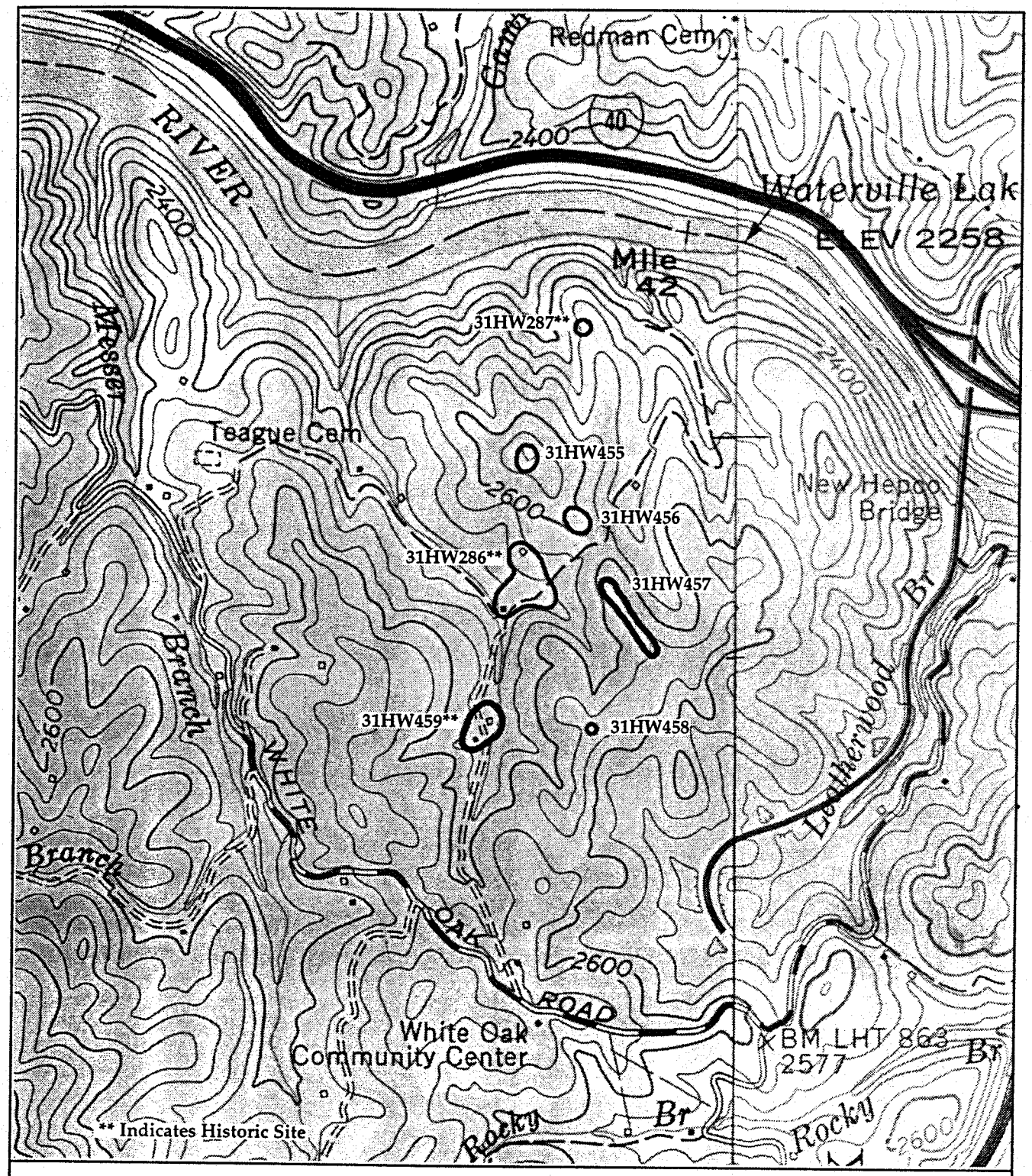
95. OTHER CURATION FACILITY:

96. OTHER ACCESSION NUMBER(S):

97. OWNER/TENANT INFORMATION:

98. BIBLIOGRAPHIC REFERENCE #'S **Patrick H. Garrow, 1998, *Phase I Cultural Resource Survey of the Proposed Haywood County Landfill Expansion Site, Haywood County, North Carolina.* TRC Garrow Associates Inc., Atlanta. Submitted to Municipal Engineers, Garner, N.C.**

99. COMMENTS/NOTES:



contour interval = 40 feet

0 mile 1

0 feet 4000

0 kilometer 1

North

PROJECT AREA

Map source: Cove Creek Gap/Pine Creek, N.C. Quadrangles, 7.5 minute 1967,1987/1967,1976

NORTH CAROLINA ARCHAEOLOGICAL SITE FORM
OFFICE OF STATE ARCHAEOLOGY / DIVISION OF ARCHIVES AND HISTORY

1. STATE SITE NUMBER: **31HW458**

2. SITE NAME(S): **none**

3. OTHER SITE NUMBER:

4. INSTITUTION ASSIGNING: **TRC Garrow Associates Inc.**

5. PROJECT SITE NUMBER: **TRC-5**

6. SITE COMPONENT: **Unknown Prehistoric**

7. QUAD MAP: **Cove Creek, NC** CODE:

8. UTM ZONE: **17** NORTHING: **3948 050** EASTING: **318 520**

9. COUNTY: **Haywood** DATE RECORDED: **7/8/98**

RECORDED BY: **Christopher T. Espenshade**

PROJECT NAME: **Haywood County Landfill Expansion**

11. RESULT OF COMPLIANCE PROJECT: **Yes**

12. ER/CH/GRANT#:

13. CODING DATE: CODED BY:

DIRECTIONS TO SITE: see attached map

>>> ATTACH USGS OR OTHER DETAILED SITE MAP <<<

14-18. OSA RESERVED CODES

14. NATIONAL REGISTER STATUS:
1. DETERMINED ELIGIBLE
2. PLACED ON STUDY LIST
3. APPROVED FOR NOMINATION BY SPRC
4. CURRENTLY LISTED ON NRHP
5. REMOVE FROM NRHP
6. NOT ELIGIBLE AFTER EVALUATION
7. UNASSESSED
8. NC ARCHAEOLOGICAL RECORDING PROGRAM

14.a. NATIONAL REGISTER CRITERION:
a. SIGNIFICANT UNDER CRITERION A.
b. SIGNIFICANT UNDER CRITERION B.
c. SIGNIFICANT UNDER CRITERION C.
d. SIGNIFICANT UNDER CRITERION D.

15. TYPE OF FORM: **11 - ARCHAEOLOGICAL SITE FORM VI**

16. RECORDER'S STATUS:
1. NCAC MEMBER
2. AMATEUR
3. UNKNOWN
4. OTHER
5. STUDENT

17. FORM RELIABILITY:
1. CODING COMPLETE
2. CODING INCOMPLETE
3. CODING UNRELIABLE

18. LOCATION RELIABILITY:
1. ACCURATE
2. WITHIN 100M RADIUS
3. UNRELIABLE
4. UNKNOWN LOCATION
5. WITHIN 500M RADIUS
6. WITHIN 1KM RADIUS

19. RESEARCH POTENTIAL:

20. POTENTIAL IMPACTS ARTIFICIAL: **Destruction**

21. POTENTIAL IMPACTS ENVIRONMENTAL:

22. EXPLANATION OF IMPACTS: Within the expansion area of a landfill

23. RECOMMENDATIONS: **ineligible**

24. EXPLAIN RECOMMENDATIONS:

25. DATE ON REGISTER

26. EXCAVATION DATE:

27. INSTITUTION EXCAVATING:

CODE:

28. EXCAVATION RESULTS:

29. PERCENT DESTROYED:

30. DATE DESTROYED:

31. CAUSES OF DESTRUCTION:

ENVIRONMENTAL INFORMATION

32. TOPOGRAPHIC SITUATION: Upland Ridge

33. ELEVATION:FT. **2,650 ft. AMSL**

34. SLOPE PERCENT: **0**

35. SLOPE FACE DIRECTION:

36. SOIL COMPOSITION: 5 cm of topsoil over subsoil

37. SCS SOIL TYPE CODE:

SERIES NAME: **undetermined**

ASSOCIATION: undetermined

38. MODERN VEGETATION bulldozed, but surrounded by hardwood

39. DISTANCE TO WATER: (METERS) 213 40. (YARDS) 195

41. TYPE OF NEAREST PERMANENT WATER: unnamed stream

42. STREAM RANK: 2

43. DRAINAGE BASIN: Pigeon

SITE EVALUATION AND CONDITION

44. SITE CONDITION NATURAL: heavily eroded

45. SITE CONDITION ARTIFICIAL: recent bulldozing

46. GROUND VISIBILITY: 100%

47. COLLECTION MADE: surface

48. COLLECTION STRATEGY: total

49. AREA COVERED SQUARE METERS: 1sqm

50. SUBSURFACE TESTING: 1 adjacent STP

51. SUBSURFACE TESTING METHODS: judgmentally placed STP

52. SUBSURFACE TEST RESULTS: sterile

53. SITE SIZE: 1x1m

PREHISTORIC SITE INFORMATION

54. PREHISTORIC COMPONENTS: unknown prehistoric

55. PREHISTORIC SITE FUNCTION: temporary camp? hunting or gathering?

56. MIDDEN: absent

57. FAUNAL/ETHNO BOTANICAL REMAINS: absent

58. FEATURE DESCRIPTION: absent

59. TOOL TYPES: none 60. FREQUENCIES:

61. LITHICS: 1 flake

62. PREHISTORIC - MISCELLANEOUS ITEMS/SAMPLES: none

63. CERAMIC TEMPER 1 64. SURFACE TREATMENT 1

65. CERAMIC TEMPER 2

66. SURFACE TREATMENT 2

67. CERAMIC TEMPER 3

68. SURFACE TREATMENT 3

HISTORIC SITE INFORMATION

69. PERIOD OF OCCUPATION BEGIN:

70. PERIOD OF OCCUPATION END:

71. REFINED DATE FROM:

72. REFINED DATE TO:

73. HISTORIC CULTURAL AFFILIATIONS:

74. HISTORIC SITE DEFINITION:

75. HISTORIC REMAINS DESCRIPTION:

76. MAIN STRUCTURE FUNCTION:

77. NUMBER OF OUTBUILDINGS:

78. OUTBUILDING DISTANCE:

79. OUTBUILDINGS FUNCTION:

80. OUTBUILDING DESCRIPTION:

81. KITCHEN GROUP:

82. ARCHITECTURAL GROUP:

83. ARMS GROUP:

84. MILITARY OBJECTS:

85. CLOTHING GROUP:

86. PERSONAL GROUP:

87. TOBACCO PIPE GROUP:

88. ACTIVITIES GROUP:

89. HISTORIC MISC:

90. DATEABLE CERAMICS:

ADDITIONAL SITE INFORMATION

91. ARTIFACT INVENTORY: **1 unspecialized quartz flake**

92. CURATION FACILITY: **To be Determined**

93. ACCESSION NUMBER(S):

94. ACCESSION DATE(S):

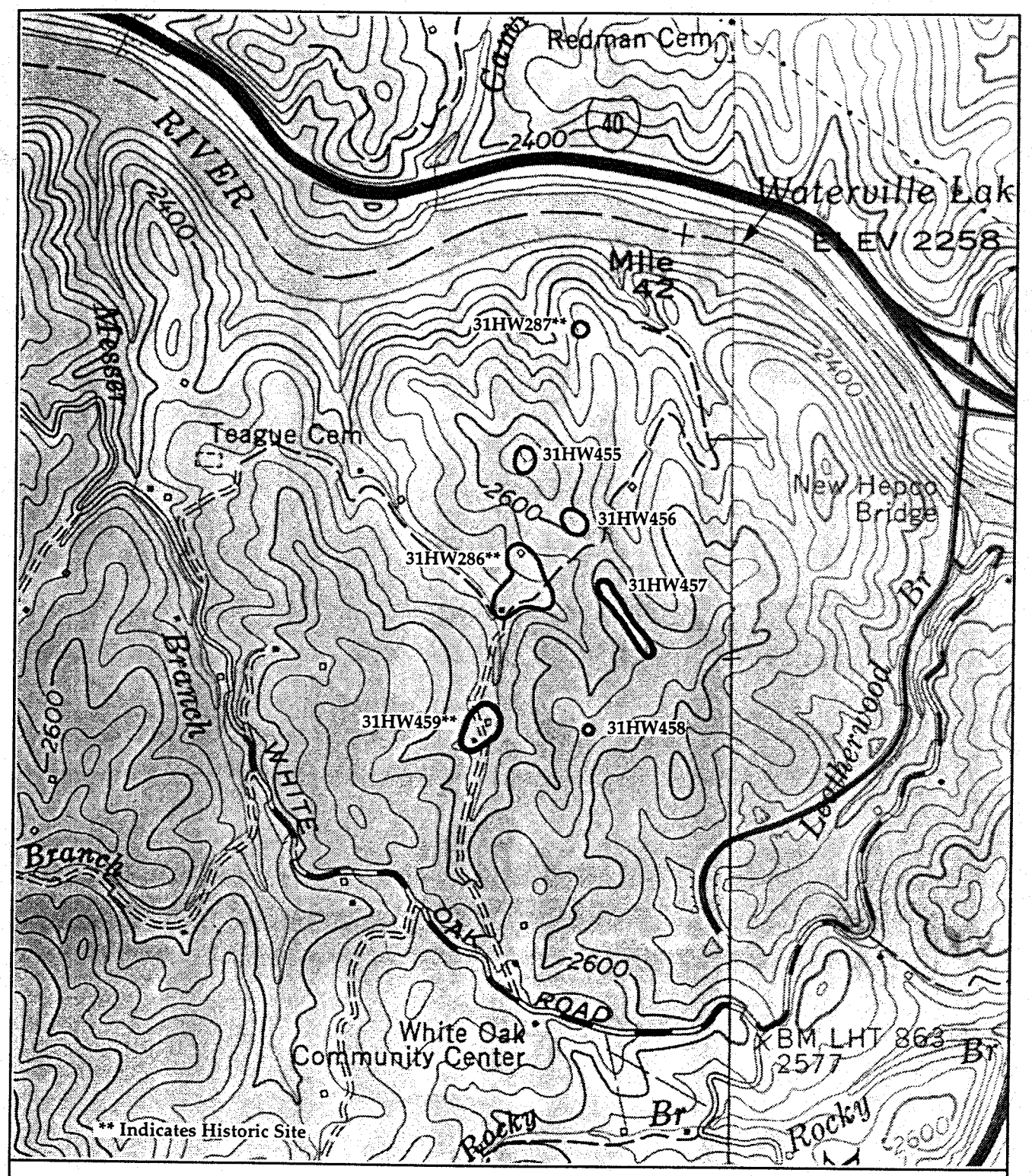
95. OTHER CURATION FACILITY:

96. OTHER ACCESSION NUMBER(S):

97. OWNER/TENANT INFORMATION:

98. BIBLIOGRAPHIC REFERENCE #'S **Patrick H. Garrow, 1998, *Phase I Cultural Resource Survey of the Proposed Haywood County Landfill Expansion Site, Haywood County, North Carolina.* TRC Garrow Associates Inc., Atlanta. Submitted to Municipal Engineers, Garner, N.C.**

99. COMMENTS/NOTES:



contour interval = 40 feet

0 mile 1

0 feet 4000

0 kilometer 1

North

PROJECT AREA

Map source: Cove Creek Gap/Pine Creek, N.C. Quadrangles, 7.5 minute 1967,1987/1967,1976

NORTH CAROLINA ARCHAEOLOGICAL SITE FORM
OFFICE OF STATE ARCHAEOLOGY / DIVISION OF ARCHIVES AND HISTORY

1. STATE SITE NUMBER: **31HW459****

2. SITE NAME(S): **none**

3. OTHER SITE NUMBER:

4. INSTITUTION ASSIGNING: **TRC Garrow Associates. Inc.**

5. PROJECT SITE NUMBER:

6. SITE COMPONENT: **20th century historic**

7. QUAD MAP: **Cove Creek, NC** CODE:

8. UTM ZONE: **17** NORTHING: **3948 030** EASTING: **318 380**

9. COUNTY: **Haywood** DATE RECORDED: **7/8/98**

RECORDED BY: **Christopher T. Espenshade**

PROJECT NAME: **Haywood County Landfill Expansion**

11. RESULT OF COMPLIANCE PROJECT: **Yes**

12. ER/CH/GRANT#:

13. CODING DATE: CODED BY:

DIRECTIONS TO SITE:

>>> ATTACH USGS OR OTHER DETAILED SITE MAP <<<

14-18. OSA RESERVED CODES

14. NATIONAL REGISTER STATUS:
1. DETERMINED ELIGIBLE
2. PLACED ON STUDY LIST
3. APPROVED FOR NOMINATION BY SPRC
4. CURRENTLY LISTED ON NRHP
5. REMOVE FROM NRHP
6. NOT ELIGIBLE AFTER EVALUATION
7. UNASSESSED
8. NC ARCHAEOLOGICAL RECORDING PROGRAM

14.a. NATIONAL REGISTER CRITERION:
a. SIGNIFICANT UNDER CRITERION A.
b. SIGNIFICANT UNDER CRITERION B.
c. SIGNIFICANT UNDER CRITERION C.
d. SIGNIFICANT UNDER CRITERION D.

15. TYPE OF FORM: **11 - ARCHAEOLOGICAL SITE FORM VI**

16. RECORDER'S STATUS:
1. NCAC MEMBER
2. AMATEUR
3. UNKNOWN
4. OTHER
5. STUDENT

17. FORM RELIABILITY:
1. CODING COMPLETE
2. CODING INCOMPLETE
3. CODING UNRELIABLE

18. LOCATION RELIABILITY:
1. ACCURATE
2. WITHIN 100M RADIUS
3. UNRELIABLE
4. UNKNOWN LOCATION
5. WITHIN 500M RADIUS
6. WITHIN 1KM RADIUS

19. RESEARCH POTENTIAL:

20. POTENTIAL IMPACTS ARTIFICIAL: **Destruction**

21. POTENTIAL IMPACTS ENVIRONMENTAL:

22. EXPLANATION OF IMPACTS: Within the expansion area of a landfill

23. RECOMMENDATIONS: **ineligible**

24. EXPLAIN RECOMMENDATIONS: **site is heavily eroded, is recent, and lacks significant deposits**

25. DATE ON REGISTER

26. EXCAVATION DATE:

27. INSTITUTION EXCAVATING:

CODE:

28. EXCAVATION RESULTS:

29. PERCENT DESTROYED:

30. DATE DESTROYED:

31. CAUSES OF DESTRUCTION:

ENVIRONMENTAL INFORMATION

32. TOPOGRAPHIC SITUATION: uplands and floodplain

33. ELEVATION:FT. **2,540-2,568 ft AMSL**

34. SLOPE PERCENT:

35. SLOPE FACE DIRECTION: Cove setting

36. SOIL COMPOSITION: 10-35 cm of toposoil over subsoil

37. SCS SOIL TYPE CODE:

SERIES NAME: **undetermined**

ASSOCIATION: undetermined

38. MODERN VEGETATION cleared

39. DISTANCE TO WATER: **(METERS) 0** 40. **(YARDS) 0**

41. TYPE OF NEAREST PERMANENT WATER: **unnamed stream**

42. STREAM RANK: **2**

43. DRAINAGE BASIN: **Pigeon**

SITE EVALUATION AND CONDITION

44. SITE CONDITION NATURAL: **heavily eroded**

45. SITE CONDITION ARTIFICIAL:

46. GROUND VISIBILITY: **%0-100%**

47. COLLECTION MADE: **Shovel test only**

48. COLLECTION STRATEGY: **Shovel test artifacts**

49. AREA COVERED SQUARE METERS: **612**

50. SUBSURFACE TESTING: **8 STPs**

51. SUBSURFACE TESTING METHODS: **judgmentally placed STPs**

52. SUBSURFACE TEST RESULTS: 7 sterile, 1 positive

53. SITE SIZE: **91 x 67 m; 277x 204 ft.**

PREHISTORIC SITE INFORMATION

54. PREHISTORIC COMPONENTS:

55. PREHISTORIC SITE FUNCTION:

56. MIDDEN:

57. FAUNAL/ETHNO BOTANICAL REMAINS:

58. FEATURE DESCRIPTION:

59. TOOL TYPES: 60. FREQUENCIES:

61. LITHICS:

62. PREHISTORIC - MISCELLANEOUS ITEMS/SAMPLES:

63. CERAMIC TEMPER 1 64. SURFACE TREATMENT 1

65. CERAMIC TEMPER 2

66. SURFACE TREATMENT 2

67. CERAMIC TEMPER 3

68. SURFACE TREATMENT 3

HISTORIC SITE INFORMATION

69. PERIOD OF OCCUPATION BEGIN: **twentieth century**

70. PERIOD OF OCCUPATION END: **late twentieth century**

71. REFINED DATE FROM:

72. REFINED DATE TO:

73. HISTORIC CULTURAL AFFILIATIONS: **farmstead**

74. HISTORIC SITE DEFINITION:

75. HISTORIC REMAINS DESCRIPTION: **residence, shed, and barn, all deteriorated and associated grounds**

76. MAIN STRUCTURE FUNCTION: **residence**

77. NUMBER OF OUTBUILDINGS: **2**

78. OUTBUILDING DISTANCE: **one adjacent (shed), one barn 60 ft from residence**

79. OUTBUILDINGS FUNCTION: **storage shed and barn**

80. OUTBUILDING DESCRIPTION: **10 x 10 ft frame storage shed w/tin roof, and collapsed loft barn with reused logs**

81. KITCHEN GROUP: **ceramics, bottle glass, child proof medicine cap**

82. ARCHITECTURAL GROUP: **window glass**

83. ARMS GROUP:

84. MILITARY OBJECTS:

85. CLOTHING GROUP: **leather scrap**

86. PERSONAL GROUP:

87. TOBACCO PIPE GROUP:

88. ACTIVITIES GROUP:

89. HISTORIC MISC:

90. DATEABLE CERAMICS: **plain white ironstone (1840-present)**

ADDITIONAL SITE INFORMATION

91. ARTIFACT INVENTORY: **2 milk glass canning seal sherds, 1 sherd of amber bottle glass, one plain clear table glass sherd, 1 plastic child-proof cap, 1 piece of indeterminate plastic, 1 piece of unidentified leather, 2 sherds of clear bottle glass, 1 sherd of light green plate window glass (2.5 mm), and 2 sherds of plain white ironstone**

92. CURATION FACILITY:

93. ACCESSION NUMBER(S):

94. ACCESSION DATE(S):

95. OTHER CURATION FACILITY:

96. OTHER ACCESSION NUMBER(S):

97. OWNER/TENANT INFORMATION:

98. BIBLIOGRAPHIC REFERENCE #'S **Patrick H. Garrow, 1998, *Phase I Cultural Resource Survey of the Proposed Haywood County Landfill Expansion Site, Haywood County, North Carolina.* TRC Garrow Associates Inc., Atlanta. Submitted to Municipal Engineers, Garner, N.C.**

99. COMMENTS/NOTES:

NORTH CAROLINA ARCHAEOLOGICAL SITE FORM
OFFICE OF STATE ARCHAEOLOGY / DIVISION OF ARCHIVES AND HISTORY

1. STATE SITE NUMBER: **31HW286****

2. SITE NAME(S):

3. OTHER SITE NUMBER:

4. INSTITUTION ASSIGNING: **Western Carolina University/TRC Garrow Associates Inc.**

5. PROJECT SITE NUMBER:

6. SITE COMPONENT: **20th Century Historic with minor unknown prehistoric**

7. QUAD MAP: **Cove Creek, NC** CODE:

8. UTM ZONE: **17** NORTHING: **3948 340** EASTING: **318 460**

9. COUNTY: **Haywood** DATE RECORDED: **latest, 7/8/98**

RECORDED BY: **latest, Christiopher T. Espenshade**

PROJECT NAME: **Haywood County Landfill Expansion**

11. RESULT OF COMPLIANCE PROJECT: **Yes**

12. ER/CH/GRANT#:

13. CODING DATE: CODED BY:

DIRECTIONS TO SITE: **see attached map**

>>> ATTACH USGS OR OTHER DETAILED SITE MAP <<<

14-18. OSA RESERVED CODES

14. NATIONAL REGISTER STATUS:
1. DETERMINED ELIGIBLE
2. PLACED ON STUDY LIST
3. APPROVED FOR NOMINATION BY SPRC
4. CURRENTLY LISTED ON NRHP
5. REMOVE FROM NRHP
6. NOT ELIGIBLE AFTER EVALUATION
7. UNASSESSED
8. NC ARCHAEOLOGICAL RECORDING PROGRAM

14.a. NATIONAL REGISTER CRITERION:
a. SIGNIFICANT UNDER CRITERION A.
b. SIGNIFICANT UNDER CRITERION B.
c. SIGNIFICANT UNDER CRITERION C.
d. SIGNIFICANT UNDER CRITERION D.

15. TYPE OF FORM: **11 - ARCHAEOLOGICAL SITE FORM VI**

16. RECORDER'S STATUS:
1. NCAC MEMBER
2. AMATEUR
3. UNKNOWN
4. OTHER
5. STUDENT

17. FORM RELIABILITY:
1. CODING COMPLETE
2. CODING INCOMPLETE
3. CODING UNRELIABLE

18. LOCATION RELIABILITY:
1. ACCURATE
2. WITHIN 100M RADIUS
3. UNRELIABLE
4. UNKNOWN LOCATION
5. WITHIN 500M RADIUS
6. WITHIN 1KM RADIUS

19. RESEARCH POTENTIAL:

20. POTENTIAL IMPACTS ARTIFICIAL: **Destruction**

21. POTENTIAL IMPACTS ENVIRONMENTAL:

22. EXPLANATION OF IMPACTS:

23. RECOMMENDATIONS: **ineligible**

24. EXPLAIN RECOMMENDATIONS: heavily eroded, recent, lack of significant deposits

25. DATE ON REGISTER

26. EXCAVATION DATE:

27. INSTITUTION EXCAVATING:

CODE:

28. EXCAVATION RESULTS:

29. PERCENT DESTROYED:

30. DATE DESTROYED:

31. CAUSES OF DESTRUCTION:

ENVIRONMENTAL INFORMATION

32. TOPOGRAPHIC SITUATION: Uplands

33. ELEVATION:FT. **2,500-2,570 ft AMSL**

34. SLOPE PERCENT: **0-25%**

35. SLOPE FACE DIRECTION: cove setting

36. SOIL COMPOSITION: 6 cm of topsoil over subsoil

37. SCS SOIL TYPE CODE:

SERIES NAME: **undetermined**

ASSOCIATION: undetermined

38. MODERN VEGETATION cleared

39. DISTANCE TO WATER: **(METERS) 0** 40. **(YARDS) 0**

41. TYPE OF NEAREST PERMANENT WATER: **unnamed stream**

42. STREAM RANK: **2**

43. DRAINAGE BASIN: **Pigeon**

SITE EVALUATION AND CONDITION

44. SITE CONDITION NATURAL: **heavily eroded**

45. SITE CONDITION ARTIFICIAL:

46. GROUND VISIBILITY: **%0-100%**

47. COLLECTION MADE: **Shovel test recovery**

48. COLLECTION STRATEGY: **Shovel test recovery**

49. AREA COVERED SQUARE METERS: **16,723/180,000 sq ft**

50. SUBSURFACE TESTING: **2 STPs**

51. SUBSURFACE TESTING METHODS: **judgmentally placed STPs**

52. SUBSURFACE TEST RESULTS: 1 sterile, 1 positive

53. SITE SIZE: **91 x 183 m/ 300 x 600 ft**

PREHISTORIC SITE INFORMATION

54. PREHISTORIC COMPONENTS: **Unknown prehistoricx**

55. PREHISTORIC SITE FUNCTION: **temporary camp?**

56. MIDDEN: **absent**

57. FAUNAL/ETHNO BOTANICAL REMAINS: **absent**

58. FEATURE DESCRIPTION: **absent**

59. TOOL TYPES: **undiagnostic PPKs** 60. FREQUENCIES:

61. LITHICS: **flakes**

62. PREHISTORIC - MISCELLANEOUS ITEMS/SAMPLES:

63. CERAMIC TEMPER 1 **grit** 64. SURFACE TREATMENT 1 **eroded**

65. CERAMIC TEMPER 2 **limestone**

66. SURFACE TREATMENT 2 **eroded**

67. CERAMIC TEMPER 3

68. SURFACE TREATMENT 3

HISTORIC SITE INFORMATION

69. PERIOD OF OCCUPATION BEGIN: **twentieth century**

70. PERIOD OF OCCUPATION END: **late twentieth century**

71. REFINED DATE FROM:

72. REFINED DATE TO:

73. HISTORIC CULTURAL AFFILIATIONS:

74. HISTORIC SITE DEFINITION: **farmstead**

75. HISTORIC REMAINS DESCRIPTION: **1 residence, 1 shed/root cellar, and 1 barn**

76. MAIN STRUCTURE FUNCTION: **residence**

77. NUMBER OF OUTBUILDINGS: **2**

78. OUTBUILDING DISTANCE: **40 ft to shed, 325 ft to barn**

79. OUTBUILDINGS FUNCTION: **storage shed/root cellar and barn**

80. OUTBUILDING DESCRIPTION: **frame storage shed over a brick-faced root cellar, barn with hand hewn log frame**

81. KITCHEN GROUP: **ceramics, bottle glass**

82. ARCHITECTURAL GROUP: **green plate window glass**

83. ARMS GROUP:

84. MILITARY OBJECTS:

85. CLOTHING GROUP:

86. PERSONAL GROUP:

87. TOBACCO PIPE GROUP:

88. ACTIVITIES GROUP:

89. HISTORIC MISC:

90. DATEABLE CERAMICS:

ADDITIONAL SITE INFORMATION

91. ARTIFACT INVENTORY: **1990 inventory: 1 chert PPK, 1 quartz PPK, 3 chert flakes, two chalcedony flakes, 2 eroded grit tempered sherds, 1 eroded limestone tempered sherd, 1 unspecified whiteware ceramic, sherds of clear and bottle glass, milk glass**

1998 inventory: 2 clear bottle glass sherds, 1 sherd of green plate window glass (2.5 mm)

92. CURATION FACILITY: **To be Determined**

93. ACCESSION NUMBER(S):

94. ACCESSION DATE(S):

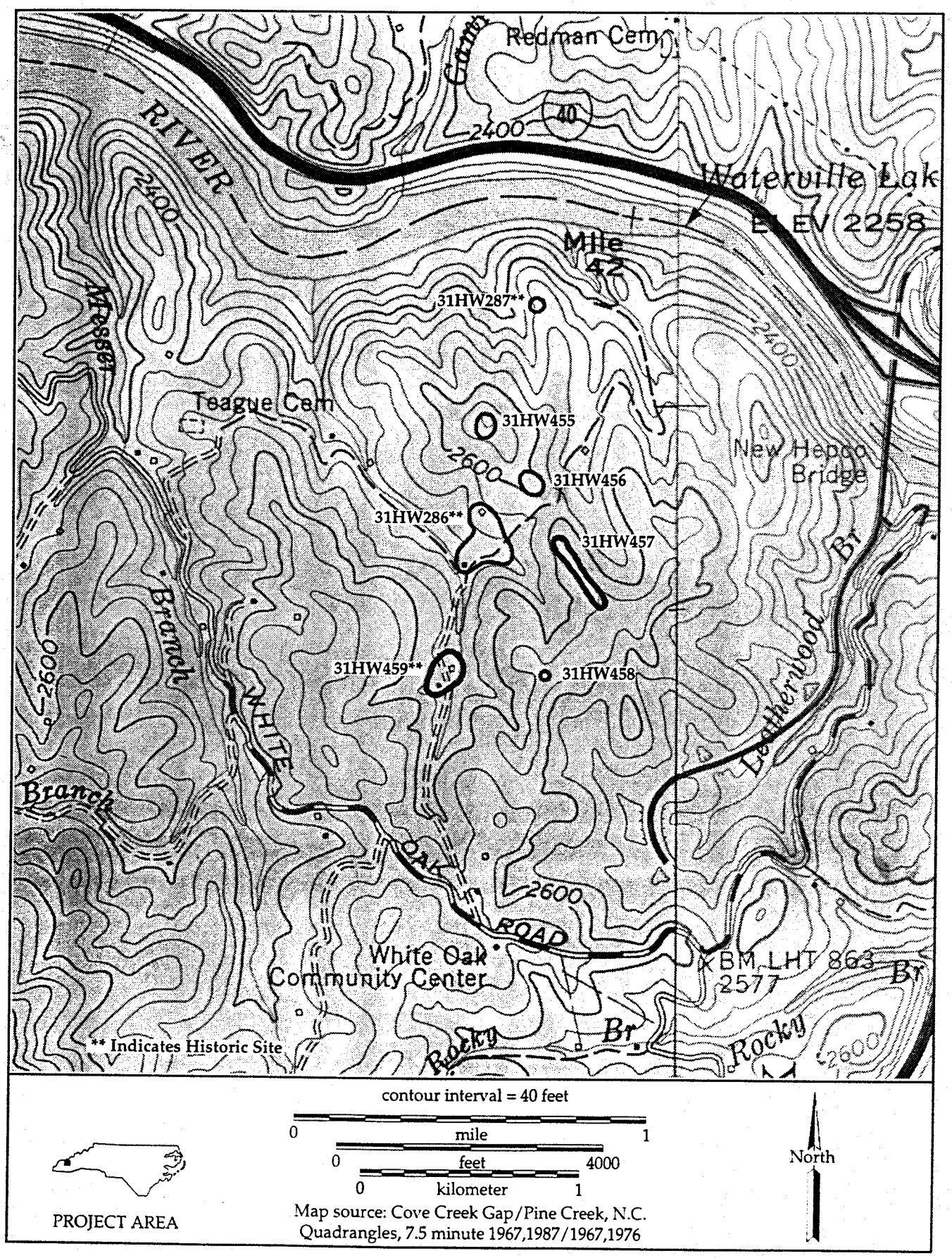
95. OTHER CURATION FACILITY:

96. OTHER ACCESSION NUMBER(S):

97. OWNER/TENANT INFORMATION:

98. BIBLIOGRAPHIC REFERENCE #'S **Patrick H. Garrow, 1998, *Phase I Cultural Resource Survey of the Proposed Haywood County Landfill Expansion Site, Haywood County, North Carolina.* TRC Garrow Associates Inc., Atlanta. Submitted to Municipal Engineers, Garner, N.C.**

99. COMMENTS/NOTES: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Creek
RIVER
2400
40
Waterville Lak
ELEV 2258
Mile
42
31HW287**
2400
Teague Cem
31HW455
New Hepco
Bridge
2600
31HW456
31HW286**
31HW457
Branch
Br
2600
31HW459**
31HW458
Leatherwood
WHITE
Branch
OAK
2600
ROAD
White Oak
Community Center
BM LHT 863
2577
Br
** Indicates Historic Site
Rocky
Br
Rocky
2600
contour interval = 40 feet
0
mile
1
0
feet
4000
0
kilometer
1
North
PROJECT AREA
Map source: Cove Creek Gap/Pine Creek, N.C.
Quadrangles, 7.5 minute 1967,1987/1967,1976

APPENDIX 2

RESUMES OF KEY PROJECT PERSONNEL

CHRISTOPHER T. ESPENSHADE

EDUCATION

M.A., Anthropology, University of Florida, 1983
B.A., Anthropology, Wake Forest University, 1979

PROFESSIONAL REGISTRATIONS

Certified, Society of Professional Archaeologists, 1983

TECHNICAL SPECIALTIES

Mr. Espenshade has 19 years of experience encompassing:

- Historical Archaeology
- Caribbean Archaeology
- Shell Midden Archaeology
- Ceramic Technology
- Georgia Prehistory

REPRESENTATIVE EXPERIENCE

Mr. Espenshade is Atlanta Branch Manager and Senior Archaeologist for TRC Garrow Associates Inc. He has a broad base of 19 years of experience in the archaeology of the Southeastern United States and the Caribbean. In addition to serving as Project Archaeologist or Principal Investigator on over 300 projects, Mr. Espenshade has developed specialized expertise in several key areas.

Historical Archaeology

Data Recovery at 38BU5, a Nineteenth Century Slave Row, Spring Island, South Carolina. Served as Principal Investigator and Ceramicist for data recovery investigations at the 38BU5 slave row. The study focused on Africanisms, the intra- and inter-plantation exchange systems, and diachronic changes in the use contexts of slave-made pottery.

Data Recovery at the Haralson Mill Site, Rockdale County, Georgia. Served as Principal Investigator for the research at the Haralson Mill site. The mill complex began with a small overshot sawmill in the 1870s and quickly expanded to include a second gristmill, a cotton gin, a furniture shop, a syrup mill, a store, and a blacksmith shop. The investigations included extensive excavation, oral history, and archival research.

Survey of a Portion of the New Hope Church Civil War Battlefield, Georgia. Served as Principal Investigator on the archaeological survey of 63 acres of the New Hope Church battlefield. Field survey, oral history, and archival research were combined to demonstrate the former presence of extensive earthworks in the study tract. Subsequently, the developer donated the most historically significant portion of the tract to the Georgia Civil War Commission.

Antebellum Site Survey, Parris Island Marine Recruit Depot, South Carolina. Under a Legacy grant, Mr. Espenshade served as Principal Investigator for the investigation of antebellum sites

on Parris Island. The project included extensive archival research, survey of 500 acres, and evaluation of discovered sites. The findings demonstrated that the island was formerly dominated by working plantations whose owners resided in nearby Beaufort.

Archaeological Data Recovery at Empire Mill, for Moreland Altobelli Associates, Cobb County, Georgia. Mr. Espenshade served as Principal Investigator for the data recovery investigations of the site of a postbellum flour mill. The research demonstrated a shift in motive power from a water-powered turbine to steam power. The mill operated from 1873 through 1896, and was exclusively a commercial operation.

Data Recovery at 38BU791, Bonny Shore Slave Row, for Spring Island Plantation, Beaufort County, South Carolina. Data recovery at this circa 1820-1860 slave row included hand excavated blocks and machine-assisted stripping. The project documented the late manufacture and use of Colonoware pottery.

Data Recovery at 38BU647, Colleton River Slave Community, for Colleton River Plantation, South Carolina. Mr. Espenshade served as Principal Investigator for the data recovery excavations at 38BU647. The 1815-1840 slave row was marked by the tabby chimneys from 21 slave cabins. The data recovery included the excavation of 50 x 50 cm units on 5 m intervals over the entire site, and block excavation of three complete structure locations. The work was supported by Colleton River Plantation.

Testing in the New Bern Historic District, North Carolina. Served as Principal Investigator on the archaeological evaluation of two blocks in the New Bern National Register district. The project included tract-specific history and map research and the field excavation of 24 5 x 5 ft units. The testing was successful in locating architectural and refuse features dating from the early 1800s through the 1930s.

Data Recovery at Camp Baird, Mitchellville, and 38BU967, Hilton Head, South Carolina. Served as Principal Investigator for investigations of three aspects of African American lifeways on Hilton Head Island. Camp Baird was the autumn 1864 encampment of the 32nd U.S. Colored Troops. Mitchellville was a freedman camp established by the federal government in 1864 to handle the large numbers of former slaves flocking to Hilton Head. Site 38BU967 is an African American, postbellum house site.

Caribbean Archaeology

Survey and Testing, Parcel 2, Estate Granard, St. Croix, U.S. Virgin Islands. Served as Principal Investigator on the survey and testing of Parcel 2, Estate Granard. The tract contained a small historic scatter and a portion of an NRHP-listed Native American site. The testing verified the presence of protohistoric period refuse of high research value. The options of preservation in place or data recovery excavation were presented.

Survey and Site Testing, Río de la Plata Flood Control Project, Puerto Rico. Served as Principal Investigator for the survey and site testing along Río de la Plata in north-central Puerto Rico. The project included archaeological survey, evaluation of three archaeological sites, and architectural evaluation of several structures. Of great interest was the discovery of two Native American sites dating to the period of earliest Spanish occupation.

Backhoe Survey, Turpentine Run, St. Thomas, U.S. Virgin Islands. Served as Principal Investigator for the deep testing of a small floodplain on Turpentine Run in southeastern St.

Thomas. Six backhoe trenches, each 10.0 m long x 2.0 m wide x 2.5 m deep, were excavated. Archaeological sampling and geomorphological interpretation verified that the floodplain was comprised of modern, extremely high energy deposits.

Data Recovery Excavations, PO-21, Cerillos Valley, Puerto Rico. Served as Field Director and Ceramicist for the data recovery excavation of an early Ostionoid hamlet site. Data recovery entailed the excavation of 38 2 x 2 m units and 91 linear m of backhoe trench. The results indicate that the site was occupied ca. A.D. 650, and the occupation was interrupted by a large-scale flood that effectively sealed the early deposits.

Archaeological Testing of Six Sites, Voice of America Radio Relay Station Tract, Cabo Rojo, Puerto Rico. Served as Principal Investigator for the evaluation of six sites in the extreme southwestern corner of Puerto Rico. The sites included a preceramic site on the tidal flats, a Saladoid shell midden, an Ostionoid shell midden, and a series of nineteenth century lime kilns. The results were interesting because the tract is the most arid portion of Puerto Rico.

Shell Midden Archaeology

Data Recovery at Minim Island, South Carolina. Served as Project Archaeologist and Ceramicist for the data recovery excavations at the Minim Island site. The site contained a shell midden deposit over two meters deep, encompassing the Early and Middle Woodland periods. The site was important in documenting the cultural interaction along a cultural boundary in the Early-Middle Woodland. The project was conducted for the U.S. Army Corps of Engineers, Charleston District.

Data Recovery at Four Wilmington Midden Sites, Colleton River Plantation, Beaufort County, South Carolina. Served as Principal Investigator and Ceramicist on data recovery excavations at four Middle Woodland shell midden sites at Colleton River. The project led to the definition of a midden type now known as "oystering stations," where large amounts of oysters were mass-processed for subsequent distribution and use. Colleton River Plantation sponsored the research.

Data Recovery at the Buck Hall Site, Francis Marion National Forest, South Carolina. In 1991, Mr. Espenshade served as Principal Investigator and Ceramicist on the data recovery excavations of Woodland and Mississippian shell middens at the Buck Hall site. The study included detailed co-occurrence and technological analyses of the recovered pottery. The work was sponsored by the National Park Service and the USDA-Forest Service.

Data Recovery at 38BU832, for Asset Management, Hilton Head Island, South Carolina. Mr. Espenshade served as Principal Investigator on the data recovery excavation of a small Wilmington period shell midden. The report was noteworthy for its critical review of the methods and results of seasonality studies on east coast middens.

Data Recovery Excavations at Site 38BU2, Spring Island, South Carolina. Served as Principal Investigator and Ceramicist on the 1994 data recovery of Late Archaic and Middle Woodland shell middens at 38BU2. The study highlighted functional differences among shell middens and offered a typology of Woodland midden types. The work was sponsored by Spring Island Company.

Georgia Prehistory

Survey of 18,352 Acres, Fort Stewart, Georgia. Served as Principal Investigator on the large-scale survey of Fort Stewart. The survey discovered 155 sites and 83 isolated finds. The results were utilized to refine the predictive model for the base.

Data Recovery Excavations at Six Prehistoric Sites, Big Haynes Creek Reservoir, Georgia. Served as Principal Investigator for the data recovery excavations at six prehistoric sites in Rockdale County, Georgia. The components spanned the Early Archaic through Historic Cherokee periods, with the major occupations in the Late Archaic.

Data Recovery Excavations at 9BL69, Milledgeville, Georgia. Served as Principal Investigator and Ceramicist on the data recovery excavations at the deeply stratified 9BL69. The site contained stratified deposits from the Early Archaic through the Late Mississippian periods. Major occupations occurred during the Morrow Mountain, Stallings, and Lamar phases.

Survey of 25,794 Acres, Strom Thurmond Reservoir, Georgia and South Carolina. Served as Principal Investigator on this massive upland survey for the U.S. Army Corps of Engineers, Savannah District. The survey was successful in validating a settlement model that stressed floodplain and ridge nose settings.

Data Recovery Excavations at 9Ri174, Augusta, Georgia. Served as Principal Investigator for the data recovery investigations at 9Ri174. The major site occupation occurred during the Lover's Lane phase of the Late Archaic. Site coverage with 50 x 50 cm units at 5 m intervals and scattered 2 x 2 m units allowed distribution mapping of various artifact classes. Despite site disturbance, a likely winter house pattern was delineated.

SELECTED PUBLICATIONS AND PRESENTATIONS

Published Articles

1998 The Changing Use Contexts of Slave-Made Pottery on the South Carolina Coast. In *African Impact on the Material Culture of the Americas*. The Museum of Early Southern Decorative Arts, Winston-Salem, North Carolina.

1998 Some Thoughts on Spalling on South Carolina Colonoware. In print, *African American Archaeology*, Spring 1998.

1998 Comment on the Inappropriateness of a Proposed Mean Ceramic Date (1780) for South Carolina Colonoware. In print, *African American Archaeology*, Spring 1998.

1997 Mimbres Pottery, Birth, and Gender: A Reconsideration. Submitted to *American Antiquity* 62(3).

1997 South Carolina Prehistoric Pottery: Reflections on the 1995 Conference at Georgetown, S.C. In *Indian Pottery of the Carolinas*, edited by D. G. Anderson. Council of South Carolina Professional Archaeologists, Columbia.

1995 Book Review: Fort Center. *Historical Archaeology* 29(4).

1983 Book Review: Archaeological Ceramics. *The Florida Journal of Anthropology* 8(1):54–58.

1981 The Lack of a Wilmington/Savannah Distinction at Kings Bay, Georgia. *Early Georgia* 9:25–32.

Selected Presented Papers

1996 The Changing Use Contexts of Slave-Made Pottery on the South Carolina Coast. Paper presented at the conference, African Impact on the Material Culture of the Americas, May 1996, Winston-Salem, North Carolina.

1995 An Early Ostionoid Vessel Assemblage from Site PO21, Cerillos Valley, Puerto Rico. Paper presented at the 60th Annual Meeting of the Society for American Archaeology, Minneapolis.

1994 With John Foss. Preliminary Geological and Archaeological Findings from Data Recovery Excavations at 9BL69, a Stratified Early Archaic through Mississippian Site, Oconee River, Georgia. Paper presented at the Second International Conference on Pedo-Archaeology, Columbia, South Carolina.

1994 Antebellum Lifeways on Parris Island, South Carolina. Lecture presented at the Autumn 1994 Meeting of the Beaufort County Historical Society, Beaufort, South Carolina.

1994 What is a Shell Midden? Paper presented at the 1994 Conference of Woodland Shell Midden Archaeology, Georgetown, South Carolina.

1990 The Early Woodland Ceramics from the Minim Island Site (38GE46), Georgetown County, South Carolina. Paper presented at the 16th Conference on South Carolina Archaeology, Columbia.

1987 With Dennis Blanton and Mary Beth Reed. Archaeological and Historical Investigations of Sligh Pottery: Stoneware Production in a Rural Industrial Complex. 20th Annual Meeting, Society for Historical Archaeology, Savannah, Georgia.

1986 Climbing on the Macro Band Wagon. Twelfth Annual Conference on South Carolina Archaeology, Columbia.

1984 Aboriginal Household Pottery Production at the Gauthier Site, Florida. 41st Annual Meeting of the Southeastern Archaeological Conference, Pensacola.

1983 Savannah Problems and Alachuan Interpretations: Ceramic Evidence from the Northeast Florida Coast. 40th Meeting of the Southeastern Archaeological Conference, Columbia.

1982 With Teresia R. Lamb and Robert C. Wilson. Ceramic Technology and the Typing of Undecorated Pottery from Southern Louisiana. 39th Annual Meeting of the Southeastern Archaeological Conference, Memphis.

Selected Contract Reports

1998 With Jeffrey Holland. An Intensive Look at Fort Stewart: Archaeological Survey of 18,352 Acres, Fort Stewart, Georgia.

1997 With David Jones and Linda Kennedy. Archaeological Investigations at 31ON190, Cape Island, Onslow County, North Carolina.

1997 With Jeff Holland. Rural Industry at Haralson Mill: Data Recovery Investigations at 9RO14, Big Haynes Creek Impoundment, Rockdale County, Georgia.

1996 With David Jones and Jeffrey Holland. Cultural Resource Survey and Testing of the Shepperd Tract, Charleston County, South Carolina.

1995 Phase I Survey of Parcel 2, with Intensive Evaluation of a Portion of 12VAm-140, Estate Granard, St. Croix, U.S. Virgin Islands.

1995 With Marian D. Roberts and M. Virginia Markham. Archaeological Data Recovery at 9CO344 and 9CO345, Cobb County, Georgia.

1994 With John Foss and Linda Kennedy. Furman Shoals in Prehistory: Archaeological Data Recovery at Site 9Bl69, Lake Sinclair Project, Baldwin County, Georgia.

1993 With Elsie Eubanks and Marian D. Roberts. Data Recovery Excavations at the Bonny Shore Slave Row, 38BU791, Spring Island, South Carolina.

1993 With B. G. Southerlin and Marian D. Roberts. Intensive Cultural Resources Survey, 22,003 Acres of FY94 Timber Harvest Tracts, Strom Thurmond Lake, Georgia and South Carolina.

1993 With Marian Roberts and C. Scott Butler. Intensive Archaeological Evaluation and Historical Research, Site 16AV48, Avoyelles Parish, Louisiana.

1992 With N. Ramirez Talavera, E. Schlafer-Román, and C. S. Butler. Archaeological and Architectural Evaluation of Five Sites and Archaeological Survey of the Río de la Plata Flood Control Project, Puerto Rico.

1992 With A. A. Chapman, B. G. Southerlin, C. M. Huddleston, M. D. Roberts, J. W. Gardner, D. Diener, and C. Scott Butler. Historical and Archaeological Investigations in Support of a Proposed Historic Properties Management Plan for John H. Kerr Dam and Reservoir near Boydton, Virginia.

1991 With Linda Kennedy. Data Recovery Investigations of Four Wilmington Phase Sites, Beaufort County, South Carolina: A Study in Middle Woodland Subsistence Strategies.

1991 With James B. Legg and Lynne M. Snyder. Camp Baird: Archaeological and Historical Investigations of the Autumn 1864 Camp of the 32nd U.S. Colored Infantry, Hilton Head Island, South Carolina.

1990 With Ramona Grunden. Contraband, Refugee, Freedman: Archaeological and Historical Investigations of the Western Fringe of Mitchellville, Hilton Head, South Carolina.

1988 With B. G. Southerlin. Limited Data Recovery Excavations at 16MO103 and 16MO60, Morehouse Parish, Louisiana.

1986 Data Recovery Excavations at Site PO-21, Cerillos River Valley, Puerto Rico.

PATRICK H. GARROW

EDUCATION

Further Graduate Studies, Anthropology, University of Georgia 1972 (Summer)
M.A., Anthropology, University of Georgia, 1968
B.A., Anthropology, University of Georgia, 1966
A.A., Christopher Newport College of the College of William and Mary, 1963

PROFESSIONAL REGISTRATIONS

Certified by the Society of Professional Archaeologists (1977)

TECHNICAL SPECIALTIES

Mr. Garrow has 32 years of experience encompassing:

- Historical Archaeology
- Prehistoric Archaeology
- Urban Archaeology
- Historic Cemetery Studies
- Cultural Resource Surveys
- Ethnohistory

REPRESENTATIVE EXPERIENCE

Mr. Garrow is Principal Archaeologist and Vice President of TRC Garrow Associates, Inc. His extensive experience in cultural resource studies has been gained during a 32-year career on projects conducted over much of the continental United States and the U.S. Caribbean. He has served as Principal Investigator, Project Manager, or Senior Technical Advisor for well over 650 projects.

Historical Archaeology

Cooper River Rediversion Canal, South Carolina. Served as Principal Investigator and report contributor for testing and data recovery investigations of the slave quarters of two Colonial-era plantations. The technical report and published articles produced as a result of this study are considered landmark documents in the development of African-American archaeology and the archaeological study of slavery.

Oxon Hill Manor, Prince Georges County, Maryland. Served as Principal Investigator and senior report author for a multi-year excavation and analysis study of a plantation site that dated from the early eighteenth century to the late nineteenth century. This project was the single largest archaeological investigation ever underwritten by the Maryland Department of Transportation.

East-West Connector, Cobb County, Georgia. Served as Principal Investigator and senior report author for survey, testing, and data recovery of a corridor proposed for road construction. Included were data recovery excavations and analyses of a late nineteenth to early twentieth century residence that had burned early in the twentieth century with its full contents. The origin and cause of the fire that consumed the house were determined, and the layout of the house and its material contents were reconstructed. This project provided valuable insights into the day-to-day life of a mill worker's family in northern Georgia at the turn of this century.

Telco Block, Manhattan, New York. Served as Project Manager for data recovery of a block in Lower Manhattan planned for construction of an office building. The site, located near the Fulton Fish Market and the Wall Street financial district, was continually used for commercial purposes from 1750, when the block was created with landfill, to the time of the excavation.

175 Water Street, Manhattan, New York. Served as Project Manager for the 175 Water Street block, which was adjacent to the Telco block (above) but done for a different client. The backyards of commercial establishments that had occupied the block from 1750 to the mid-twentieth century were intensively excavated. The most significant find made on this excavation was an intact, eighteenth century ship that had been intentionally sunk and used as a bulkhead during the creation of the block. The ship, 85 feet long and 26 feet wide, was the second-best preserved ship of that age or older (after the *Vassa*) that had been found worldwide up to that time. The identity of the ship was never established, but it was apparently built somewhere on the Chesapeake Bay in ca. 1710.

Wilmington Boulevard, Delaware. Served initially as Project Manager and later as Principal Investigator. Prepared a major portion of the report. The Wilmington Boulevard project covered a multi-block area of downtown Wilmington, Delaware, and was done for the Delaware Department of Transportation prior to construction of a ramp for I-95. The report produced as a result of this project is the basic comparative volume for urban archaeological projects in Wilmington.

Phoenix Blocks 1 and 2, Arizona. Served as Senior Technical Advisor and report co-author. This the first of a series of data recoveries conducted for the City of Phoenix, and was prepared to be the baseline comparative study for the city. The study area consisted of two blocks in the original town plan that had been part of a residential neighborhood since the 1870s. Extensive prehistoric and historic resources were found, and the prehistoric components were analyzed and reported by others.

New Bern Holiday Inn, North Carolina. Served as Principal Investigator and report co-author. The study site was a block on the waterfront in downtown New Bern that contained the archaeological remains of an eighteenth century tannery and a nineteenth century turpentine distillery. Archaeological testing was conducted on this site for Mardeck, Ltd.

Old San Juan Ballája Site, Puerto Rico. Served as Senior Technical Advisor. The Ballája project consisted of archaeological testing of two blocks in the oldest part of San Juan for the National Park Service. Extensive archaeological resources dating from the seventeenth to twentieth centuries were found and documented.

Knoxville GSA Courthouse, Tennessee. Served as Principal Investigator and senior report author. The GSA Courthouse site was a block in downtown Knoxville, Tennessee, that was proposed for construction of a new federal courthouse. The services provided on this project included background historical research, architectural survey and assessment, archaeological testing, and archaeological data recovery. The excavated features and deposits included one possible privy from the 1790s and numerous major features that dated from 1868 to ca. 1914. The investigations were done under contract to Barber & McMurry, Inc., for the General Services Administration.

Memphis Area Transit Authority Site, Tennessee. Served as Senior Technical Advisor and then as Principal Investigator and report author. This project involved background research, testing, and limited data recovery in the "Pinch" area of Memphis, Tennessee. The most intensively investigated resources were a large cistern and foundation related to the M&O Railroad, which went bankrupt in 1867. A very large collection of leather artifacts was recovered from the cistern and conserved.

Historic Cemetery Studies

Nancy Creek Primitive Baptist Church Cemetery, Georgia. Served as Principal Investigator and report co-author. This project, done in Chamblee, Georgia, involved moving 55 historic graves that were in the path of construction of a MARTA rail line. The work was done by a team that included grave removal specialists, archaeologists, and physical anthropologists. The graves were moved without incident, and the results were documented in a technical report.

Big Lazer Creek Cemetery, Georgia. Served as Principal Investigator and report co-author. This project was done under contract to the Georgia Department of Natural Resources and involved moving 12 graves exposed during construction of a fishing lake in Talbot County, Georgia. The graves were successfully moved and the results were documented in a project technical report.

Hopewell Baptist Church Litigation, Georgia. Served as Principal Investigator, Court's Expert, and Plaintiff's Expert Witness. This project was done as a part of a civil suit filed by a family against a church in the Atlanta, Georgia, area. The church was sued for bulldozing a portion of their own cemetery for planned construction without first moving the graves. Litigation lasted two and a half years, during which time Mr. Garrow was appointed as the Court's Expert and conducted several investigations in and around the cemetery. The 220 graves within the construction zone were eventually moved to a protected part of the cemetery, and 116 additional graves were preserved in place. The civil suit was decided in favor of the plaintiffs, and both actual and punitive damages were assessed against the church.

Cope Family Cemetery, North Carolina. Served as Principal Investigator and report author. This project was done for a private client in Raleigh, North Carolina, and involved monitoring the removal of over 20 graves from a small family cemetery. The purpose of the monitoring was to determine if intact graves were indeed present, as another contractor had previously claimed to have moved all human remains from the cemetery for reburial in a commercial cemetery. Each grave proved to be intact, and allegations of fraud on the part of the original contractor were supported.

Edwards-Attaway Cemetery, Georgia. Served as Principal Investigator, Expert Witness, and report author. The Edwards-Attaway cemetery project was a landmark case in terms of shaping the current Georgia burial law. A burial removal permit was initially granted under Georgia's previous law, but litigation resulted in that law being declared unconstitutional. A new law was passed, and the permit to move Edwards-Attaway was the first one granted under the new law. Parties opposed to the disinterment/reinterment immediately appealed the permit. The applicant also filed suit to test the new law's constitutionality. The permit was eventually affirmed and the new law upheld. The cemetery's 56 graves were archaeologically excavated and moved to a new cemetery. The project was documented in a technical report.

Small Cemetery Delineation Projects, Georgia. Served as Principal Investigator and report author for over 50 cemetery delineations under the current *Georgia Abandoned Cemeteries and Burial Grounds Act* for both private and public clients.

Cultural Resource Surveys

Chickamauga Reservoir Resurvey, Tennessee. Served as Principal Investigator for a multi-year survey of Chickamauga Reservoir in southern Tennessee that focused primarily on shoreline areas. This project was done for the Tennessee Valley Authority.

Proposed Champlain Pipeline Natural Gas Pipeline Corridor, Vermont, New Hampshire, and Massachusetts. Served as Senior Technical Advisor. This project investigated a proposed pipeline corridor that extended from the Canadian border in western Vermont to several points

in Massachusetts. This project was canceled after the background research and part of the archaeological survey was completed.

Turpentine Run Flood Control Project, St. Thomas, U.S. Virgin Islands. Served as Principal Investigator and report author. This project, conducted for the Jacksonville District of the Corps of Engineers, focused on creek improvement areas on the eastern end of St. Thomas.

Atlanta Gas Pipeline Corridor, Northwest Georgia. Served as Principal Investigator and report co-author. This project involved survey of a pipeline corridor for Atlanta Gas Light Company that extended from Ball Ground, Georgia, to Chattanooga, Tennessee. The corridor was rerouted around almost all significant sites and was constructed under a greatly restricted schedule.

Plant Vogtle Transmission Line Surveys, various locations in Georgia. Served as Principal Investigator, and editor, author, or co-author of a series of reports. This project involved investigation of over 300 miles of transmission line corridors that crossed Georgia from north to south and east to west. Over 300 archaeological sites were found and assessed, and testing and data recovery were done on sites that could not be avoided during construction.

Ethnohistory

Powhatan Tribes Ethnohistorical Research. This study involved extensive historical research on the Powhatan Indian tribes of eastern Virginia, based primarily on existing literature. The research was conducted in preparation of a master's thesis and was subsequently published as an issue of *The Chesopiean*, by the Chesopiean Archaeological Association.

Mattamuskeet Tribes Ethnohistorical Research. The Mattamuskeet study was done as an independent project while employed as a Senior Archaeologist by the State of North Carolina. The research used archival sources, primarily public records, to reconstruct the history of the Mattamuskeet Indians of eastern North Carolina. The research innovated the use of public archival records in ethnohistorical research and enabled the identification of contemporary descendants of the Mattamuskeets who had otherwise lost all knowledge of their Indian heritage.

PROFESSIONAL AFFILIATIONS AND PROFESSIONAL OFFICES HELD

Affiliations

Society of Professional Archaeologists (SOPA), since 1977
Society for Historical Archaeology (SHA)
Society for American Archaeology (SAA)
Southeastern Archaeological Conference (SEAC)
American Anthropological Association (AAA)
Georgia Council of Professional Archaeologists (GCPA)
Society for Georgia Archaeology (SGA)
Greater Atlanta Archaeological Society (GAAS)

Professional Offices Held

1978 President of the SGA
1981–1982 Member of the North Carolina National Register Review Board
1981–1984 Member of the Georgia National Register Review Board
1984 Delegate to the Southeast Cultural Resource Management Task Force, and Topic Spokesman at the 1984 SEAC

1986–1992 Editor, SGA Newsletter
1988–1990 Founder and Member of the Board of Directors of GAAS
1991–1993 Member of the Board of Directors of SGA
1992–1994 and 1997–1999 Member of the Board of Directors of the GCPA
1995–Present Member of the Public Education Committee, SAA
1995–1996 Member of the Native American Relations Committee, SAA
1996–Present Chairman of the Membership Committee, SAA
1996–1998 Second Alternate on the Standards Board, SOPA
1997–1997 SAA Representative on the SOPA Board of Directors
Conference Chairman, 1998 SHA Meeting

SELECTED PUBLICATIONS AND PRESENTATIONS

Books and Monographs

1970 Editor, with Wyman Trotti, *Readings in Cultural Anthropology*, Selected Academic Readings, Simon & Schuster, Inc., New York.
1973 With Marvin T. Smith, *The King Site (9Fl-5) Excavations April, 1971 through August, 1973: Collected Papers*. Patrick H. Garrow, Rome, Georgia.
1974 *An Ethnohistorical Study of the Powhatan Tribes*, The Chesopiean Archaeological Association 12(1–2), February-April, Norfolk, Virginia.
1975 *The Mattamuskeet Documents: A Study in Social History*, Archaeology Section, Division of Archives and History, Department of Cultural Resources, Raleigh, 3 printings.
1979 With Robert W. Foss and Silas D. Hurry, *Archaeological Investigations of the Edenton Snuff and Tobacco Manufacture*. North Carolina Archaeological Council No. 12. Raleigh, 2 printings.
1984 Editor, with Terry Klein, *Final Archaeological Investigations at the Wilmington Boulevard Monroe Street to King Street, Wilmington, Delaware*. Delaware Department of Transportation, Archaeological Series No. 29.
1992 Compiler, with George S. Lewis, *The Profile Papers*, The Society for Georgia Archaeology Special Publication No. 1.

Published Articles (Last Ten Years Only)

1989 A Preliminary Seriation of Coffin Hardware Forms in Nineteenth and Twentieth Century Georgia. *Early Georgia* 15(1–2):19–45.
1989 Ceramics as Reflectors of Nineteenth Century Social Life. In *Pottery and Porcelain on Peachtree Street*, edited by Delores M. Martin, pp. 67-79. Thirty-Fourth Annual Wedgwood International Seminar, Atlanta.
1989 Georgia Lamarchaeology. *The Profile* 63:9. The Society for Georgia Archaeology.
1989 The Bottle Glass/Ceramic Comparison: A Potential Tool for Comparing Socioeconomic Status Levels. *South Carolina Antiquities* 21(1–2):1–10.
1990 Colonoware Ceramics: The Evidence from Yaughan and Curriboo. In *Studies in South Carolina Archaeology: Essays in Honor of Robert L. Stephenson*. Anthropological Studies 8. Occasional Papers of the South Carolina Institute of Archaeology and Anthropology, Columbia. With Thomas R. Wheaton.
1992 Ahead to the Past. *The Profile* 75:8. The Society for Georgia Archaeology. With George S. Lewis.
1993 Ethics and Contract Archaeology. *Practicing Anthropology* 15(3):10–13. Reprinted in *SOPA Newsletter* 17(9/10):1–4.
1993 Analysis of Ceramics from an Early Twentieth Century Mill Worker's House in Cobb County, Georgia. *Ohio Valley Historical Archaeology* 10:55–66.
1994 The Remains of a Vanished Culture. *Federal Archeology Report* 7(1):3–4.

1994 Women in Contract Archaeology. In *Women in Archaeology*, edited by Cheryl Claason. University of Pennsylvania Press. With Barbara Avery Garrow and Pat A. Thomas.
1996 Woodstock Culture and the Question of Mississippian Emergence. *American Antiquity* 61(1):21–37. With Charles R. Cobb.
1996 The Gwinnett Stone Mounds. *Early Georgia*. In Press.

Selected Presented Papers (Last Ten Years Only)

1990 Archaeologists as Expert Witnesses. Presented before the 89th Annual Meeting of the American Anthropological Society, New Orleans.
1992 At Rest in the Arms of Hopewell. Presented before the Annual Meeting of the Society for Historical Archaeology, Kingston, Jamaica.
1992 Ethics and Contract Archaeology. Presented before the Annual Meeting of the Society for Applied Anthropology, Memphis.
1992 The Status and Future of Urban Archaeology. Presented before the Annual Meeting of the Society for American Archaeology, Pittsburgh.
1992 Archaeological Investigations of the Sandy Creek Cemetery. Presented before the Spring Meeting of the Society for Georgia Archaeology, Savannah, Georgia.
1993 Analysis of Ceramics from an Early Twentieth Century Mill Worker's House in Cobb County, Georgia. Presented before the Annual Meeting of the Conference on Historic and Underwater Archaeology, Kansas City, and the Symposium on Ohio Valley Urban and Historical Archaeology, Makamba, Illinois.
1994 Archaeology and the Olympics. Presented before the Spring Meeting of the North Carolina Archaeological Society, Raleigh, North Carolina.
1994 Postbellum Life on Hilton Head Island: The Frazier Cabin Site. Presented before the Joint Annual Meeting of the Southeastern Archaeological Conference and the Midwest Archaeological Conference, Lexington, Kentucky.
1994 The Gwinnett Stone Mounds. Presented before the Spring Meeting of the Society for Georgia Archaeology, Statesboro, Georgia.
1995 Historic Cemetery Studies under the Georgia Abandoned Cemeteries and Burial Grounds Act. Presented before the Annual Meeting of the Conference on Historic and Underwater Archaeology, Washington, D.C.
1995 Archaeological Investigations of the Courthouse Block, Knoxville, Tennessee. Presented before the 7th Annual Meeting of Current Research in Tennessee Archaeology, Nashville.
1995 Archaeological Investigations of the Courthouse Block, Knoxville, Tennessee. Presented before the Annual Meeting of the Symposium on Ohio Valley Urban and Historical Archaeology, Greenville, Ohio.
1995 La Iglesía de Maragüez: A Local Ceremonial Center in the Cerillos River Valley, Ponce, Puerto Rico. Presented before the Annual Meeting of the Society for American Archaeology, Minneapolis.
1995 Excavation and Analysis of a Late 19th Century Privy in the Knoxville Commercial District. Presented before the Annual Meeting of the Southeastern Archaeological Conference, Knoxville, and the 1996 Annual Meeting of the Symposium on Ohio Valley Urban and Historical Archaeology, Louisville.
1995 Public Education on Cultural Resource Management Projects. Presented before the Annual Chacmool Conference, University of Calgary, Alberta, Canada.
1996 Archaeological Investigations of the Courthouse Block, Knoxville, Tennessee. Presented before the Annual Meeting of the Conference on Historic and Underwater Archaeology, Cincinnati, and the 17th Annual Meeting of the Mid-South Archaeological Conference, Memphis (June 1996).
1996 Urban Archaeology in Tennessee: Exploring the Cities of the Old South. Presented before the Annual Meeting of the Southeastern Archaeological Conference, Birmingham, Alabama.

WORK HISTORY

Vice President and Principal Archaeologist
TRC Garrow Associates Inc.
1997–present

Executive Vice President and Chief Corporate Archaeologist
Garrow & Associates, Inc.
1983–1997

Chief Corporate Archaeologist
Soil Systems, Inc.
1976–1983

Senior Archaeologist
Archaeology Section, Division of Archives and History,
Department of Cultural Resources, State of North Carolina
1974–1976

Field Director, King Site Project
University of Georgia
1974

Director, King Site Project
Shorter and Berry Colleges
1971–1973

Assistant Director
Carter's Dam Archaeological Project
1972

Director
Chieftains Excavation
1970–1971

Instructor of Anthropology
Shorter College
1970–1973

Instructor of Anthropology
Augusta College
1968–1970

Archaeological Consultant
Celanese Fibers Corporation, Rome, Georgia
1969

Syms–Eaton Museum, Hampton, Virginia
1968

Instructor of Sociology
Christopher Newport College
1968

Teaching Assistant
Department of Anthropology, University of Georgia
1967–1968

Assistant Director
West Point Archaeological Project
1967

Research Assistant, Labor Force Study
University of Georgia
1966

Assistant Supervisor
Bellfield Mound Excavation
1965

TRC

PROTECTED SPECIES SURVEY AND WETLANDS DELINEATION FOR THE PROPOSED HAYWOOD COUNTY LANDFILL EXPANSION, HAYWOOD COUNTY, NORTH CAROLINA

October 1998

TRC

MUNICIPAL ENGINEERING
RECEIVED
OCT 16 1998
SERVICES COMPANY

PROTECTED SPECIES SURVEY AND JURISDICTIONAL WETLANDS DELINEATION FOR THE PROPOSED HAYWOOD COUNTY LANDFILL EXPANSION, HAYWOOD COUNTY, NORTH CAROLINA

Submitted to:

Municipal Engineering Services Company, P.A.
P.O. Box 97
Garner, North Carolina 27529

Submitted by:
TRC Garrow Associates, Inc.
3772 Pleasantdale Road, Suite 200
Atlanta, Georgia 30340-4214
Project #24698

Field Investigation and Report Preparation by:

William R. Nethery, Senior Environmental Scientist
James V. Hamilton Jr., Environmental Scientist

October 12, 1998

PROTECTED SPECIES SURVEY AND JURISDICTIONAL WETLANDS DELINEATION FOR THE PROPOSED HAYWOOD COUNTY LANDFILL EXPANSION, HAYWOOD COUNTY, NORTH CAROLINA

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October 12 , 1998

EXECUTIVE SUMMARY

A protected species survey and jurisdictional wetlands delineation were conducted for a proposed expansion of the Haywood County Sanitary Landfill in Haywood County, North Carolina. The 35-acre expansion project area is in a 235-acre parcel just west of the Pigeon River, northwest of the intersection of I-40 and Fines Creek Road. The project area and adjacent portions of the property are mainly forest and pasture. The project property contains three ecological communities: Fallow Field, Pine-Hardwood Forest, and Mesic Hardwood Forest.

Information on previous occurrences of protected species near the project area was obtained from the U.S. Fish and Wildlife Service and the North Carolina Natural Heritage Program at the time of the survey. The project area contains marginal habitat for one state and federally protected plant and five state protected plants. The project area contains potential habitat for six state protected animal species. No state or federally protected species (or evidence such as remnant plant parts, burrows, or nests) were observed in the project area. We recommend return surveys in May for the state and federally protected small-whorled pogonia in relatively open forest areas within the proposed expansion project area.

A jurisdictional wetland that will be impacted by the proposed expansion exists in a drainage adjacent to a cell of the existing landfill. An additional wetland is associated with a pond on the western boundary of the project property. However, this wetland is not in the proposed expansion area and will never be impacted by the landfill activities. Several spring-fed streams are waters of the United States, which are also regulated by the U.S. Army Corps of Engineers (COE) under Section 404 of the Clean Water Act. This project may qualify for Nationwide Permit 26 for wetlands above headwaters or other Nationwide Permits if impacts to these stream channels become necessary. Nationwide Permit 26 allows no more than 500 total linear feet of stream impact. We recommend designing the facility to reduce or avoid wetland impacts to the extent practicable. Should impacts become necessary, a Pre-Construction Notification to the COE may be required for this project. We recommend a pre-application meeting with COE and other agency personnel to determine the most appropriate permitting scenario and to ensure that all agency concerns can be adequately addressed.

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1.0 INTRODUCTION

The proposed Haywood County Landfill Expansion project is approximately 35 acres on a parcel totaling 235 acres. The purpose of this study conducted by TRC Garrow Associates Inc. is twofold: (1) to survey for Federal and state rare and protected species and their habitats; (2) to identify and delineate all jurisdictional wetlands and waters of the United States.

Legally protected species include animals listed as Endangered, Threatened, Special Concern, or Extirpated by the North Carolina Wildlife Resources Commission (NCWRC); plants listed as Endangered, Threatened, or Special Concern by the North Carolina Department of Agriculture (NCDA); and plants and animals listed as Endangered or Threatened by the U.S. Fish and Wildlife Service (FWS 1989, 1990a, 1990b). Rare, but not legally protected, species include Candidates for federal listing by FWS and those listed as Candidates or as Significantly Rare by the North Carolina Natural Heritage Program (NCNHP). Efforts to accommodate these species found on a project area are encouraged but not required; such efforts help preserve a rare species before it becomes critically imperiled and legally protected.

Waters of the United States are protected under Section 404 of the Clean Water Act. Waters of the United States include wetlands, as well as areas that do not meet the criteria for wetlands, but that hold impounded or running water during some or all of the year. This term applies to such features as lakes, ponds, rivers, perennial and intermittent streams, and, in some cases, ditches. Wetlands are defined by the U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency as: "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (Environmental Laboratory 1987).

2.0 MATERIALS AND METHODS

2.1 Literature Review and Records Search

Lists of protected plant and animal species potentially occurring in the project area and their habitat requirements were obtained from NCNHP (1998) and FWS (1998). Additionally, specialized information was used to supplement these lists, including FWS (1994) and Kral (1983). Available specimens of rare and protected plant species were viewed at the University of Georgia (Athens) Botany Department Herbarium. The protected species information, including habitat requirements, is summarized in Appendix 1.

Information on plant and animal species identification, distribution, and habitat requirements was compiled from a number of sources, including field guides and distribution atlases: Brown and Kirkman (1990), Burt and Grossenheider (1976), Conant and Collins (1991), Foote and Jones (1989), Godfrey and Wooten (1979, 1981), LeGrand and Hall (1993), Radford et al. (1968), Scott (1988), Smith (1998), Snyder and Bruce (1986), and Weakley (1993). Information on ecological communities in the Blue Ridge region came primarily from (Schafele& Weakley 1990).

Additional resources utilized for community identification and potential wetlands locations included the Cove Creek Gap and Fines Creek, North Carolina quadrangle National Wetlands Inventory (NWI) maps (FWS 1987; 1976); soil survey maps; and the United States Geological

Survey (USGS) Cove Creek Gap and Fines Creek, North Carolina quadrangle 7.5 minute topographic maps (1976;1987). Information on geology of the study area was gathered from North Carolina Division of Mineral Resources. Mapped soil series were checked for hydric classification using Hydric Soils of the U.S. (SCS 1991). Common names are used in the text for plant and animal species; scientific names for rare and protected species are found in Appendix 1. Commonly found plants and animals are listed in Appendix 2.

2.2 Field Survey

Field investigations were conducted in May 1998, by William R. Nethery, Senior Environmental Scientist. Both alternate project areas were examined to determine ecological communities based on dominant vegetation. A pedestrian survey for rare and protected species and their habitats was conducted throughout the study areas. Locations of all plant communities and potential protected species habitats were recorded on field maps. Habitats and significant species were photographed.

Potential protected species habitats of marginal to high quality were surveyed more intensively than low quality, disturbed, or unsuitable habitats. One hundred percent of suitable habitats were surveyed within and adjacent to the project corridor by following transects 10-30 feet apart, depending on visibility and size of target organism. Habitats were searched less intensively for species listed as Significantly Rare by NCNHP or Candidates by FWS, which receive no legal protection, than for protected species.

The wetlands survey was conducted in accordance with the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and the memorandum "Clarification and Interpretation of the 1987 Manual" (COE 1992). The routine determinations method was followed. Application of this procedure required identification of plant community types and characterization of vegetation, hydrology, and soils using established criteria. Wetland indicator statuses for plant species were assigned according to Reed (1988). Soil colors were determined in the field using Munsell Soil Color Charts (Munsell Color 1992).

Wetland sampling locations were placed according to one or more of the following criteria: (1) at least one in each discrete wetland; (2) at a significant community change along a continuous wetland line; (3) at roughly 200-foot intervals within the same community; and (4) in highly disturbed areas where reliable topographic or vegetative indicators were absent. Soil profiles were examined as necessary to accurately establish wetland boundaries. Wetland boundaries were flagged adequately for surveying.

3.0 RESULTS AND DISCUSSION

3.1 General Project Area Description

The project area is located northwest of the intersection of Fines Creek Road and Interstate 40, just west of the Pigeon River (Appendix 3, Figure 1). The project area is in the Blue Ridge region in extreme western North Carolina. The tract is underlain largely by the Cranberry granite gneiss (Division of Mineral Resources 1958). The project area is drained by the Pigeon River and its tributaries. Elevations range from approximately 2450 ft above mean sea level in a drainage to over 2650 ft on ridges (USGS 1976; 1987). Soil survey maps (Allison and Hale 1988) indicate that the site contains Brasstown-Junalaska Complex soils, which are well-drained soils.

The project area contains pasture, mixed pine-hardwood and hardwood forests. All ecological communities are discussed in Section 3.2. Figures illustrating the project corridor are contained in Appendix 3.

3.2 Description of Ecological Communities

Three ecological communities exist in the project area: Pasture, Pine/Hardwood Forest, and Mesic Hardwood Forest. The approximate boundaries of terrestrial communities are depicted in Figure 2. The entire project property has historically and recently been grazed by cattle.

3.2.1 Fallow Field. Although cattle have been removed from the property recently, fallow pastures are still dominated by grasses and other herbaceous species, with woody shrubs and trees beginning to colonize these open areas (Figure 3). Besides remnant fescue and other planted grasses, native vegetation exists in these areas, including blackberry, goldenrod, ragweeds, sunflower, wild oats, virgin bower, spurge, pokeweed, cocklebur, broomsedge, NewYork ironweed, and blackberry. Invasive woody species include smooth sumac, winged sumac, tulip poplar, pitch pine, Virginia pine, oaks and hickories. Mourning dove, American crow, turkey vulture, bluejay, mockingbird, indigo bunting, goldfinch, and red-tailed hawk were seen in this community.

3.2.2 Pine-Hardwood Forest. The Pine-Hardwood Forest community is present on several ridges and slopes in the project area. The canopy in this mature forest type includes white pine, with red maple, northern red oak, hemlock, mockernut hickory, and white ash Figure 4). Understory species include tree saplings, flowering dogwood, etc. Ground layer vegetation includes poison ivy, Japanese honeysuckle, microstegium, catbrier, beggar lice, cocklebur, white baneberry, and jewelweed. Animals observed in the Pine-hardwood Forest community include hairy woodpecker, rufous-sided towhee, robin, cardinal, tufted titmouse, and raccoon.

3.2.3 Mesic Hardwood Forest. The Mesic Hardwood Forest community exists in broad drainages, coves, and slopes in the project area. This community is characterized by a mature stand of tulip poplar, white oak, northern red oak, black walnut, red maple, and occasional hemlock (Figure 5). The understory is dominated by dense stands of poison ivy, beggar lice, or rose in many cases (Figure 6). Where these disturbance response species are not prevalent, mesic ground layer vegetation includes white baneberry, Indian cucumber, Solomon's seal, false Solomon's seal, cocklebur, wild yam, violets, Christmas fern, and hay-scented fern (Figure 9). Animals observed in this community include Carolina wren, yellow-shafted flicker, rufous-sided towhee, robin, cardinal, mourning dove, red-bellied woodpecker, red-winged blackbird, ruby-throated hummingbird, and raccoon.

3.3 Protected Species Assessment

The NCNHP and FWS produced lists of rare and protected animal and plant species that are known in Haywood County (NCNHP 1998; FWS 1998). These lists contain a total of 24 state or federally protected animals and 12 state or Federally protected plants that are known to occur in Haywood County. Tables listing these species and their legal status, scientific names, habitat requirements, and status in the project area can be found in Appendix 1.

Legal protection for Federally listed species, Threatened or Endangered status, is conferred by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1534). This act makes it illegal to kill, harm, harass, or remove any federally listed animal species from the wild; plants are similarly protected, but only on Federal lands. Section 7 of this Act requires Federal agencies to ensure that actions they fund or authorize do not jeopardize any Federally listed species.

Species that are being considered for Federal protection, though not currently listed, are designated as Candidate species and may be listed in the future.

Legal protection in the State of North Carolina is provided by the North Carolina Department of Agriculture for state listed plants under the Plant Protection and Conservation Act of 1979. Protected animals are listed in *Endangered Wildlife of North Carolina* (NCDEHNR 1992). There are three categories of state protected species: Endangered, Threatened, and Special Concern. Federally protected species are usually protected by the state as well, and state protected species are sometimes Candidates for federal listing. The harassment or killing of any state listed animal species is prohibited on all lands in the State of North Carolina, both public and private. State listed plant species receive protection only on public lands and can be removed only with written authorization from NCDA Plant Protection Division. Protected plant species are listed in Weakley (1993). While state-designated Significantly Rare species and federal Candidate species are not legally protected, the NCDA and FWS monitor these species to determine if future listing will be warranted. Efforts to avoid adverse impacts to these legally unprotected species are encouraged by both agencies.

3.3.1 Animals. The NCNHP (1998) and FWS (1998) rare and protected animal species lists serve as the basis for this protected animal study. Five state and federally protected animal species and nineteen state protected animal species are known from Haywood County. Marginal Habitat exists in the project area for six state protected animal species.

Potential habitat for the state protected species, Appalachian Bewick's wren, exists in thickets throughout the project property, but none were observed. Marginal habitat exists in the Pine-Hardwood and Mesic Hardwood Forest for Appalachian woodrat and golden-crowned kinglet, but no specimens or nests were observed in the project area. Potential habitat for Cooper's hawk is present in forests and edges throughout the project area, but no nests were observed. Very marginal habitat for the state Threatened bog turtle exists in the palustrine emergent wetland in the project area, but none were observed. Marginal habitat for southern zigzag salamander is present in the spring-fed stream in the project area, but this stream had been adversely impacted and no salamanders were observed there. There is no habitat for other state or federal protected animal species in the project property. No state or federal protected animal species were observed in the project area.

One state Significantly Rare animal species, Diana fritillary, is known from near the project area. Habitat for this species is present in the project area in the Mesic Hardwood Forest community. No Diana fritillary were observed in the project area, but a return survey would be required to definitively determine its presence/absence. This species is not currently protected.

3.3.2 Plants. The NCNHP (1998) and FWS (1998) lists of rare or protected plant species known to occur in Haywood County serve as the basis for the protected plant study. Four state and federally protected plant species and eight state protected plant species are known to occur in Haywood County. Marginal habitat is present in the project area for one state and federally protected plant species and five state protected plant species. Previous grazing by cattle reduces the likelihood, but does not rule out, the potential for protected plant species in the project area.

Marginal habitat for the state and federally protected small-whorled pogonia is present in portions of the Pine-Hardwood Forest that have a relatively sparse ground layer of vegetation. No small-whorled pogonia was observed in the project area. However, due to lower than normal rainfall, this species may not have been detectable at the time of the field survey. Marginal habitat for the state protected piratebush is present under scattered hemlocks in the Pine-Hardwood Forest and Mesic Hardwood Forest communities. Piratebush was not observed in the project area. Habitat is present in the Mesic Hardwood forest for the state protected

Alabama least trillium and royal catchfly, and in all forests for the Fraser's loosestrife and tall larkspur. None of these species were observed in the project area, but Alabama least trillium would not have been readily detectable at the time of the survey. Habitat is not present in the project area for other state or federally protected plant species and none were observed in the project areas.

Very marginal habitat is present in the project area for the state Significantly Rare fringed campion, but none were observed during field surveys. This species is not currently protected.

3.4 Assessment of Wetlands and Waters of the United States

The Fines Creek, and Cove Creek North Carolina quadrangle NWI maps do not indicate wetlands in the project area (FWS 1992). Soil survey maps (Allison and Hale 1988) do not show any hydric soil in the project area. A small amount of jurisdictional wetlands and waters of the United States occur in the project area.

A jurisdictional wetland is present in a drainage adjacent to the existing landfill. This wetland is largely a palustrine emergent wetland; its location is shown in Figure 2. The palustrine emergent wetland adjacent to the existing landfill may be partly created by landfill activities, including changes in hydrology and drainage sediments. The emergent wetland is dominated by wetland vegetation such as soft rush, cattails, woolgrass, beakrush, sedges, tearthumb, New York ironweed, and an occasional black willow. The primary hydric soil indicators are low chroma, mottling, and redoximorphic features. Wetland hydrology indicators include drainage patterns, oxidized rhizospheres, and water-stained leaves.

One 1-5-foot-wide, 1 foot-deep spring-fed channel is present in the project area. This stream, below mean high water, is regulated by the COE as waters of the United States under Section 404 of the Clean Water Act. Locations of waters of the United States are shown in Figure 2.

4.0 SUMMARY AND RECOMMENDATIONS

A protected species survey and jurisdictional wetlands delineation were conducted for the proposed Haywood County Sanitary Landfill Expansion project. The existing landfill is approximately 40 acres and will be expanded by 35 acres to a total of approximately 75 acres.

The project area contains three ecological communities: Fallow Field, Pine-Hardwood Forest, and Mesic Hardwood Forest. These habitats had some potential to support rare or protected species.

Twenty-four state or federally protected animal species and 12 protected plant species are known to occur in Haywood County. Marginal habitat exists in the project area for six protected animal species and six protected plant species. None were observed in the project area; however, some of these species may not have been detectable at the time of the survey. No marginal habitat or habitat is present in the project area for any other protected species known to occur in Haywood County. No state or federally protected animal or plant species were observed during field surveys of the proposed landfill expansion. We recommend return surveys in May to seek the state and federally Threatened small-whorled pogonia and the Alabama least trillium, in relatively open forests in the project area.

A small amount of jurisdictional wetlands found within the project property will be impacted by the proposed landfill expansion. One spring-fed stream exists in the project property, which is a water of the United States regulated under Section 404 of the Clean Water Act. Impacts to

wetlands or waters of the United States will require a permit from the COE. This project may qualify for Nationwide Permit 26, for impacts to wetlands above headwaters, if stream impacts can be kept below the maximum allowable threshold of 500 total linear feet. We recommend pre-application consultation with the COE to determine if proposed impacts would be allowable under the Nationwide Permit program. If impacts cannot be kept within those stipulated by conditions of the Nationwide Permit(s), an Individual Permit from the COE would be required.

In response to concerns expressed by U.S. Fish and Wildlife Service, we recommend following their guidelines for reducing attraction of bear and other large mammals to the landfill. Also, interim and final closure plans should include provisions for planting and maintaining preferred native wildlife food plants. The FWS will provide recommendations for seed mixes and may ask for some commitment from the county to maintain a "natural" early successional plant community on the closed cells.

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APPENDICES

APPENDIX 1. RARE AND PROTECTED PLANT AND ANIMAL SPECIES OF HAYWOOD COUNTY

COMMON NAME *Scientific Name*	LEGAL STATUS*	HABITAT REQUIREMENTS	PRESENCE IN STUDY AREA**
Animals			
Appalachian Bewick's Wren *Thryomanes bewickii altus*	NE	Highland woodland borders, farms, and fields	HP, NO
Appalachian Elktoe *Alasmidonta raveneliana*	FE,NE	Tennessee drainages (Little Tennessee and Nolichucky rivers)	NP
Bald Eagle *Haliaeetus leucocephalis*	FT, NT	Inland waterways and estuarian areas in Georgia.	NP
Black-Capped Chickadee *Parus atricapillus*	NSC	High elevation forests, feeding in lower elevations	NP
Bog Turtle *Clemmys muhlenbergii*	NT	Open wet areas	MP, NO
Carolina Northern Flying Squirrel *Glaucomys sabrinus coloratus*	FE, NE	High elevation forests	NP
Cooper's Hawk *Accipeter cooperii*	NSC	Forests and edges	HP, NO
Eastern Cougar *Felis concolor cougar*	FE, NE	Wilderness areas	NP
Engraved Covert *Mesodon orestes*	NT	Endemic to Plott Balsam mountains	NP
Golden-Crowned Kinglet *Regulus satrapa*	NSC	Forests	MP,NO
Hellbender *Cryptobranchus alleganiensis*	NSC	Large, clear, fast streams	NP
Lamellate Supercoil *Paravitrea lamellidens*	NSC	Southern half of mountains	NP
Longtail Salamander *Eurycea longicauda longicauda*	NSC	Moist woods and floodplains	NP
Long-Tailed Shrew *Sorex dispar*	NSC	High elevation forest slopes and outcrops	NP
Mountain Chorus Frog *Pseudacris brachyphona*	NSC	Forests near pools, in extreme southwest mountains	NP
Northern Saw-Whet Owl *Aegolius acdicus*	NSC	High elevation forests	NP
Olive-Sided Flycatcher *Contopus cooperi*	NSC	Montane conifer forests	NP
Queen Crater *Mesodon chilhoweensis*	NSC	Southern half of the mountains	NP
Smoky Mountain Covert *Mesodon ferrissi*	NT	Endemic to Smoky Sountains and Plott Balsams	NP
Southern Rock Vole *Microtus chrotorrhinus carolinensis*	FSC, NSD	High elevation rocky outrops, forests and fields	NP
Southern Appalachian Woodrat *Neotoma floridana haematoreia*	NSC	Rocky areas in deciduous or mixed forests	MP, NO
Southern Water Shrew *Sorex palustris punctulatus*	NSC	Montane forest spring banks	MP

Southern Zigzag Salamander *Plethodon dorsalis*	NSC	Springs	MP, NO
Velvet Covert *Mesodon subpalliatus*	NSC	Central mountains from Avery to Haywood counties	

Plants

Alabama Least Trillium *Trillium pusillum var 1*	NE	Rich cove forests	MP, NO
Royal Catchfly *Silene ovata*	FC, NT	Rich Forests, calcerous bluffs.	MP, NO
Fraser's Loosestrife *Lysimachia fraseri*	NE	Forests and roadsides	MP, NO
Piratebush *Buckleya distichophylla*	NE	Bluffs or lower slope forests	MP, NO
Queen of the Prairie *Filipendula rubra*	NE	Bogs and wet meadows`	NP
Rock Gnome Lichen *Gymnoderma lineare*	FE, NT	High elevation rocky outcrops	NP
Liverwort *Plagiochila caduciloba*	NE	Areas within sprayzone of falls	NP
Rugel's Ragwort *Rugelia nudicaulis*	NT	Spruce-fir forests	NP
Small Whorled Pogonia *Isotria medeoloides*	NE	Open hardwood forest, especially with pine.	MP, NO
Smoky Mountain Mannagrass *Glyceria nubigena*	NT	High elevation seeps	NP
Tall Larkspur *Delphinium exaltatum*	NE-SC	Grassy areas, woodlands	MP, NO

*LEGAL STATUS:

FE Listed as Endangered, FWS.
FT Listed as Threatened, FWS.
FC Candidate for federal listing [not legally protected].
NE Listed as Endangered by the North Carolina Department of Agriculture or North Carolina Wildlife Resources Commission.
NT Listed as Threatened by the North Carolina Department of Agriculture or North Carolina Wildlife Resources Commission.
SR Listed as Significantly Rare by the North Carolina Natural Heritage Program [not legally protected]

**PRESENCE IN STUDY AREA:

HP Habitat present on study area.
MP Marginal habitat present on study area
NP Habitat not present on study area.
SP Species present on study area.
NO Species not observed on study area.
NS Specialized sampling required; not conducted during this survey.

APPENDIX 2. SCIENTIFIC NAMES OF COMMONLY FOUND PLANT AND ANIMAL SPECIES

Common Name	*Scientific Name*
Plant species	
American holly	*Ilex opaca*
Arabis laevigata	*Arabis laevigata*
Baneberry	*Actaea pachypoda*
Beggar-lice	*Desmodium* sp.
Blackberry	*Rubus* sp.
Black cohosh	*Cimicifuga racemiflora*
Black willow	*Salix nigra*
Bluebell	*Campamula divaricata*
Blueberry	*Vaccinium* sp.
Blue cohosh	*Caulophyllum thalictroides*
Broomsedge	*Andropogon* spp.
Buckeye	*Aesculus* sp.
Buttercup	*Ranunculus* sp.
Canada hemlock	*Tsuga canadensis*
Catbrier	*Smilax* sp.
Cattail	*Typha latifolia*
Chinese privet	*Lugustrum sinense*
Christmas fern	*Polystichum acrostichoides*
Cocklebur	*Agrimony* spp.
Cranefly orchid	*Tipularia discolor*
Cucumber tree	*Magnolia fraseri*
Dandelions	*Taraxacum* sp.
Duck-potato	*Sagittaria* sp.
Ebony spleenwort	*Asplenium platyneuron*
Elderberry	*Sambucus canadensis*
Elephant's foot	*Elephantopus* sp.
False nettle	Boehmeria cylindrica
False Solomon's seal	Uvularia
Fescue	*Festuca* sp.
Flowering dogwood	*Cornus florida*
Giant cane	*Arundinaria gigantea*
Goldenrod	*Solidago* spp.
Grape	*Vitis rotundifolia*
Green ash	*Fraxinus pennsylvanica*
Honewort	*Cryptotaenia canadensis*
Houstonia	*Houstonia purpurea*
Ironweed	*Vernonia novaeboracensis*
Japanese honeysuckle	*Lonicera japonica*
Jewelweed	*Impatiens capensis*
Leatherflower	*Clematis* sp.
Liverleaf	*Hepatica acutiloba*
Maidenhare fern	Adiantum pedatum
May-apple	*Podophyllum peltatum*
Meadowrue	*Thalictrum thalictroides*
Microstegium	*Microstegium vamineum*
Milkvine	*Mikamia scandens*
Mountain mint	*Pycnanthemum* sp.

Musclewood	*Carpinus caroliniana*
Pignut hickory	*Carya glabra*
Pipsissewa	*Chimaphila maculata*
Pitch pine	*Pinus rigida*
Poison ivy	*Toxicodendron radicans*
Pokeweed	*Phytolacca americana*
Queen Anne's lace	*Daucus carota*
Ragweed	*Artemesia* sp.
Rattlesnake plantain	*Goodyera pubescens*
Red maple	*Acer rubrum*
Rose pink	*Sabatia angularis*
Hay-scented fern	*Dennstaedtia punctilobula*
Sedges	*Carex* spp. and *Cyperus* spp.
Shortleaf pine	*Pinus echinata*
Smartweed	*Polygonum* sp.
Soft rush	*Juncus effusus*
Solomon's seal	*Smilacina racemosa*
Sunflower	*Helianthus* sp.
Sweet cicely	*Osmorhiza claytonii*
Sweetgum	*Liquidambar styraciflua*
Sycamore	*Platanus occidentalis*
Tear thumb	*Polygonum* spp.
Tulip poplar	*Liriodendron tulipifera*
Umbrella magnolia	*Magnolia tripetala*
Virginia creeper	*Parthenocissus quinquefolia*
Water oak	*Quercus nigra*
White baneberry	*Actaea pachypoda*
White oak	*Quercus alba*
White pine	*Pinusstrobus*
Wild ginger	*Hexastylis virginianum*
Woolgrass	*Scirpus cyperinus*

Animal species

American crow	*Corvus brachyrhynchos*
Blue jay	*Cyanocitta cristata*
Cardinal	*Cardinalis cardinalis*
Carolina chickadee	*Parus carolinensis*
Carolina wren	*Thryosurus ludovicianus*
Downy woodpecker	*Picoides pubescens*
Eastern box turtle	*Terrapene carolina*
Eastern cottontail rabbit	*Sylvilagus floridanus*
European starling	*Sturnus vulgaris*
Fence lizard	*Sceloporus undulatus undulatus*
Gray squirrel	*Sciura carolinensis*
Hairy woodpecker	*Picoides villosus*
Mockingbird	*Mimus polyglottus*
Mosquitofish	*Gambusia affinnis*
Mourning dove	*Zenaida macroura*
Pileated woodpecker	*Dryocopus pileatus*
Raccoon	*Procyon lotor*
Red-bellied woodpecker	*Melanerpes carolinus*
Red-winged blackbird	*Agelaius phoeniceus*
Robin	*Turdus migratorius*
Ruby-throated hummingbird	*Archilocus colubris*

Rufous-sided towhee	*Pipilo erythropthalmus*
Sharp-shinned hawk	*Accipiter striatus*
Tufted titmouse	*Parus bicolor*
White-tailed deer	*Odocoileus virginianus*
White-throated sparrow	*Zonotrichia albicollis*
Yelow-bellied sapsucker	*Sphyrapicus varius*
Yellow-rumped warbler	*Dendroica coronata*
Yellow-shafted flicker	*Colaptes auratus*

APPENDIX 3. FIGURES

1. Location of Project Area.
2. Ecological Communities, Wetlands, and Waters of the United States.
3. Fallow Field.
4. Pine-Hardwood Forest Community.
5. Mesic Hardwood Forest Community.
6. Dense Poison Ivy in Understory
7. Palustrine Emergent Wetland
8. Spring-Fed Perennial Stream-- Waters of the U.S.

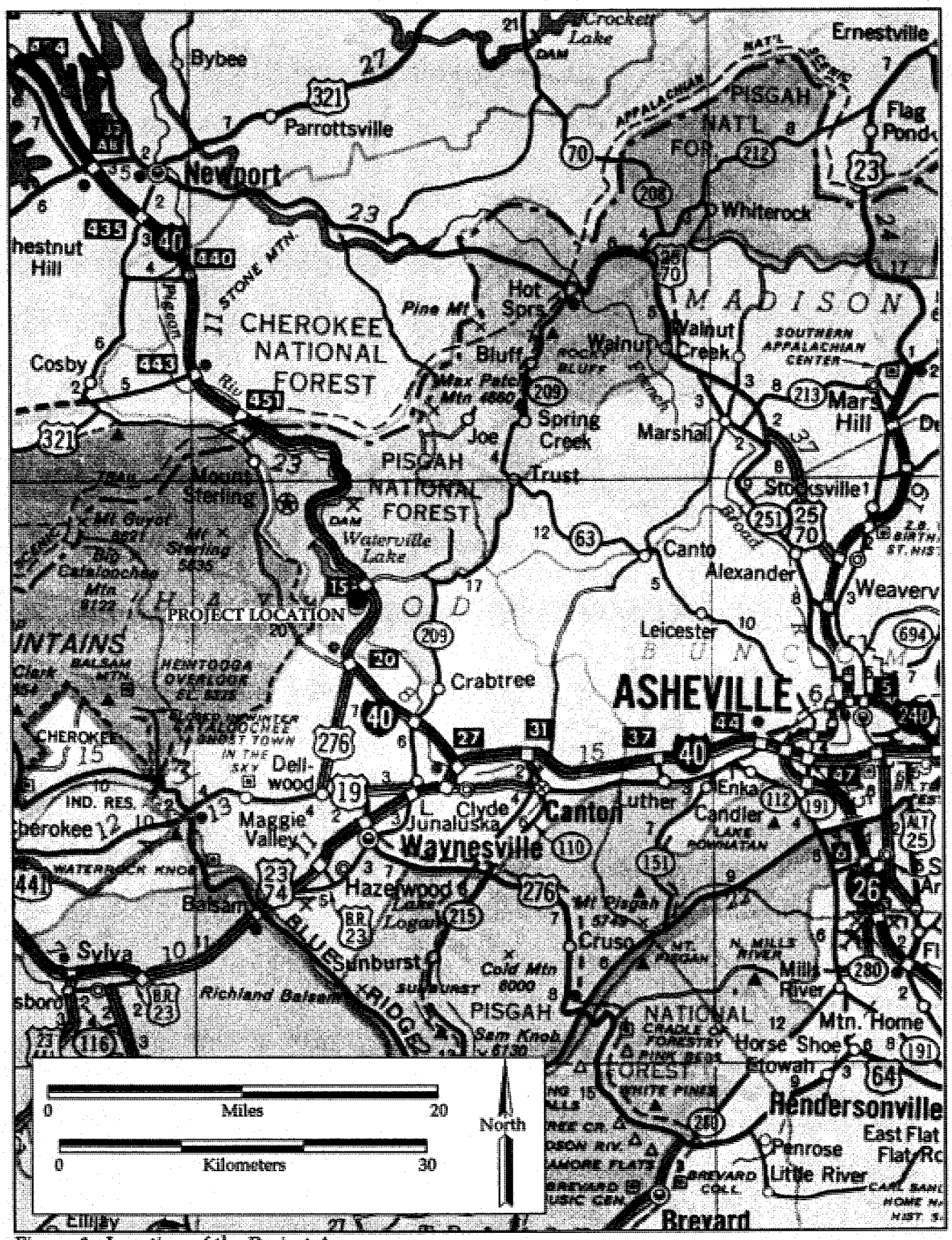

Figure 1. Location of the Project Area.

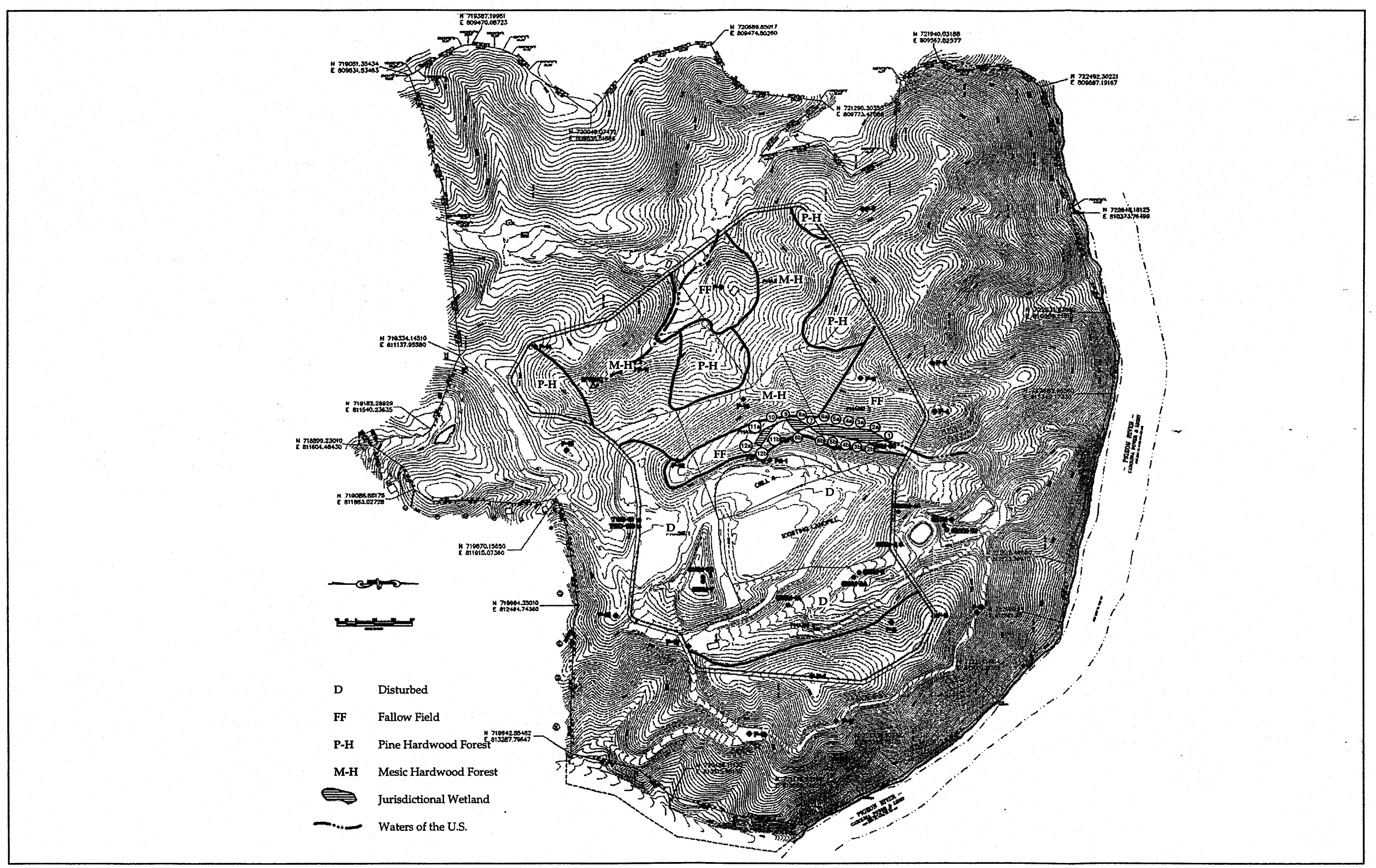

Figure 2. Ecological Communities, Jurisdictional Wetlands, and Waters of the U.S.

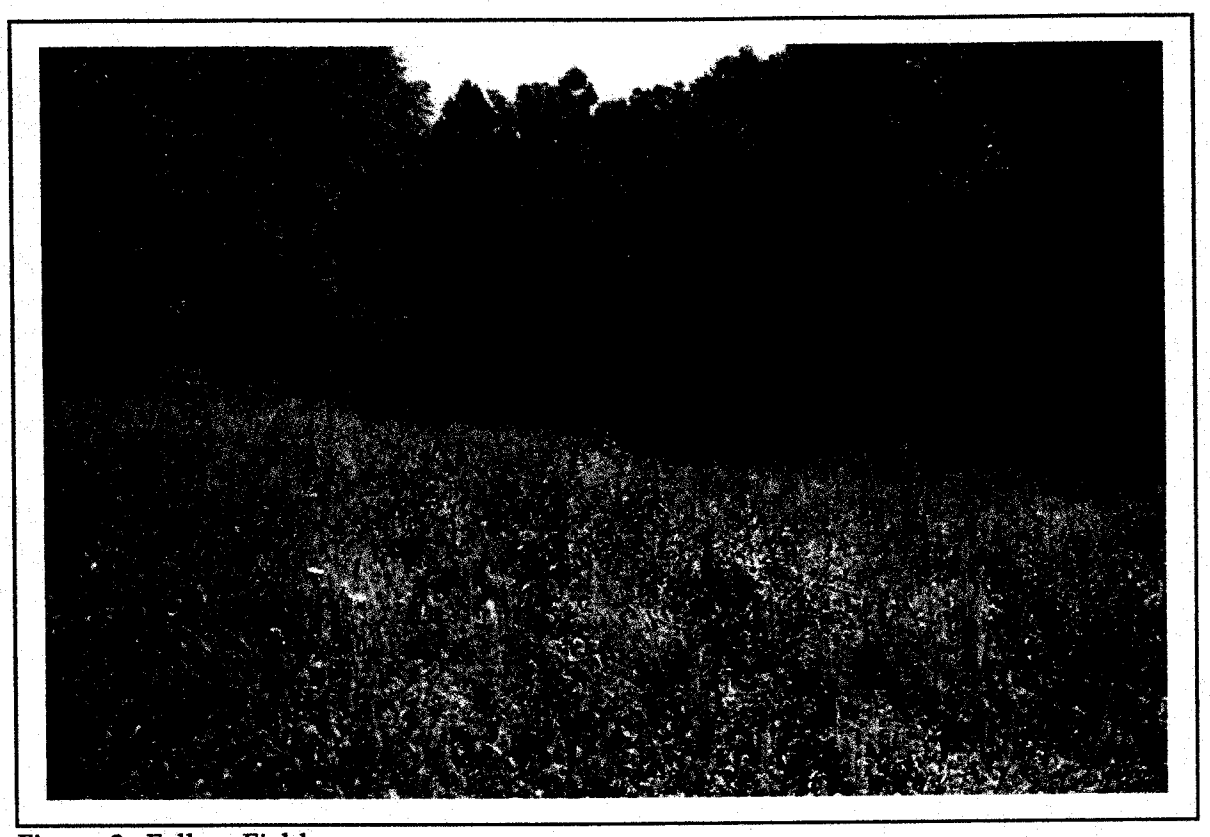

Figure 3. Fallow Field.

Figure 4. Pine Hardwood Forest.

Figure 5. Mesic Hardwood Forest.

Figure 6. Dense Poison Ivy in Understory.

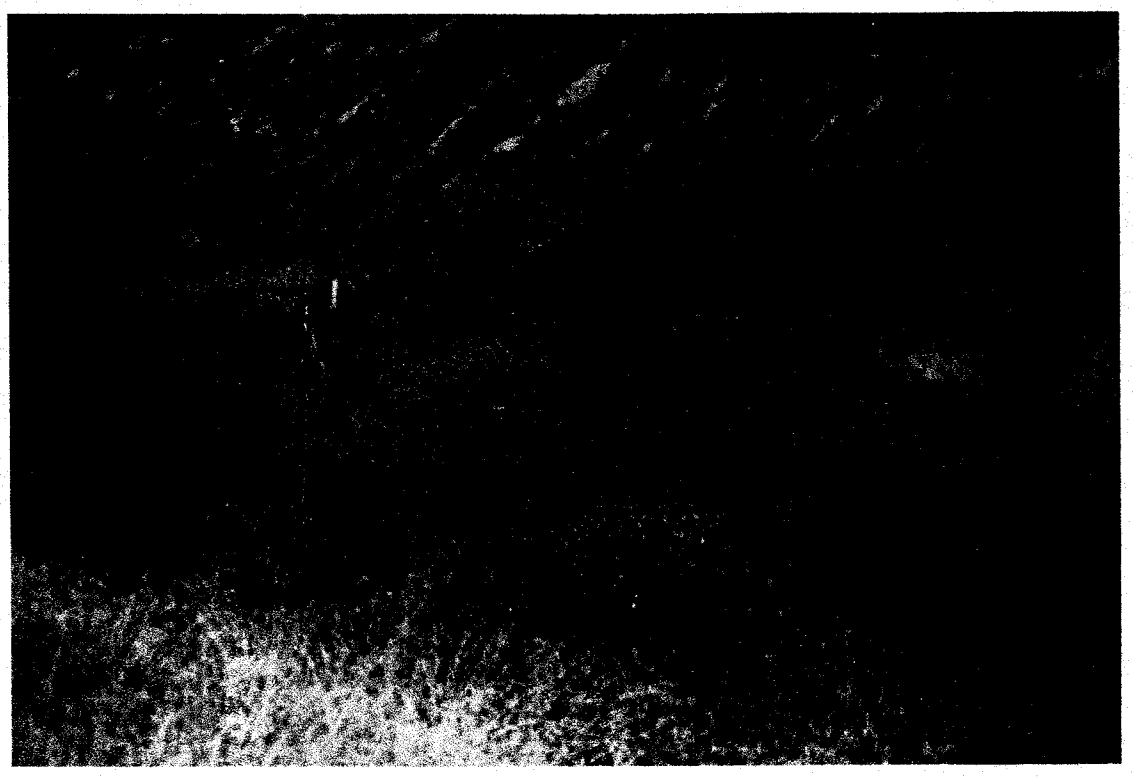

Figure 7. Palustrine Emergent Wetland.

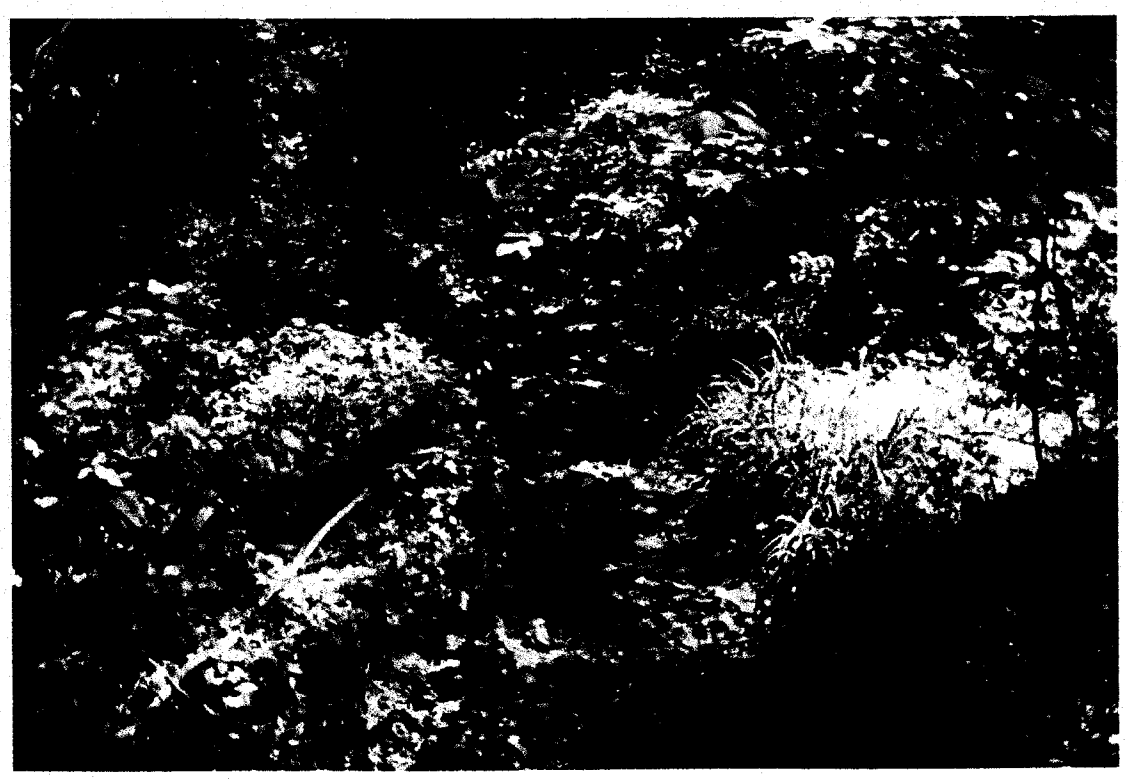

Figure 8. Spring-Fed Stream - Waters of the U.S.

APPENDIX 4. COE WETLAND DATA FORMS

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: Haywood County Landfill
Applicant/Owner: Haywood County
Investigator: Bill Nettery & Hamilton PHC Garrow

Date: 9-24-98
County: Haywood
State: NC

Do Normal Circumstances exist on the site? (Yes) No
Is the site significantly disturbed (Atypical Situation)? Yes (No)
Is the area a potential Problem Area? Yes (No)
(If needed, explain on reverse.)

Community ID: ____
Transect ID: ____
Plot ID: PEM wetland

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Scirpus cyperinus	H	OBL	9.		
2. Polygonum sagittatum	H	OBL	10.		
3. Juncus effusus	H	FACW	11.		
4. Unknown wet grass	H	—	12.		
5. Carex spp	H	FACW	13.		
6. Rhynchospora	H	FACW	14.		
7. Impatiens capensis	H	FACW	15.		
			16.		

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-): ____

Remarks: PEM wetland Somewhat disturbed

HYDROLOGY

___ Recorded Data (Describe in Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other
✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: 1 (in.)

Depth to Free Water in Pit: 0 (in.)

Depth to Saturated Soil: 0 (in.)

Wetland Hydrology Indicators:
Primary Indicators:
✓ Inundated
✓ Saturated in Upper 12 Inches
___ Water Marks
___ Drift Lines
✓ Sediment Deposits
✓ Drainage Patterns in Wetlands
Secondary Indicators (2 or more required):
___ Oxidized Root Channels in Upper 12 Inches
✓ Water-Stained Leaves
___ Local Soil Survey Data
___ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks: Saturated Floodplain

APPENDIX 5. RESUME OF PRINCIPAL INVESTIGATOR

WILLIAM R. NETHERY

EDUCATION

M.S., Forestry (Ecology), North Carolina State University, 1991
B.S., Forestry (Biology), North Carolina State University, 1987

Specialized Training and Certification

Qualified Consultant for Environmentally Sensitive Property, State of Georgia
Native Grasses for the Southeast U.S., North Carolina Arboretum, 1997
Coastal Plain Wetland Delineation, University of Georgia, 1995
Shigo on Trees Workshop, 1995
Groundwater and Associated Environmental Concerns Seminar, 1992
Ninth Annual Forest Biology Symposium, 1990
P.C. SAS Basics Training Course, SAS Institute, 1989
Symposium on Barrier Island Ecology of the Atlantic Coast, 1989
Project Learning Tree Facilitator's Training, 1987

TECHNICAL SPECIALTIES

Mr. Nethery has 7+ years of experience encompassing:

- Wetlands Science
- Protected Species
- Environmental Impact Assessment
- Environmental Compliance
- Urban Forestry
- Hazardous Waste Assessment

REPRESENTATIVE EXPERIENCE

Mr. Nethery is Senior Environmental Scientist for TRC Garrow Associates Inc. He has experience in planning, conducting, and managing ecological environmental studies, including wetlands delineations, protected species surveys, mitigation planning and monitoring, and other environmental studies. He has served as Scientist on numerous studies for over three years and Senior Scientist/Project Manager for at least three additional years.

Wetlands Science

King George County Landfill Mitigation Design and Implementation, King George, Virginia. Serving as Senior Environmental Scientist in planning, design and implementation of 5-acre wetland mitigation site in previously pastured drainage within landfill property. The project purpose is to mitigate for 4.6 acres of wetland impacts during construction and operation of the new King George County Landfill. The mitigation area will be converted to a forested wetland by installing checkdams, grading, and planting wetland tree species. The site will be monitored annually.

Niagara-Mohawk Natural Gas Pipeline Connector Project, Albany, New York. Serving as Senior Environmental Scientist on 2.7 mile pipeline project, including associated access roads and work spaces. Numerous wetlands were delineated in the project corridor and report is in progress. Results of environmental surveys will be submitted to the New York Department of Environmental Conservation for review.

Destin Pipeline Project, Southern Mississippi. Served as subconsulting field crew leader, wetlands specialist (and protected species scientist) on a 135-pipeline from the Gulf of Mexico to a compressor station south of Meridian, Mississippi. Numerous wetlands, including salt marsh, wet pine flatwoods, cypress-gum swamps, maple-bay forests, and disturbed wetlands were delineated along the pipeline corridor.

Protected Species and Wetlands Delineation and Mitigation Plan, Barnesville Reservoir, Georgia. Served as Senior Scientist for protected species survey and wetlands delineation for a reservoir expansion. Identified potential protected plant habitat in slope forests and floodplain forests in the project area. Eighteen acres of wetlands to be impacted required mitigation. Conducted followup protected plant surveys and wrote mitigation concept and detailed mitigation plan, which were accepted by the Corps of Engineers.

Maplewood Landfill Mitigation Monitoring, Amelia, Virginia. Serving as Senior Environmental Scientist in ongoing mitigation plan, including monitoring plots in 7-acre created wetland. Vegetation, soils, and hydrology are recorded for each plot in addition to general observations in the created wetland. Results are reported to the U.S. Army Corps of Engineers as specified in the Mitigation Plan (Garrow & Associates and USA Waste, Inc.).

Landfill Expansion Wetlands and Protected Species Surveys, Wayne County, North Carolina. Served as Senior Environmental Scientist for wetlands and protected species surveys in this project area. Most wetlands were in the undisturbed buffer zones, but several narrow drainages in the impact area contained jurisdictional wetlands. Project qualified for a Nationwide Permit based on our delineation of wetlands.

Protected Species

Effingham County Industrial Park, Protected Species Survey and Relocation, Georgia. Served as Project Manager and Senior Scientist. Conducted initial protected species survey of partially developed industrial park, finding active burrows of the gopher tortoise (state protected), which potentially harbor indigo snake (federally protected). Hired indigo snake expert (Mr. Ed Wester) to scope burrows and rule out presence of indigo snake. Worked with gopher tortoise specialists (Dr. David Rostal, Georgia Southern University) to relocate 10 gopher tortoises from the project area to a state Wildlife Management Area in Burke County Georgia.

ETNG-SONAT Natural Gas Pipeline, Wetlands and Protected Species Surveys, Catoosa County, Georgia. Served as Senior Environmental Scientist for wetlands delineation and protected species survey of an 8-mile pipeline corridor. Conducted additional surveys for protected aquatic species (with subconsultant specialists) and one protected plant. Several state protected fish species and one federally protected plant species were discovered in the project area, necessitating reroutes and mitigation planning. Project was put on hold pending FERC rulings.

Environmental Impact Assessment

Medical Training Facility EA, Fort Gordon, Georgia. Served as Technical Advisor/Editor and Wetlands and Protected Species Scientist under contract to Hydrovision Inc., which received a work order for an EA but had no experience with NEPA. The proposed training facility would have minimal impacts, but the documentation had to be coordinated and reviewed and a site visit was conducted to confirm reports of earlier surveys in the project area. Assisted with writing, editing, and responding to reviewer comments.

Catawba River Raw Water Intake and Pump Station EA, Mecklenburg County, North Carolina. Served as Senior Environmental Scientist to Metcalf & Eddy for the Mecklenburg County Utilities Department. Conducted background research for primary, secondary, and cumulative impacts, authored EA, and responded to agency comments. FONSI was written based on our EA.

Environmental Compliance and Miscellaneous Studies

ECAMP- Seymour Johnson Air Force Base, North Carolina. Served as Project Scientist in Environmental Compliance Agreement survey on the base. Investigated facilities for compliance with chemical storage, waste disposal, and solid waste rules, erosion control regulations, wetlands, protected species, and water quality planning and monitoring requirements.

Sedimentation and Erosion Control Violation Investigation-B&G Lumber Co., Yadkin County, North Carolina. Served as forester and regulatory/technical advisor to a lumber company that had been cited for a violation of the Sedimentation and Erosion Control Act. Client had not installed appropriate erosion control measures and left standing timber so that current landowners could develop property, causing logging company to lose exemption from the Act. Recommended installing all ordinary harvest site erosion control measures and removing remaining timber (and replanting) to ensure that site remained in forestry.

Biological Inventory for Proposed North Chattahoochee River Nature Park, Fulton County, Georgia. Served as Senior Environmental Scientist for an inventory along the Chattahoochee River adjacent to the Fulton Industrial Park. Mapped ecological communities, and associated hydrology and soils information, disturbance, scenic value, and recreation and educational values in a GIS coverage of ecological community polygons. Industrial isolation, previous disturbance and development, severe pollution problems, and unstable substrates in the project area presented excessively difficult problems in using this site as a nature park.

Urban Forestry

Tree Inventory and Management Plan. A street tree inventory and management plan was prepared for the Historic District at Fort Benning, Georgia, as part of the Historic Preservation Plan (by Garrow & Associates, Inc.) for Fort Benning. Served as Urban Forester and Project Manager with Mr. Dudley Hartel (Information Systems, Inc.) as Consulting Urban Forester. This inventory and plan involved recording pertinent data for some 4,000 street trees in the Historic District that were suffering from neglect and poor management. Numerous removals of poor quality or hazardous trees were recommended, along with a strict planting and maintenance regime to lead toward a sustainable urban forest in the Historic District that is in keeping with general planning principles espoused by early planners at Fort Benning.

Phase I Hazardous Waste Assessments

Wastewater Treatment Plant Expansion, Salisbury, North Carolina. Served as Environmental Scientist on Phase I Audit (as part of state-level EA) for an expansion of the existing treatment facility into a regional facility. Investigated reports of barrels and other potential toxic waste at the project area.

Fire Department Renovations, Durham, North Carolina. Served as Environmental Scientist on Phase I Audit of one firehouse in Durham. Verified LUST (petroleum) and recommended corrective action before conducting transactions on the property.

Red Roof Inns, Atlanta, Georgia. Served as Environmental Scientist on Phase I Audit of one Red Roof Inn in Atlanta. Verified no environmental concerns on the property.

PROFESSIONAL AFFILIATIONS

Society of Wetlands Scientists (SWS), since 1995

PUBLICATIONS

Master's Thesis: *Effects of gibberellic acid and kinetin on coastal-source wax myrtle (*Myrica cerifera*) seed germination.* North Carolina State University, Raleigh.

Nethery, William R., and L. Jervis, 1990. Effects of Canopy Transmission of PAR Light on *Cypripedium acaule* in Schenck Forest. NCSU Forest Biology Research Center, Raleigh.

WORK HISTORY

Senior Environmental Scientist
TRC Garrow Associates Inc.
1997–present

Senior Environmental Scientist
Garrow & Associates, Inc.
1993–1997

Senior Wetlands Scientist
Robert J. Goldstein & Associates, Inc., Raleigh
1990

Graduate Teaching Assistant and Research Technician
Forestry Department, NCSU, Raleigh
1988–1990

Research Technician
Clemson University, U.S. Forest Service Research Lab, Charleston, South Carolina
1986

Municipal
Services
Garner, N.C.

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

Site Hydrogeologic Study
White Oak Subtitle D Landfill
Haywood County, North Carolina

Project No. G98010.5

White Oak Landfill
Site Hydrogeologic Study

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PURPOSE AND SCOPE OF STUDY

This study was undertaken to begin defining, with borings and piezometers, the soil and rock types and conditions of the uppermost aquifer regime at the proposed Haywood County MSWLF site. It is drafted to meet the requirements set forth by the North Carolina Department of Environment and Natural Resources in Solid Waste Management Rule 15A NCAC 13B.1623(a).

SITE DESCRIPTION

The proposed Haywood County MSWLF site is located on 268 acres (109 acres of which have site suitability, Law Engineering, 1990) including the existing White Oak Landfill (*Plate 1*). The site is 12 miles north of Waynesville at the Fines Creek Exit (Exit 15) off Interstate 40 almost 9 miles from the North Carolina-Tennessee state line.

The site lies within the Blue Ridge physiographic province characterized by mountainous topography. The site has a total relief of approximately 450 feet. The highest point is at 2700 feet above MSL in the central-southern portion of the property. The lowest area is at an elevation of 2250 feet above mean sea level (MSL). This area is located along the Pigeon River reservoir on the northern property boundary [Walters Dam, located approximately 3.5 miles northwest of the site, was constructed along the Pigeon River for hydroelectric purposes. The resulting reservoir was named Waterville Lake (Walters Lake on older USGS Quadrangles). However, for the purpose of this report, it will be referred to as the Pigeon River]. On site slopes average 20%, though certain areas have considerably higher grades. Slopes that rise from the Pigeon River on the eastern border of the site have grades approaching 42%. Grades as low as 10% are found on shallow slopes between ridgelines in the central and western portion of the site. Three springs occur in the area where the water table intersects the land surface. The resulting waters drain north toward the Pigeon River. The property has historically been used as pasture

and farmland. Several abandoned buildings occupy the clearing on the western side of the site. There are several paths that provide access for light vehicles. A General Site Plan is located on Plate 1.

GEOLOGIC CONSIDERATIONS

The stratigraphy and structure of the southern Appalachian region have been the topic of many investigations and professional papers. In addition to previous observations by Law Engineering and Hatcher, MESCO personnel documented rock types and structure within the vicinity of the proposed landfill site. These observations were used in conjunction with extensive field reconnaissance performed by Hadley and Goldsmith (1963) to construct a geologic map outlining structures and lithologies within and surrounding the proposed site. The derived geologic map and accompanying field notes are presented in Plate 2.

Regional Geology

Regionally the site lies near Ocoee series rocks that include both the older Snowbird Group and younger Great Smoky Group. The site itself overlies the Precambrian age basement complex that consists of metamorphosed plutonic rocks and the Carolina Gneiss (Hadley and Goldsmith, 1963). Both units have experienced various degrees of polymetamorphism in both the Precambrian and Paleozoic where the original structure of the rocks was massively deformed, if not completely destroyed. The plutonic rocks, as described by Hadley and Goldsmith, stratigraphically overlie the Carolina Gneiss and are described as massive, often coarse textured rocks with varying textures and compositions. The composition of these metacrystalline plutonic rocks (orthogneisses) suggests the parent materials were felsic igneous intrusions, namely granite and granodiorite. Though the underlying Carolina Gneiss is similar in texture and appearance, its composition suggests it was derived from very old metasedimentary units (Hadley and Goldsmith, 1963). A nonconformity exists between the plutonic rocks of the basement complex and

the overlying Thunderhead Sandstone that outcrops to the west and south of the site.

Structurally, the site is located very near the Cataloochee Divide Syncline between the kyanite and staurolite isograds. The degree of metamorphism increases to the south-southeast (Hadley and Goldsmith, 1963). The Cataloochee Anticlinorium, located to the northwest of the site, is bounded by the Greenbrier Fault and bisected by the Cold Springs Fault. Located north-northwest of the site are small, high angle reverse faults that roughly parallel the Cold Springs Fault. However, the lateral continuity of these faults is not established across the Pigeon River. Ridgeline orientation typically parallels structural features which trend northeast/southwest.

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

The site lies within a seismic impact zone defined as an area having greater than 10 percent probability that the maximum expected horizontal acceleration expressed as a percentage of the earth's gravitational pull (g) will exceed 0.10g in 250 years (Algermissen, et al, 1990). There are no Holocene faults present within 200 feet of the landfill site (Howard, et al, 1978).

Site Specific Geology

Rock outcrop and core samples support the boundaries outlined by Hadley and Goldsmith (1963). Most of the core samples are layered, coarse-grained gneiss with varied degrees of fracturing and weathering. Some samples display granitic texture and good relict crystalline structure with only slight secondary orientation. Other samples show a typically gneissic texture that is massively foliated with interlayers of biotite mica and coarse-grained plagioclase and quartz. Although changes in texture and composition are observed, the rocks underlying and outcropping within and directly adjacent to the site are classified as preCambrian plutonic basement rocks.

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

Small boulders of fine grained, white sandstone are found on the head of the slope where abandoned borehole P-8 is located. These are likely relicts of the overlying Thunderhead Sandstone. Soils weathered from the sandstone unit are not present in any borehole within the proposed site nor are there any sandstone outcrops within the site boundaries. The reported contact between the Thunderhead Sandstone and the basement complex lies west and south of the site as mapped by Hadley and Goldsmith (1963). The location of this contact was confirmed in the field by MESCO personnel.

FIELD INVESTIGATION

MESCO installed twenty-one borings for the site hydrogeologic study in March through May 1998. Piezometers were installed in all borings that reached the water table and their locations were surveyed by MESCO in accordance with 15A NCAC 13B.1632. Boring B-8 reached neither the surface of intact rock nor the water table and was terminated and abandoned at a depth of 120 feet. Borings were drilled to provide both extended groundwater readings and subsurface data necessary for site characterization. Elevations from both the piezometers and monitoring wells will be used to define the potentiometric surface and groundwater flow characteristics. The locations of all borings and monitoring wells are provided on Plate 1. Water elevations and pertinent bore-hole and monitoring well depths are presented on Table 1.

Under the supervision of a MESCO geologist, Graham and Currie Well Drilling Company installed twenty temporary piezometers (P-1 through P-7, P-9 through P-19, P2-1 and P2-2) using a CME-850 track mounted drill rig. Borings were augered with $4^1/_4$-inch ID hollow stem augers. Those borings extending below auger refusal were enlarged with $6^1/_4$-inch ID hollow stem augers to install a 4" casing for support of overburden soils during coring and/or air hammering. Piezometers screened in rock with two inch diameter PVC (P-1, P-3, P-5, P-6, P-7, P-9, P-17, and P-18) were installed with a $3^3/_8$ inch air hammer. Core samples were taken from six borings (P-1, P-4, P-9, P-14, P-18, and P-19) using a 2 inch diameter core barrel. Borings P-4, P-14, and P-18 were installed with one inch diameter PVC in the core hole. Standard split-barrel samples of subsurface soils were taken at five foot intervals. Standard penetration tests were conducted in conjunction with split-barrel sampling in accordance with ASTM Test Procedure D 1586-84 using a 2-inch OD split-barrel sampler. Shelby tube samples were obtained of select cohesive soils for laboratory classification and *in situ* permeability testing. MESCO conducted slug tests in the field on July 6-8, 1998 to measure hydraulic conductivity of select lithologic units.

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

SUBSURFACE CONDITIONS

Textural distinctions occur throughout the saprolite within the upper aquifer. Even though these variations are indicated on the boring logs, they do not imply the vertical or lateral extent of lithologies. The boring logs are divided into different soil lithologies only to add insight to the type and gradation of soils to be encountered. Divisions on the logs are made based on expected hydrogeologic implications and how such variations are expected to influence the vertical and/or horizontal migration of groundwater.

The subsurface conditions at this particular site are best divided into three hydrogeologically distinct units. Boundaries for these units are made based on field inspection during installation, visual and laboratory sample analysis, and surrounding subsurface conditions. The uppermost portion of the site consists of saprolite defined as *in situ* chemically weathered crystalline rock. In this zone, a dense soil is found that grades slightly in composition, size, and degree of weathering depending on zonal variations in parent bedrock. Small scale structures are found in the overlying saprolite that, upon visual inspection, are similar to underlying gneissic bedrock. Relict structures include foliations, thin fractures with iron-stains and clay replacement, broken quartz intrusions, phyllitic texture, and weathered crystals. Because the extent of chemical weathering of a rock depends largely upon the ease of access of water to the rock, a thick overburden (saprolite) layer can be an indication that the rock from which is derived is abundantly fractured or has interstices of some type through which water can flow. A

thick saprolite unit which is generally porous although not necessarily very permeable, serves as a reservoir to feed water into fractures (LeGrand and Mundorff, 1952).

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

The third distinct unit is the underlying fractured gneissic bedrock. This unit, as previously described, is composed of metacrystalline plutonic rocks. These orthogneisses vary in composition, texture, and structure. Fractures commonly parallel gneissic foliation at approximately 45 to 65 degrees in core sample. The abundance of fractures within bedrock is often dependent on rock type. Strongly metamorphosed rock, such as that underlying the Haywood County Site, develops planes of cleavage owing to the growth of micaceous minerals. Cleavage planes provide openings along which water may enter and flow (LeGrand and Mundorff, 1952). Degree of fracturing is evident in an examination of core recovery (REC) and rock quality designation (RQD) values. The borings on ridgelines and toward the top of slopes (P-1, P-4, P-19) show higher average REC and RQD values. P-1, located on a broad ridgeline, has REC of 96% and RQD of 73%. REC and RQD values from P-4, which is located on a narrow ridge with steep slopes on either side, are 89% and 69% respectively. P-19 is located near the top of the steep slope rising from the Pigeon River. The average REC is 90% and average RQD is 71%. These high

REC's and RQD's are an indication of intact and moderately fractured rock. Such high values can also provide reason for the existence of ridgelines, steep topography, and abundant outcrop in certain areas on-site. Conversely, borings located in valleys and toward the bottom of shallow slopes (P-9, P2-1) display a decrease in REC and RQD values. REC and RQD values from P2-1, located midslope (before previous grading), are 84% and 48% respectively. P-9 is located very near a drainage feature. The average REC is 65% and the average RQD is 21%.

Along with supplying soil sample, standard penetration tests (SPT's) provide information to determine the relative *in situ* density of the saprolite unit. This information, when viewed in conjunction with other subsurface data, can help define weathering patterns and the presence of relict structures. A plot of average bpf versus depth ratio of borings (*Chart 1*) indicates blow counts increase only slightly from ground surface through the majority of the boring. Average standard penetration values of saprolite fall between 10 and 40 blows per foot (bpf). However, toward auger refusal (80% to 100% depth), the standard penetration values increase rapidly. This sudden rise in in-situ densities indicate an extensively and uniformly weathered overburden soil. Variations in the plot might account for zones of resistance such as partially weathered rock and broken quartz veins.

Groundwater was initially encountered in all three distinct units. Due to the general absence of subsurface structure that might influence groundwater movement (horizontal displacement, unweathered intrusions, etc.), water elevations are largely a function of overlying topography. Water was initially encountered in saprolite in borings P-10, P-11, P-12, P-13, P-14, and P-16. Groundwater was encountered initially in partially weathered rock in P-2, P-4, P-15, and P-18; and initial water elevations occurred in rock in the remaining borings (P-1, P-3, P-5, P-6, P-7, P-9, P-17, P-19, P2-1, and P2-2). Of these, water in P-6, P2-1, and P2-2 was found just below the soil/rock interface as defined by auger refusal. Once allowed to stabilize after piezometer installation, the head in P-6, P-9, P-10, P-11, P-12, P-13, P-15, P-16, and P-19 increased. Boring P-6 rose to the

saprolite portion of the upper aquifer just above the soil/rock interface. Similarly, the head in P-1, P-2, P-4, P-14, and P-18 fell after stabilization. After installation, P-14 fell below the soil/rock interface. The remaining borings (P-3, P-5, P-7, P-17, P2-1, P2-2) stabilized to levels comparable to those recorded while drilling. Stabilized water levels across the site indicate groundwater levels fall within 10 feet above or below the soil/rock interface.

Cross-sections are presented on Plates 5A through 5E. These sections display subsurface soil, rock, and groundwater conditions. The cross-sections show a somewhat uniform rock surface that generally mimics the topography. Bedrock data was not available from all borings, therefore the bedrock surface under and between certain boreholes (B-8, P-10, P-13, P-15) is interpretive. Partially Weathered Rock occurs directly over the bedrock surface in most areas. It is most abundant on ridges and hills where it can be found in thick units on top of the rock surface as well as suspended in the saprolite unit. This is a result of reduced joints and fractures on the resistant hills and ridges. The saprolite remains thick, with larger zones of PWR. In the valleys and draws, saprolite tends to be thin, while the PWR unit often pinches out on either side of the draw.

The estimated long term seasonal high water table is presented on all cross-sections. The seasonal high surface generally occurs in the saprolite or PWR and tends to mimic topographic and bedrock surface contours. Proposed subgrade elevations are also included on the cross-sections to show the four foot separation between the seasonal high water table elevations and subgrade elevations. The general profile presented on Plate 6 shows sections B-B' and D-D' all the way to the river. The water table line shown on these is the single day line. The general profile shows the extreme topographic relief onsite as well as general hydrogeologic conditions. Cross-sections 5A-5E are more detailed and do not extend to the Pigeon River.

Hydraulic conductivities were determined using the Bouwer and Rice (1976) method. This slug test method was developed as a bail-down test; that is, the water level is lowered by bailing so that the water flows from the aquifer into the well (Fetter, 1994). The test is appropriate for water levels that intersect the well screen or those where the water rises above the screened interval. A total of sixteen slug tests provided data to determine the hydraulic conductivities of the three distinct lithologic units comprising the uppermost aquifer.

Slug tests were performed on P-10, P-11, P-12, P-13, and P-16 which are screened in the saprolite portion of the upper aquifer. The average hydraulic conductivity for these wells is 5.54×10^{-5} cm/sec. This average value includes permeability tests run on five Shelby tubes taken from varying zones within the saprolite unit. Slug tests run on P-2 and P-15, which are screened in partially weathered rock, yield an average hydraulic conductivity of 1.05×10^{-5} cm/sec. Borings P-1, P-5, P-6, P-7, P-9, P-17, P-19, P2-1, and P2-2 are screened in fractured gneissic bedrock. The average for this unit is 4.65×10^{-5} cm/sec. A Hydraulic Considerations Table and calculations are included in Appendix B.

LABORATORY TEST RESULTS

Selected soil samples were tested in the laboratory in accordance with ASTM Standards to assist in classification and the estimation of engineering parameters. Laboratory tests included analysis of specific gravity, particle size through sieve analysis and hydrometer, and Atterberg limits. Tests on Shelby tube samples from P-8, P-9, P2-1, and P2-2 determined in-situ hydraulic conductivities. Particle size plotted on textural classification triangles determined effective porosities for the overburden soils. Total and effective porosity values used in calculating flow rates are presented in Table 2. Table 3 summarizes the laboratory results and Appendix B includes all related documentation.

Atterberg limits (ASTM D-4318) were determined for 12 samples representative of variations within the saprolite unit. Liquid Limits ranged from 37% to 55% with an average of 44%. Plastic Limits ranged from 27% to 48% with an average of 35%. Plasticity Index ranged from 0 to 26% with an average of 11%. Test results for natural moisture content indicate an average of 23.6% with a range from 13.4% to 30.4%. By Unified Soil Classification System parameters, these soils are low plasticity inorganic silts and fine sands and slightly plastic clayey silts.

GROUNDWATER CONSIDERATIONS

Regionally, the upper aquifer occurs in regolith overlying fractured crystalline bedrock. Regolith is inclusive of all unconsolidated material that overlies intact bedrock. Most groundwater storage is located in the regolith because it has a higher porosity than fractured bedrock (Heath, 1984). Infiltration occurs when precipitation reaches the land surface and penetrates the unsaturated soil. Water then moves laterally and downward through a temporary saturated zone. Ultimately, water will move into bedrock and be transported along interconnected fractures to points of discharge (Heath, 1984).

Onsite groundwater mainly occurs near the bedrock surface except on the crests of broad ridges underlain by thick saprolite and in deep draws, where the groundwater occurs in the saprolite. Plate 4 provides a single day potentiometric map generated from August 17, 1998 water level elevations. Groundwater flow is toward the main discharge feature, the Pigeon River. Recharge areas occur on the tops of the largest ridges on the property (P-13, P-1, and B-8). Groundwater on the extreme southern portion of the site flows south and southeast from the proposed Phase 1 area.

As discussed above, the hydraulic conductivities for all three distinct units are very comparable. This is evidence to the fact that a change from saprolite or PWR to rock does not greatly affect flow within the aquifer. Groundwater is preferentially flowing

along relict fractures and foliation in the saprolite. Because fractures in core samples and outcrops parallel foliations, foliations are a zone of preferential groundwater flow in both the rock and the saprolite. Major stream traces also follow foliation and joint orientations observed in outcrop.

Groundwater flow rates for each distinct lithology are calculated using permeability and effective porosity data from Table 2 and vertical and horizontal gradients generated from potentiometric data. Saprolite and PWR generally have the lowest flow rates. This is largely because they have a higher effective porosity than Gneiss. For two hydrogeologic units with the similar hydraulic conductivity, flow rate is controlled by effective porosity. In the flow rate equation, effective porosity is inversely proportional to flow rate; the lower the effective porosity, the higher the flow rate. The average flow rate in saprolite is 60.19 ft/yr with a maximum of 229.33 ft/yr and minimum 0.65 ft/yr. The maximum flow rate occurs in P-12 which is located in a draw while the minimum occurs at P-13 located on top of a ridge. Flow rates in PWR average 17.44 ft/yr, with the maximum of 30.80 ft/yr on a slope at P-18. The minimum flow rate (3.32 ft/yr) occurs on a ridge at P-15. Fractured Gneiss contains higher flow rates averaging 165.64 ft/yr. The maximum flow rate for gneiss is 673 ft/yr at P-1 on a ridge. The slowest rates occur on slopes at 1.19 ft/yr in P-19 and 7.60 ft/yr in P-7.

Plate 7 is an aerial photograph showing houses with wells within 2000 feet of the landfill boundary. The nearest supply wells are located just south of the property. The wells are across a groundwater divide which occurs from P-14 to P-13 through TWD-10. Phase 1 limits cross this divide in the southeastern portion of Phase 1. The majority of groundwater under proposed waste cells will flow north toward the Pigeon River and discharge into the River or local streams which feed the river. A minimal amount of groundwater flows toward the supply wells south of the property. This localized southern flow can be easily monitored with monitoring wells. There is also a group of wells west of the site. Based on topography and the location of local streams, groundwater will flow

north to northeast in the area of these wells, that is, groundwater will be flowing from these wells toward the landfill. Supply wells are also located north of the property, however these wells are north of the Pigeon River and will not be affected by groundwater originating in the landfill area.

Local Precipitation

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

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

Observation Well Data

Data from local USGS observation wells were used to track natural fluctuations in the regional water table. NC-40 is the closest currently maintained observation well. It is located approximately 20 miles to the southeast of the site along US 276. The well is 18 feet deep and is screened in saprolite of Precambrian gneiss. This is similar to the saprolite at the White Oak Landfill. The highest water level recorded during the 1997 water year was 2.71 feet below land surface in March. The low occurred in October, 1996 at 6.04 feet below land surface for a difference of 3.33 feet. Observation well NC-40 is a climatic effects well located in a valley. The maximum fluctuation recorded in this well is approximately 4 feet. NC-144 is located in Transylvania County just south of

Haywood County in a moderately sloped area. The well is screened in saprolite of gneiss to 70 feet. The high for the 1997 water year occurred in May 1997 at 25.09 feet below land surface, while the low was 32.88 feet below land surface in November 1996 for a difference of 7.79 feet. Observation well NC-144 is a terrain effects well. The maximum fluctuation observed in NC-144 in one year was 12 feet. All observation well locations and data are provided in Appendix C.

Limited data is available for groundwater fluctuations at the landfill site. Water level elevations are available only since the boring program was completed. Data from the temporary piezometers was obtained during a period when groundwater levels are historically low. Taking into account fluctuations in terrain and climatic effects data provided by the USGS, 12 feet was added to the lowest reading on each piezometer located on a slope or ridge, while 8 feet was added to the lowest reading on piezometers located in valleys and draws. This coincides with USGS data suggesting groundwater levels do not fluctuate as greatly in draws and valleys. The maximum expected fluctuation was added to be conservative for engineering design. The seasonal high estimation is summarized in Table 4, and all calculation and documentation is included in Appendix C.

SITE SUITABILITY

Overall the White Oak Landfill Site is suitable for development as a Subtitle D Municipal Solid Waste Landfill Facility. The majority of the groundwater flows toward a major discharge feature (Pigeon River). Because Haywood County owns the property to this point, the site will be easily monitored. No faults, mines, lithologic contacts, or other geologic features which influence groundwater flow have been located onsite.

CLOSURE

This report was prepared to determine the site suitability of the proposed regional lined landfill and completes the requirements of Rule .1623(a). Geological and hydrological data, information, and conclusions contained here and in reports of surrounding areas indicate no hindrance to developing a landfill at the White Oak Site in Haywood County, NC. The contents of this report discuss our investigations and conclusions of soil, rock, and groundwater conditions at the site. The scope of work is limited solely to the White Oak Landfill Site and is not meant to infer conditions outside of the study area.

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

Respectfully submitted,

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United States Geological Survey, 1967, Cove Creek Gap 7.5 minute quadrangle.

United States Geological Survey, 1967, Fines Creek 7.5 minute quadrangle.

Table 2
Haywood County Lined Landfill
Hydrologic Properties of Lithologic Units

Lithologic Unit	Average Hydraulic Conductivity (cm/sec)	Total Porosity (%)	Effective Porosity (%)	Average Flow Rate (ft/yr)
Saprolite	5.54E-05	27.0	11.4	60.2
Partially Weathered Rock	1.05E-05	10.0	10.0	17.4
Fractured Gneiss	4.65E-05	5.00	5.00	165.6

Data and Calculations for all properties are provided in Appendix B

Table 3

Haywood County Lined Landfill

Lab Results for Soil Samples

Boring	Depth (ft)	Soil Description	Liquid Limit	Plastic Limit	Plasticity Index	Percent Gravel (%)	Percent Sand (%)	Percent Silt (%)	Percent Clay (%)	Permeability ASTM D 5084 (cm/sec)	Specific Gravity	Natural Moisture Content (%)
P2-1*	1-5'	SaCl	55	29	26	2.4	43.5	26.4	27.7	--	2.71	24.0
P2-1*	6-10'	SaCl	48	27	21	3.5	45.1	24.6	26.8	--	2.69	22.9
P2-1	10-12'	SiSa	39	40	NP	1.6	57.0	23.5	17.9	2.20E-06	2.71	22.1
P2-1	21-23'	SaSi	37	NP	--	.3	39.5	36.2	24.0	1.30E-06	2.72	30.4
P2-2	3-5'	SiSa	44	34	10	8.4	47.6	28.2	15.8	2.00E-07	2.75	21.5
P-1	3-5'	SiSa	NP	NP	NP	0.0	47.7	39.2	13.1	--	2.83	21.7
P-8	39-40'	SiSa	48	48	0	0.0	58.4	26.3	15.3	2.20E-05	2.73	26.3
P-8	44-46'	ClSi	44	41	3	0.1	31.3	47.5	21.1	--	2.74	23.6
P-9	0-2'	SaCl	47	28	19	0.5	35.5	15.3	48.8	--	2.68	26.6
P-9	8-10'	SiSa	37	36	1	0.0	51.2	34.3	14.5	1.50E-04	2.72	22.2
P-14	0-2'	ClSi	40	36	4	0.0	34.1	45.7	20.0	--	2.75	28.3
P-15	13-15'	SaSi	NP	NP	NP	0.0	42.6	45.0	12.4	--	2.65	13.4

* denotes composite sample

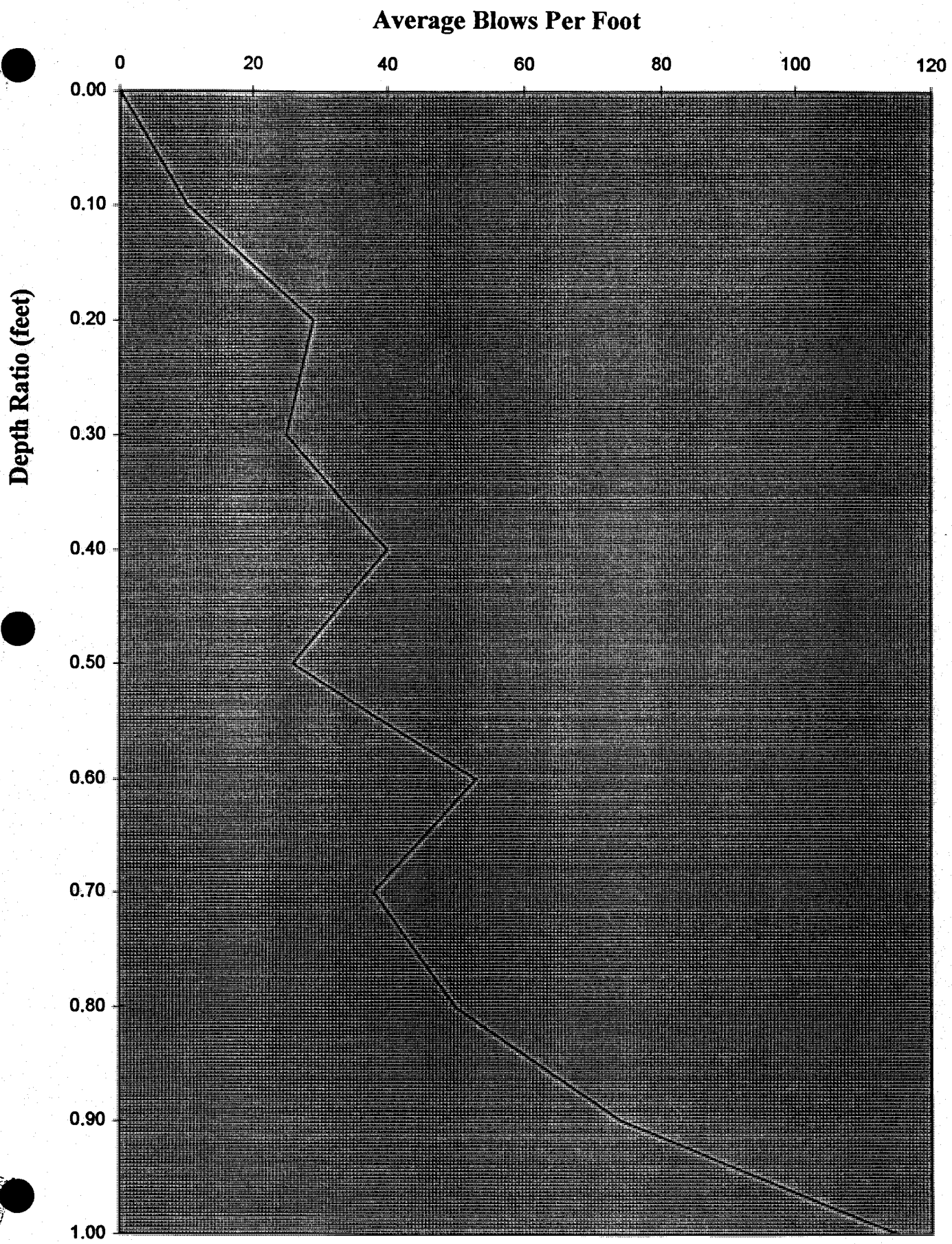
Table 4

Haywood County Lined Landfill

Seasonal High Estimation

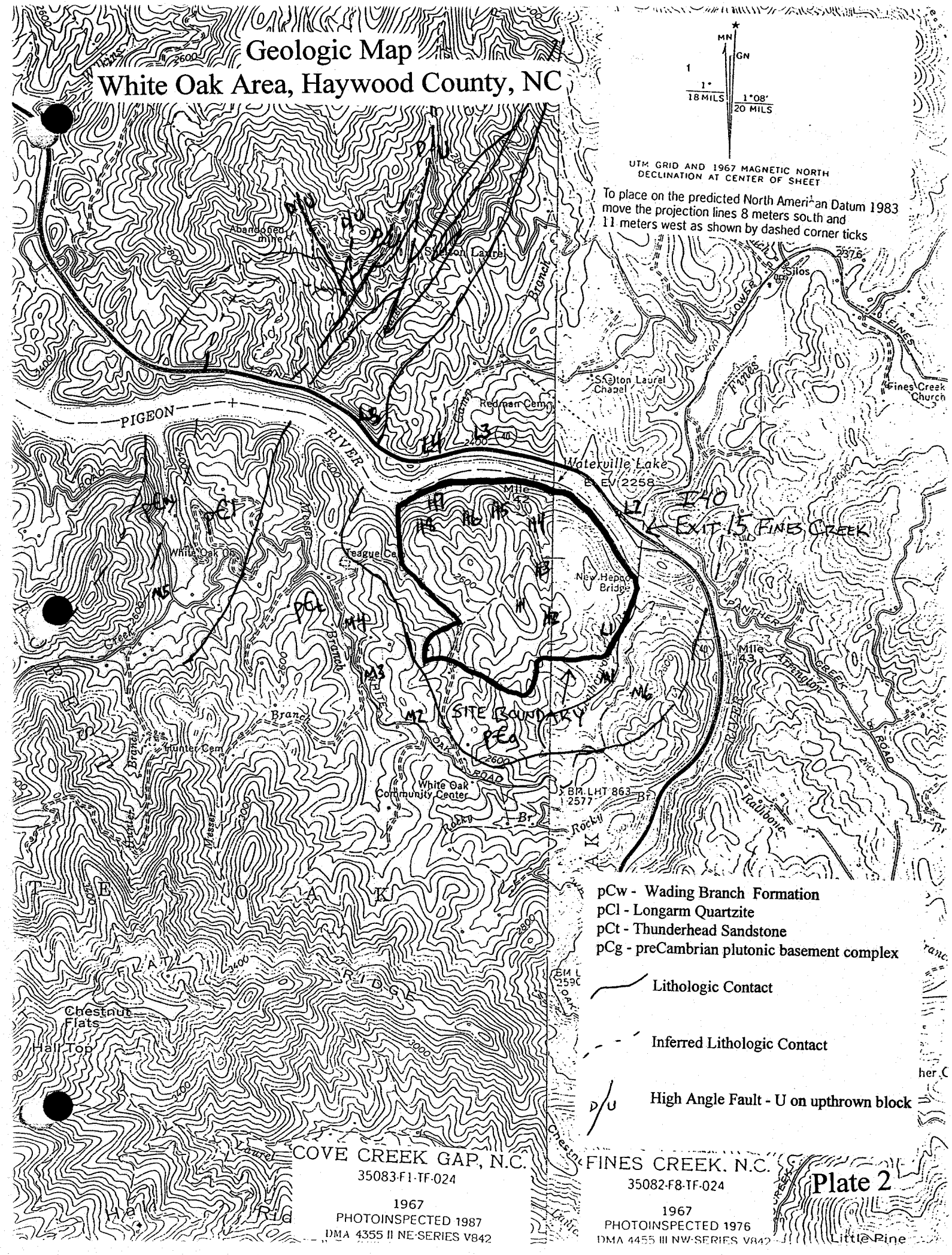
Piezometer	Low Reading	Topographic Setting	Expected Fluctuation	Estimated High
P-1	2558.11	Ridge	12	2570.11
P-2	2489.11	Slope	12	2501.11
P-3	2509.81	Ridge	12	2521.81
P-4	2503.83	Ridge	12	2515.83
P-5	2459.59	Draw	8	2467.59
P-6	2538.54	Ridge	12	2550.54
P-7	2519.23	Slope	12	2531.23
P-9	2487.72	Valley	8	2495.72
P-10	2531.65	Ridge	12	2543.65
P-11	2535.98	Draw	8	2543.98
P-12	2548.75	Draw	8	2556.75
P-13	2599.34	Ridge	12	2611.34
P-14	2579.38	Ridge	12	2591.38
P-15	2527.26	Ridge	12	2539.26
P-16	2535.85	Slope	12	2547.85
P-17	2480.65	Slope	12	2492.65
P-18	2451.32	Slope	12	2463.32
P-19	2409.59	Slope	12	2421.59
P2-1	2532.20	Slope	12	2544.20
P2-2	2530.20	Slope	12	2542.20
GWM-1A	2502.83	Draw	8	2510.83
GWM-2	2465.90	Draw	8	2473.90
GWM-2A	2466.14	Draw	8	2474.14
GWM-3	2427.31	Draw	8	2435.31
GWM-3D	2420.05	Draw	8	2428.05
GWM-4A	2457.26	Slope	12	2469.26
GWM-5A	2496.43	Draw	8	2504.43
GWM-5D	2495.90	Draw	8	2503.90
GWM-6A	2522.21	Draw	8	2530.21
GWM-7	2580.67	Ridge	12	2592.67
GWM-7D	2578.67	Ridge	12	2590.67
GWM-8	2445.72	Draw	8	2453.72
TWD-10	2585.17	Ridge	12	2597.17
TWD-10D	2585.04	Ridge	12	2597.04

NOTES: Fluctuations for slopes and ridges were taken from the maximum fluctuations for USGS terrain effects observation wells. Fluctuations for draws and valleys was taken from the maximum fluctuations for USGS climatic effects observation wells.
All observation well data is included in Appendix C



Standard Penetration Test **Chart 1**

Geologic Map
White Oak Area, Haywood County, NC



OUTCROP LOCATIONS IN THE WHITE OAK AREA, HAYWOOD COUNTY

Hatcher's Observations

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

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

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

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

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

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

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

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

Law Engineering Observations

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

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

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

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

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

Municipal Engineering Observations

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

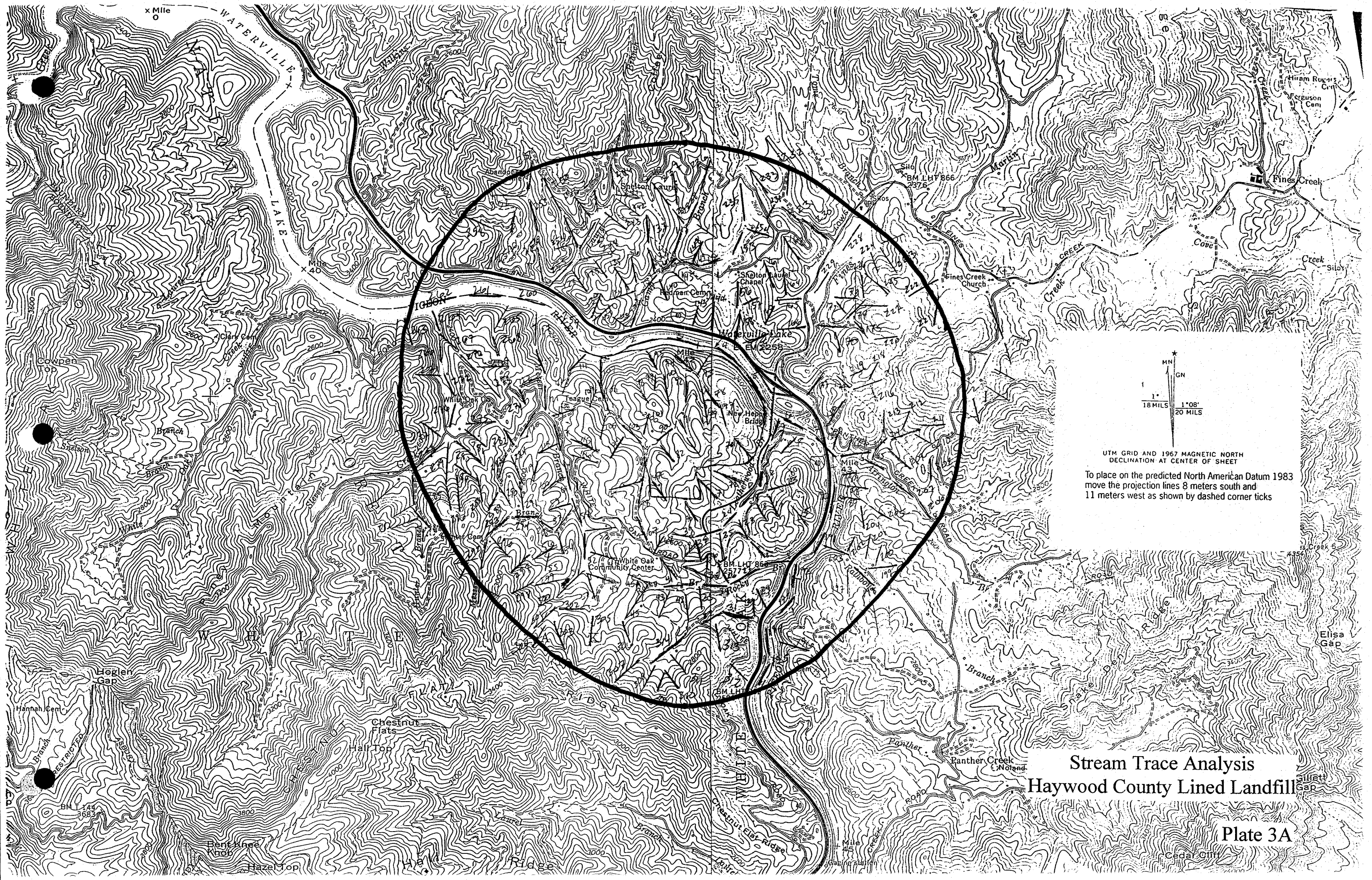
M2. Boulders of garnet schist in road cut. (Thunderhead Sandstone Unit)

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

M4. Garnet schist Foliation N5W/85NE

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

M6. Boulders of biotite gneiss with quartz and plagioclase.



Stream Trace Analysis
Haywood County Lined Landfill

Plate 3A

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

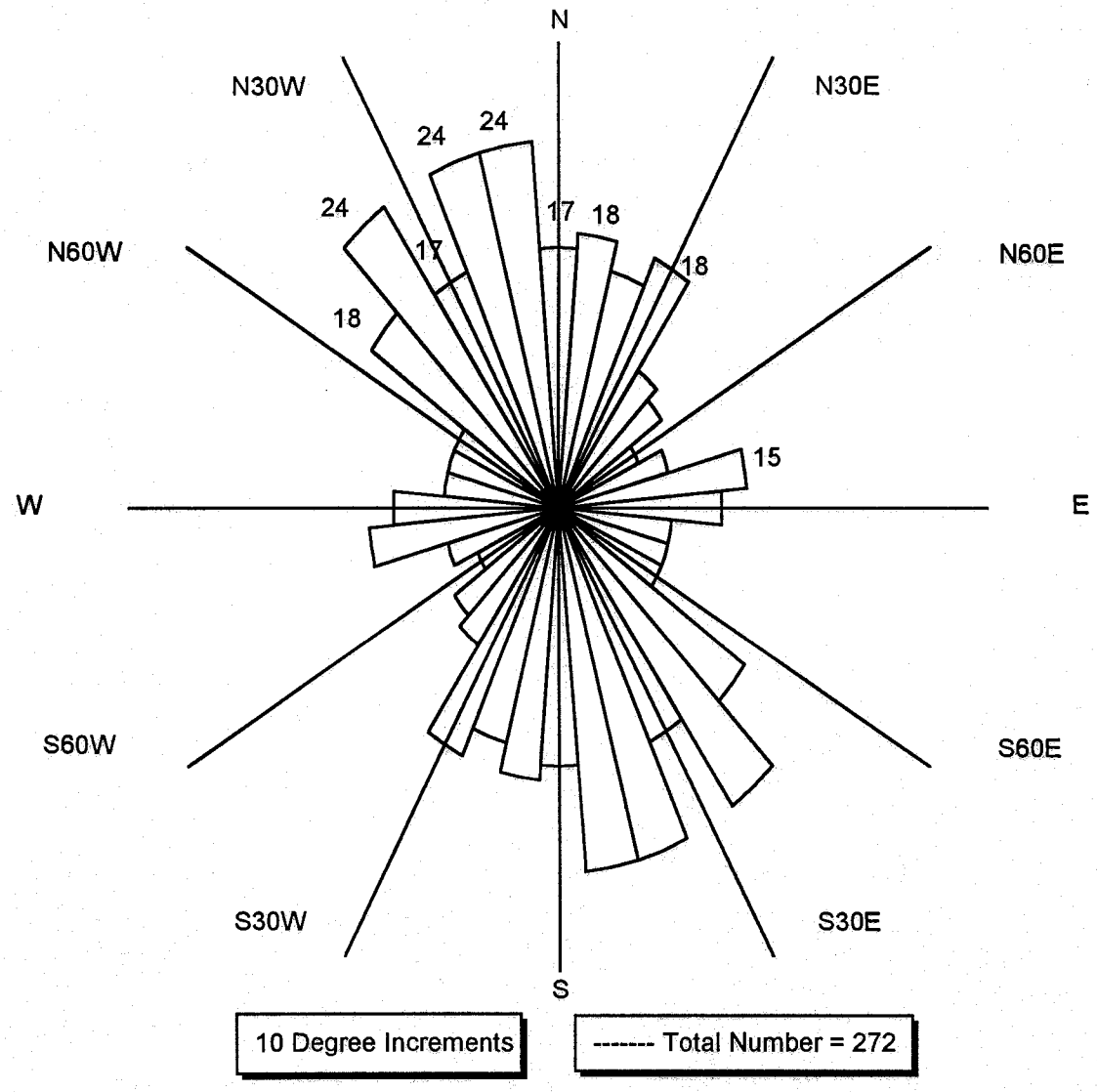


Plate 3B

Table 1

Haywood County Lined Landfill

Waynesville, North Carolina

Groundwater Elevation Summary

Piezometer Number	Date Drilled	Completion Depth	Ground Elevation	Top of Rock	Top of Pipe	While Drilling	After Drilling	24 Hours After Drilling	7 Days After Drilling	6/9/98	7/7/98	8/17/98	9/25/98	10/27/98	Temporal High	Temporal Low	Difference
P-1	5/20/98	2549.56	2629.56	2574.56	2632.34	2574.06	2559.09	2577.34	2558.19	2558.11	2558.47	2558.48	2558.14	2557.67	2558.48	2557.67	0.81
P-2	4/2/98	2483.37	2520.37	2483.37	2523.82	2499.37	2494.17	2493.97	2496.54	2494.05	2492.34	2490.10	2489.11	2488.42	2494.05	2488.42	5.63
P-3	5/19/98	2496.40	2564.00	2516.00	2566.64	2509.00	2509.01	2512.04	2512.07	2511.95	2511.40	2510.62	2509.81	2509.21	2511.95	2509.21	2.74
P-4	5/9/98	2490.66	2571.66	2512.66	2573.73	2509.66	2523.41	2507.23	2573.73	2503.83	2504.54	2504.80	2504.32	2503.71	2504.80	2503.71	1.09
P-5	5/25/98	2433.24	2485.54	2465.54	2488.38	2460.54	2449.54	2461.88	-	2462.70	2461.33	2460.32	2459.59	2459.12	2462.70	2459.12	3.58
P-6	5/25/98	2526.69	2594.19	2536.19	2597.24	2535.19	2537.29	-	2538.57	2538.65	2538.80	2538.68	2538.54	2538.20	2538.80	2538.20	0.60
P-7	5/25/98	2508.52	2550.52	2523.52	2553.15	2520.52	2528.52	2520.48	2553.15	2520.46	2519.23	2520.05	2519.92	2519.74	2520.46	2519.23	1.23
P-9	5/21/98	2473.68	2520.98	2505.98	2524.12	2478.98	2486.62	2488.85	2524.12	2488.77	2488.12	2487.82	2487.72	2487.87	2488.77	2487.72	1.05
P-10	3/19/98	2506.49	2579.49	-	2581.86	2527.49	2529.99	2530.16	2531.40	2534.05	2533.82	2532.81	2531.65	2531.03	2534.05	2531.03	3.02
P-11	3/18/98	2525.56	2550.56	2525.56	2553.87	2533.06	2537.06	2537.75	2537.67	2536.07	2536.09	2535.98	2536.23	2535.88	2536.23	2535.88	0.35
P-12	3/13/98	2537.29	2555.29	2537.29	2557.56	2547.29	2548.29	2550.14	2548.36	2549.41	2549.21	2548.83	2548.75	2548.31	2549.41	2548.31	1.10
P-13	4/21/98	2575.66	2671.66	-	2675.69	2587.66	2589.56	2596.18	2598.97	2599.34	2599.82	2600.48	2600.98	2601.31	2601.31	2599.34	1.97
P-14	5/12/98	2569.53	2650.93	2585.93	2654.13	2588.93	2605.53	-	-	2579.38	2579.86	2580.78	2581.19	2580.82	2581.19	2579.38	1.81
P-15	3/28/98	2499.49	2603.49	-	2606.51	2512.49	2527.12	2527.10	-	2527.26	2527.38	2527.88	2527.87	2527.77	2527.88	2527.26	0.62
P-16	3/29/98	2515.91	2557.91	2515.41	2560.57	2521.91	2535.14	2534.64	2534.98	2535.89	2536.04	2536.29	2535.85	2535.45	2536.29	2535.45	0.84
P-17	5/21/98	2469.29	2559.29	2534.29	2562.25	2478.29	2478.22	2479.67	2480.41	2480.65	2481.35	2481.65	2480.75	2479.90	2481.65	2479.90	1.75
P-18	5/10/98	2450.71	2491.71	2462.71	2495.26	2463.71	2469.26	2454.39	-	2452.06	2454.56	2451.48	2451.32	2451.35	2454.56	2451.32	3.24
P-19	4/2/98	2380.52	2478.02	2455.02	2481.55	2402.02	2382.02	2411.18	2411.10	2411.13	2411.15	2411.09	2409.59	2406.55	2411.15	2406.55	4.60
P2-1	5/21/98	2520.24	2572.74	2538.74	2575.93	2535.74	2531.74	2533.63	2533.54	2533.53	2533.43	2532.95	2532.20	2531.40	2533.53	2531.40	2.13
P2-2	5/21/98	2526.36	2573.66	2542.66	2574.13	2540.66	2531.66	2532.19	2531.93	2531.84	2531.53	2530.93	2530.20	2529.83	2531.84	2529.83	2.01
GWM-1A	9/17/93	2491.97	2517.97	2497.47	2520.46	-	2501.97	-	-	2504.21	2503.77	2503.13	2502.83	2502.58	2504.21	2502.58	1.63
GWM-2	9/16/93	2468.45	2494.45	2468.45	2497.00	-	-	-	-	2467.64	2467.20	2466.43	2465.90	2465.82	2467.64	2465.82	1.82
GWM-2A	9/23/93	2458.95	2494.45	2458.95	2497.94	-	-	-	-	2467.44	2467.42	2467.43	2466.14	2466.04	2467.44	2466.04	1.40
GWM-3	9/16/93	2380.30	2435.40	2398.50	2437.66	-	-	-	-	2430.10	2429.58	2428.41	2427.31	2426.89	2430.10	2426.89	3.21
GWM-3D	9/23/93	2413.38	2434.58	2413.38	2436.90	-	-	-	-	2421.65	2421.62	2420.59	2420.05	2419.75	2421.65	2419.75	1.90
GWM-4A	9/29/93	2459.19	2496.19	2474.79	2499.45	-	-	-	-	2460.35	2464.37	2463.71	2457.26	2461.17	2464.37	2457.26	7.11
GWM-5A	9/25/93	2402.17	2502.47	2474.47	2504.06	-	-	-	-	2497.70	2497.04	2496.76	2496.43	2496.36	2497.70	2496.36	1.34
GWM-5D	9/29/93	2482.37	2502.47	2482.37	2503.28	-	-	-	-	2496.62	2496.23	2496.07	2495.90	2495.88	2496.62	2495.88	0.74
GWM-6A	9/24/93	2491.68	2527.88	-	2530.52	-	-	-	-	2523.90	2522.82	2522.27	2522.21	2521.99	2523.90	2521.99	1.91
GWM-7	7/12/93	2560.76	2643.56	2560.76	2645.74	-	-	-	-	2581.50	2581.92	2581.37	2580.67	2580.18	2581.92	2580.18	1.74
GWM-7D	9/30/93	2540.36	2643.56	-	2644.82	-	-	-	-	2579.62	2579.80	2579.39	2578.67	2578.19	2579.80	2578.19	1.61
GWM-8	-	-	2475.13	-	2477.70	-	-	-	-	2447.08	2446.87	2446.23	2445.72	2445.46	2447.08	2445.46	1.62
TWD-10	-	-	2614.39	-	2617.16	-	-	-	-	2588.21	2587.74	2586.48	2585.17	2584.20	2588.21	2584.20	4.01
TWD-10D	-	-	2614.39	-	2617.48	-	-	-	-	2588.00	2587.57	2586.33	2585.04	2584.08	2588.00	2584.08	3.92

LOG OF BORING: P-1

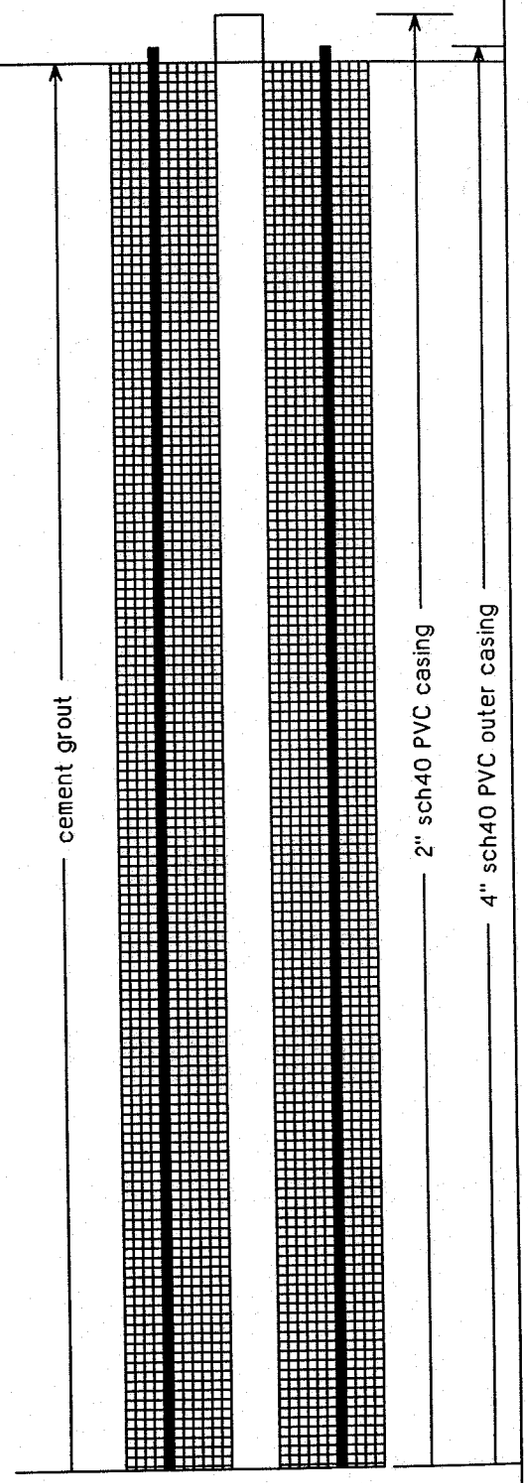
Project: Haywood County
Project No. G98010.5
T[illegible]A SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2629.56ft
Top of Casing: 2632.34ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	6			CLAYEY SILT (ML); red to brown, firm, with root debris
5	14			SILTY SAND (SM); brown, stiff, faint relict structure, mica zones
10	21			-grades orange to brown, very stiff
15	21			-grades dark green with yellow to white sand, rock fragments, near vertical quartz vein
	45			PARTIALLY WEATHERED ROCK, dark green, gneissic texture
25	25			SANDY SILT (SM); very dense, relict structure, vertical layers of sand
30	42			PARTIALLY WEATHERED ROCK, some sand, vertical clay layer
35	23			SILT (ML); tan-brown, very stiff, with sand, relict structure, black veins
40	38			-grades with clay
45	39			SANDY SILT (ML); dark tan-brown, dense, relict structure, small layers of coarse quartz grains

PIEZOMETER DIAGRAM



Completion Depth: 80ft
DATE: 5/20/98

Depth to Water: 67.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-1

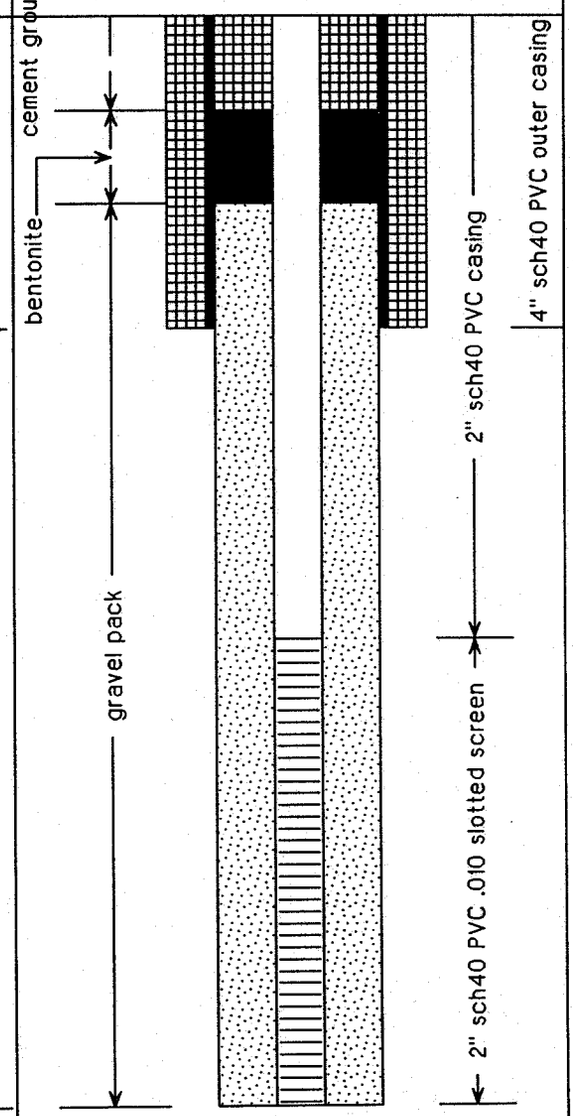
Project: Haywood County
Project No. G98010.5
Ty HSA SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2629.56ft
Top of Casing: 2632.34ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	50/4			-grades very dense, with mica and more sand
50				
	ref/6			Auger Refusal at 55.0 feet
55				GNEISS; dark grey with white banding at 65 to 80 degrees, quartz, plagioclase, muscovite, fractures at 65 degrees, REC=89%, RQD=70%
60				-weathered, fractures mainly horizontal with rust staining, REC=100% RQD=68%
				-grades slightly weathered, fractures horizontal or at 75 degrees with rust staining, REC=98%, RQD=80%
70				
75				
80				End of Boring at 80.0 feet
85				
90				

PIEZOMETER DIAGRAM



Completion Depth: 80ft
DATE: 5/20/98

Depth to Water: 67.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-2

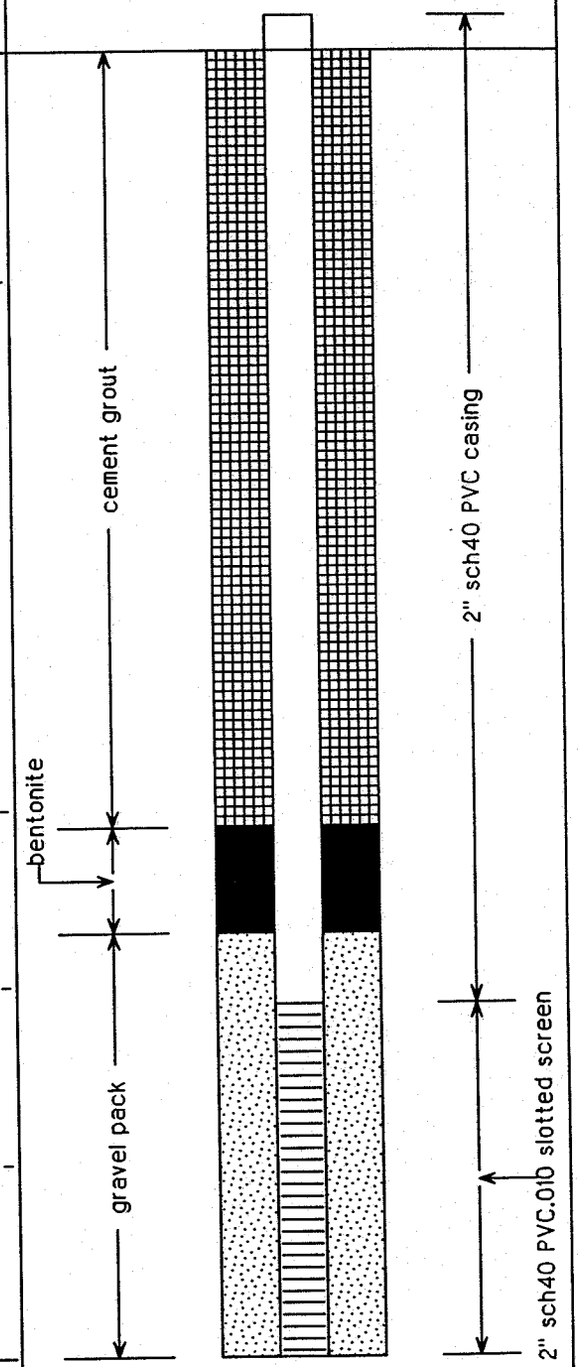
Project: Haywood County
Project No. G98010.5
T SA SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2520.37ft
Top of Casing: 2524.82ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	7			SILTY CLAY (CL); brown, firm, damp, grades with coarse sand, trace root debris near surface, damp
5	8			-grades with mica, relict structure
	8			SILT (ML); brown, firm, micaceous, grades with fine sand and clay
10				
	7			-grades light brown, relict stucture
15				
	12			
20				
	50/5			PARTIALLY WEATHERED ROCK; gray-green fragments with microcrystalline texture, some silt and coarse sand, clay on fracture surfaces
25				
	ref/5			CLAYEY SILT (MH); brown, hard, saturated, micaceous, iron mineralization between relict layers
30				
	ref/2.5			PARTIALLY WEATHERED ROCK; dark gray-green, gneissic layering, rust stains on fractures, zones of clayey silt
35				
				End of Boring at Auger Refusal 37.0 feet

PIEZOMETER DIAGRAM



Completion Depth: 37.0ft
DATE: 4/2/98

Depth to Water: 21.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-3

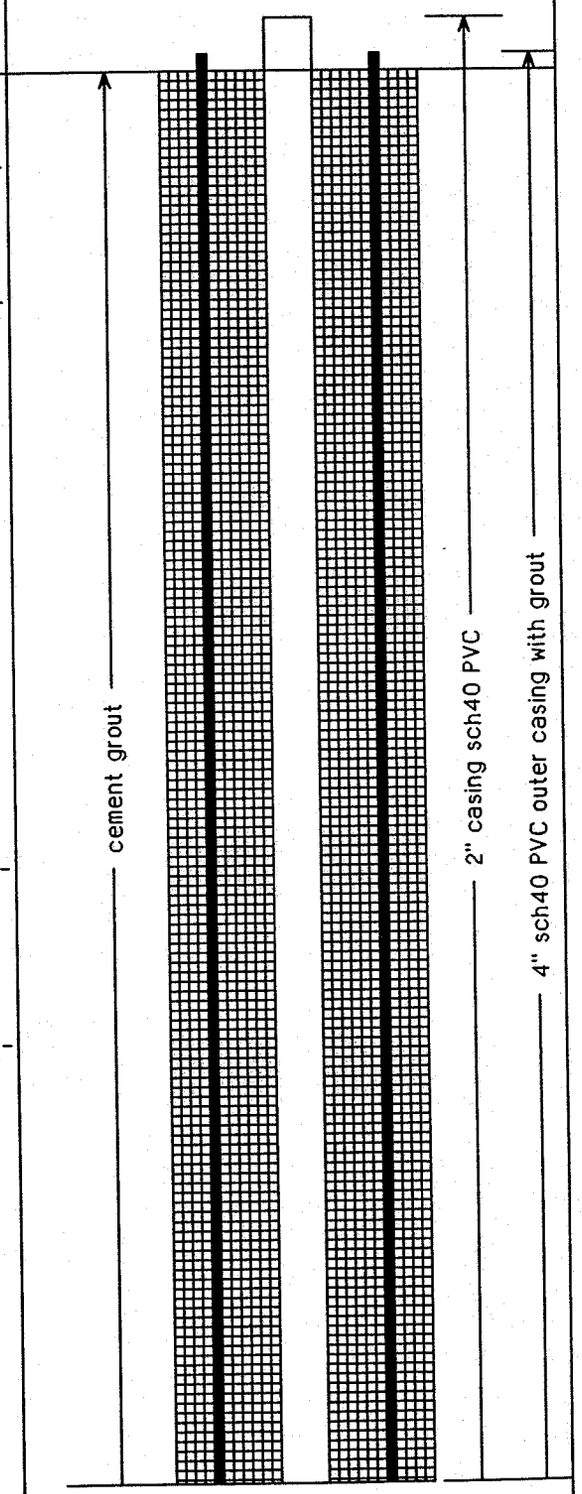
Project: Haywood County
Project No. G98010.5
T[illegible]ISA SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2564.00ft
Top of Casing: 2566.64ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	6			CLAYEY SILT (ML); reddish brown, loose, root debris, trace mica
5	32			SANDY SILT (ML); orange, dense, relict structure, some rock fragments
10	34			SILTY SAND (SM); brownish-orange, dense, medium to coarse, abundant Iron staining, relict structure
15	22			-grades with rock fragments, medium dense, fine grains with trace coasre grains
20	27			-grades reddish brown, medium dense, fine to medium sand, black mottles, relict layering
25	50/1.5			PARTIALLY WEATHERED ROCK, iron stained surfaces
30	43			SANDY SILT, brown, dense, micaceous
35	16			
[illegible]	50/5			-grades very dense, relict fractures

PIEZOMETER DIAGRAM



Completion Depth: 67.6ft
DATE: 5/19/98

Depth to Water: 55 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-3

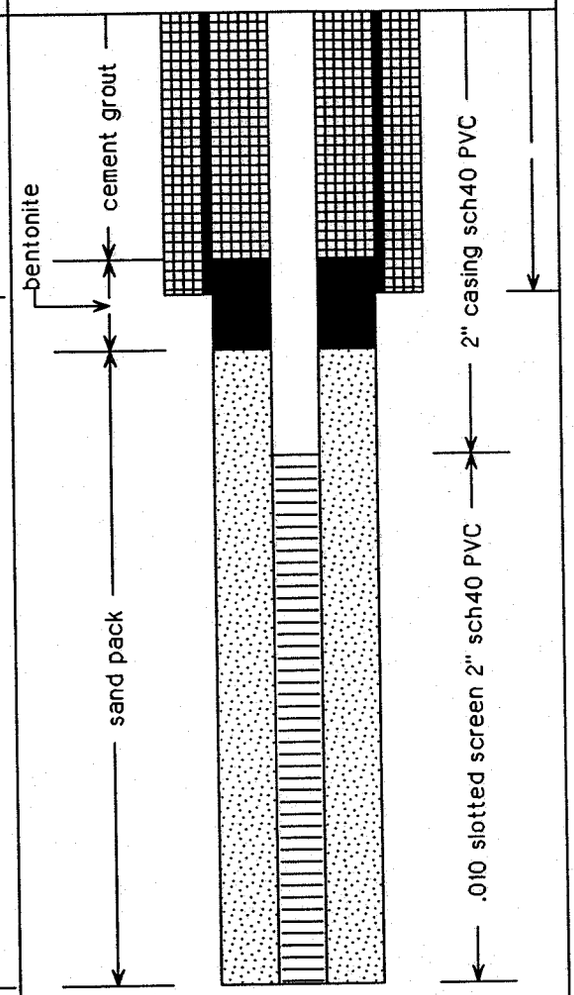
Project: Haywood County
Project No. G98010.5
T[illegible]ISA SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2564.00ft
Top of Casing: 2566.64ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
45	50/4			-grades with iron and rust staining
				Auger Refusal at 48.0 feet
				GNEISS
50				
55				
60				
65				
				End of Boring at 67.6 feet
70				
75				
[illegible]				

PIEZOMETER DIAGRAM



Completion Depth: 67.6ft
DATE: 5/19/98

Depth to Water: 55 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-4

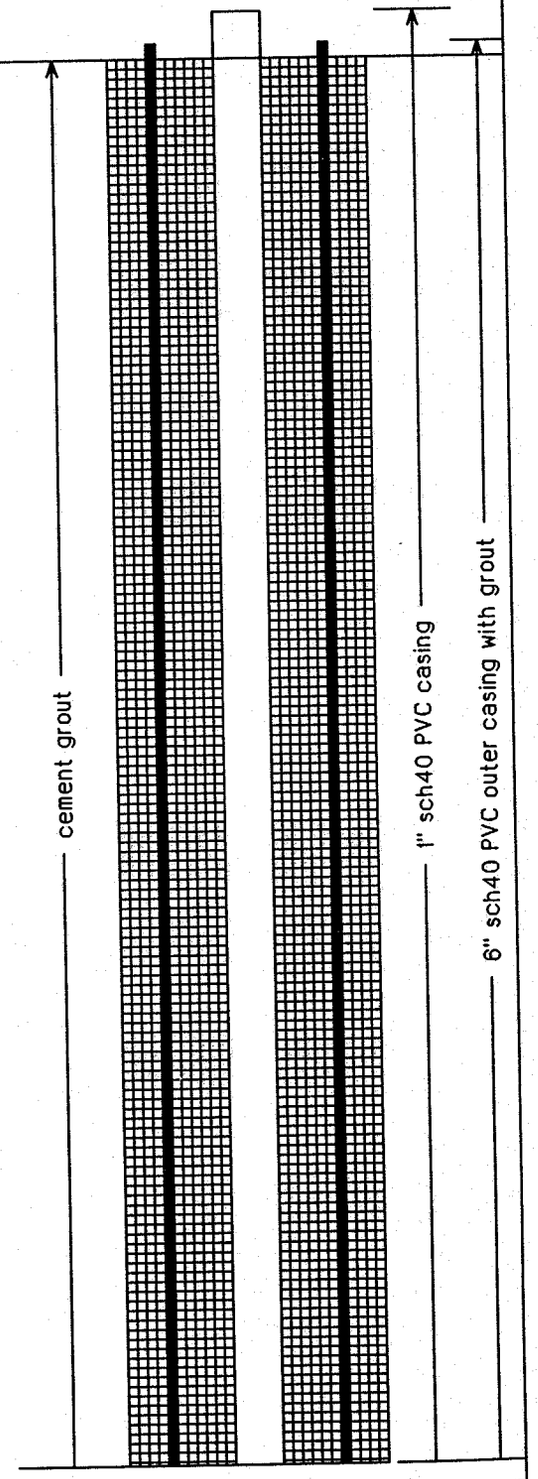
Project: Haywood County
Project No. G98010.5
T: SA SS NQ

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2571.66ft
Top of Casing: 2573.73ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	8			Topoil top 2"
				CLAYEY SILT (ML); red to brown, firm, with sand and small white and black rock fragments
5	20			SANDY SILT (ML); medium dense, saprolite, medium to coarse grained, trace clay
10	29			-grades with thin veins and rock fragments
15	30			SILTY SAND (SM); red-brown and white, medium dense, fine sand, saprolite, some fragments
				PARTIALLY WEATHERED ROCK, fine and coarse layers
	41			
25	58			-grades with rock fragments, highly fractured quartz vein
30	91			-rock fragments
				SANDY SILT (ML); tan orange, dense, saprolite, iron staining on relict minerals, some mica, trace clay
35	50/4			
40	43			
45	50/4			-grades to phyllitic texture

PIEZOMETER DIAGRAM



Completion Depth: 81ft
DATE: 5/9/98

Depth to Water: 62 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-4

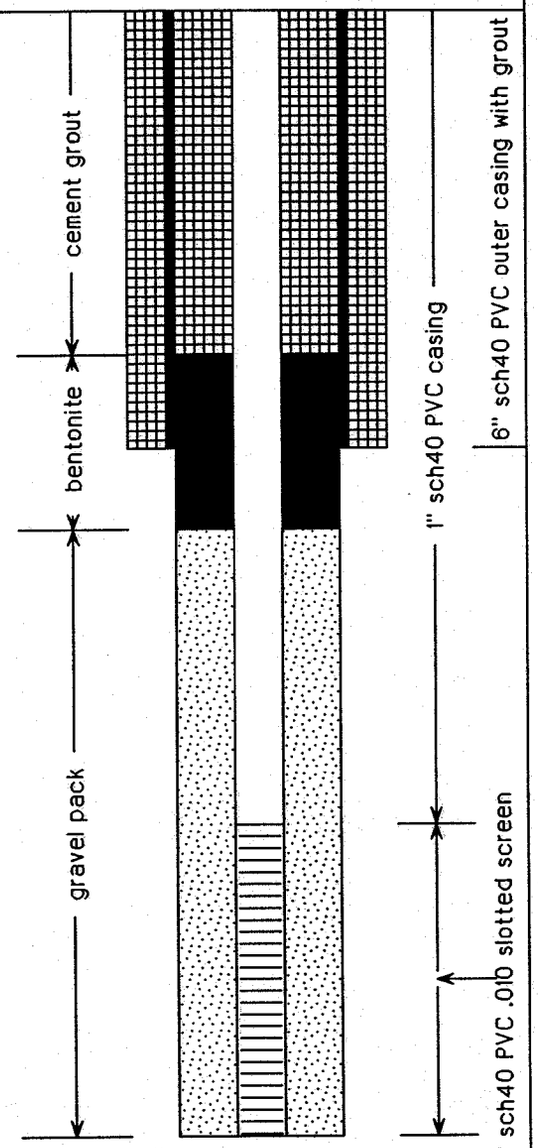
Project: Haywood County
Project No. G98010.5
T[illegible]HSA SS NQ

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2571.66ft
Top of Casing: 2573.73ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
50	30			-grades medium dense, some mica, trace quartz grains and clay
55	42			-grades with medium to coarse grains
				Auger Refusal at 59 feet
60				PARTIALLY WEATHERED ROCK
70				GNEISS; grey, moderately weathered, muscovite, biotite, quartz, feldspar, iron staining in fractures fractures parallel to banding at 45 to 60 degrees; REC=77%, RQD=59%
75				REC=100%, RQD=78%
80				End of Boring at 81 feet
85				
90				

PIEZOMETER DIAGRAM



[illegible]ompletion Depth: 81ft
DATE: 5/9/98

Depth to Water: 62 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-5

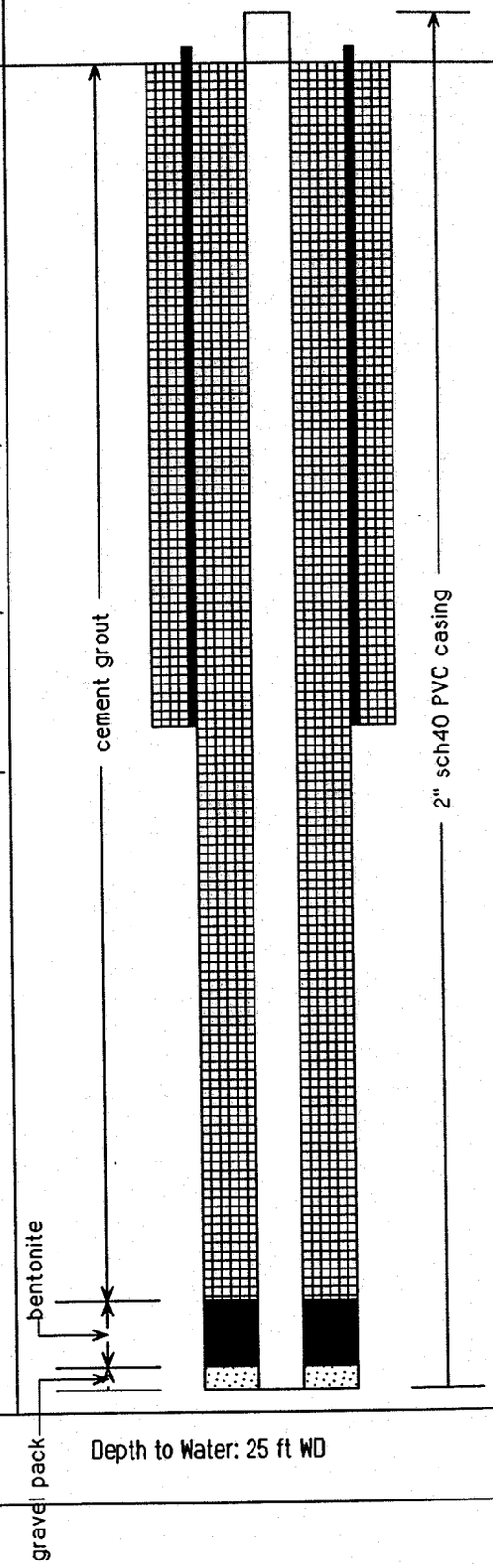
Project: Haywood County
Project No. G98010.5
T[illegible]SA SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2485.54ft
Top of Casing: 2488.38ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	6			Topsoil top 2"
				CLAYEY SILT (ML); dark brown, moist, firm, root debris and organics, trace mica
	12			SANDY SILT (ML); dark brown, medium dense, with coarse sand, pebbles and rock fragments, trace mica
5				
	18			-grades with trace pebbles, trace rock fragments
10				
				SILT (ML); medium brown, moist, firm, with yellow mottles, micaceous, trace clay
	7			
15				
	50/5			SILTY SAND (SM); tan, moist, very dense, few pebbles and rock fragments
20				Auger Refusal at 20.0 feet
				GNEISS
25				
30				
35				
40				

PIEZOMETER DIAGRAM



Completion Depth: 52.3ft
DATE: 5/25/98

Depth to Water: 25 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-5

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

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2485.54ft
Top of Casing: 2488.38ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	PIEZOMETER DIAGRAM
45					gravel pack; 2" sch40 PVC .010 slotted screen
50					
				End of Boring at 52.3 feet	
55					
60					
65					
70					
75					
80					

Completion Depth: 52.3ft
DATE: 5/25/98

Depth to Water: 25 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-6

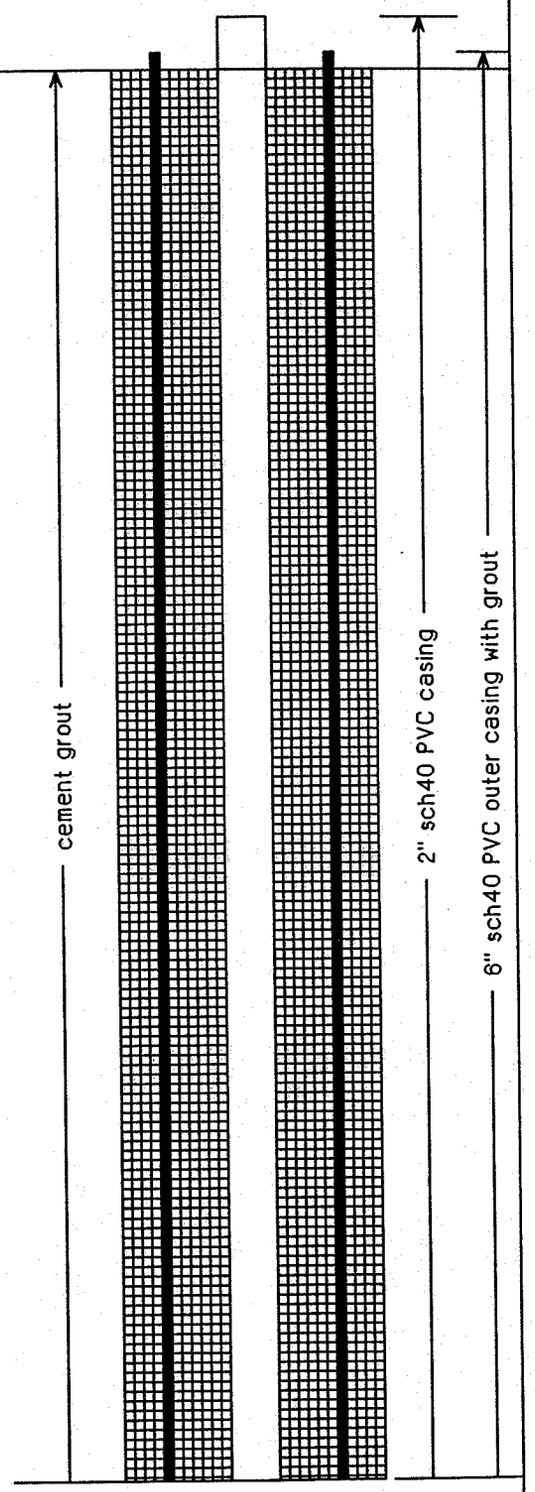
Project: Haywood County
Project No. G98010.5
T[illegible]SA SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2594.19ft
Top of Casing: 2597.24ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	6		X	CLAYEY SILT (ML); red to brown, damp, with black mottles, some mica and coarse sand, trace root debris
5	9		X	SANDY SILT (ML); light orange to tan, loose, micaceous, some coarse grains
10	14		X	-grades light orange to tan, medium dense, faint relict structure
15	14		X	SILT (ML); brown, damp, medium dense, with medium to coarse sand and mica
20	22		X	-grades light brown, with fine to coarse sand, trace rock fragments
25	18		X	-grades less micaceous, less medium sand, brown and black mottles
30	19		X	SANDY SILT (ML); medium to dark brown, medium dense, zones of coarse sand and fragments, some mica
35	23		X	-zone of biotite gneiss
	20		X	PARTIALLY WEATHERED ROCK; iron staining on relict fracture surfaces

PIEZOMETER DIAGRAM



Completion Depth: 67.5ft
DATE: 5/25/98

Depth to Water: 59 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-6

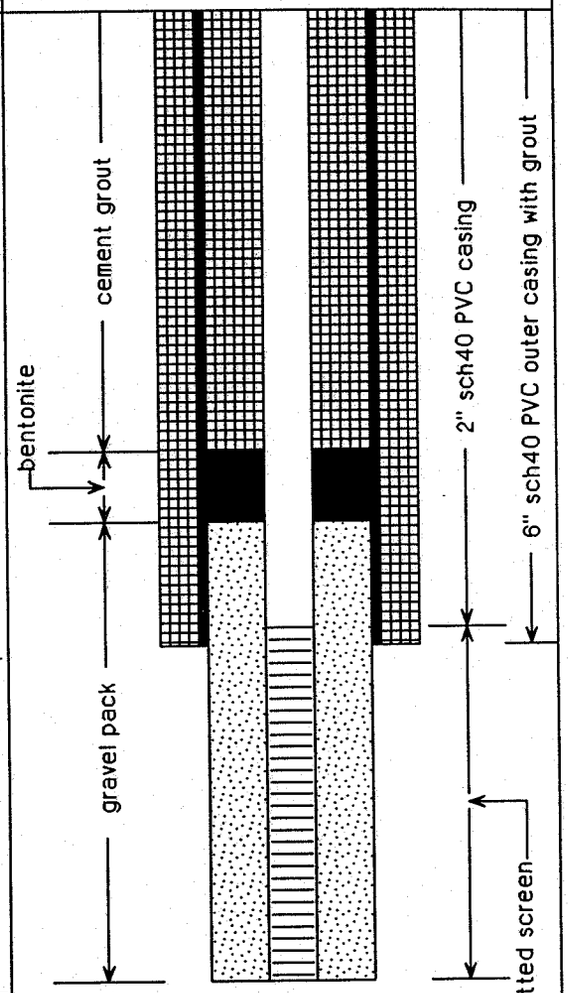
Project: Haywood County
Project No. G98010.5
T[illegible]HSA SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2594.19ft
Top of Casing: 2597.24ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
45	45			-grades with angular quartz fragments
50	52			SANDY SILT (ML); zones of white fine sand and silt, dark brown micaceous layers
55	50/5			SILTY SAND (SM); brown, very dense, medium to coarse grained, with rock fragments, some mica
				Auger Refusal at 58 feet
60				GNEISS -fracture at 60 feet
65				fracture at 67 feet
				End of Boring at 67.5 feet
70				
75				

PIEZOMETER DIAGRAM



Completion Depth: 67.5ft
DATE: 5/25/98

Depth to Water: 59 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-7

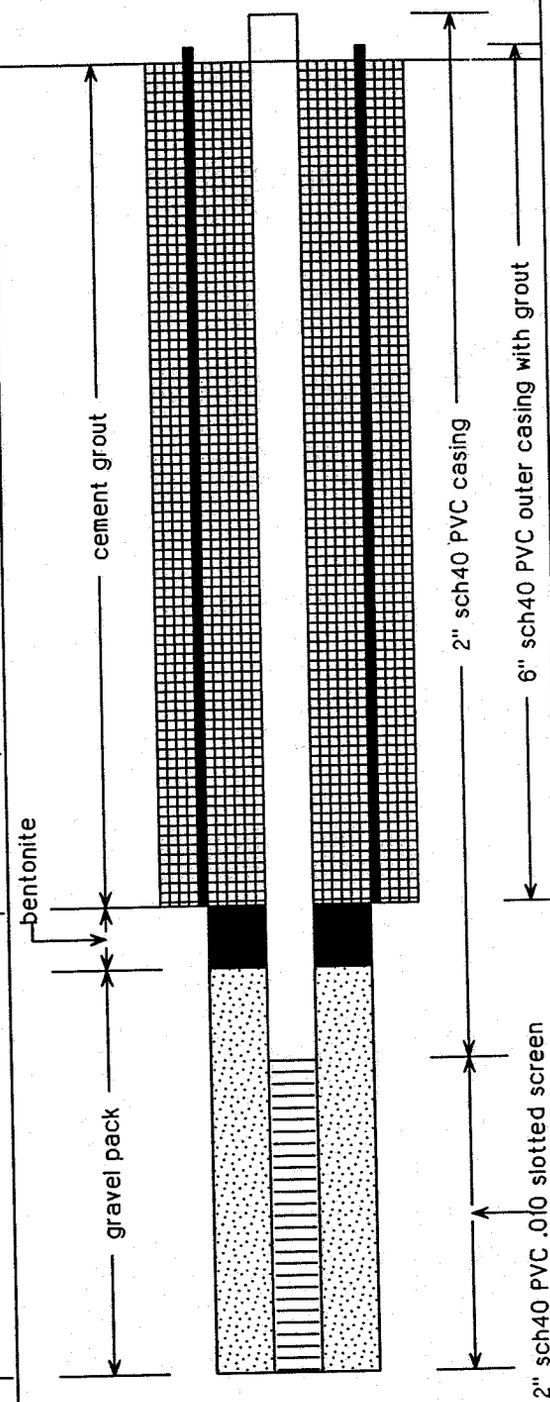
Project: Haywood County
Project No. G98010.5
Ty[illegible]A SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2550.52ft
Top of Casing: 2553.15ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	8		X	SANDY SILT (ML); brown, moist, loose, micaceous, rust staining and relict crystals, medium and coarse sand
5	21		X	SILTY SAND (SM); tan-brown, medium dense, medium and coarse grained, with pebbles and rock fragments, saprolite
10	23		X	-grades with yellow and black layering, relict minerals apparent, some rust staining
15	23		X	SANDY SILT (ML); brown to black, damp, medium dense, some coarse grains, trace angular quartz fragments
	18		X	-grades with yellow mottles, fine grained, some iron staining
25	50/4		X	PARTIALLY WEATHERED ROCK Auger Refusal at 27.0 feet
30 35 40				GNEISS
				End of Boring at 42.0 feet

PIEZOMETER DIAGRAM



Completion Depth: 42.0ft
DATE: 5/25/98

Depth to Water: 30 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: B-8

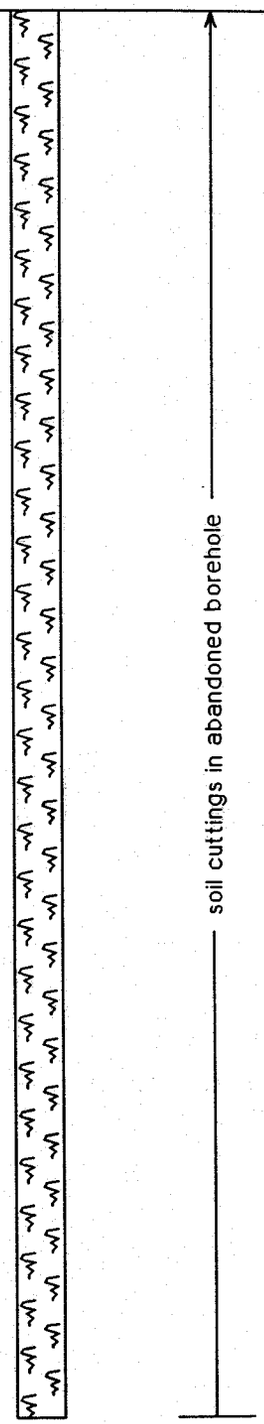
Project: Haywood County
Project No. G98010.5
[illegible]A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: ft
Top of Casing: ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	4			Topsoil top 2"
	22			SILTY CLAY (CL); red-brown, soft, few angular pebbles and coarse grains
5				SILT (ML); gray to white, very stiff, pebbles of fine grain white sandstone
10	9			
15	8			-orange-red, with medium grained sand, trace clay and coarse grains
[illegible]	14			-grades stiff, purple-orange, relict structure
25	17			-grades red, some fine to medium sand
30	16			-grades with white and orange layers, trace fine sand and mica, trace clay
35	20			-grades red-purple, very stiff, with yellow veins
40				SILTY SAND (SM); trace gravel
45	20			CLAYEY SILT (ML) grades tan-yellow to brown, relict structure, well sorted

PIEZOMETER DIAGRAM



Completion Depth: 120ft
DATE: 4/21/98

Depth to Water: dry ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: B-8

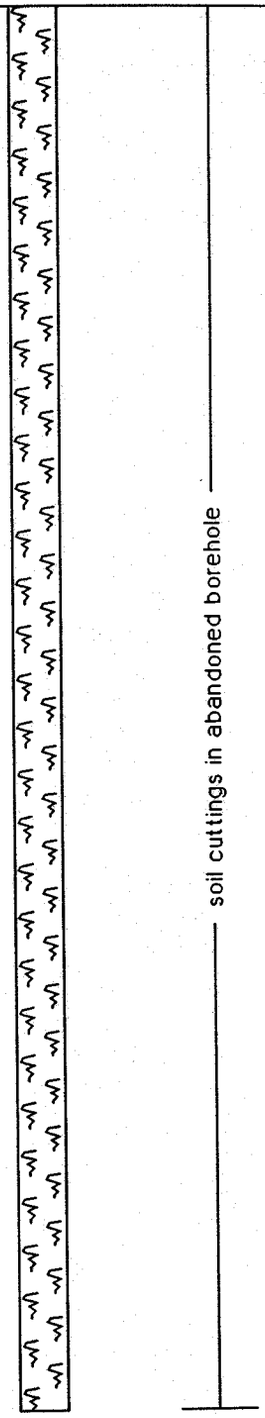
Project: Haywood County
Project No. G98010.5
[illegible]A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: ft
Top of Casing: ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
				SILT (ML);grades purple with white mottles, some clay, relict stucture
50	30			
55	31			
60	23			-grades orange brown, trace mediume sand, trace mica
65	32			-grades with some clay
70	28			-grades with some mica, relict veins with iron staining
75	37			-grades red-brown with yellow mottles, micaceous
80	27			
85	40			-grades pink to red with white mottles, hard, with angular coarse pebbles
	30			SANDY SILT (ML); brown to red, dense, dry, white highly weathered crystals, black mottles, some mica, relict structure

PIEZOMETER DIAGRAM



Completion Depth: 120ft
DATE: 4/21/98

Depth to Water: dry ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: B-8

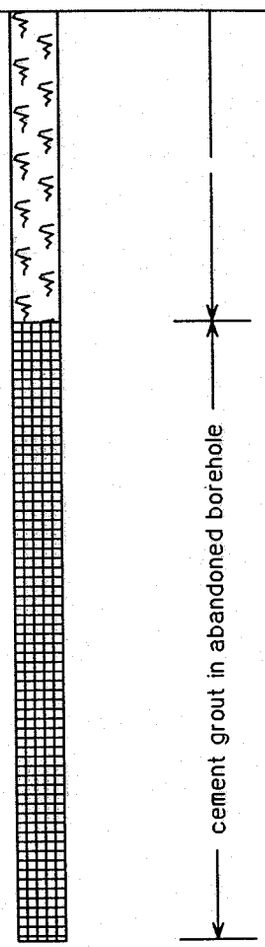
Project: Haywood County
Project No. G98010.5
[illegible]A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: ft
Top of Casing: ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
95	34		X	-grades light brown to yellow, zones of rust staining
				SILT (ML); light brown, dense, trace medium and coarse grains, micaceous, relict stucture
100	30		X	
105	24		X	-grades damp, with weathered mica and sand layers,
				SANDY SILT (ML); brown with tan layers, dense, moist, black and red banding, trace clay
[illegible]	40		X	
115	34		X	-grades with zones of dark brown to black, layers of yellow-tan silt and fine sand, relict structure
				SILT (ML); brown, dense, moist, abundant fine mica, trace medium and coarse grains, zones of iron mineralization
120	45		X	End of boring at 120 feet
125				
130				
[illegible]				

PIEZOMETER DIAGRAM



Completion Depth: 120ft
DATE: 4/21/98

Depth to Water: dry ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-9

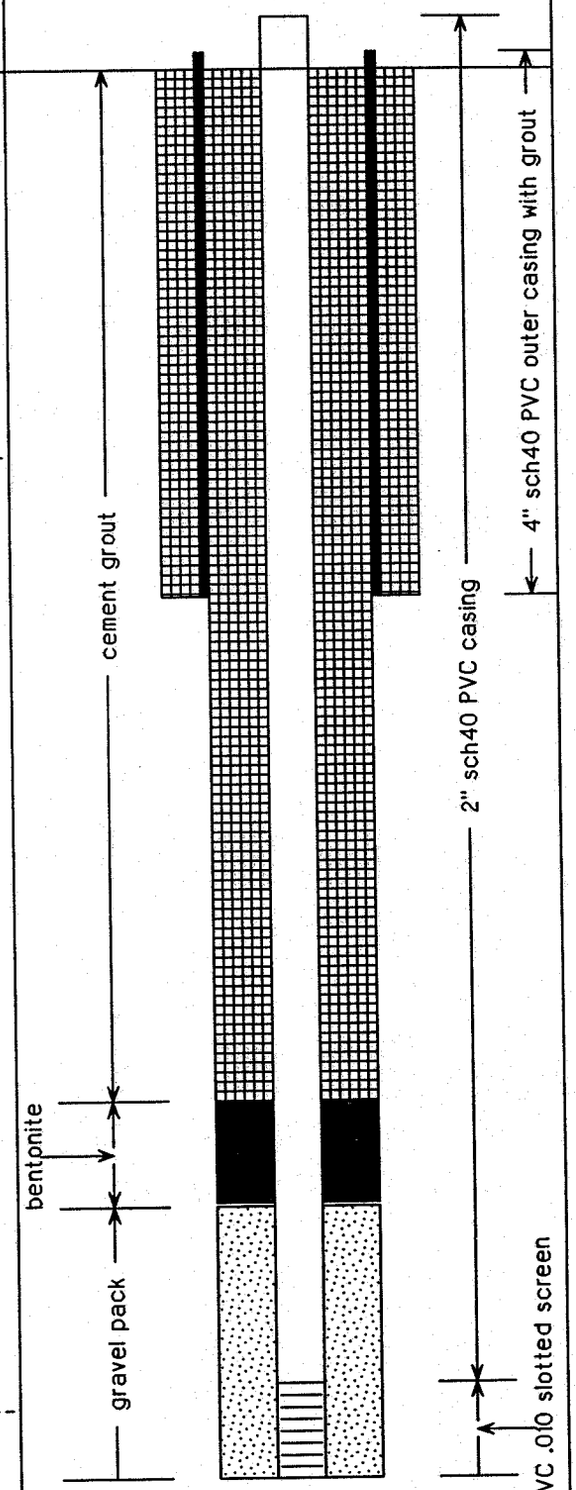
Project: Haywood County
Project No. G98010.5
T[illegible]ISA SS NG AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2520.98ft
Top of Casing: 2524.12ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	5			SANDY CLAY (CL); red to brown, moist, stiff, trace medium sand and mica, few pebbles
	8			SILTY SAND (SM); light brown with yellow-orange and black mottles, loose, trace medium and coarse sand
5				
10				PARTIALLY WEATHERED ROCK, tan to gray, micaceous
	50/5			
15				Auger Refusal at 15.0 feet
				-REC=89%, RQD=44%
20				-REC=75%, RQD=0%
				-REC=25%, RQD=0%
25				-zone of saprolite, REC=80%, RQD=20%
30				-weathered fracture zone at 32 feet
35				
				GNEISS

PIEZOMETER DIAGRAM



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

Depth to Water: 42 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-9

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

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2520.98ft
Top of Casing: 2524.12ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	PIEZOMETER DIAGRAM
45					gravel pack; 2" sch40 PVC .010 slotted screen
				End of boring at 47.3 feet	
50					
55					
60					
65					
70					
75					

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

Depth to Water: 42 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-10

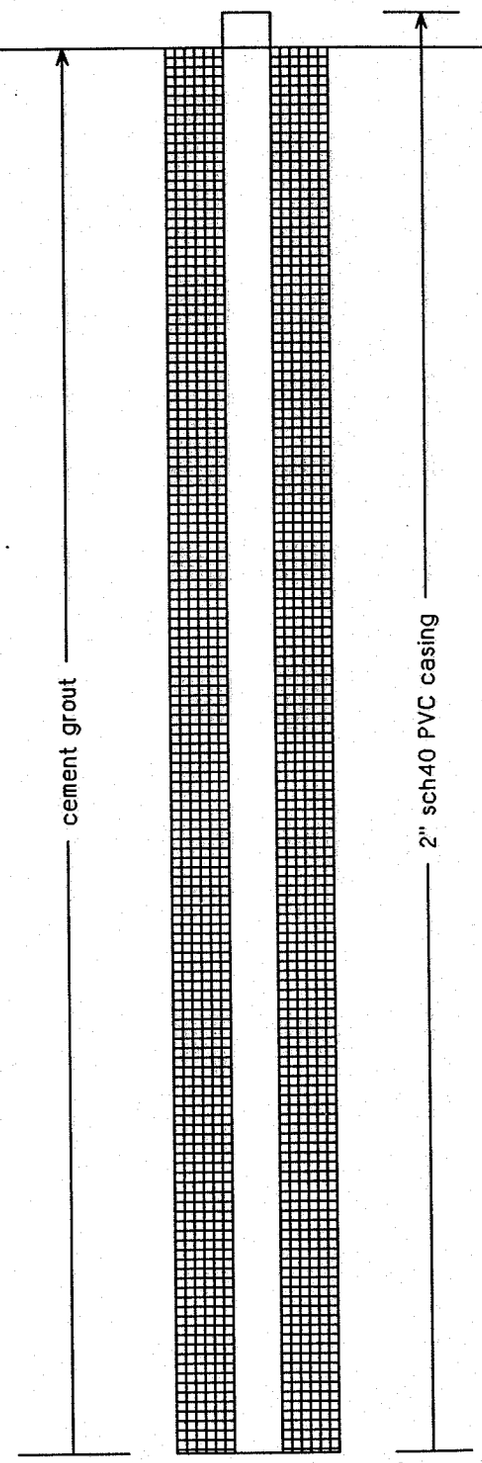
Project: Haywood County
Project No. G98010.5
Ty[illegible]SA SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2579.49ft
Top of Casing: 2581.86ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	5		X	SILT (ML); pink-brown, firm, with sand and clay, trace mica, relict structure
5	7		X	-grades with weathered zones of biotite
10	12		X	SANDY SILT (ML); olive green to brown, medium dense, fine to coarse sand, relict structure, weathered relict crystals, some mica
15	17		X	SILT (ML); brown to white, very stiff,trace fine sand and rock fragments, layers of mica
20	26		X	SANDY SILT (ML); red to brown, medium dense, sand medium grained, zones of muscovite
25	32		X	-grades brown, dense, fine sand, rock fragments, iron stained, relict gneissic layering
30	31		X	-grades brown to rust colored, poorly sorted sand, rock fragments relict structure
35	34		X	-grades with rock fragments
	50/4		X	-grades very dense, relict gneissic structure, rust staining

PIEZOMETER DIAGRAM



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

Depth to Water: 52 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-10

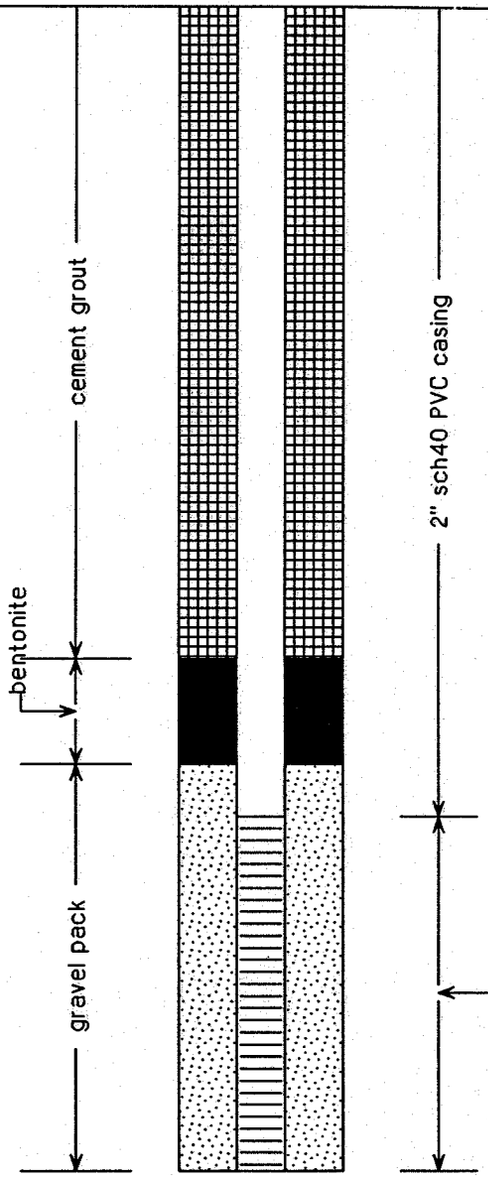
Project: Haywood County
Project No. G98010.5
Ty[illegible]SA SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2579.49ft
Top of Casing: 2581.86ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
45	38		X	-grades moist, dense, gneissic structure, trace coarse sand, some mica
50	18		X	-grades medium dense, with mica and trace clay, iron stained relict fracture
55	27		X	-grades wet
60	25		X	-grades with more clay
65	50/4		X	-grades very dense, relict foliation near vertical
70	50/5		X	-grades with black and white relict layering
75				End of Boring at 73.0 feet
80				

PIEZOMETER DIAGRAM



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

Depth to Water: 52 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-11

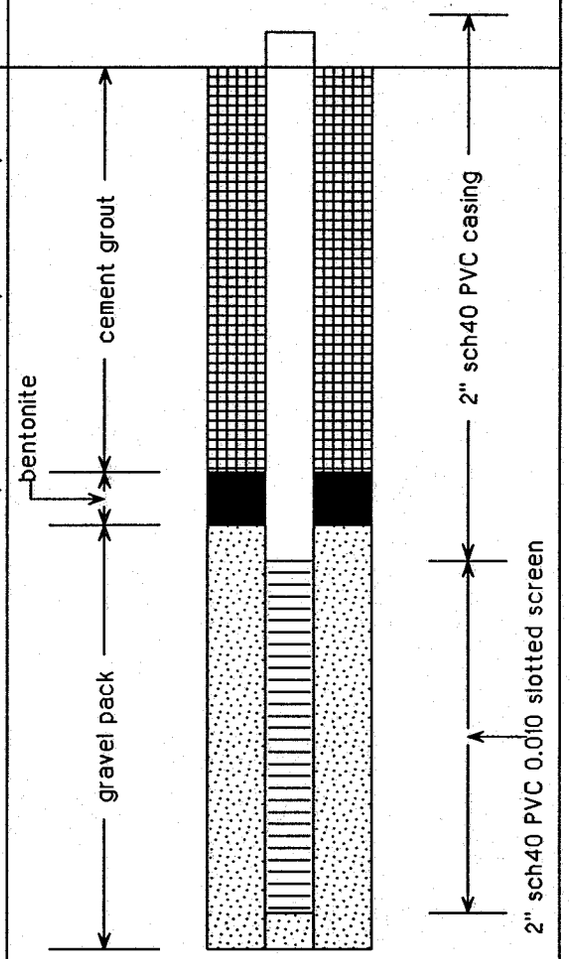
Project: Haywood County
Project No. G98010.5
Type: SA,SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: ft
Top of Casing: 2553.82ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	4			SILTY CLAY (CL); Medium brown, moist, soft, with medium to coarse sand
5	3			CLAYEY SILT (ML); Brown, moist, soft, some root debris, trace coarse sand and mica
10	11			SILT (ML); dark brown, stiff, saprolitic, with mica and fine sand layers, some clay, rust stained relict foliation
15	16			SANDY SILT (ML); black/white gneissic banding, moist, very stiff, saprolitic, some coarse quartz grains
20	50/1			-grades dark brown with tan and orange layers, saturated, very dense, micaceous
25	ref/3			-grades with few rock fragments, some coarse grains, trace mica
				End of Boring at Auger Refusal 25.0 feet
30				
35				
40				

PIEZOMETER DIAGRAM



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

Depth to Water: 17.5 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-12

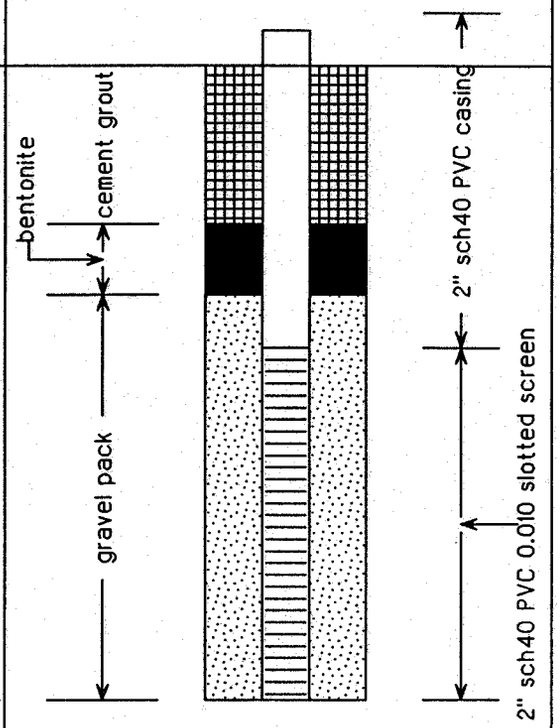
Project: Haywood County
Project No. G98010.5
Ty[illegible]A,SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2555.29ft
Top of Casing: 2557.56ft

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

PIEZOMETER DIAGRAM



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

Depth to Water: 8.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-13

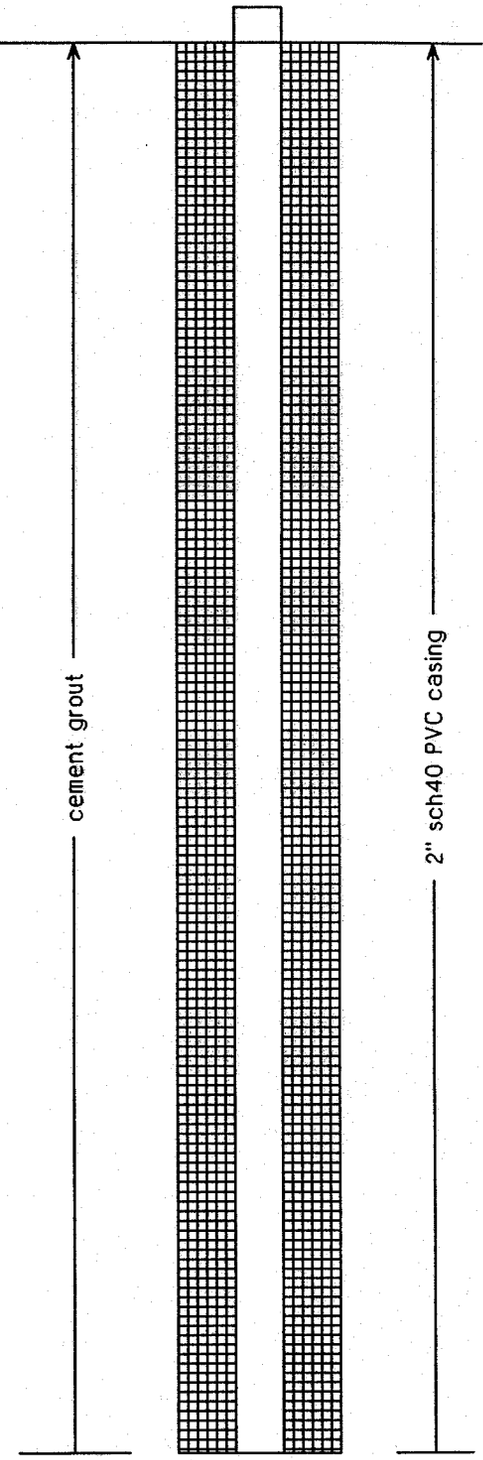
Project: Haywood County
Project No. G98010.5
Ty[illegible]A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2671.66ft
Top of Casing: 2675.69ft

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

PIEZOMETER DIAGRAM



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

Depth to Water: 84.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-13

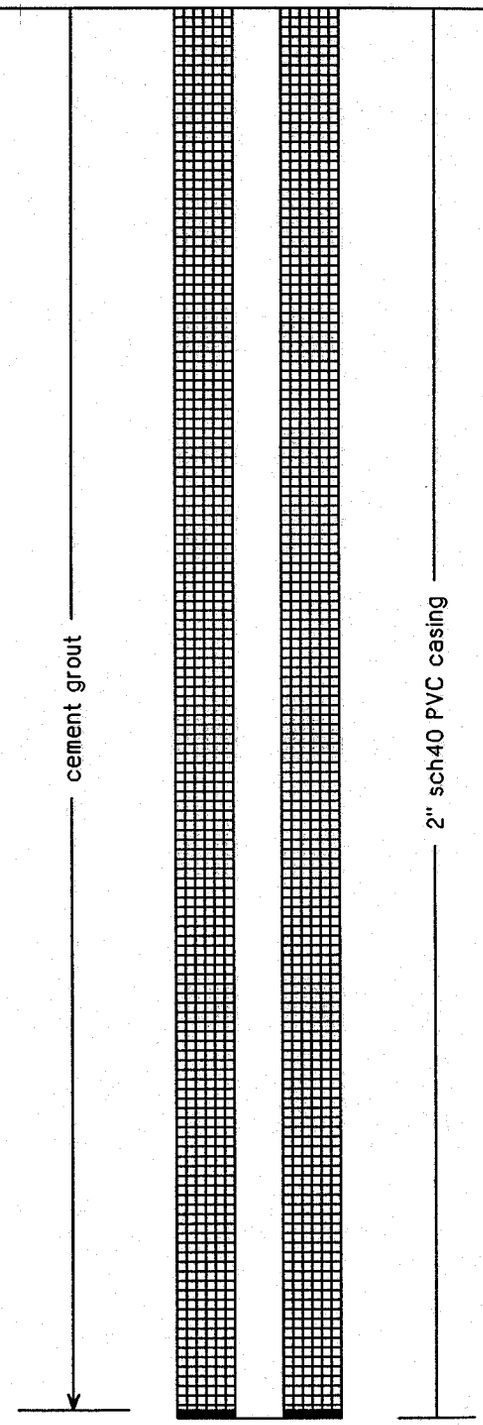
Project: Haywood County
Project No. G98010.5
Ty[illegible]SA SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2671.66ft
Top of Casing: 2675.69ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
			X	saprolite, medium to coarse grained sand, iron mineralization on relict foliation
45	30		X	-grades with mica, rust staining on mica surfaces
50	51		X	-grades with quartz fragments and coarse sand
55	29		X	-grades with fine sand and rust stained schistose layers
60	68		X	-grades with medium grained sand and biotite, relict foliation
65	27		X	-grades with fine grained sand and trace coarse sand
70	29		X	-grades dark brown with trace clay
75	31		X	-grades with fine sand, less clay, lighter color, relict foliation
80	69		X	

PIEZOMETER DIAGRAM



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

Depth to Water: 84.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-13

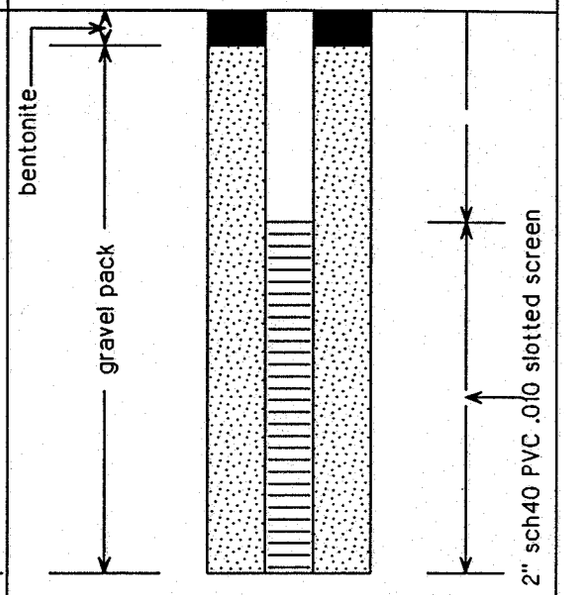
Project: Haywood County
Project No. G98010.5
Tyr A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2671.66ft
Top of Casing: 2675.69ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
				-grades darker with coarse sand, micaceous
85	53			-grades wet, micaceous, relict foliation
90	68			-grades to gray and black gneissic banding, wet
95	50/2			
				End of Boring at 96.0 feet
100				
105				
110				
115				
120				

PIEZOMETER DIAGRAM



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

Depth to Water: 84.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-14

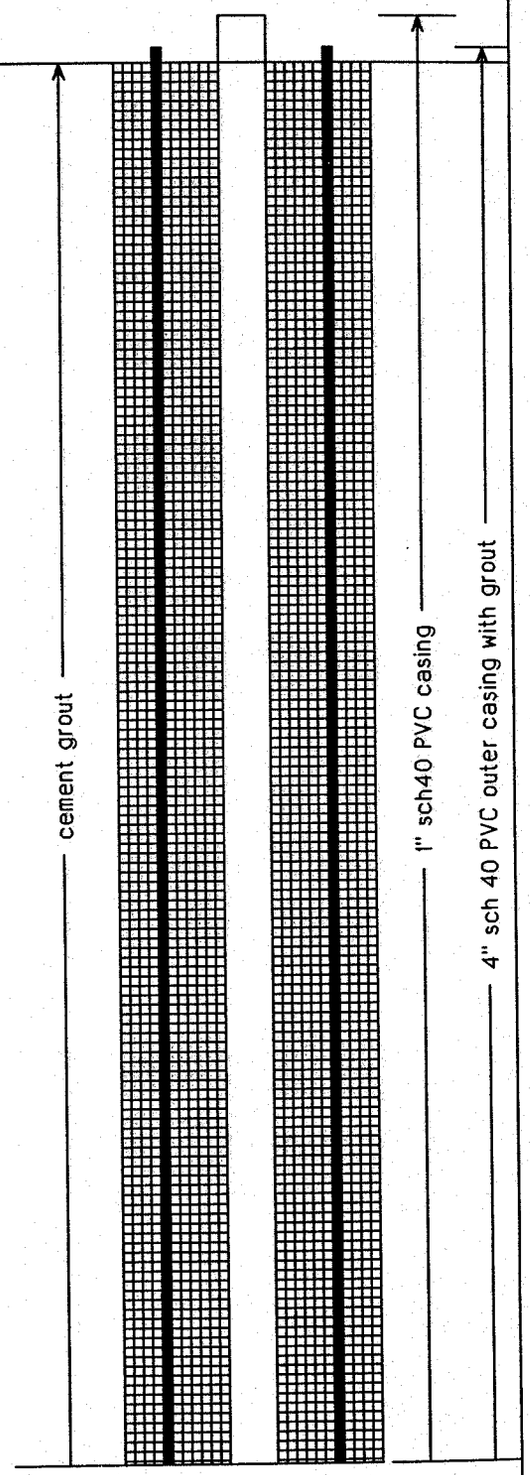
Project: Haywood County
Project No. G998010.5
Ty[illegible]A SS NQ

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2650.93ft
Top of Casing: 2654.13ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	2			CLAYEY SILT (ML); red to brown, very soft, relict structure, mica layers, trace coarse sand
5	9			SILT (ML); light red/pink, stiff, with trace clay and sand, some relict structure, layers of medium grained sand
10	12			-grades with sand, trace mica, relict structure
15	12			-grades yellow and brown, small layers of muscovite, relict foliation, dense iron stained mica layers
	26			SILTY SAND (SM); yellow, medium dense, fine grained, trace coarse grains, micaceous layers with iron staining, relict structure
25	21			-grades damp, micaceous, rust staining, iron stained quartz vein
30	59			-grades light yellow, very dense, trace coarse grains, highly weathered rock, faint structure
35	20			SILT (ML); damp, very stiff with trace sand, black iron stained crystals and mica layers, relict vertical fractures
40	66			SANDY SILT (ML); damp, very dense, with rock fragments, relict structure
45	32			-grades white to tan, damp, dense, some coarse grains, relict banding, iron staining

PIEZOMETER DIAGRAM



Completion Depth: 81.4ft
DATE: 5/12/98

Depth to Water: 62 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-14

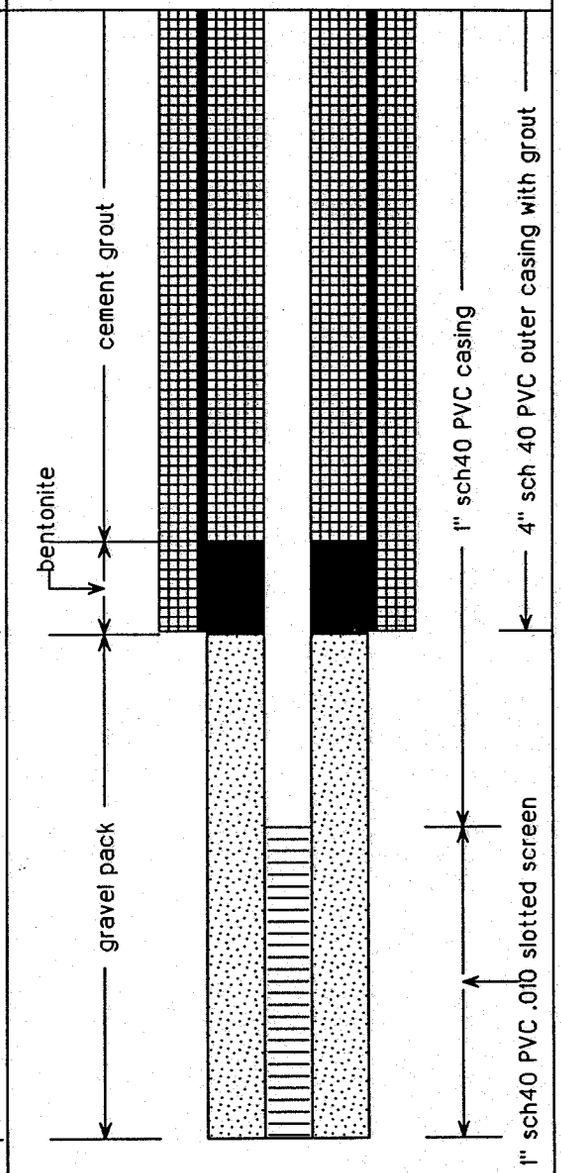
Project: Haywood County
Project No. G998010.5
Ty[illegible]A SS NQ

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2650.93ft
Top of Casing: 2654.13ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
50	30			-grades with more sand, rocky layer
55	42			-grades gray to green, dense, gneissic banding, micaceous, highly weathered rock
60	50/5			-grades white and tan layered, very dense, brown to black mica, with iron and rust staining, few rock fragments
	50/8			Auger Refusal at 65.0 feet
				GNEISS; dark grey, with muscovite and pyrite, iron and rust staining in fractures, highly fractured REC=45%, RQD=0%
70				-slightly fractured, fracutures parallel to banding at 35 to 60 degrees, REC=93%, RQD=73%
				-fractures and banding approximately 45 degrees REC=100% RQD=93%
75				-banding and fractures at 60 degrees, few horizontal fractures REC=57%, RQD=40%
80				
				End of Boring at 81.3 feet
85				
90				

PIEZOMETER DIAGRAM



Completion Depth: 81.4ft
DATE: 5/12/98

Depth to Water: 62 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-15

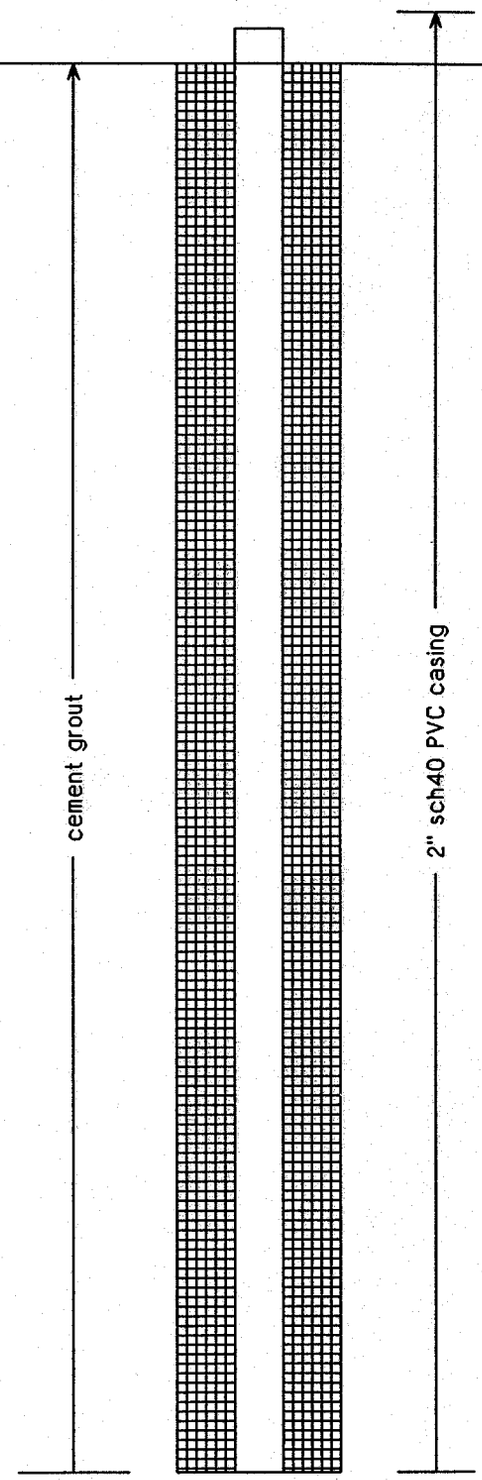
Project: Haywood County
Project No. G98010.5
Ty[illegible]A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2603.49ft
Top of Casing: 2606.51ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	4		X	TOPSOIL top 3"
				CLAYEY SILT (ML); brown, soft, micaceous, trace fine sand
5	8		X	SILT (ML); brown, firm, with clay and mica, grades with quartz fragments
10	8		X	SANDY SILT (ML); pink with orange mottles, loose, some mica, trace coarse sand, relict structure
15	21		X	-grades light brown to pink, medium dense, fine to medium grained, relict crystalline texture fragmented quartz vein at 14 feet
20	16		X	-grades with white layers and medium to coarse grains, iron stained fractures
25	12		X	-grades brown, medium dense, some mica, trace coarse grains, relict fractures
30	46		X	SILT (ML); dark green, hard, trace coarse grains, schistose texture, rust staining on relict foliations
35	54		X	-grades to green-brown, with fine sand, near vertical relict foliation
40	27		X	SILTY SAND (SM); light brown to tan with brown mottles, medium dense, fine grained, trace coarse grains

PIEZOMETER DIAGRAM



Completion Depth: 104.0ft
DATE: 3/28/98

Depth to Water: 91.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-15

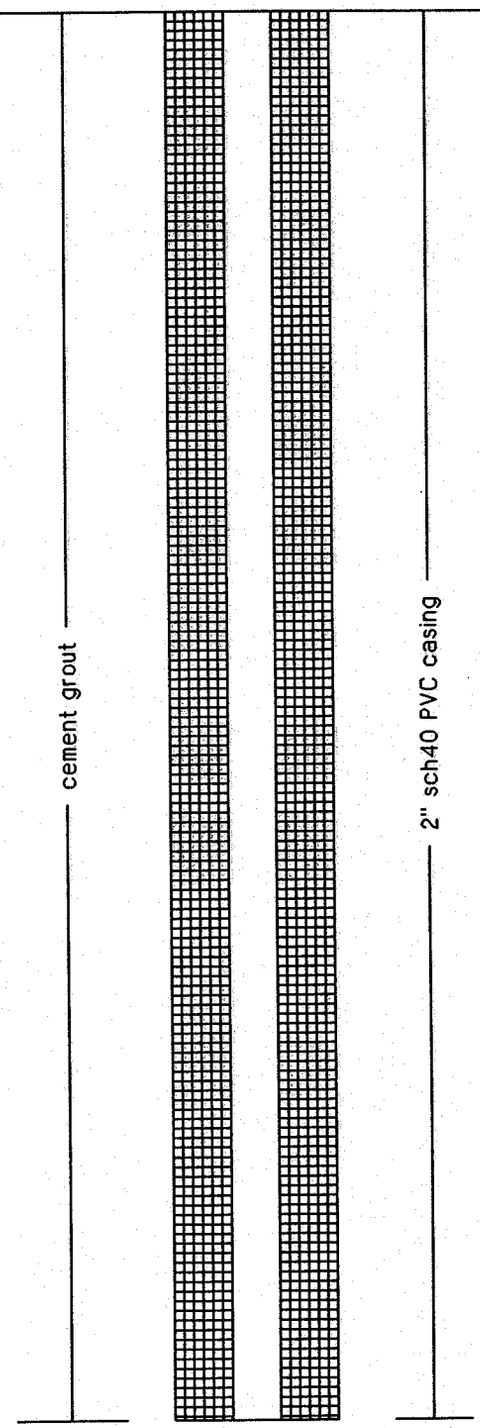
Project: Haywood County
Project No. G98010.5
Ty[illegible] A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2603.49ft
Top of Casing: 2606.51ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
				SAND (SP); light brown-yellow, medium dense, fine grained, with silt, trace coarse grains
45	26			
				SILT (ML); light brown, very stiff, some fine sand, micaceous
50	16			
55	70			-grades dark green to brown, hard, schistose texture, iron staining on foliation surfaces
				SANDY SILT (ML); light brown to tan, dense, saprolite, fine grained, relict dark and light layers, micaceous
60	45			
65	51			-grades very dense, less mica
70	45			-grades less dense, fine to medium grained
75	47			-grades with some coarse grains
80				

PIEZOMETER DIAGRAM



Completion Depth: 104.0ft
DATE: 3/28/98

Depth to Water: 91.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-15

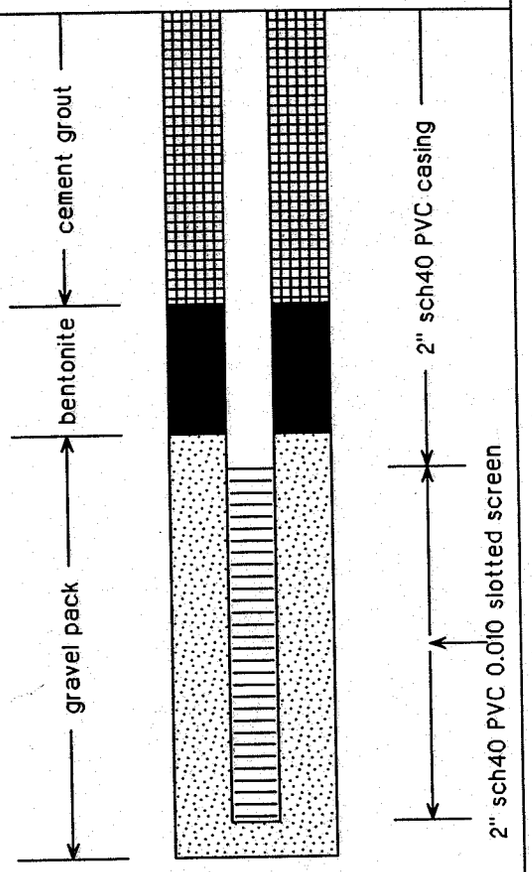
Project: Haywood County
Project No. G98010.5
Ty[illegible]A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2603.49ft
Top of Casing: 2606.51ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
85	70			-grades grayish brown with yellow staining, moist, very dense, relict gneissic structure
90	43			SILT (ML); dark gray-brown, moist, dense, gneissic structure, dark micaceous layers
95	ref/5			PARTIALLY WEATHERED ROCK, green, saturated
100	ref/1			-grades schistose, rust stains on foliations
105	ref/1.5			End of Boring at 104 feet
110				
115				

PIEZOMETER DIAGRAM



Completion Depth: 104.0ft
DATE: 3/28/98

Depth to Water: 91.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-16

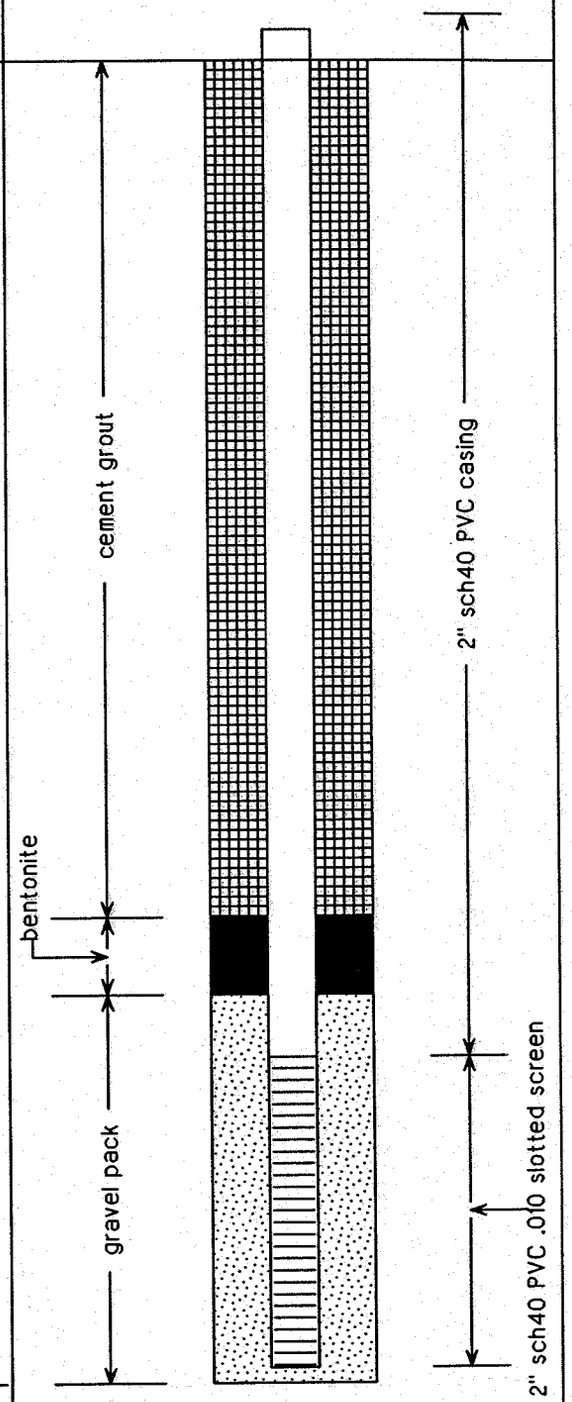
Project: Haywood County
Project No. G98010.5
Ty[illegible]A SS

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2557.91ft
Top of Casing: 2560.37ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	8		X	CLAYEY SILT (ML); brown, firm, with fine to medium grained sand, some angular rock fragments
5	7		X	SANDY SILT (ML); orange-white, loose, fine grained, trace mica, faint relict structure
10	9		X	-grades with fine to medium grade sand; some mica
15	48		X	SILT (ML); dark brown, saprolite, very hard, relict fractures, micaceous
	9		X	-grades white and brown, firm, relict structure, zones of staining
25	18		X	-grades brown, very stiff, white and black mottles, trace clay, trace rock fragments
30	14		X	-grades with red and black mottles, damp
35	15		X	-grades greenish brown, damp, trace clay and sand
40	50/3		X	-grades with relict phyllitic texture, saturated
45				End of Boring at Auger Refusal 42.5 feet

PIEZOMETER DIAGRAM



Completion Depth: 42.5ft
DATE: 3/29/98

Depth to Water: 36.0 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-17

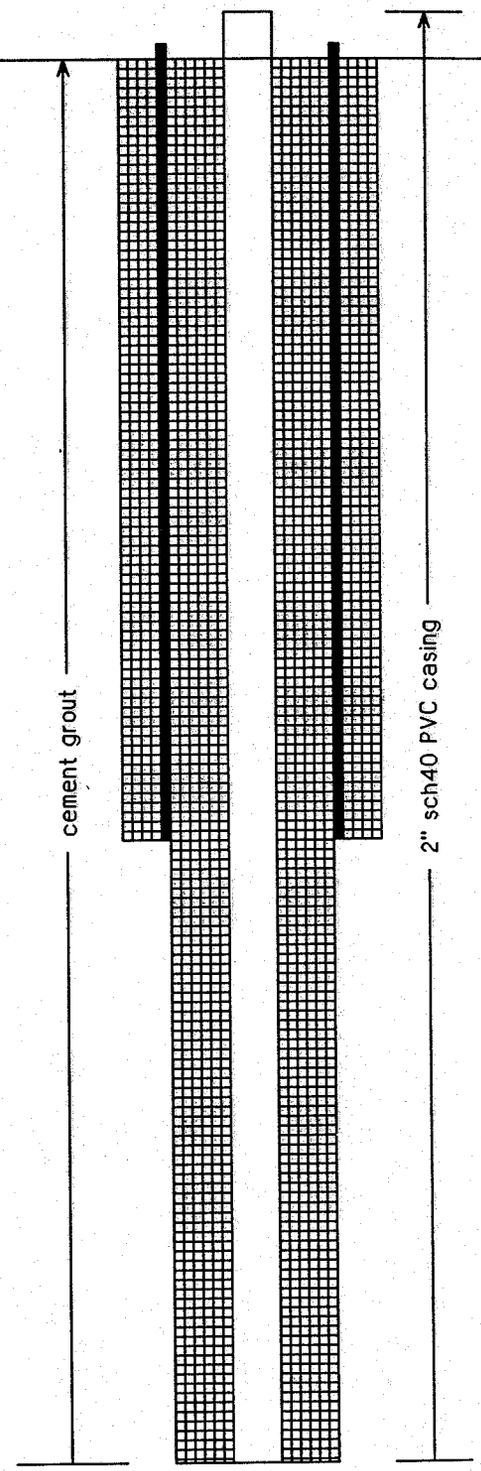
Project: Haywood County
Project No. G98010.5
Type: A SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2559.29ft
Top of Casing: 2562.25ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	61			SILTY SAND (SM); orange-brown, very dense, medium to coarse grained, rock fragments
5	50/4			PARTIALLY WEATHERED ROCK; tan to brown, iron stained and rusted micaceous layers
10	50/5.5			-grades brown with more mica, trace clay
15	54			SILTY SAND (SM); white to yellow-orange, very dense, fine to medium grained, relict structure
	24			-grades loose, with clay in relict fractures
25	ref/5.5			Auger Refusal at 25.0 feet
				GNEISS
30				
35				
40				
45				

PIEZOMETER DIAGRAM



Completion Depth: 90ft
DATE: 5/21/98

Depth to Water: 81 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-17

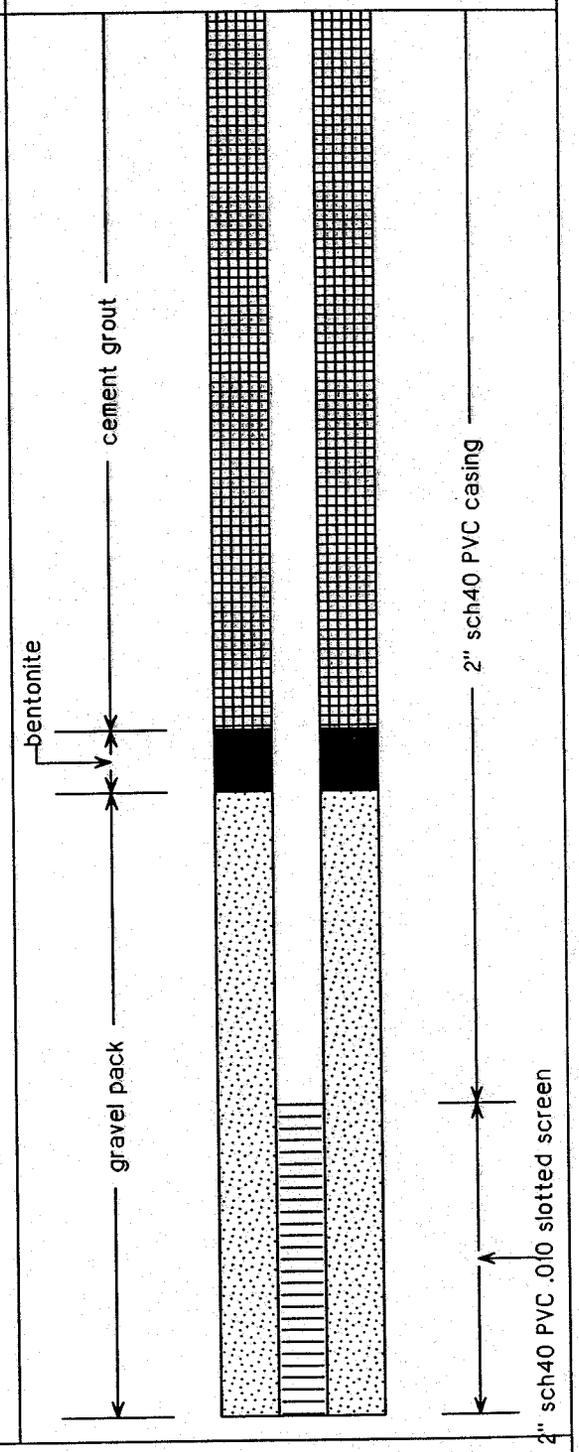
Project: Haywood County
Project No. G98010.5
Ty[illegible]A SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2559.29ft
Top of Casing: 2562.25ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
50				
55				
60				
70				
75				
80				-fracture
85				-fracture -fracture
90				

PIEZOMETER DIAGRAM



Completion Depth: 90ft
DATE: 5/21/98

Depth to Water: 81 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-18

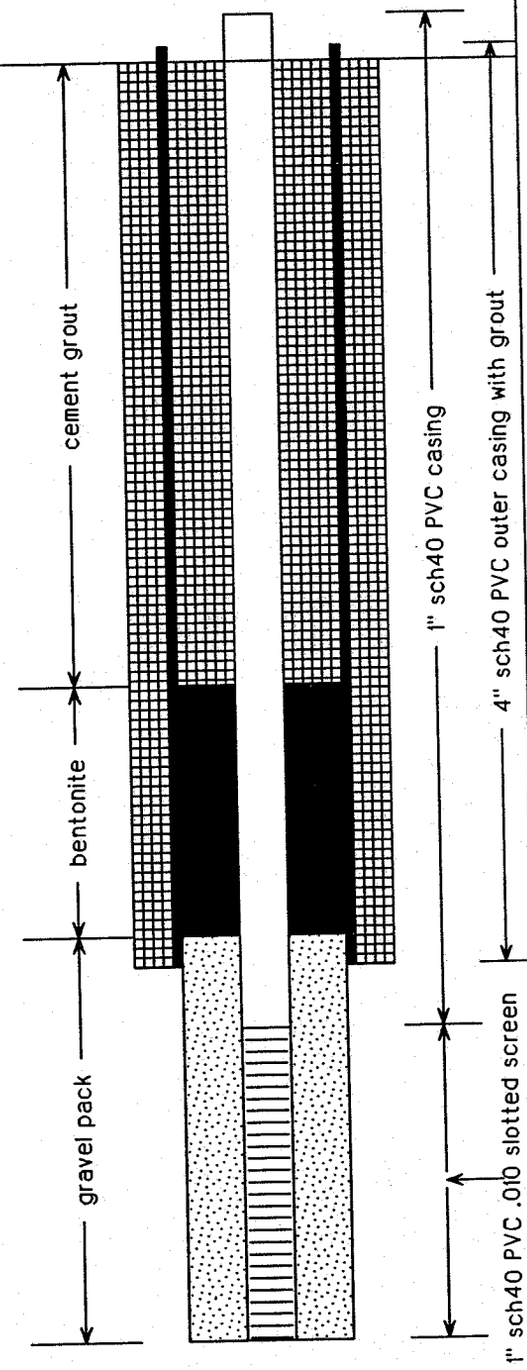
Project: Haywood County
Project No. G98010.0
Ty A SS NQ

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2491.71ft
Top of Casing: 2495.26ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	14			Topsoil top 4"
	18			SILTY SAND (SM); orange to gray, medium dense, coarse grains, trace clay, with mica
5				SANDY SILT (ML); brown to green, medium dense, trace clay, some coarse grains, grades with rock fragments, faint relict structure
	50/5			-grades very dense, with coarse sand, clay-filled relict fractures
10				
	48			-grades with clay, micaceous
15				
	65			SILT (ML); tan to green, hard, micaceous, faint layering, trace sand
	ref/5			-grades with less mica
25				
				Auger Refusal at 29.0 feet
30				PARTIALLY WEATHERED ROCK, rust stains on fractures,REC=25%, RQD=8%
35				
40				
				End of Boring at 41.0 feet

PIEZOMETER DIAGRAM



Completion Depth: 41ft
DATE: 5/10/98

Depth to Water: 28 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-19

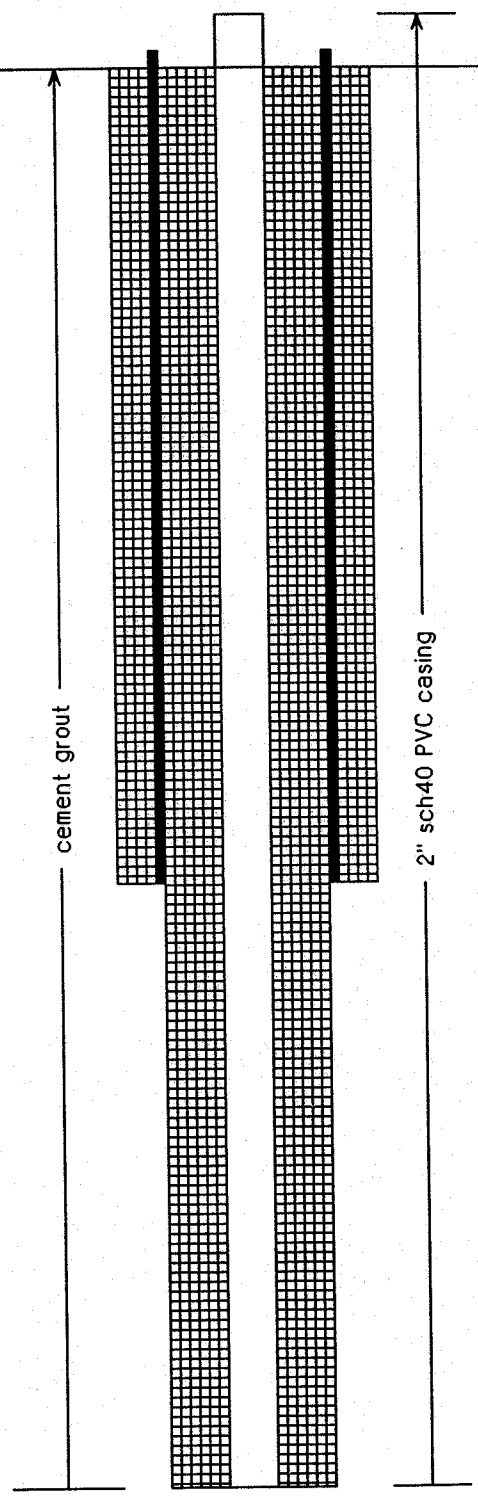
Project: Haywood County
Project No. G98010.0
T SA SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2478.02ft
Top of Casing: 2481.55ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
	5			CLAYEY SILT (MH); dark brown with black weathered mica, firm, trace coarse sand, lenses of yellow-orange sand
5	50/3			SAND (SP); gray to tan, very dense, poorly sorted with silt, rock fragments, quartz layers, micaceous
10	35			SILTY SAND (SM); brown, dense, with rock fragments, faint structure, clayey deposits in iron stained relict fractures
15	14			SILT (ML); gray to brown; damp, stiff, with clay, micaceous, relict structure, rust staining, small black veins
20	52			SILTY SAND (SM); black and white mottles, very dense, saprolite, rock fragments Auger Refusal at 23.0 feet
25				GNEISS; dark grey and white banding, muscovite, quartz, fractures parallel to banding at 30 to 40 degrees REC=88%, RQD=57% -grades lighter grey, slightly weathered, fractures undular and horizontal, REC=84%, RQD=71%
30				-grades white with mafic minerals, iron stained fractures at 45 degrees, REC=97%, RQD=85%
35				

PIEZOMETER DIAGRAM



Completion Depth: 97.5ft
DATE: 4/2/98

Depth to Water: 76 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

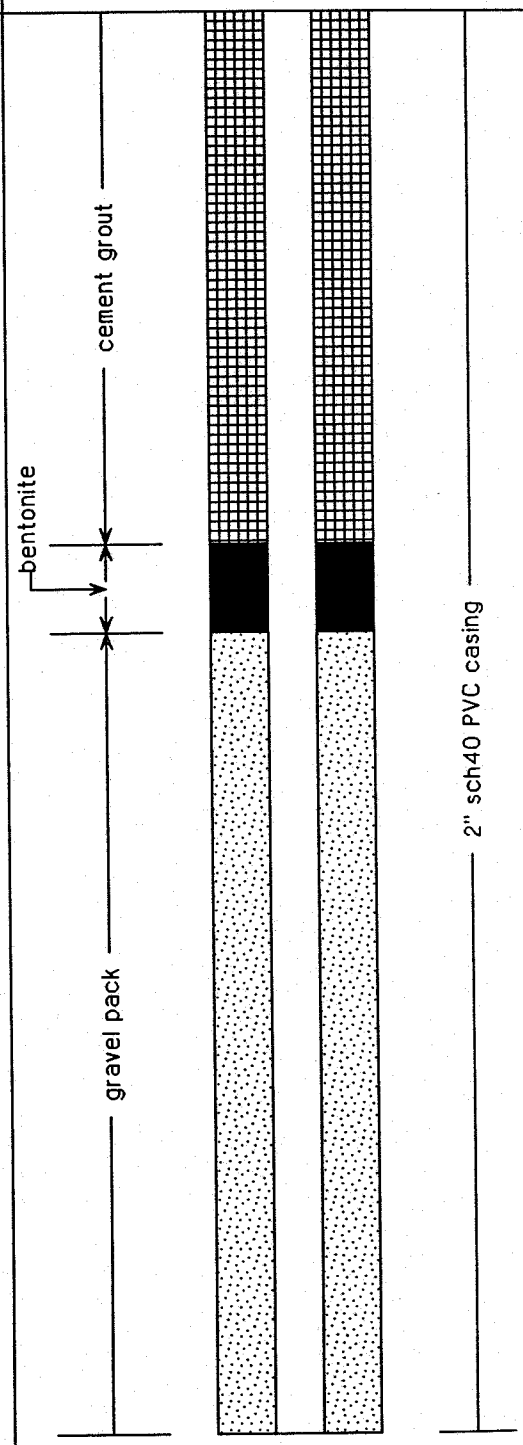
LOG OF BORING: P-19

Project: Haywood County
Project No. G98010.0
T[illegible]HSA SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2478.02ft
Top of Casing: 2481.55ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	PIEZOMETER DIAGRAM
45					cement grout
50					
55					bentonite
				-fracture at 57 feet	
60				-fracture at 60 feet	
65				-fracture at 67 feet	gravel pack
70					
75				-fracture at 76 feet -fracture at 77.5 feet	



Completion Depth: 97.5ft
DATE: 4/2/98

Depth to Water: 76 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P-19

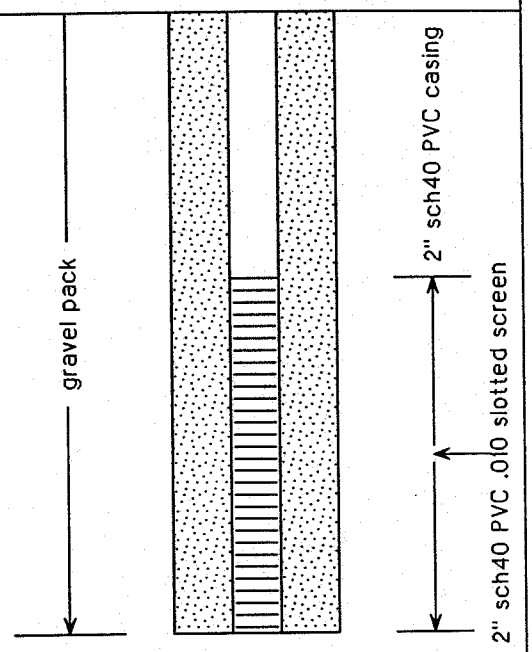
Project: Haywood County
Project No. G98010.0
T[illegible]SA SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2478.02ft
Top of Casing: 2481.55ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL
85				
90				
95				
				End of Boring at 97.5 feet
100				
105				
110				
115				

PIEZOMETER DIAGRAM



Completion Depth: 97.5ft
DATE: 4/2/98

Depth to Water: 76 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P2-1

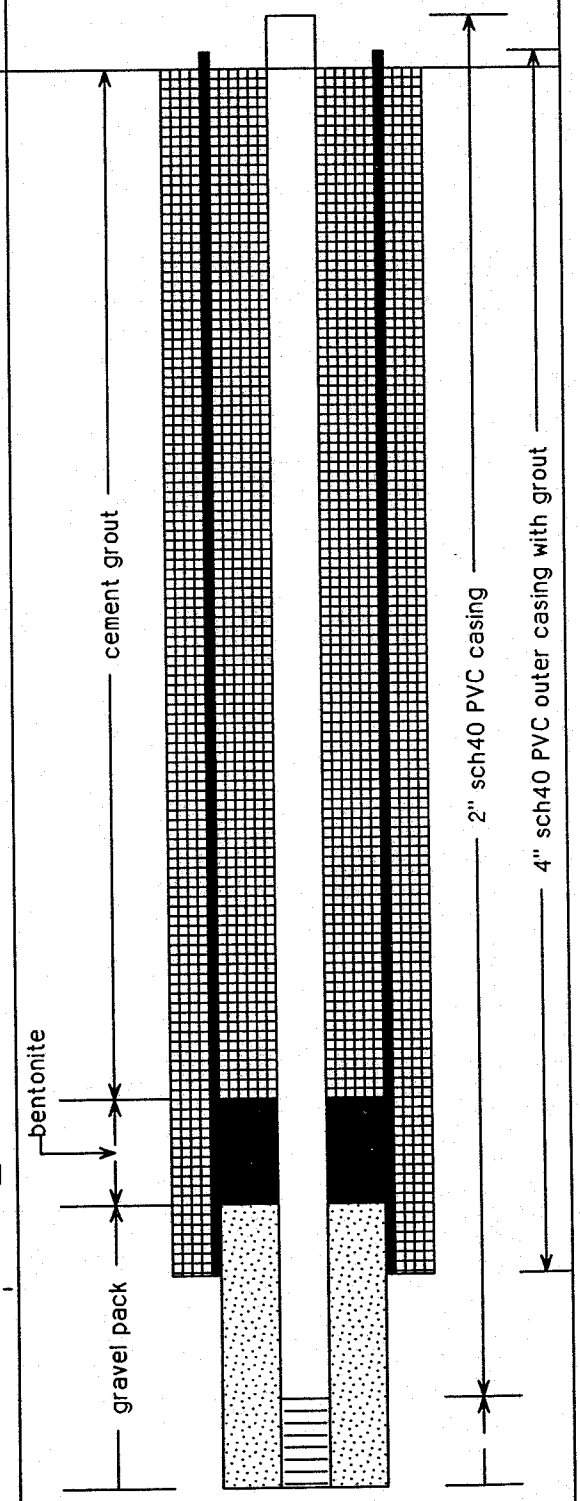
Project: Haywood County
Project No. G98010.5
T[illegible]SA SS NQ AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2572.74ft
Top of Casing: 2576.93ft

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

PIEZOMETER DIAGRAM



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

Depth to Water: 37 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

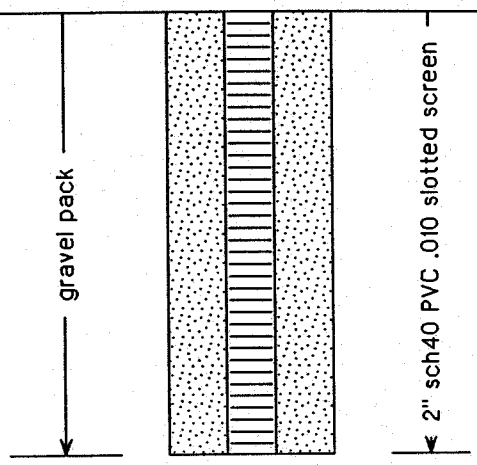
LOG OF BORING: P2-1

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

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2572.74ft
Top of Casing: 2576.93ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	PIEZOMETER DIAGRAM
				-REC=85%, RQD=52%	
45				-slightly weathered, fractures parallel to banding at 30 degrees REC=100%, RQD=92%	
50					
				End of Boring at 52.5 feet	
55					
60					
65					
70					
75					



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

Depth to Water: 37 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P2-2

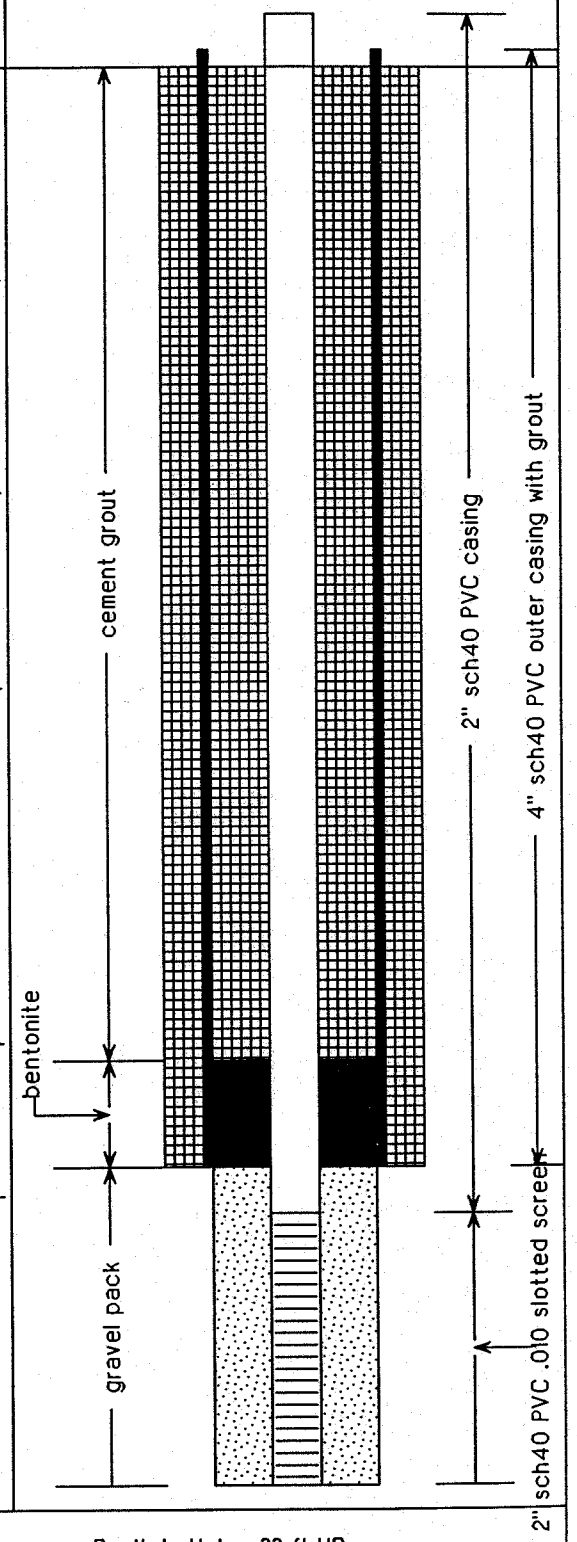
Project: Haywood County
Project No. G98010.5
Ty[illegible]A SS AH

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2573.66ft
Top of Casing: 2574.13ft

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

PIEZOMETER DIAGRAM



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

Depth to Water: 33 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

LOG OF BORING: P2-2

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

Drilling Contractor: Graham & Currie
Registration Number: 537

Surface Elevation: 2573.66ft
Top of Casing: 2574.13ft

DEPTH (ft)	BLOWS PER FOOT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	PIEZOMETER DIAGRAM
45					gravel pack; 2" sch40 PVC .010 slotted screen
				End of Boring at 47.3 feet	
50					
55					
60					
65					
70					
75					

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

Depth to Water: 33 ft WD

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)	
0.0	FILL, consists of stiff to very stiff moist brown fine sandy micaceous silt (ML)			19
10.0	Firm moist yellow-brown and light-brown silty micaceous fine to coarse SAND (SM), with trace rock fragments			14
15.0	PARTIALLY WEATHERED ROCK (PWR), sampled as white, gray, and light-brown silty micaceous sand, with rock fragments			13
20.5	Auger refusal encountered at 20.5 feet. Boring terminated.			50/6" 50/0"

REMARKS:

Borehole dry at completion of drilling. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-1
DATE DRILLED	September 15, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	Firm moist brown silty fine to coarse micaceous SAND (SM)		20
5.0	Firm moist orange-brown fine to medium sandy micaceous SILT (ML)		8
	1.0-foot thick boulder or lense of partially weathered rock encountered at 13.5'.		50/1"
18.0	Firm wet orange-brown silty micaceous fine to coarse SAND (SM), with rock fragments.		11
			20
26.0	Auger refusal encountered at 26.0 feet. Boring terminated.		50/0"

REMARKS:

Groundwater encountered at 16.0 feet. Type II Monitoring Well installed. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

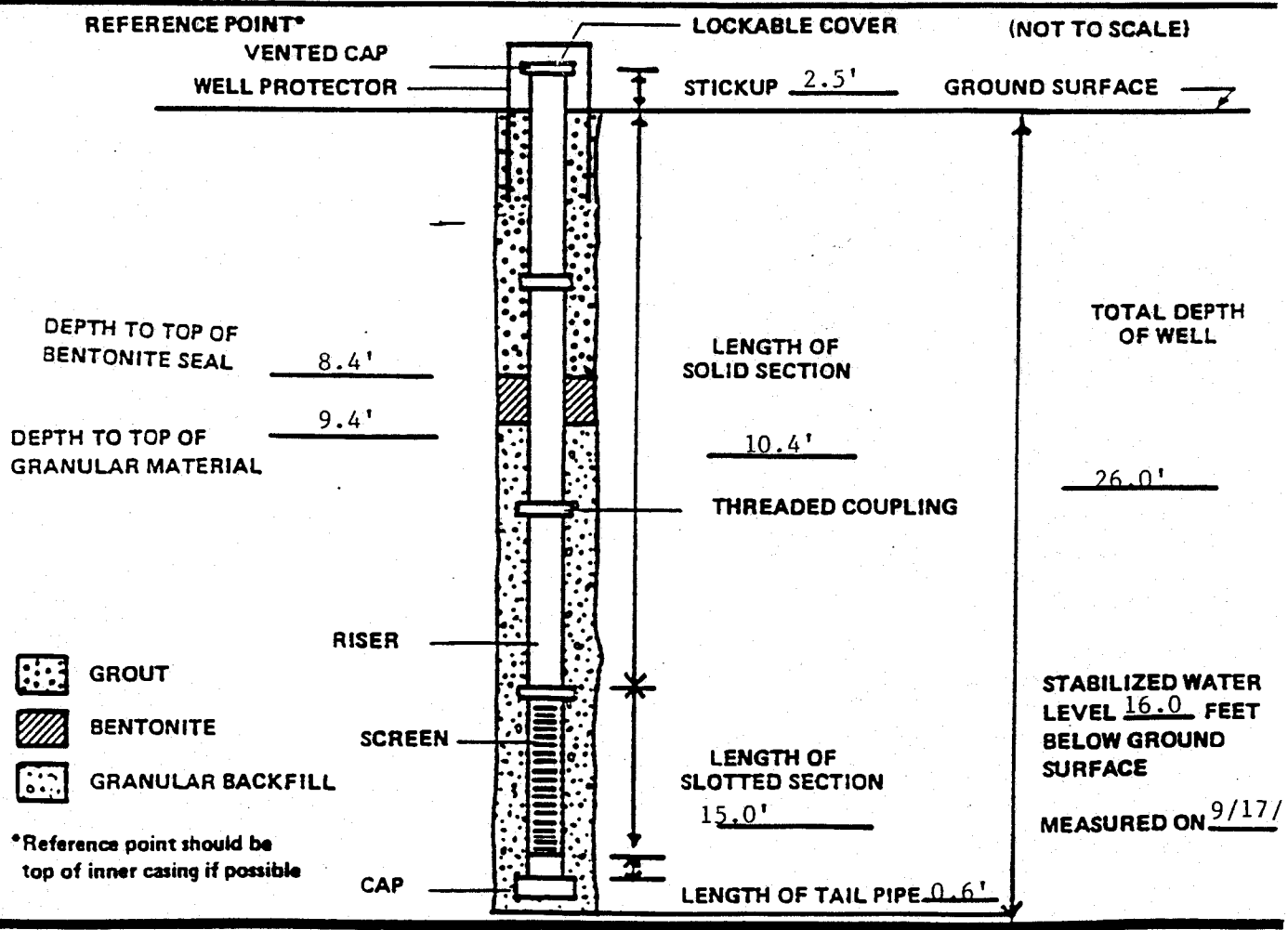
TEST BORING RECORD

BORING NUMBER	GWM-1A
DATE DRILLED	September 17, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME: White Oak Landfill
JOB NUMBER: 472-07913-03
WELL NUMBER: GWM-1A
INSTALLATION DATE: 09/17/93
LOCATION: East Slope (See Record Drawings)
GROUND SURFACE ELEVATION:
REFERENCE POINT ELEVATION:
GRANULAR BACKFILL MATERIAL: NC #2 Sand
SLOT SIZE: 0.010"
SCREEN MATERIAL: PVC
SCREEN DIAMETER: 2"
RISER MATERIAL: PVC
RISER DIAMETER: 2"
DRILLING TECHNIQUE: HSA
DRILLING CONTRACTOR: Law Engineering
BOREHOLE DIAMETER: 8"
LAW ENGINEERING FIELD REPRESENTATIVE: Hoda Kablawi
LOCK BRAND: Master
SIZE/MODEL: #3
KEY CODE/COMBINATION: 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

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

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

GWM-1A

DRILLING CONTRACTOR Law Engineering

DRILLER REGISTRATION NUMBER 332

LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: White Oak, North Carolina
(Road, Community, or Subdivision and Lot No.)

County: Haywood

2. OWNER Haywood County, North Carolina
ADDRESS 420 N. Main Street (Street or Route No.)
Waynesville, NC 28786 (City or Town, State, Zip Code)

3. DATE DRILLED 9/17/93 USE OF WELL Monitoring
4. TOTAL DEPTH 26.0' CUTTINGS COLLECTED ☒ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
6. STATIC WATER LEVEL: 18.5 FT. ☐ above ☒ below TOP OF CASING.
TOP OF CASING IS 2.5 FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST N/A
8. WATER ZONES (depth):

9. CHLORINATION: Type N/A Amount N/A

10. CASING:

	Depth From	To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	10.4 Ft.	2"		PVC
		Ft.			
		Ft.			

11. GROUT:

	Depth From	To	Material	Method
	0	8.4 Ft.	Cem-Bent	Tremie
		Ft.		

12. SCREEN:

	Depth From	To	Diameter	Slot Size	Material
	10.4	25.4 Ft.	2 in.	0.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

13. GRAVEL PACK:

	Depth From	To	Size	Material
	9.4	26.0 Ft.		NC#2 sand
		Ft.		

14. REMARKS: Bentonite 8.4' to 9.4'

Depth From	To	DRILLING LOG Formation Description
0'	5'	Silty sand
5'	18'	Sandy silt
18'	26'	Silty sand

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)

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

Thomas M. Schuppert 10/1/93
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/84

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

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	FILL, consists of firm moist fine sandy micaceous silt (ML)		
4.5	Firm to very stiff moist light-brown silty micaceous fine to coarse SAND (SM)		6
			24
12.0	Stiff moist white and brown fine to medium micaceous SILT (ML)		9
19.0	Loose to firm, moist to wet, white and brown silty micaceous fine to coarse SAND (SM), with rock fragments		16
			8
			12
34.5	PARTIALLY WEATHERED ROCK (PWR), appears as white and brown silty micaceous fine to coarse sand, with rock fragments.		50/6"
35.5	Auger refusal encountered at 35.5 feet. Boring terminated.		50/0"

REMARKS:

Groundwater encountered at 30.5 feet. Type II Monitoring Well installed. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-2
DATE DRILLED	September 16, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME White Oak Landfill

JOB NUMBER 472-07913-03

WELL NUMBER GWM-2

INSTALLATION DATE 09/16/93

LOCATION East Access Road, Cell 1 (See Record Drawings)

GROUND SURFACE ELEVATION

REFERENCE POINT ELEVATION

GRANULAR BACKFILL MATERIAL NC #2 sand

SLOT SIZE 0.010"

SCREEN MATERIAL PVC

SCREEN DIAMETER 2"

RISER MATERIAL PVC

RISER DIAMETER 2"

DRILLING TECHNIQUE HSA

DRILLING CONTRACTOR Law Engineering

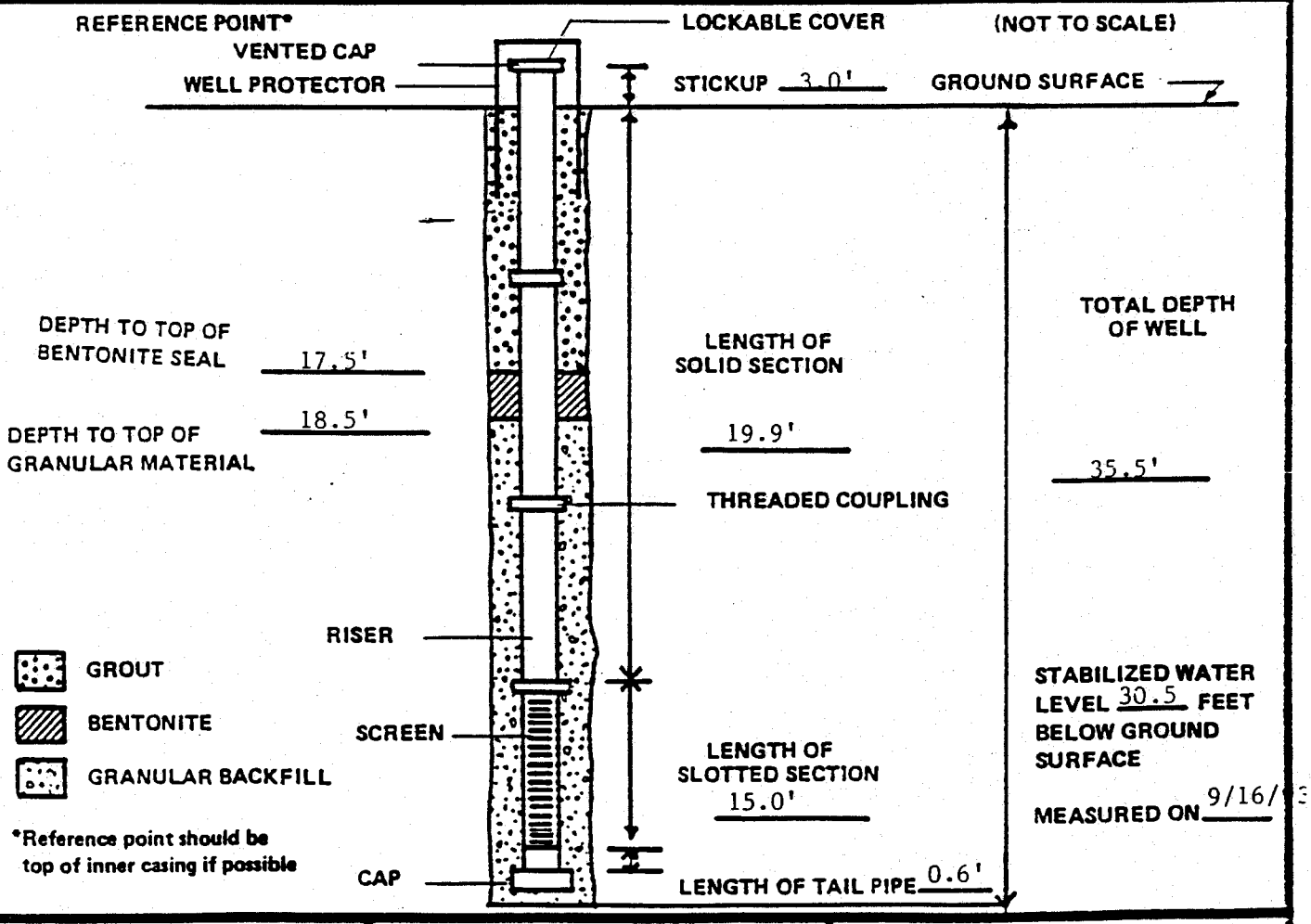
BOREHOLE DIAMETER 8"

LAW ENGINEERING FIELD REPRESENTATIVE Hoda Kablawi

LOCK BRAND Master

SIZE/MODEL #3

KEY CODE/COMBINATION 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-6083

FOR OFFICE USE ONLY

Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

GWM-2

DRILLING CONTRACTOR Law Engineering

DRILLER REGISTRATION NUMBER 332

LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)

Nearest Town: White Oak, North Carolina

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

County: Haywood

2. OWNER Haywood County, North Carolina

ADDRESS 420 N. Main Street (Street or Route No.)

Waynesville (City or Town) NC (State) 28786 (Zip Code)

3. DATE DRILLED 9/16/93 USE OF WELL Monitoring

4. TOTAL DEPTH 35.5 CUTTINGS COLLECTED ☒ Yes ☐ No

5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No

6. STATIC WATER LEVEL: 33.5 FT. ☐ above ☒ below TOP OF CASING,
TOP OF CASING IS 3.0 FT. ABOVE LAND SURFACE.

7. YIELD (gpm): N/A METHOD OF TEST N/A

WATER ZONES (depth): _____

9. CHLORINATION: Type N/A Amount N/A

10. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	19.9	2 in		PVC

11. GROUT:

	Depth From	Depth To	Material	Method
	0	17.5	Cem-Bent	Tremie

12. SCREEN:

	Depth From	Depth To	Diameter	Slot Size	Material
	19.9	34.9	2 in.	0.010 in.	PVC
			in.	in.	
			in.	in.	

13. GRAVEL PACK:

	Depth From	Depth To	Size	Material
	18.5	35.5		NC#2 sand

14. REMARKS: Bentonite 17.5' to 18.5'

Depth From	Depth To	DRILLING LOG Formation Description
0'	4.5'	FILL sandy SILT
4.5'	12'	Silty Sand
12'	19'	sandy silt
19'	34.5'	silty sand
34.5'	35.5'	Partially weathered rock

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)

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

Thomas M. Schuppout 10/1/93
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/94

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

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
0.0	Overburden Soils (Brown silty sand and sandy silt.) See Boring GWM-2 for detailed soil descriptions		
36.9	White and gray, fresh, hard to very hard GRANITIC GNEISS, with no joints, very thin to thin foliation		

REMARKS:

Type III Monitoring Well Installed. Drillers: J.Voekel and M.Wagner. Drill Rig: Truck Mount. Boring Type: 8-1/4" ID HSA and PQ Rock Coring.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-2D
DATE DRILLED	September 23, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	White and gray, fresh, hard to very hard GRANITIC GNEISS, with no joints, very thin to thin foliation		
48.8	Dark gray, white, and brown, slight to moderately weathered, moderately hard to hard GRANITIC GNEISS, with close jointing and very thin to thin foliation		
55.1	Core Run #1: 36.9 to 39.8 feet RQD = 100% Core Run #2: 39.8 to 42.9 feet RQD = 100% Core Run #3: 42.9 to 47.9 feet RQD = 100% Core Run #4: 47.9 to 53.0 feet RQD = 95% Core Run #5: 53.0 to 55.1 feet RQD = 95% Boring terminated at 55.1 feet on 9/26/93.		

REMARKS:

Type III Monitoring Well Installed. Drillers: J.Voekel and M.Wagner. Drill Rig: Truck Mount. Boring Type: 8-1/4" ID HSA and PQ Rock Coring.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-2D
DATE DRILLED	September 23, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 2	

LAW ENGINEERING

TYPE III MONITORING WELL INSTALLATION RECORD - Part A

JOB NAME White Oak Sanitary Landfill JOB NUMBER 472-07913-03

WELL NUMBER GWM-2D INSTALLATION DATE 9/23 - 9/26/93

LOCATION Haywood County, North Carolina

GROUND SURFACE ELEVATION

CASING MATERIAL PVC CASING DIAMETER 6"

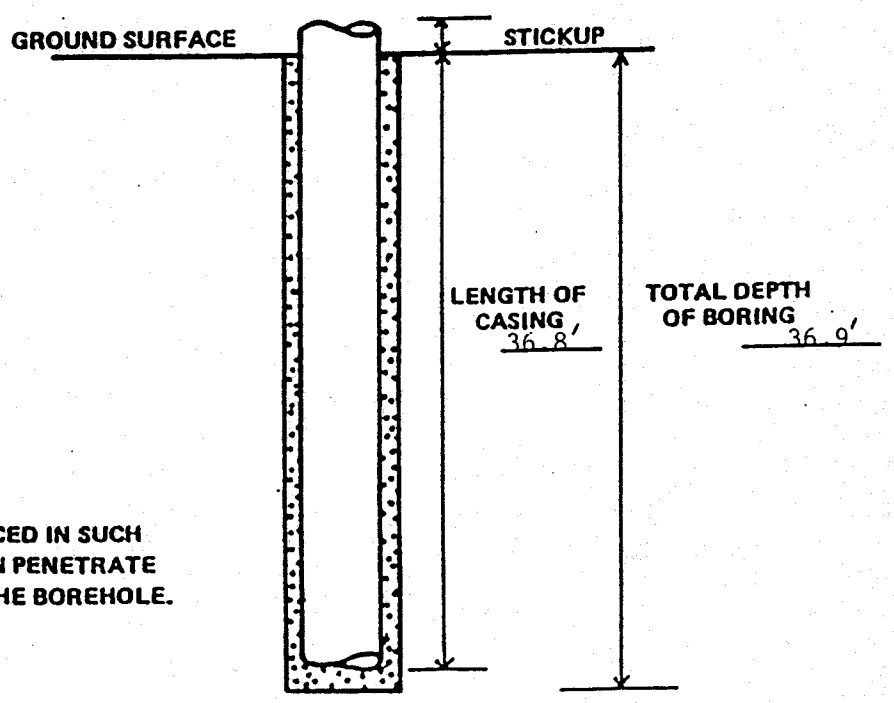
BOREHOLE DIAMETER 12 5/8"

DRILLING TECHNIQUE HSA

DRILLING CONTRACTOR Law Engineering

LAW ENGINEERING FIELD REPRESENTIVE Hoda S. Kablawi

(NOT TO SCALE)



GROUT

NOTE:

CASING SHOULD BE PLACED IN SUCH A WAY THAT GROUT CAN PENETRATE UNDERNEATH IT INTO THE BOREHOLE.

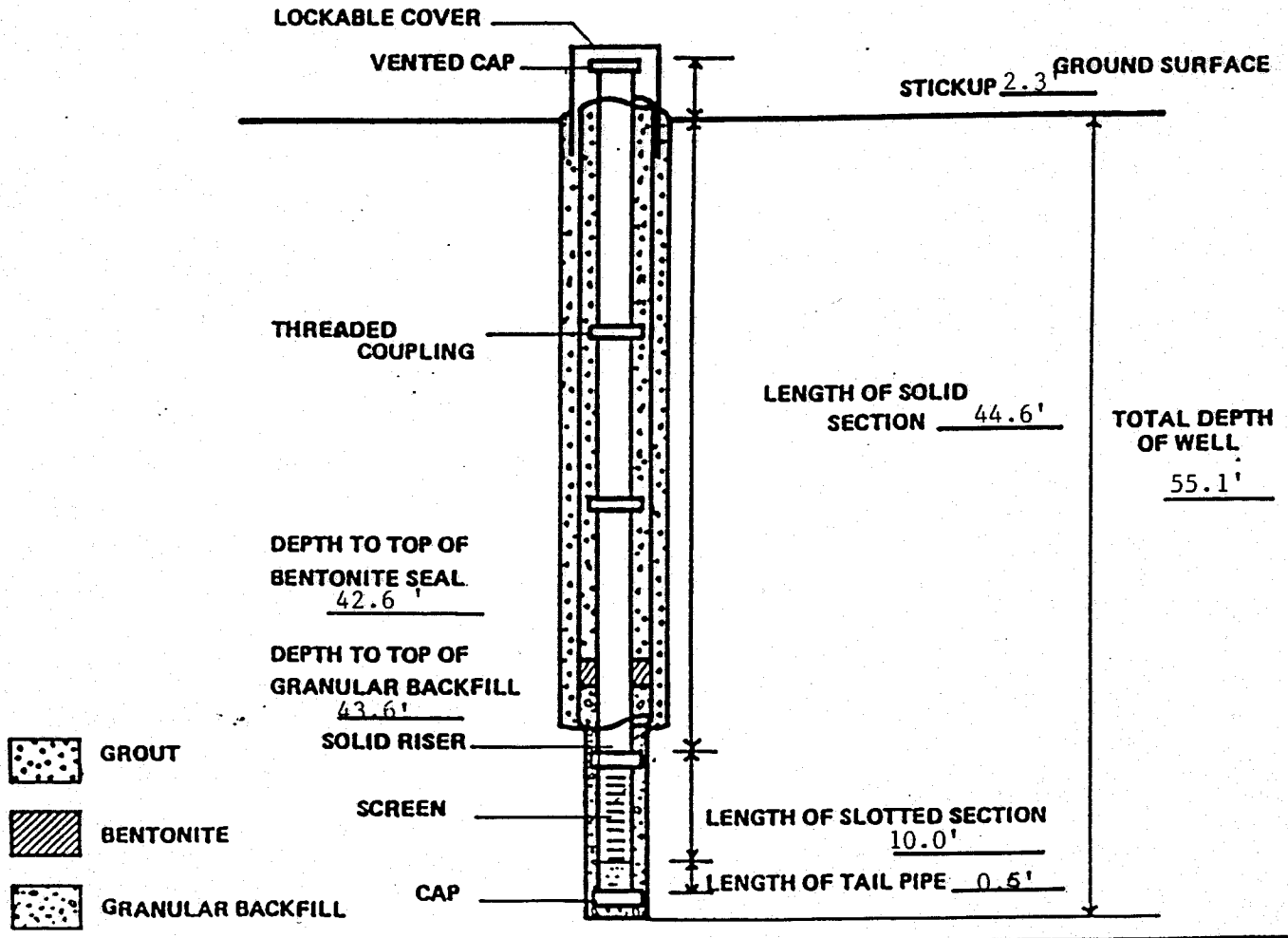
LAW ENGINEERING TESTING COMPANY

FIGURE 3 A

TYPE III MONITORING WELL INSTALLATION RECORD - Part B

JOB NAME White Oak Landfill
JOB NUMBER 472-07913-03
WELL NUMBER GWM-2D
INSTALLATION DATE 9/23 - 9/26/93
LOCATION East Access Road, Cell 1 (See Record Drawings)
GROUND SURFACE ELEVATION
REFERENCE POINT ELEVATION
GRANULAR BACKFILL NC #2 Sand
SLOT SIZE 0.010"
SCREEN MATERIAL PVC
SCREEN DIAMETER 2"
RISER MATERIAL PVC
RISER DIAMETER 2"
BOREHOLE DIAMETER 4.8"
LAW ENGINEERING FIELD REP. Hoda Kablawi
DRILLING TECHNIQUE HSA & PQ-Coring
DRILLING CONTRACTOR Law Engineering
LOCK: BRAND Master SIZE/MODEL #3 KEYCODE/COMBINATION 0536
STABILIZED WATER LEVEL 28.0 FEET BELOW GROUND SURFACE, MEASURED ON 9/30/93

(NOT TO SCALE)



LAW ENGINEERING TESTING COMPANY

FIGURE 3 B

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent.

WELL CONSTRUCTION RECORD

GWM-2D

DRILLING CONTRACTOR: Law Engineering

LANDFILL **CONSTRUCTION PERMIT NUMBER:** 44-07

DRILLER REGISTRATION NUMBER: 332

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: White Oak, North Carolina County: Haywood
   (Road, Community, or Subdivision and Lot No.)
2. OWNER Haywood
   ADDRESS 1420 N. Main Street
   (Street or Route No.)
   Waynesville NC 28786
   City or Town State Zip Code
3. DATE DRILLED 9/23-9/26/93 USE OF WELL Monitoring
4. TOTAL DEPTH 55.1'
5. CUTTINGS COLLECTED YES [X] NO [ ]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 30.3 FT.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.3 FT. Above Land Surface*
   * Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118
9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth):
11. CHLORINATION: Type N/A Amount N/A

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0'	36.9'	Sandy Silt/Silty Sand
36.9'	55.1'	Hard Rock

If additional space is needed use back of form

12. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	36.8 Ft.	6"		PVC
	0	44.6 Ft.	2"		PVC
		Ft.			

13. GROUT:

	Depth From	Depth To	Material	Method
	0	36.9 Ft.	Cem-Bent.	Tremie
	0	42.6 Ft.	Cem-Bent.	Tremie

14. SCREEN:

Depth From	Depth To	Diameter	Slot Size	Material
44.6	54.6 Ft	2" in.	0.010 in.	PVC
	Ft.	in.	in.	
	Ft.	in.	in.	

15. SAND/GRAVEL PACK:

Depth From	Depth To	Size	Material
43.6	55.1 Ft.		NC#2 Sand
	Ft.		

16. REMARKS: Bentonite 42.6' to 43.6'

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

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

Thomas M. Shufford 10-4-93
SIGNATURE OF CONTRACTOR OR AGENT DATE

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

GW-1 REV. 5/91

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	FILL, consists of soft to firm moist orange-brown fine to coarse sandy micaceous silt (ML)		6
			3
14.0	Soft to very stiff wet orange-brown fine to coarse sandy micaceous SILT (ML), with rock fragments		4
			26
21.2	Auger refusal encountered at 21.2 feet. Boring terminated.		50/0"

REMARKS:

Groundwater encountered at 12.2 feet. Type II Monitoring Well installed. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

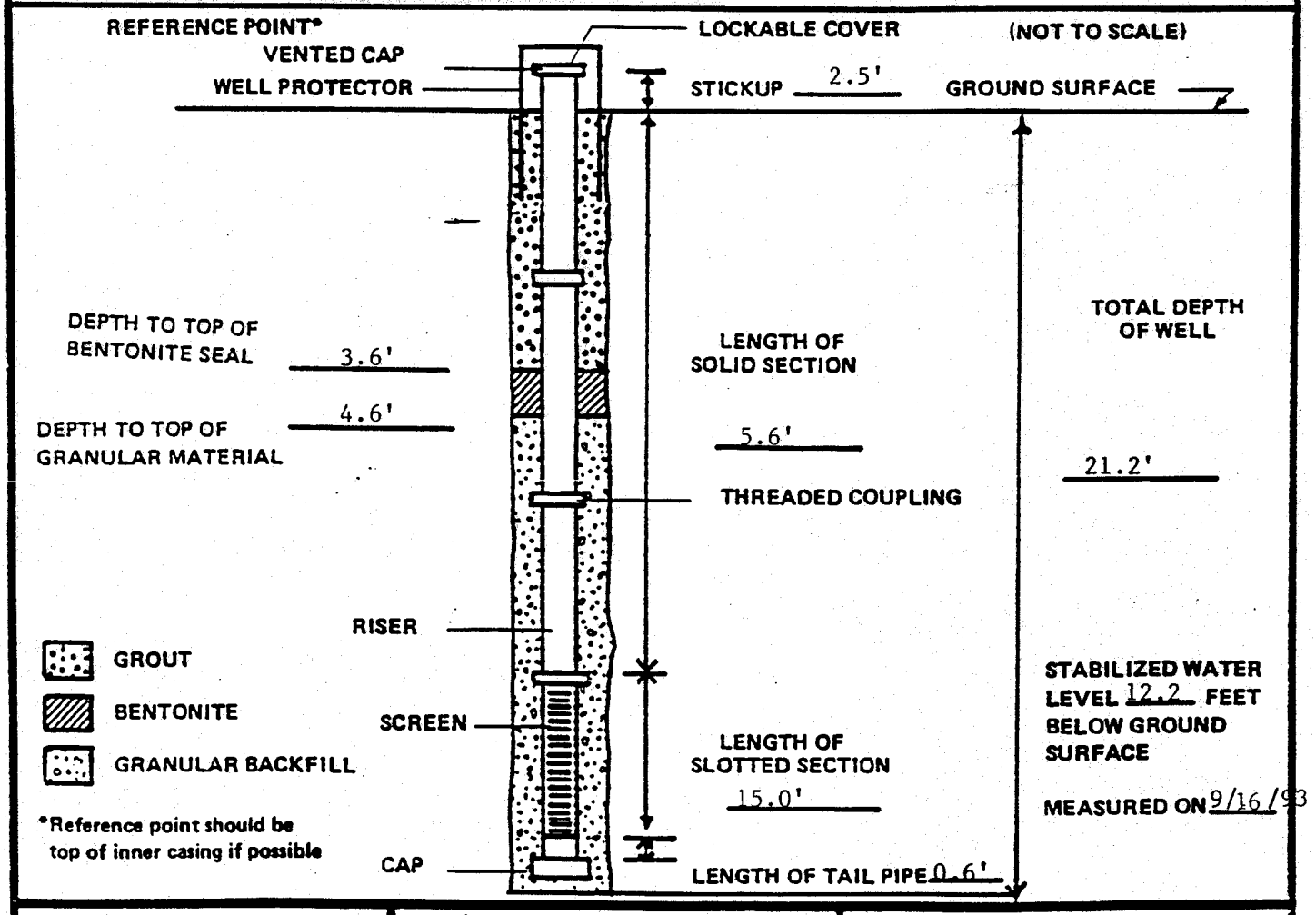
TEST BORING RECORD

BORING NUMBER	GWM-3
DATE DRILLED	September 16, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME: White Oak Landfill
JOB NUMBER: 472-07913-03
WELL NUMBER: GWM-3
INSTALLATION DATE: 09/16/93
LOCATION: North of Leachate Pond (See Record Drawings)
GROUND SURFACE ELEVATION:
REFERENCE POINT ELEVATION:
GRANULAR BACKFILL MATERIAL: NC #2 sand
SLOT SIZE: 0.010"
SCREEN MATERIAL: PVC
SCREEN DIAMETER: 2"
RISER MATERIAL: PVC
RISER DIAMETER: 2"
DRILLING TECHNIQUE: HSA
DRILLING CONTRACTOR: Law Engineering
BOREHOLE DIAMETER: 8"
LAW ENGINEERING FIELD REPRESENTATIVE: Hoda Kablawi
LOCK BRAND: Master
SIZE/MODEL: #3
KEY CODE/COMBINATION: 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT – GROUNDWATER SECTION
P.O. BOX 27687 – RALEIGH, N.C. 27611, PHONE (919) 733-6063

FOR OFFICE USE ONLY

Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR Law Engineering

DRILLER REGISTRATION NUMBER 332

GWM-3 LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: White Oak, North Carolina
   (Road, Community, or Subdivision and Lot No.)
   County: Haywood
2. OWNER Haywood, North Carolina
   ADDRESS 420 N. Main Street (Street or Route No.)
   Waynesville (City or Town) NC (State) 28786 (Zip Code)
3. DATE DRILLED 9/16/93 USE OF WELL Monitoring
4. TOTAL DEPTH 21.2' CUTTINGS COLLECTED ☒ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
6. STATIC WATER LEVEL: 14.7 FT. ☐ above ☒ below TOP OF CASING.
   TOP OF CASING IS 2.5 FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST N/A
8. WATER ZONES (depth): _____
9. CHLORINATION: Type N/A Amount N/A
10. CASING:

	Depth From	To	Diameter	Wall Thickness or Weight/Ft.	Material
From	0	5.6 Ft.	2 in.		PVC
From		Ft.			
From		Ft.			

11. GROUT:

	Depth From	To	Material	Method
From	0	3.6 Ft.	Cem-Bent	Tremie
From		Ft.		

12. SCREEN:

	Depth From	To	Diameter	Slot Size	Material
From	5.6	20.6 Ft.	in.	0.010 in.	PVC
From		Ft.	in.	in.	
From		Ft.	in.	in.	

13. GRAVEL PACK:

	Depth From	To	Size	Material
From	4.6	21.2 Ft.		NC#2 sand
From		Ft.		

14. REMARKS: Bentonite 3.6' to 4.6'

DRILLING LOG

Depth From	To	Formation Description
0'	14'	FILL
14'	16'	Silty SAND
16'	21.2'	Sandy SILT

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)

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

Thomas M. Schippout 10/1/93

SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/84

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

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
0.0	Overburden Soils (Orange-brown sandy silt) See Boring GWM-3 for detailed soil descriptions		
21.4	Dark gray and brown, moderately weathered, medium hard GRANITIC GNEISS, with very close joints and thin foliation Core Run #1: 21.4 to 25.6 feet RQD = 38% Core Run #2: 25.6 to 30.6 feet RQD = 82% Core Run #3: 30.6 to 35.6 feet RQD = 80%		
35.6	Dark gray, white and brown, slight to moderately weathered, moderately hard GRANITIC GNEISS, with close joints and very thin to thin foliation		
37.0	Boring terminated at 37.0 feet on 9/24/93. Core Run #4: 35.6 to 37.0 feet RQD = 95%		

REMARKS:

Type III Monitoring Well Installed. Drillers: J.Voekel and M.Wagner. Drill Rig: Truck Mount. Boring Type: 8-1/4" ID HSA and PQ Rock Coring.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-3D
DATE DRILLED	September 23, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE III MONITORING WELL INSTALLATION RECORD - Part A

JOB NAME White Oak Sanitary Landfill JOB NUMBER 472-07913-03

WELL NUMBER GWM-3D INSTALLATION DATE 9/23 - 9/24/93

LOCATION North of Leachate Pond (See Record Drawings)

GROUND SURFACE ELEVATION

CASING MATERIAL PVC CASING DIAMETER 6"

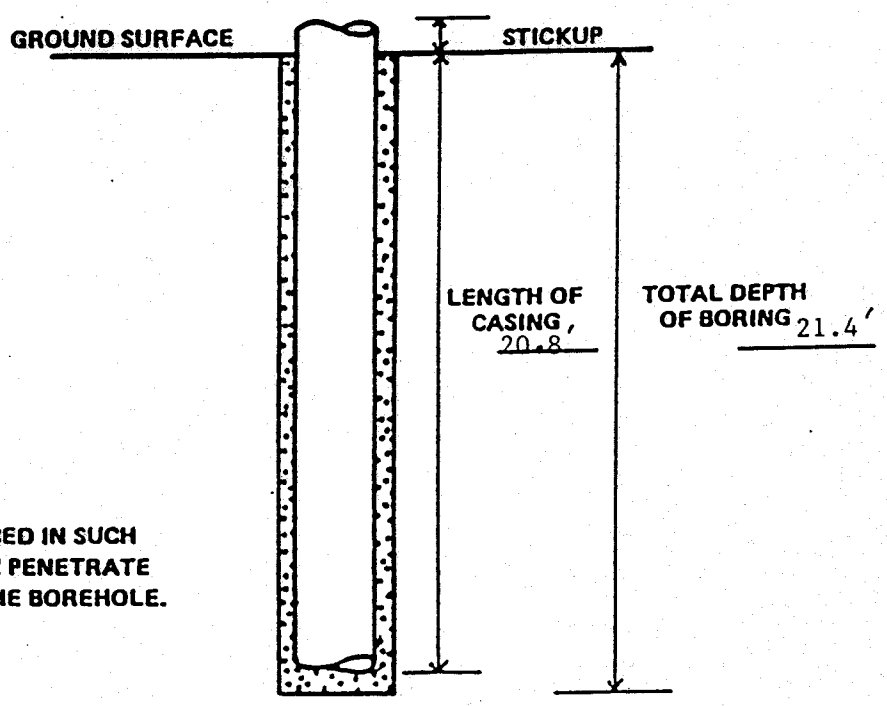
BOREHOLE DIAMETER 12 5/8"

DRILLING TECHNIQUE HSA

DRILLING CONTRACTOR Law Engineering

LAW ENGINEERING FIELD REPRESENTIVE Hoda S. Kablawi

(NOT TO SCALE)



GROUT

NOTE:

CASING SHOULD BE PLACED IN SUCH A WAY THAT GROUT CAN PENETRATE UNDERNEATH IT INTO THE BOREHOLE.

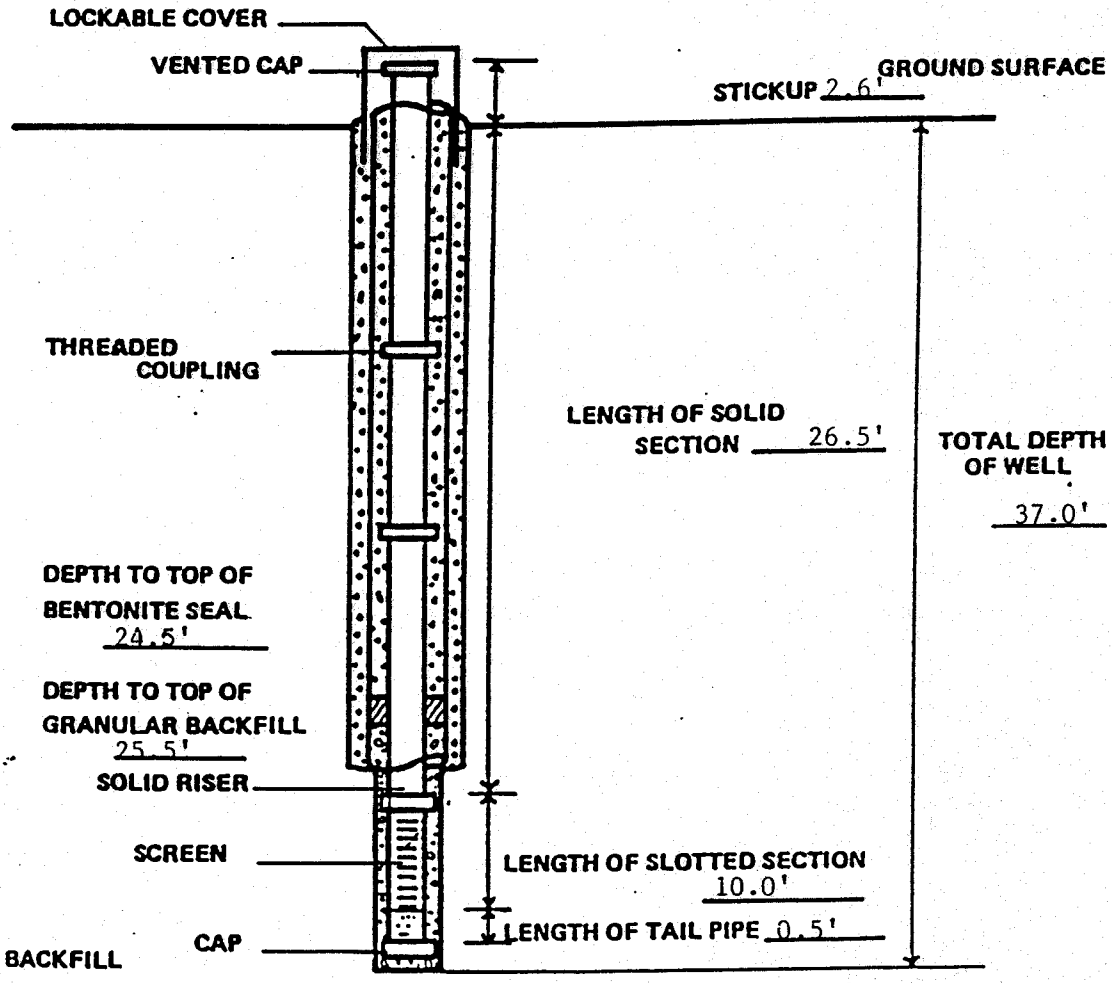
LAW ENGINEERING TESTING COMPANY

FIGURE 3A

TYPE III MONITORING WELL INSTALLATION RECORD - Part B

JOB NAME White Oak Landfill
JOB NUMBER 472-07913-03
WELL NUMBER GWM-3D
INSTALLATION DATE 9/23 - 9/24/93
LOCATION North of Leachate Pond (See Record Drawings)
GROUND SURFACE ELEVATION
REFERENCE POINT ELEVATION
GRANULAR BACKFILL NC #2 Sand
SLOT SIZE 0.010"
SCREEN MATERIAL PVC
SCREEN DIAMETER 2"
RISER MATERIAL PVC
RISER DIAMETER 2"
BOREHOLE DIAMETER 4.8"
LAW ENGINEERING FIELD REP. Hoda Kablawi
DRILLING TECHNIQUE HSA & PQ Coring
DRILLING CONTRACTOR Law Engineering
LOCK: BRAND Master SIZE/MODEL #3 KEYCODE/COMBINATION 0536
STABILIZED WATER LEVEL 14.6' FEET BELOW GROUND SURFACE, MEASURED ON 9/30/93

(NOT TO SCALE)



LAW ENGINEERING TESTING COMPANY

FIGURE 3 B

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

GWM-3D

DRILLING CONTRACTOR: Law Engineering

DRILLER REGISTRATION NUMBER: 332

LANDFILL **CONSTRUCTION PERMIT NUMBER:** 44-07

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: White Oak, North Carolina County: Haywood
(Road, Community, or Subdivision and Lot No.)

2. OWNER Haywood County, North Carolina
ADDRESS 420 N. Main Street
(Street or Route No.)
Waynesville NC 28786
City or Town State Zip Code

3. DATE DRILLED 9/23-9/24/93 USE OF WELL Monitoring
4. TOTAL DEPTH 37.0'
5. CUTTINGS COLLECTED YES [XX] NO [ ]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 17.2 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.6 FT. Above Land Surface*
* Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118
9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): _____

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0'	21.4'	Silty sand/sandy silt
21.4'	37.0'	Hard Rock

If additional space is needed use back of form

11. CHLORINATION: Type N/A Amount N/A
12. CASING:

	Depth From	To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
	0	20.8		6"		PVC
	0	26.5		2"		PVC

13. GROUT:

	Depth From	To	Ft.	Material	Method
	0	21.4		Cem-Bent.	Tremie
	0	24.5		Cem-Bent.	Tremie

14. SCREEN:

	Depth From	To	Ft	Diameter	Slot Size	Material
	26.5	36.5		2" in.	0.010 in.	PVC
				in.	in.	
				in.	in.	

15. SAND/GRAVEL PACK:

	Depth From	To	Ft.	Size	Material
	25.5	37.0			NC #2 Sand

16. REMARKS: Bentonite 24.5' to 25.5'

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

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

Thomas M. Schiffrout 10-4-93
SIGNATURE OF CONTRACTOR OR AGENT DATE

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

GW-1 REV. 5/91

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	FILL, consists of stiff moist brown fine sandy micaceous silt (ML)		9
8.5	Very stiff moist brown micaceous silty CLAY (CL)		17
13.5	Stiff to very stiff moist brown fine sandy micaceous SILT (ML)		12
			19
			28
26.0	PARTIALLY WEATHERED ROCK (PWR) Not sampled.		
27.9	Auger refusal encountered at 27.9 feet. Boring terminated.		

REMARKS:

Borehole dry at completion of drilling. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-4
DATE DRILLED	September 14, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
0.0	Overburden Soils (Brown sandy silt and silty sand) See Boring GWM-4 for detailed soil descriptions		
28.0	Hard Rock (Gray)		

REMARKS:

Borehole dry at completion of drilling.
Groundwater measured at 90.8 feet after 24 hrs.
Type II Monitoring Well Installed. Driller:
Caldwell Well Drilling. Drill Rig: Truck-Mount
Driltech D25. Boring Type:6-1/4" Air-Rotary

SEE KEY SHEET FOR EXPLANATION OF
SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-4A
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	Hard Rock (Gray)		

REMARKS:

Borehole dry at completion of drilling.
Groundwater measured at 90.8 feet after 24 hrs.
Type II Monitoring Well Installed. Driller:
Caldwell Well Drilling. Drill Rig: Truck-Mount
Driltech D25. Boring Type:6-1/4" Air-Rotary

SEE KEY SHEET FOR EXPLANATION OF
SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-4A
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	Hard Rock (Gray)		
100.3	Boring terminated at 100.3 feet		

REMARKS:

Borehole dry at completion of drilling.
Groundwater measured at 90.8 feet after 24 hrs.
Type II Monitoring Well Installed. Driller:
Caldwell Well Drilling. Drill Rig: Truck-Mount
Driltech D25. Boring Type:6-1/4" Air-Rotary

SEE KEY SHEET FOR EXPLANATION OF
SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-4A
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 3 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	Hard Rock (Gray)		
100.3	Boring terminated at 100.3 feet		

REMARKS:

Borehole dry at completion of drilling.
Groundwater measured at 90.8 feet after 24 hrs.
Type II Monitoring Well Installed. Driller:
Caldwell Well Drilling. Drill Rig: Truck-Mount
Driltech D25. Boring Type:6-1/4" Air-Rotary

SEE KEY SHEET FOR EXPLANATION OF
SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-4A
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 3 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
0.0	Overburden Soils (Brown sandy silt and silty sand) See Boring GWM-4 for detailed soil descriptions		
25.0	Hard Rock (Brown)		

REMARKS:

Borehole dry at completion of drilling & after 4 hrs. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-4B
DATE DRILLED	September 30, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	Hard Rock (Gray)		
57.7	Boring terminated at 57.7 feet		

REMARKS:

Borehole dry at completion of drilling & after 4 hrs. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-4B
DATE DRILLED	September 30, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 2	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME White Oak Landfill

JOB NUMBER 472-07913-03

WELL NUMBER GWM-4A

INSTALLATION DATE 9/30/93

LOCATION South End (See Record Drawings)

GROUND SURFACE ELEVATION

REFERENCE POINT ELEVATION

GRANULAR BACKFILL MATERIAL NC #2 Sand

SLOT SIZE 0.010"

SCREEN MATERIAL PVC

SCREEN DIAMETER 2"

RISER MATERIAL PVC

RISER DIAMETER 2"

DRILLING TECHNIQUE Air-Rotary

WELL INSTALLATION: DRILLING CONTRACTOR Law Engineering Caldwell

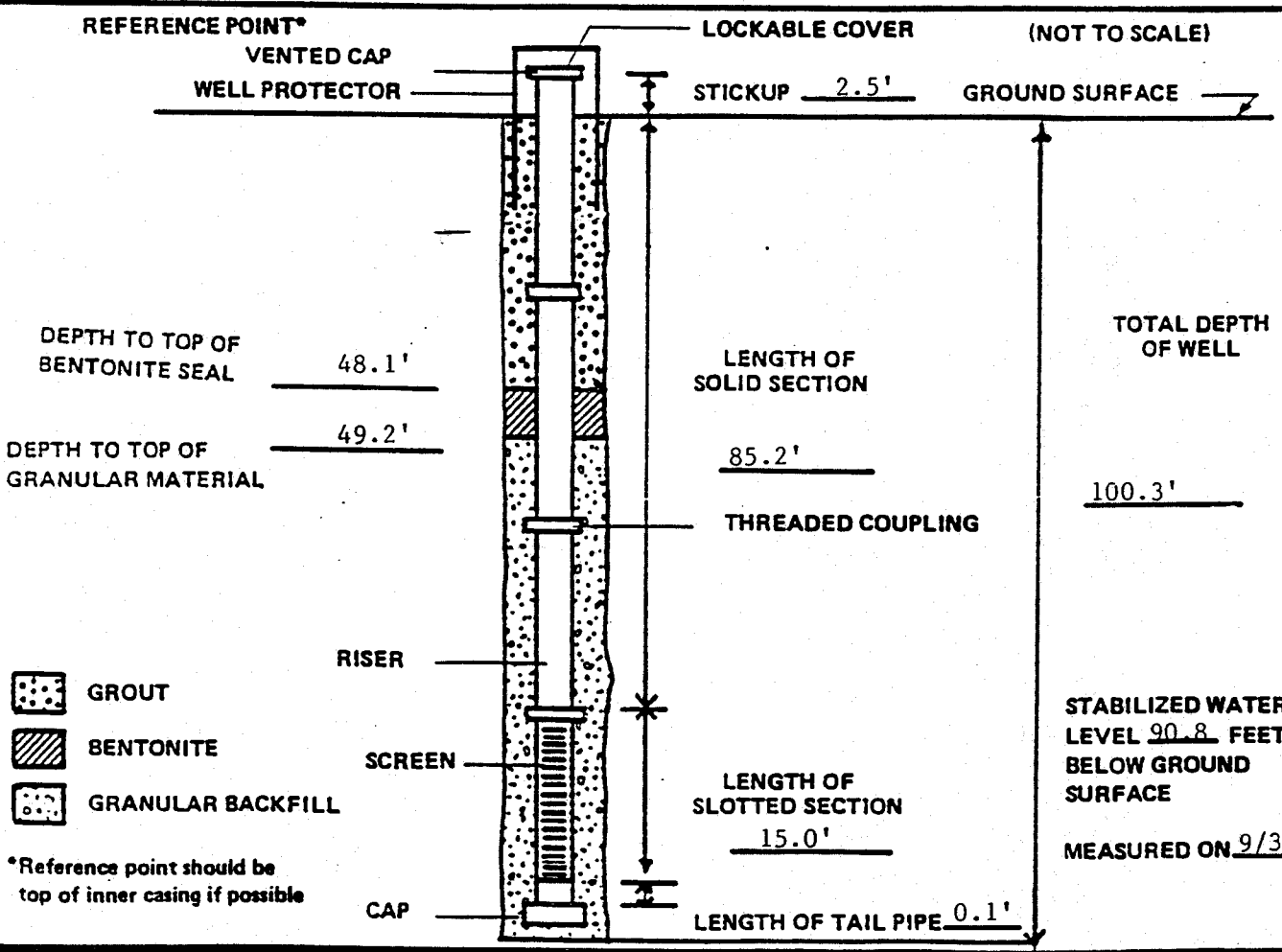
BOREHOLE DIAMETER 6 1/4"

LAW ENGINEERING FIELD REPRESENTATIVE T.Schipporeit

LOCK BRAND Master

SIZE/MODEL #3

KEY CODE/COMBINATION 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent.

WELL CONSTRUCTION RECORD

GWM-4A

DRILLING CONTRACTOR: Caldwell Well Drilling
WELL INSTALLATION: Law Engineering
DRILLER REGISTRATION NUMBER: 332

LANDFILL CONSTRUCTION
PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: White Oak County: Haywood
(Road, Community, or Subdivision and Lot No.)

2. OWNER Haywood County, North Carolina
ADDRESS 420 N. Main Street
(Street or Route No.)
Waynesville NC 28786
City or Town State Zip Code

3. DATE DRILLED 9/29-9/30/91 USE OF WELL Monitoring
4. TOTAL DEPTH 100.3'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 93.3 FT.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.5' FT. Above Land Surface*
* Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118
9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth):

11. CHLORINATION: Type N/A Amount N/A
12. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	85.2 Ft.	2		PVC
		Ft.			
		Ft.			

13. GROUT:

	Depth From	Depth To	Material	Method
	0	48.1 Ft.	Cem-Bent.	Tremie
		Ft.		

14. SCREEN:

	Depth From	Depth To	Diameter	Slot Size	Material
	85.2	100.2 Ft.	2 in.	0.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

15. SAND/GRAVEL PACK:

	Depth From	Depth To	Size	Material
	49.2	100.3 Ft.		NC #2 Sand
		Ft.		

16. REMARKS: Bentonite 48.1' to 49.2'

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0'	28'	Sandy silt/silty sand
28'	100.3'	Hard Rock

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)

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

Thomas M. Schiffbauer 10-4-93
SIGNATURE OF CONTRACTOR OR AGENT DATE

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

GW-1 REV. 5/91

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	FILL, consists of stiff to very stiff moist brown fine sandy micaceous silt (ML).		23
			14
12.0	Firm moist red-brown silty micaceous fine to coarse SAND (SM).		18
15.0	Stiff moist brown and orange-brown fine sandy micaceous SILT (ML).		13
			11
26.0	PARTIALLY WEATHERED ROCK (PWR), sampled as dry yellow, gray, and orange-brown silty micaceous fine to coarse sand, with trace rock fragments.		50/4"
			50/2"
37.2	Auger refusal encountered at 37.2 feet. Boring terminated.		50/0"

REMARKS:

Borehole dry at completion of drilling. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-5
DATE DRILLED	September 15, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	Firm moist brown fine to coarse sandy micaceous SILT (ML)		8
8.0	Loose wet brown, gray, and white silty micaceous fine to coarse SAND (SM), with rock fragments and boulders		6
			9
18.5	PARTIALLY WEATHERED ROCK (PWR), sampled as wet brown, gray, and white silty micaceous sand, with rock fragments		50/6"
20.1	Auger refusal encountered at 20.1 feet. Boring terminated.		

REMARKS:

Groundwater encountered at 9.0 feet. Type II Monitoring Well Installed. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-5A
DATE DRILLED	September 25, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME White Oak Landfill

JOB NUMBER 472-07913-03

WELL NUMBER GWM-5A

INSTALLATION DATE 09/25/93

LOCATION West Drainage Feature (See Record Drawings)

GROUND SURFACE ELEVATION

REFERENCE POINT ELEVATION

GRANULAR BACKFILL MATERIAL NC #2 sand

SLOT SIZE 0.010"

SCREEN MATERIAL PVC

SCREEN DIAMETER 2"

RISER MATERIAL PVC

RISER DIAMETER 2"

DRILLING TECHNIQUE HSA

DRILLING CONTRACTOR Law Engineering

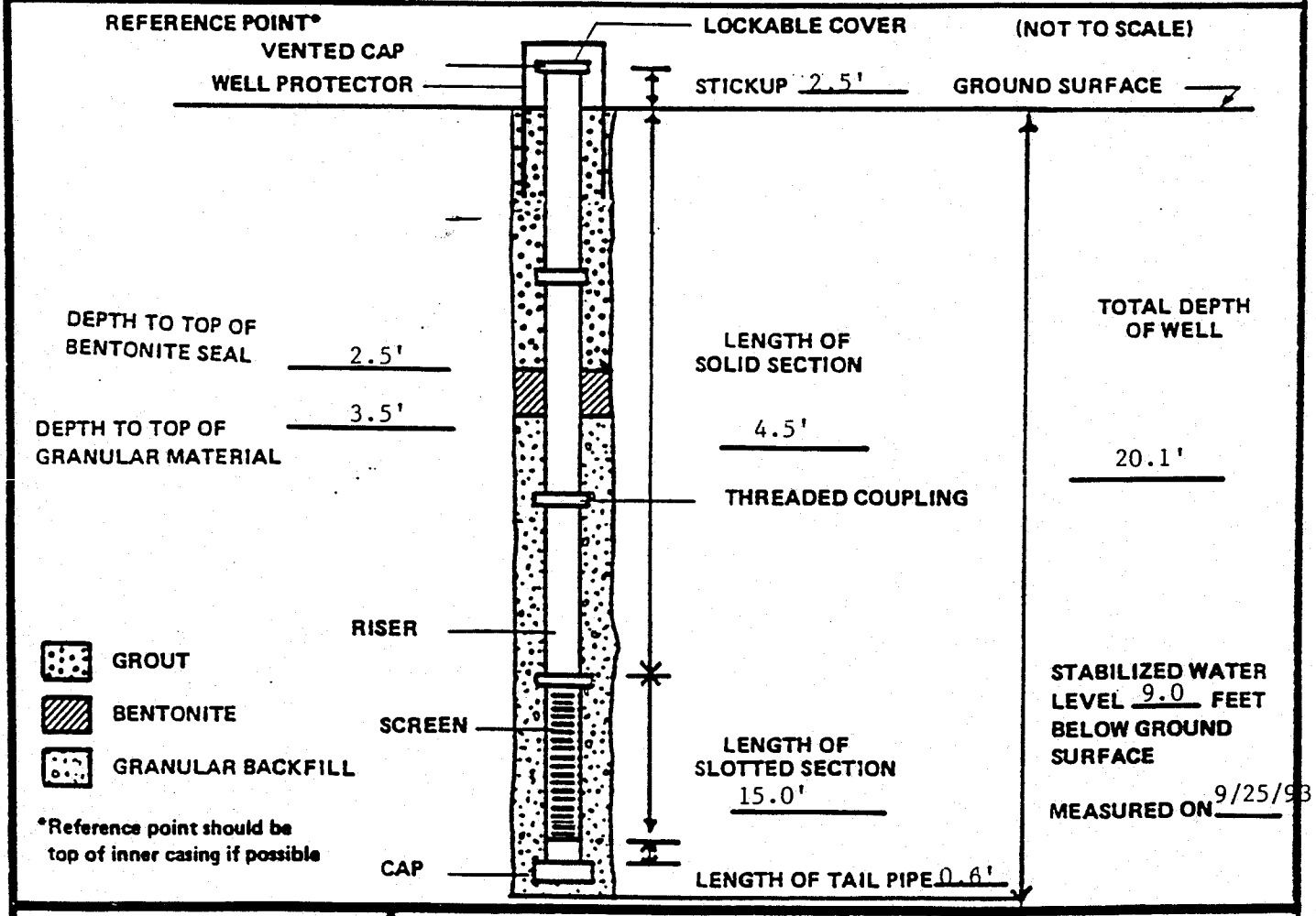
BOREHOLE DIAMETER 8"

LAW ENGINEERING FIELD REPRESENTATIVE Hoda Kablawi

LOCK BRAND Master

SIZE/MODEL #3

KEY CODE/COMBINATION 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-6083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR Law Engineering

DRILLER REGISTRATION NUMBER 332

GWM-5A
LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: White Oak, North Carolina
(Road, Community, or Subdivision and Lot No.)

County: Haywood

2. OWNER Haywood County, North Carolina
ADDRESS 420 N. Main Street (Street or Route No.)
Waynesville (City or Town) NC (State) 28786 (Zip Code)

3. DATE DRILLED 9/25/93 USE OF WELL Monitoring
4. TOTAL DEPTH 20.1' CUTTINGS COLLECTED ☒ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
6. STATIC WATER LEVEL: 11.5' FT. ☐ above ☒ below TOP OF CASING,
TOP OF CASING IS 2.5' FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST N/A
8. WATER ZONES (depth): _____
9. CHLORINATION: Type N/A Amount N/A

10. CASING:

	Depth From	To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	4.5 Ft.	2"		PVC
		Ft.			
		Ft.			

11. GROUT:

	Depth From	To	Material	Method
	0	2.5 Ft.	Cem-Bent	Tremie
		Ft.		

12. SCREEN:

	Depth From	To	Diameter	Slot Size	Material
	4.5	19.5 Ft.	2" in.	0.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

13. GRAVEL PACK:

	Depth From	To	Size	Material
	3.5'	20.1 Ft.		NC#2 sand
		Ft.		

14. REMARKS: Bentonite 2.5' to 3.5'

Depth From	To	DRILLING LOG Formation Description
0'	8'	Sandy SILT
8'	18.5'	Silty sand
18.5'	20.1'	Partially weathered rock

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)

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

Thomas M. Shipholt 10/1/93
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/84
Submit original to Division of Environmental Management and copy to well owner

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
0.0	Overburden Soils (Brown silty sand) See Boring GWM-5A for detailed soil descriptions		
20.0	Hard Rock (Brown)		
36.2	Boring terminated at 36.2 feet		

REMARKS:

Groundwater measured at 6.1 feet after stabilization. Type II Monitoring Well Installed. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

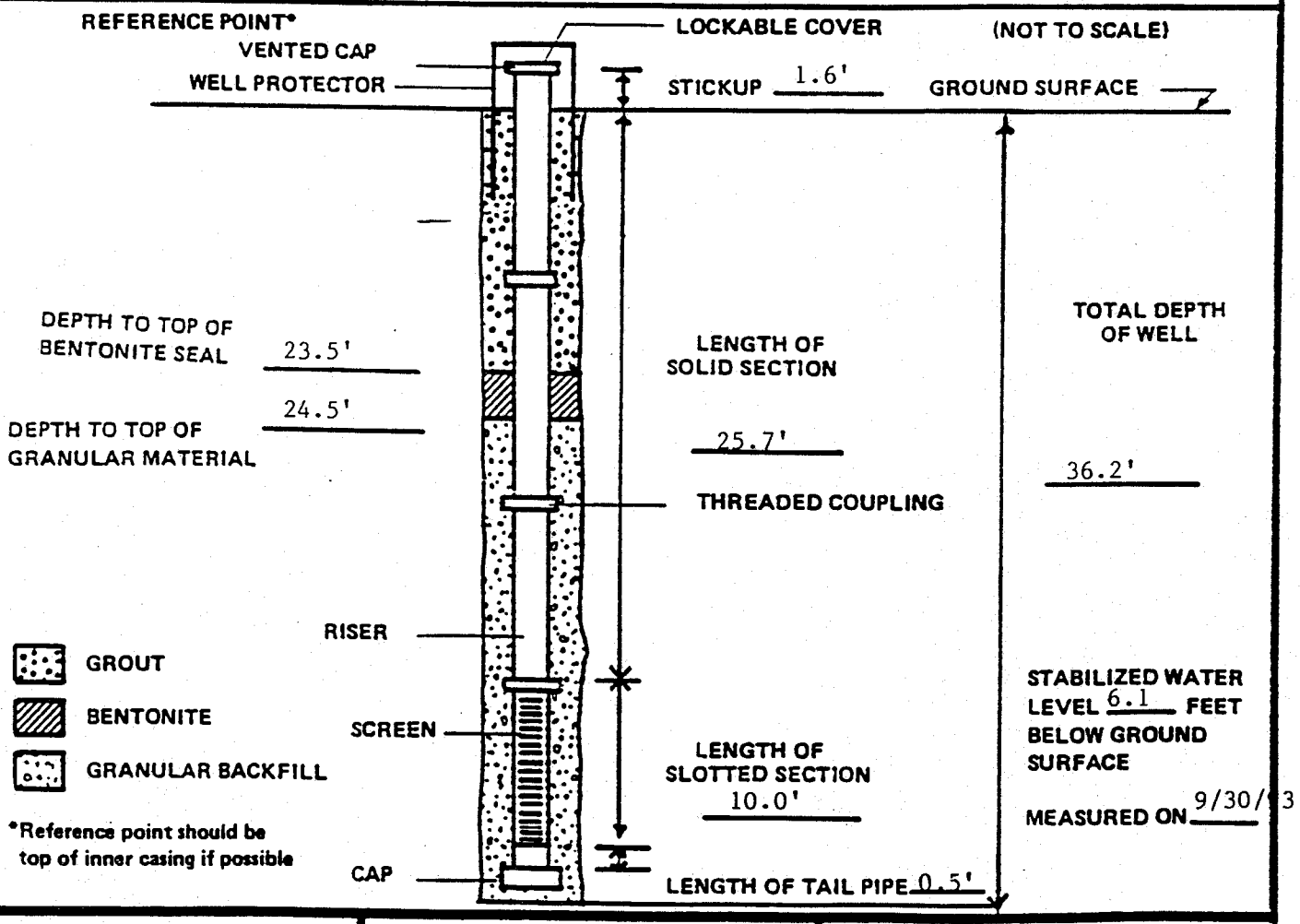
TEST BORING RECORD

BORING NUMBER	GWM-5D
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME: White Oak Landfill
JOB NUMBER: 472-07913-03
WELL NUMBER: GWM-5D
INSTALLATION DATE: 9/29/93 & 9/30/93
LOCATION: West Drainage Feature (See Record Drawings)
GROUND SURFACE ELEVATION: _____
REFERENCE POINT ELEVATION: _____
GRANULAR BACKFILL MATERIAL: NC #2 Sand
SLOT SIZE: 0.010"
SCREEN MATERIAL: PVC
SCREEN DIAMETER: 2"
RISER MATERIAL: PVC
RISER DIAMETER: 2"
DRILLING TECHNIQUE: Air-Rotary
DRILLING CONTRACTOR: Caldwell
BOREHOLE DIAMETER: 6 1/4"
LAW ENGINEERING FIELD REPRESENTATIVE: T. Schipporeit
LOCK BRAND: Master
SIZE/MODEL: #3
KEY CODE/COMBINATION: 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent.

WELL CONSTRUCTION RECORD

GWM-5D

DRILLING CONTRACTOR: Caldwell

LANDFILL CONSTRUCTION

DRILLER REGISTRATION NUMBER: 99 **PERMIT NUMBER:** 44-07

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: White Oak County: Haywood
   (Road, Community, or Subdivision and Lot No.)
2. OWNER Haywood County, North Carolina
   ADDRESS 420 N. Main Street
   (Street or Route No.)
   Waynesville NC 28786
   City or Town State Zip Code
3. DATE DRILLED 9/29/93 USE OF WELL Monitoring
4. TOTAL DEPTH 36.2'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 7.7 FT.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 1.6 FT. Above Land Surface*
   * Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118
9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): _____
11. CHLORINATION: Type N/A Amount N/A
12. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	25.7 Ft.	2"		PVC
		Ft.			
		Ft.			

13. GROUT:

	Depth From	Depth To	Material	Method
	0	23.5 Ft.	Cement-Bent.	Tremie
		Ft.		

14. SCREEN:

	Depth From	Depth To	Diameter	Slot Size	Material
	25.7	35.7 Ft	2 in.	0.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

15. SAND/GRAVEL PACK:

	Depth From	Depth To	Size	Material
	24.5	36.2 Ft.		NC #2 Sand
		Ft.		

16. REMARKS: Bentonite 23.5' to 24.5'

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0'	20'	Silty sand
20'	36.2'	Hard Rock

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)

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

Thomas M. Shuffpoint 10-4-93
SIGNATURE OF CONTRACTOR OR AGENT DATE

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

GW-1 REV. 5/91

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	FILL, consists of very stiff moist brown fine sandy micaceous silt (ML), with gravel and cobbles.		28
6.0	Firm moist brown and red-brown silty micaceous fine to coarse SAND (SM)		19
			26
18.5	Very stiff moist brown fine sandy micaceous SILT (ML).		28
24.5	PARTIALLY WEATHERED ROCK (PWR), sampled as dry to moist silty sand, with trace rock fragments		50/5"
			50/3"
			50/3"
38.5	Very dense moist brown micaceous fine to medium SAND (SP), with trace rock fragments		80

REMARKS:

Groundwater encountered at 42.5 feet. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-6
DATE DRILLED	September 14, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)	
	Very dense moist brown micaceous fine to medium SAND (SP), with trace rock fragments.			
43.5	Auger refusal encountered at 43.5 feet. Boring terminated.		●	50/0"

REMARKS:

Groundwater encountered at 42.5 feet. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-6
DATE DRILLED	September 14, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)	
0.0	Stiff moist brown fine to coarse sandy micaceous SILT (ML)			10
6.0	Loose to firm wet gray and brown micaceous silty fine to coarse SAND (SM)			12
				8
18.5	Auger refusal encountered at 18.5 feet. Boring terminated.			

REMARKS:

Groundwater encountered at 6.5 feet. Type II Monitoring Well Installed. Drillers: W.Whichard and G.Copland. Drill Rig: CME-550 ATV. Boring Type: 8" HSA.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

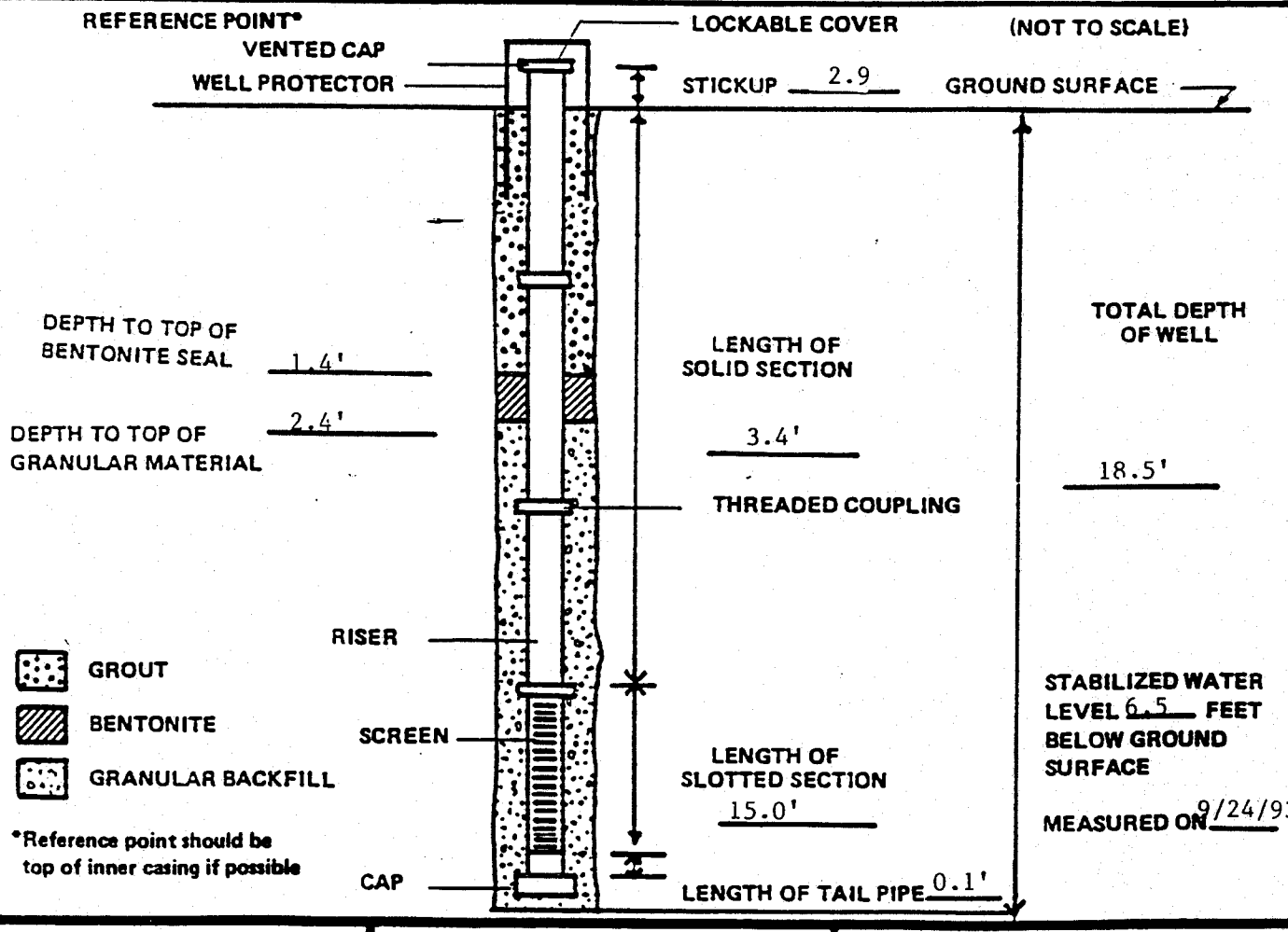
TEST BORING RECORD

BORING NUMBER	GWM-6A
DATE DRILLED	September 24, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 1	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME: White Oak Landfill
JOB NUMBER: 472-07913-03
WELL NUMBER: GWM-6A
INSTALLATION DATE: 09/24/93
LOCATION: West Drainage Feature (See Record Drawings)
GROUND SURFACE ELEVATION: _____
REFERENCE POINT ELEVATION: _____
GRANULAR BACKFILL MATERIAL: NC #2 sand
SLOT SIZE: 0.010"
SCREEN MATERIAL: PVC
SCREEN DIAMETER: 2"
RISER MATERIAL: PVC
RISER DIAMETER: 2"
DRILLING TECHNIQUE: HSA
DRILLING CONTRACTOR: Law Engineering
BOREHOLE DIAMETER: 8"
LAW ENGINEERING FIELD REPRESENTATIVE: Hoda Kablawi
LOCK BRAND: Master
SIZE/MODEL: #3
KEY CODE/COMBINATION: 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-6083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc ____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR Law Engineering GWH-6A
DRILLER REGISTRATION NUMBER 332
LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: White Oak, North Carolina
County: Haywood
(Road, Community, or Subdivision and Lot No.)

2. OWNER Haywood County, North Carolina
ADDRESS 420 N. Main Street (Street or Route No.)
Waynesville (City or Town) NC (State) 28786 (Zip Code)

3. DATE DRILLED 9/24/93 USE OF WELL Monitoring
4. TOTAL DEPTH 18.5' CUTTINGS COLLECTED ☒ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
6. STATIC WATER LEVEL: 9.4 FT. ☐ above ☒ below TOP OF CASING.
TOP OF CASING IS 2.9 FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST N/A
8. WATER ZONES (depth):
9. CHLORINATION: Type N/A Amount N/A

10. CASING:

	Depth From	To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	3.4 Ft.	2"		PVC
		Ft.			
		Ft.			

11. GROUT:

	Depth From	To	Material	Method
	0	1.4 Ft.	Cem-Bent	Tremie
		Ft.		

12. SCREEN:

	Depth From	To	Diameter	Slot Size	Material
	3.4	18.4 Ft.	2" in.	in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

13. GRAVEL PACK:

	Depth From	To	Size	Material
	2.4	18.5 Ft.		NC#2 sand
		Ft.		

REMARKS: Bentonite 1.4' to 2.4'

Depth From	To	DRILLING LOG Formation Description
0'	6'	Sandy SILT
6'	18.5'	Silty sand

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)

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

Thomas M. Schyhout 10/1/93
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/94
Submit original to Division of Environmental Management and copy to well owner

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
0.0	Stiff moist brown fine sandy micaceous SILT (ML)		11
			15
13.0	Very stiff to hard moist brown and gray fine sandy micaceous SILT (ML)		25
			22
			34
			25
			31
38.0	Very stiff moist gray, brown, and white fine to medium sandy micaceous SILT (ML)		26

REMARKS:

Type III Monitoring Well installed 07-14-93. Drillers: W.Whichard and C.Coumbes. Drill Rig: CME 550 ATV. Boring Type: Open-hole wash using 6" tri-cone bit.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7
DATE DRILLED	July 12, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT (0 10 20 30 40 60 80 100)
	Very stiff moist gray, brown, and white fine to medium sandy micaceous SILT (ML)		
43.0	Hard to very hard moist brown and gray fine sandy micaceous SILT (ML), with trace rock fragments		34
			34
			37
			57
60.0	PARTIALLY WEATHERED ROCK (PWR), sampled as moist brown and gray fine sandy micaceous silt, with trace rock fragments		50/4"
68.0	Very dense moist brown and gray silty micaceous fine SAND (SM), with trace rock fragments		81
71.0	PARTIALLY WEATHERED ROCK (PWR), sampled as moist brown and gray fine sandy micaceous silt		50/5"
			50/2"

REMARKS:

Type III Monitoring Well installed 07-14-93. Drillers: W.Whichard and C.Coumbes. Drill Rig: CME 550 ATV. Boring Type: Open-hole wash using 6" tri-cone bit.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7
DATE DRILLED	July 12, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	PARTIALLY WEATHERED ROCK (PWR), sampled as moist brown and gray fine sandy micaceous silt		
82.8	Tri-cone bit refusal encountered at 82.8 feet on 07-13-93. Boring terminated.		

REMARKS:

Type III Monitoring Well installed 07-14-93. Drillers: W.Whichard and C.Coumbes. Drill Rig: CME 550 ATV. Boring Type: Open-hole wash using 6" tri-cone bit.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7
DATE DRILLED	July 12, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 3 OF 3	

LAW ENGINEERING

TYPE III MONITORING WELL INSTALLATION RECORD - Part A

JOB NAME White Oak Sanitary Landfill JOB NUMBER 472-07913-03

WELL NUMBER GWM-7 INSTALLATION DATE 7-12 through 7-14-93

LOCATION Haywood County, North Carolina

GROUND SURFACE ELEVATION

CASING MATERIAL PVC CASING DIAMETER 4"

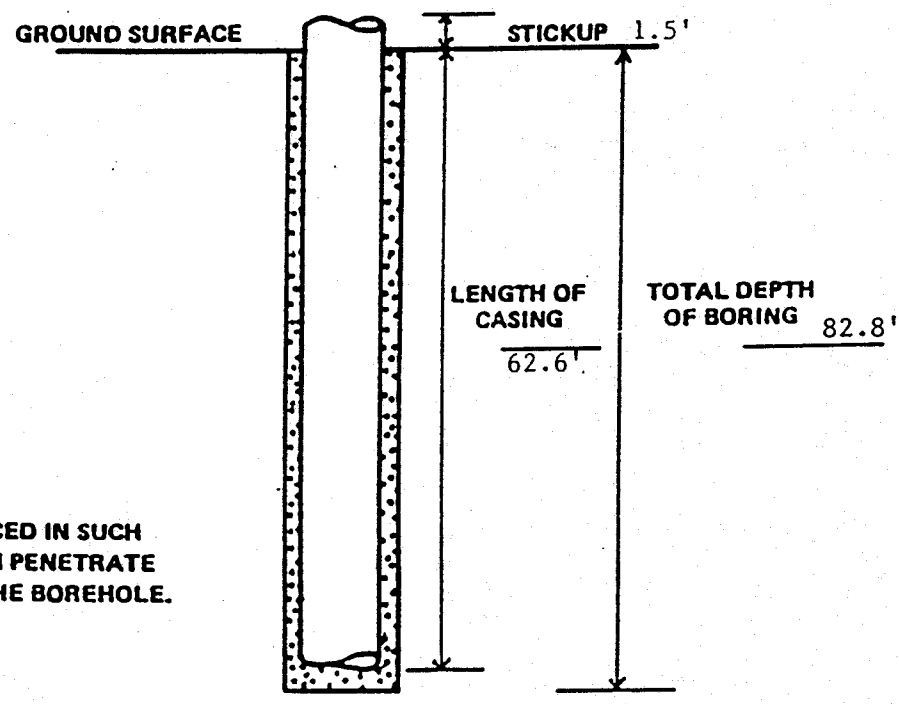
BOREHOLE DIAMETER 6"

DRILLING TECHNIQUE Open-hole wash with tri-cone bit

DRILLING CONTRACTOR Law Engineering (332)

LAW ENGINEERING FIELD REPRESENTIVE T. Schipporeit

(NOT TO SCALE)



GROUT

NOTE:

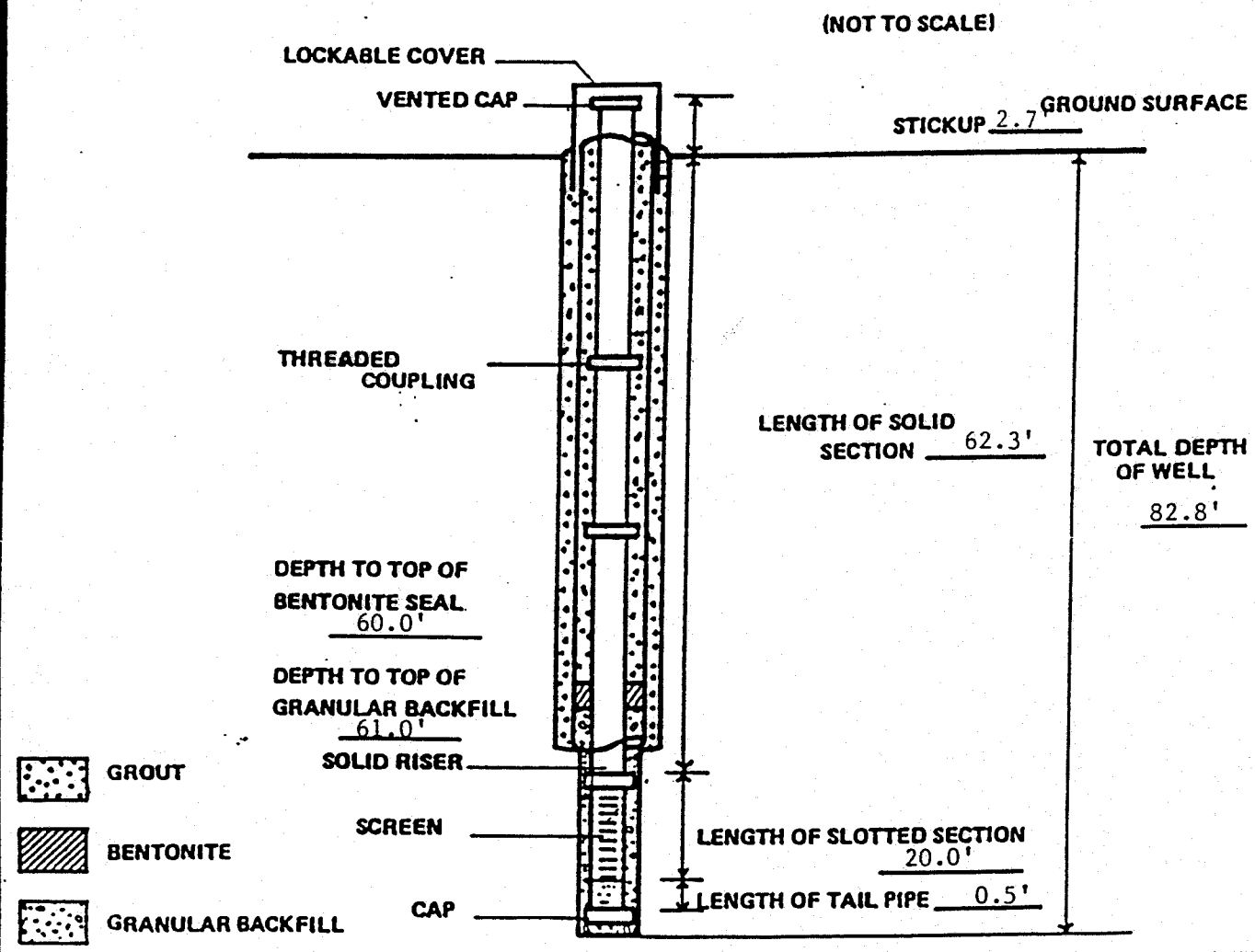
CASING SHOULD BE PLACED IN SUCH A WAY THAT GROUT CAN PENETRATE UNDERNEATH IT INTO THE BOREHOLE.

LAW ENGINEERING TESTING COMPANY

FIGURE 3 A

TYPE III MONITORING WELL INSTALLATION RECORD - Part B

JOB NAME White Oak Sanitary Landfill
JOB NUMBER 472-07913-03
WELL NUMBER GWM-7
INSTALLATION DATE 7-12 through 7-14-93
LOCATION Haywood County, North Carolina
GROUND SURFACE ELEVATION
REFERENCE POINT ELEVATION
GRANULAR BACKFILL NC #2 , Sand
SLOT SIZE 0.010"
SCREEN MATERIAL PVC
SCREEN DIAMETER 2"
RISER MATERIAL PVC
RISER DIAMETER 2"
BOREHOLE DIAMETER 6"
LAW ENGINEERING FIELD REP. T. Schipporeit
DRILLING TECHNIQUE Open-hole wash
DRILLING CONTRACTOR Law Engineering
LOCK: BRAND Master
SIZE/MODEL #3
KEYCODE/COMBINATION 0536
STABILIZED WATER LEVEL 59.5 FEET BELOW GROUND SURFACE, MEASURED ON 7-15-93



LAW ENGINEERING TESTING COMPANY

FIGURE 3 B

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT - GROUNDWATER SECTION
P.O. BOX 27687 - RALEIGH, N.C. 27611, PHONE (919) 733-6083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc.
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

GWM-7

DRILLING CONTRACTOR Law Engineering
DRILLER REGISTRATION NUMBER 332
LANDFILL CONSTRUCTION PERMIT NUMBER: 44-07

1. WELL LOCATION: (Show sketch of the location below)
Nearest Town: White Oak, North Carolina
County: Haywood
(Road, Community, or Subdivision and Lot No.)

2. OWNER Haywood County, North Carolina
ADDRESS 420 N. Main Street (Street or Route No.)
Waynesville (City or Town) NC (State) 28786 (Zip Code)

3. DATE DRILLED 7-12/7-13-92 USE OF WELL Monitoring
4. TOTAL DEPTH 82.8' CUTTINGS COLLECTED ☒ Yes ☐ No
5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No
6. STATIC WATER LEVEL: 62.2 FT. ☐ above ☒ below TOP OF CASING,
TOP OF CASING IS 2.7 FT. ABOVE LAND SURFACE.
7. YIELD (gpm): N/A METHOD OF TEST N/A
8. WATER ZONES (depth):
9. CHLORINATION: Type N/A Amount N/A

10. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	62.6 Ft.	4 in		PVC
	0	62.3 Ft.	2 in		PVC
		Ft.			

11. GROUT:

	Depth From	Depth To	Material	Method
	0	60.0 Ft.	Cem.-Bent.	Tremie
		Ft.		

12. SCREEN:

	Depth From	Depth To	Diameter	Slot Size	Material
	62.3	82.3 Ft.	2 in.	0.010 in.	PVC
		Ft.	in.	in.	
		Ft.	in.	in.	

13. GRAVEL PACK:

	Depth From	Depth To	Size	Material
	61.0'	82.8 Ft.		NC #2 Sand
		Ft.		

14. REMARKS: Bentonite 60.0' to 61.0'

DRILLING LOG

Depth From	Depth To	Formation Description
0'	60'	Sandy silt
60'	82.8'	Partially weathered rock

If additional space is needed use back of form.

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

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

Thomas M. Schuppert 10/1/93
SIGNATURE OF CONTRACTOR OR AGENT DATE

GW-1 Revised 11/84

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

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
0.0	Overburden Soils (Brown sandy silt and silty sand) See Boring GWM-7 for detailed soil descriptions		

REMARKS:

Groundwater measured at 64.6 feet after stabilization. Type II Monitoring Well Installed. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7D
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 1 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	Overburden Soils (Brown sandy silt and silty sand) See Boring GWM-7 for detailed soil descriptions		

REMARKS:

Groundwater measured at 64.6 feet after stabilization. Type II Monitoring Well Installed. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7D
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 2 OF 3	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT 0 10 20 30 40 60 80 100
	Overburden Soils (Brown sandy silt and silty sand) See Boring GWM-7 for detailed soil descriptions		
85.0	Hard Rock (Brown)		
103.2	Boring terminated at 103.2 feet		

REMARKS:

Groundwater measured at 64.6 feet after stabilization. Type II Monitoring Well Installed. Driller: Caldwell Well Drilling. Drill Rig: Truck-Mount Driltech D25. Boring Type: 6-1/4" Air-Rotary.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	GWM-7D
DATE DRILLED	September 29, 1993
PROJECT NUMBER	472-07913-03
PROJECT	White Oak Sanitary Landfill
PAGE 3 OF 3	

LAW ENGINEERING

TYPE II MONITORING WELL INSTALLATION RECORD

JOB NAME White Oak Landfill

JOB NUMBER 472-07913-03

WELL NUMBER GWM-7D

INSTALLATION DATE 9/29 - 9/30/93

LOCATION South End (See Record Drawings)

GROUND SURFACE ELEVATION

REFERENCE POINT ELEVATION

GRANULAR BACKFILL MATERIAL NC #2 Sand

SLOT SIZE 0.010"

SCREEN MATERIAL PVC

SCREEN DIAMETER 2"

RISER MATERIAL PVC

RISER DIAMETER 2"

DRILLING TECHNIQUE Air-Rotary

DRILLING CONTRACTOR Caldwell

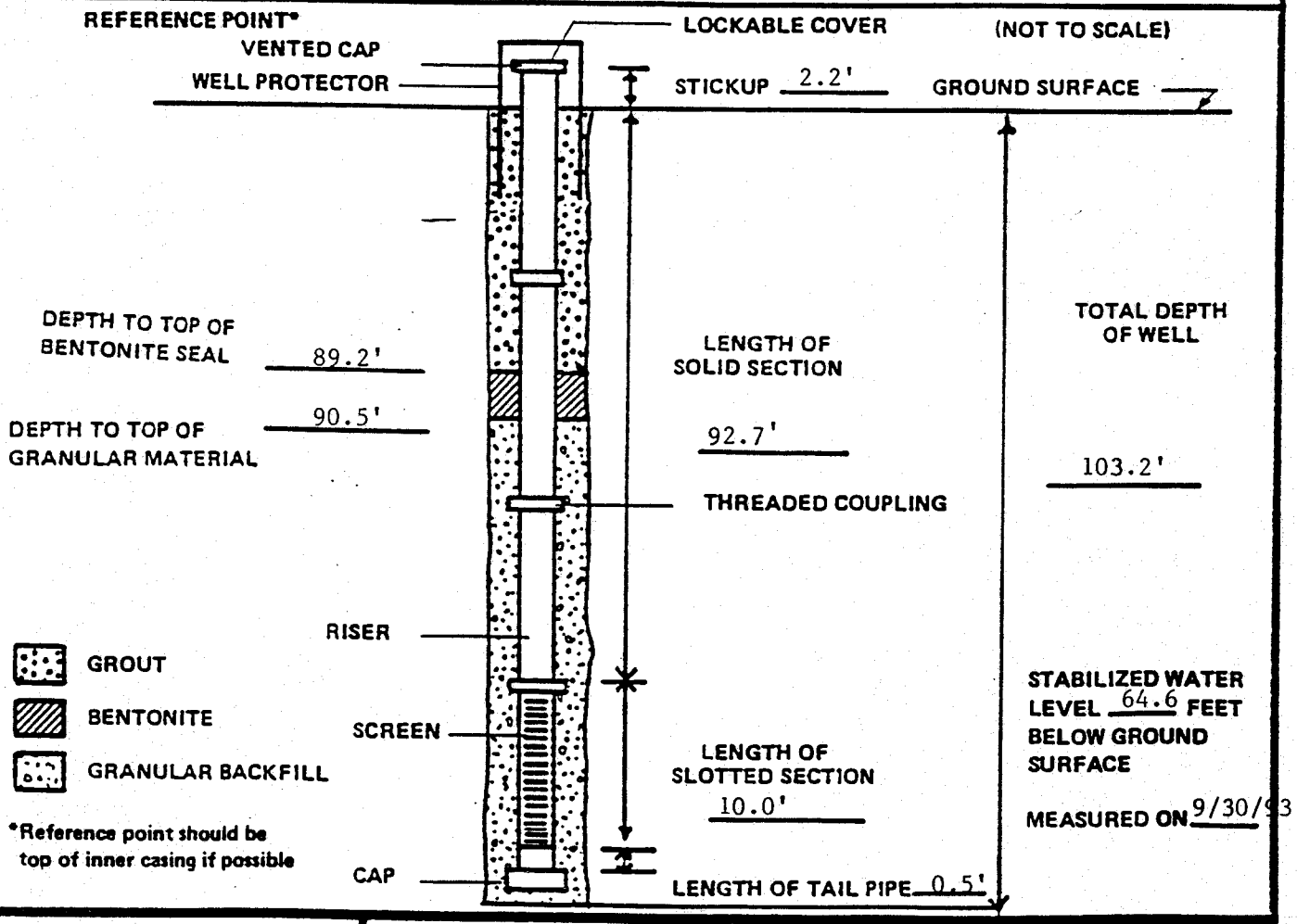
BOREHOLE DIAMETER 6 1/4"

LAW ENGINEERING FIELD REPRESENTATIVE T. Schipporeit

LOCK BRAND Master

SIZE/MODEL #3

KEY CODE/COMBINATION 0536



LAW ENGINEERING TESTING COMPANY

TYPE II MONITORING WELL INSTALLATION RECORD

FIGURE 2

North Carolina - Department of Environment, Health, and Natural Resources
Division of Environmental Management - Groundwater Section
P.O. Box 29535 - Raleigh, N.C. 27626-0535
Phone (919) 733-3221

FOR OFFICE USE ONLY
QUAD. NO. _____ SERIAL NO. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent.

WELL CONSTRUCTION RECORD

GWM-7D

DRILLING CONTRACTOR: Caldwell

DRILLER REGISTRATION NUMBER: 99

LANDFILL **CONSTRUCTION PERMIT NUMBER:** 44-07

1. WELL LOCATION: (Show sketch of the location below)
   Nearest Town: White Oak County: Haywood
   (Road, Community, or Subdivision and Lot No.)
2. OWNER Haywood County, North Carolina
   ADDRESS 420 N. Main Street
   (Street or Route No.)
   Waynesville NC 28786
   City or Town State Zip Code
3. DATE DRILLED 9/29/93 USE OF WELL Monitoring
4. TOTAL DEPTH 103.2'
5. CUTTINGS COLLECTED YES [ ] NO [X]
6. DOES WELL REPLACE EXISTING WELL? YES [ ] NO [X]
7. STATIC WATER LEVEL Below Top of Casing: 66.8 FT.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.2 FT. Above Land Surface*
   * Casing Terminated at/or below land surface is illegal unless a variance is issued in accordance with 15A NCAC 2C .0118
9. YIELD (gpm): N/A METHOD OF TEST N/A
10. WATER ZONES (depth): _____
11. CHLORINATION: Type N/A Amount N/A
12. CASING:

	Depth From	Depth To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
	0	92.7		2"		PVC

13. GROUT:

	Depth From	Depth To	Ft.	Material	Method
	0	89.2		Cement-Bent.	PVC

14. SCREEN:

	Depth From	Depth To	Ft.	Diameter	in.	Slot Size	in.	Material
	92.7	102.7		2		0.010		PVC

15. SAND/GRAVEL PACK:

	Depth From	Depth To	Ft.	Size	Material
	90.5	103.2			NC #2 Sand

16. REMARKS: Bentonite 89.2' to 90.5'

DEPTH From	DEPTH To	DRILLING LOG Formation Description
0'	85'	Sandy silt/silty sand
85'	103.2'	Hard rock

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)

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

Thomas M. Shufflouit 10-4-93
SIGNATURE OF CONTRACTOR OR AGENT DATE

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

GW-1 REV. 5/91

STEFFEN ROBERTSON & KIRSTEN (US)
CONSULTING ENGINEERS & SCIENTISTS

JOB NO.: 83504
LOCATION: Haywood County
WELL NUMBER: GMW-8

SHEET 1 OF 1

DRILL SUMMARY

DATE: 1-28-97	
DRILLED BY: Craig Bender	
LOGGED BY: Larry Mattila	
DRILLING METHOD: 4.25 ID Hollow Stem Auger	

SURVEY INFORMATION

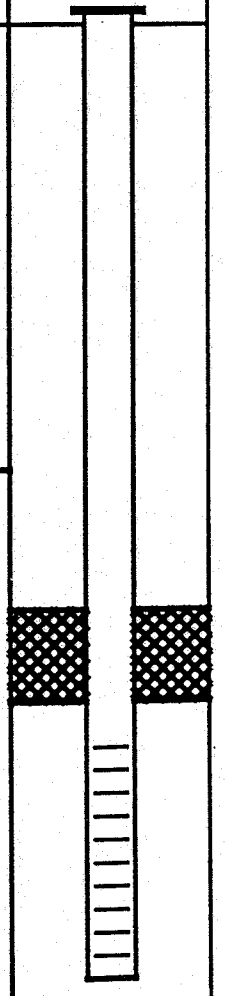
CASING HEIGHT: 2.5 ft. AGS	
LAND SURFACE ELEVATION:	
STATIC WATER LEVEL: 31 Ft @ drilling	
LATITUDE: LONGITUDE:	

WELL SPECIFICATIONS

GROUT: 0' – 27'	SEAL: Bentonite, 27' – 29'	GRAVEL PACK: 20' – 30' Silica, 29' – 42'	
CASING TYPE: Pvc 40	DIAMETER: 2 in.	DEPTH: 0 – 31'	HOLE DIA.: 8 in.
SCREEN TYPE: PVC 40	SLOT: 0.010	DIAMETER: 2 in.	DEPTH: 31' – 41'	TOTAL DEPTH: 42'

O V A	PEN. RES.	DEPTH (FT)	LITHOLOGY	LITHOLOGIC TEXTURE / REMARKS
		0		Fill. Rock at 3' moving 2' south (auger refusal).
				Sa Si
				Si
	1, 2, 4, 10	10	GM	Fill, silt mixed with partially weathered rock. Yellowish brown. Trace of rock to 16 ft.
				Auger refusal at 17 ft. Move 12 ft east (install solid head auger).
		20	ML	Silt. Yellowish brown.
				Silt
		30	ML	Saturated at 31 ft.
				Silt with trace of rock (partially weathered rock).
		40		Silt. Yellowish brown.
				Total depthe = 42 ft.

WELL COMPLETION



White Oak Lined Landfill

Total Porosity Calculations

Total porosity (n) is defined as the ratio of void volume to total volume and may range from a small fraction to about 0.90.

$n_p = V_v/V = (V-V_m)/V = 1-V_m/V = 1-q_d/(q_w * G_s)$

where

n_p=porosity
V_v=volume of voids
V=total volume of sample
V_m=volume of the soil (material)
q_w=unit weight of water 62.4 lb/cf

Saprolite	Gs
P2-1	2.71
P2-1	2.69
P2-1	2.71
P2-1	2.72
P2-2	2.75
P-1	2.83
P-8	2.73
P-8	2.74
P-9	2.68
P-9	2.72
P-14	2.75
P-15	2.65
Average	**2.72**

what depth are these samples taken from

	Dry Density (qd)	Specific Gravity (Gs)	**Total Porosity (np)**
Saprolite[1]	123.55	2.72	**27%**

[1] Values derived from Table1.4 by Peck, Hanson and Thornburn, 1973.

WHITE OAK HAYWOOD COUNTY LANDFILL

Hydraulic Considerations

Piezometer	Geomorphology	Lithology	Permeability (cm/sec)	Test Method
* P-1	ridge	Gneiss	1.71E-04	Bail-Down
P-2	draw	PWR	1.85E-05	Bail-Down
P-3	ridge	Gneiss	*4.65E-05*	
P-4	ridge	Gneiss	*4.65E-05*	
P-5	draw	Gneiss	4.41E-05	Bail-Down
P-6 questionable	slope	Gneiss	2.84E-06	Bail-Down
P-7	slope	Gneiss	1.13E-05	Bail-Down
P-8	ridge	Saprolite	*5.54E-05*	
P-9 highly questionable	valley	Gneiss	1.35E-05	Bail-Down
P-10	ridge	Saprolite	4.84E-05	Bail-Down
P-11	draw	Saprolite	4.80E-05	Bail-Down
P-12	draw	Saprolite	2.36E-04	Bail-Down
P-13	ridge	Saprolite	5.81E-07	Bail-Down
P-14	head of slope	Gneiss	*4.65E-05*	
P-15	ridge	PWR	2.48E-06	Bail-Down
P-16	slope	Saprolite	3.40E-05	Bail-Down
P-17	slope	Gneiss	1.52E-06	Bail-Down
P-18	slope	PWR	*1.05E-05*	
P-19	slope	Gneiss	1.74E-07	Bail-Down
P2-1	head of slope	Gneiss	1.50E-04	Bail-Down
P2-2	head of slope	Gneiss	2.45E-05	Bail-Down

Lithology	Piezometer Tested	K (cm/sec)
Saprolite	P-10	4.84E-05
	P-11	4.80E-05
	P-12	2.36E-04
	P-13	5.81E-07
	P-16	3.40E-05
	P-9*	1.50E-04
	P-8*	2.20E-05
	P2-1*	2.20E-06
	P2-1*	1.30E-05
	P2-2*	2.00E-07
	average:	5.54E-05
PWR	P-2	1.85E-05
	P-15	2.48E-06
	average:	1.05E-05
Fractured Gneissic Bedrock	P-1	1.71E-04
	P-5	4.41E-05
	P-6	2.84E-06
	P-7	1.13E-05
	P-9	1.35E-05
	P-17	1.52E-06
	P-19	1.74E-07
	P2-1	1.50E-04
	P2-2	2.45E-05
	average:	4.65E-05

Hydraulic conductivities were calculated from field data using the Bouwer and Rice (1976) method.
Those values in italics are averages from calculations of each lithology
'*' indicates values derived from laboratory run in-situ permeability tests

Average of Flow Rates and Effective Porosity for Lithologic Units
White Oak Haywood County Landfill

Saprolite	Effective Porosity (%)
P2-1	13.0
P2-1	6.0
P2-2	14.5
P-1	15.5 - bedrock well
P-8	14.5
P-8	8.0
P-9	1.0
P-9	16.0
P-14	9.5
P-15	15.5
Average:	**11.4**

PWR	Effective Porosity (%)
P-2	10.0
P-15	10.0
P-18	10.0
Average:	**10.0**

Gneiss	Effective Porosity (%)
Default	**5.0**

Saprolite	Flow Rate (FT/YR)
P-10	18.82
P-11	36.52
P-12	229.33
P-13	0.65
P-16	39.06
GWM-1A	85.89
GWM-2	57.53
GWM-3	37.16
GWM-5A	41.95
GWM-6A	31.38
GWM-8	83.85
Total	**662.13**
Average	**60.19**

Gneiss	Flow Rate (FT/YR)
P-1	672.81
P-3	425.02
P-4	218.12
P-5	189.92
P-6	11.70
P-7	7.60
P-9	22.76
P-14	65.41
P-17	17.50
P-19	1.19
P2-1	325.50
P2-2	30.10
Total	**1987.64**
Average	**165.64**

PWR	Flow Rate (FT/YR)
P-2	20.44
P-15	3.32
P-18	30.80
GWM-7	15.21
Total	**69.77**
Average	**17.44**

NOTE: Effective Porosity values for PWR and fractured gneiss are default values based on porosity of fractured crystalline rocks (Fetter, 1994) and degree of fracturing in core samples.

WHITE OAK HAYWOOD COUNTY LANDFILL
FLOW RATES AND DIRECTIONS

c= 1034646
v = (ki/n)c

Piezometer	Geomorphology	Lithology	Screen Interval	k Permeability (cm/sec)	n Effective Porosity (%)	h Change in Head	d Change in Distance	i=h/d Change/ Distance	v Groundwater flow (Ft./Yr)	Groundwater flow Direction
P-1	ridge	Gneiss	65.0-80.0	1.71E-04	5.00%	33.48	176.08	0.190	672.81	N90W
P-2	draw	PWR	27.0-37.0	1.85E-05	10.00%	15.1	141.41	0.107	20.44	S85W
no slug test → P-3	ridge	Gneiss	52.6-67.6	*4.65E-05*	5.00%	85.62	194.04	0.441	425.02	N16E
not slug tested → P-4	ridge	Gneiss	71.0-81.0	*4.65E-05*	5.00%	54.8	242	0.226	218.12	N23W
P-5	draw	Gneiss	42.3-52.3	4.41E-05	5.00%	35.32	169.71	0.208	189.92	N14W
P-6 questionable	slope	Gneiss	57.5-67.5	2.84E-06	5.00%	38.68	194.32	0.199	11.70	N23W
P-7	slope	Gneiss	32.0-42.0	1.13E-05	5.00%	4.95	152.3	0.033	7.60	N86W
P-9	valley	Gneiss	37.3-47.3	1.35E-05	5.00%	12.18	149.47	0.081	22.76	N86W
P-10	ridge	Saprolite	63.0-73.0	4.84E-05	11.40%	7.81	182.32	0.043	18.82	N48E
P-11	draw	Saprolite	14.0-24.0	4.80E-05	11.40%	10.98	130.99	0.084	36.52	N35W
P-12	draw	Saprolite	8.0-18.0	2.36E-04	11.40%	26.17	244.42	0.107	229.33	N29W
P-13	ridge	Saprolite	86.0-96.0	5.81E-07	11.40%	25.48	205.57	0.124	0.65	N72W
P-14	head of slope	Gneiss	71.3-81.3	*4.65E-05*	5.00%	30.78	453.25	0.068	65.41	N12E
P-15	ridge	PWR	93.0-103.0	2.48E-06	10.00%	22.12	170.93	0.129	3.32	S53E
P-16	slope	Saprolite	32.5-42.5	3.40E-05	11.40%	38.71	305.83	0.127	39.06	S78E
P-17	slope	Gneiss	80.0-90.0	1.52E-06	5.00%	106.65	191.65	0.556	17.50	N72E
P-18	slope	PWR	31.0-41.0	*1.05E-05*	10.00%	73.52	259.06	0.284	30.80	S69E
P-19	slope	Gneiss	87.5-97.5	1.74E-07	5.00%	86.09	260.36	0.331	1.19	N22E
P2-1	head of slope	Gneiss	37.5-52.5	1.50E-04	5.00%	7.95	75.81	0.105	325.50	N51W
P2-2	head of slope	Gneiss	32.3-47.3	2.45E-05	5.00%	5.93	99.89	0.059	30.10	N51W
GWM-1A	slope	Saprolite	10.4-25.4	*5.54E-05*	11.40%	21.87	128.12	0.171	85.89	N28E
GWM-2	draw	Saprolite	19.9-34.9	*5.54E-05*	11.40%	33.57	293.60	0.114	57.53	N03W
GWM-3	draw	Saprolite	5.6-20.6	*5.54E-05*	11.40%	21.59	292.33	0.074	37.16	N38W
GWM-4A	slope	Gneiss	85.2-100.2	*4.65E-05*	5.00%	36.29	196.20	0.185	178.16	N27E
GWM-5A	draw	Saprolite	4.5-19.5	*5.54E-05*	11.40%	28.24	338.68	0.083	41.95	N26W
GWM-6A	draw	Saprolite	3.4-18.4	*5.54E-05*	11.40%	27.73	444.69	0.062	31.38	N47W
GWM-7	ridge	PWR	62.3-82.3	*1.05E-05*	10.00%	31.37	223.84	0.140	15.21	N76E
GWM-8	draw	Saprolite	31.0-41.0	*5.54E-05*	11.40%	28.77	172.64	0.167	83.85	N27E

Note: **Italicized numbers above are averaged values per lithology.**

Bouwer and Rice (P-1)

Bail-Down Test Piezometer P-1

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 73.37
Depth to Water (feet) at to **(H)** 75.05
Initial Change in Head (feet), **(yo)** 1.68

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
9:50:26	0	0	0	75.05	1.68
9:50:34	00:08	8	8	74.95	1.58
9:50:36	00:02	2	10	74.85	1.48
9:50:38	00:02	2	12	74.80	1.43
9:50:47	00:09	9	21	74.60	1.23
9:50:50	00:03	3	24	74.55	1.18
9:50:54	00:04	4	28	74.50	1.13
9:50:57	00:03	3	31	74.45	1.08
9:50:59	00:02	2	33	74.40	1.03
9:51:02	00:03	3	36	74.35	0.98
9:51:06	00:04	4	40	74.30	0.93
9:51:11	00:05	5	45	74.25	0.88
9:51:20	00:09	9	54	74.20	0.83
9:51:30	00:10	10	64	74.15	0.78
9:52:07	00:37	37	101	74.10	0.73
9:53:48	01:41	101	202	74.05	0.68
9:57:04	03:16	196	398	74.00	0.63
10:07:16	10:12	612	1010	73.95	0.58
10:35:47	28:31	1711	2721	73.91	0.54

Bouwer and Rice (P-1)

Bail-Down Calculations Piezometer P-1

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

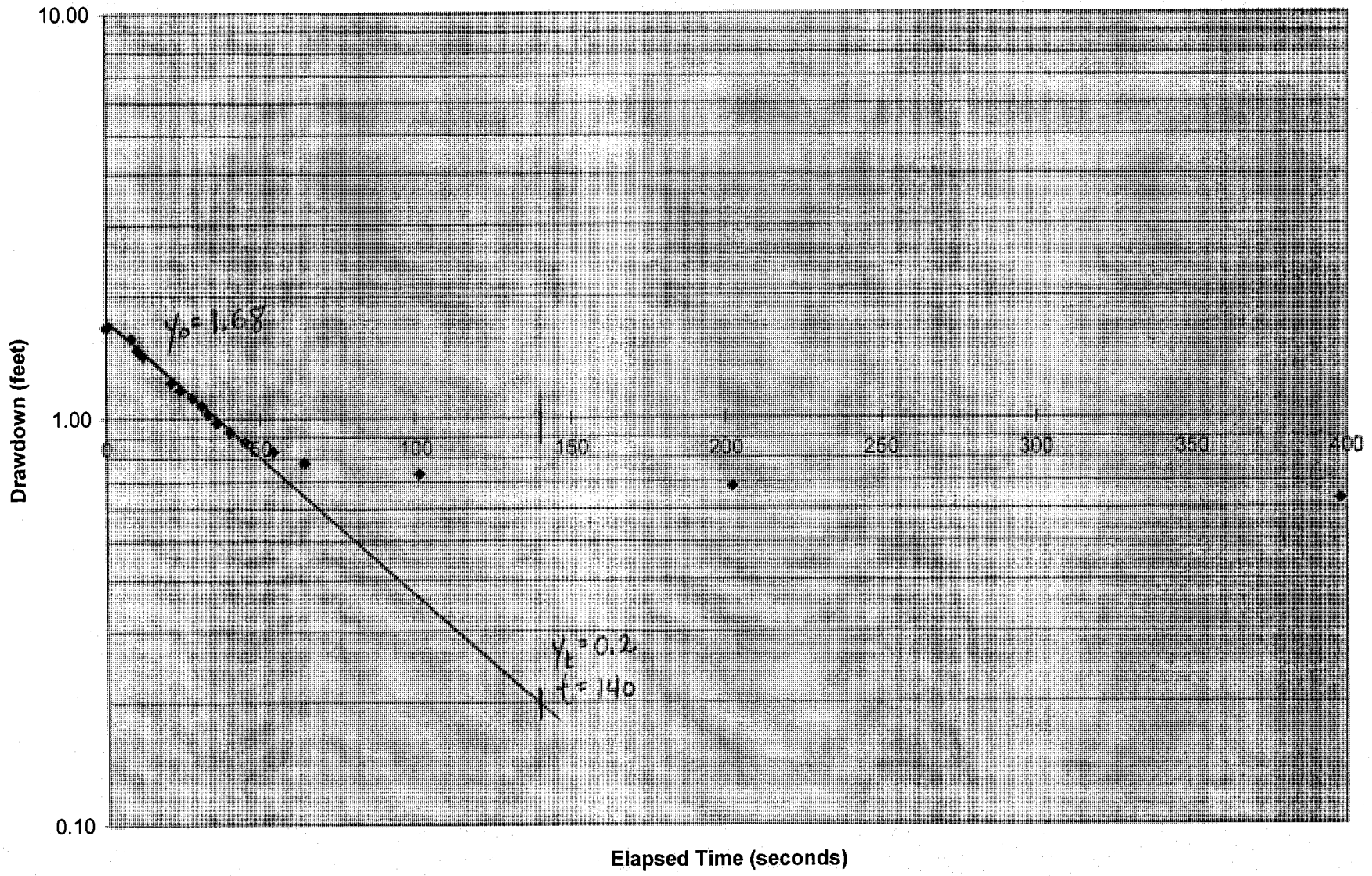
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.1039	**rc**	radius of the well casing (feet)
0.1406	**rw**	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
8.96	**Le**	the open section of the well through which water can enter (feet)
1.68	**yo**	drawdown at time = 0 (seconds)
0.2	**yt**	drawdown time at t = t (seconds)
140	**t**	elapsed time between yo and yt
3.4	**A**	dimensionless parameter
0.6	**B**	dimensionless parameter
8.96	**Lw**	initial water column in well

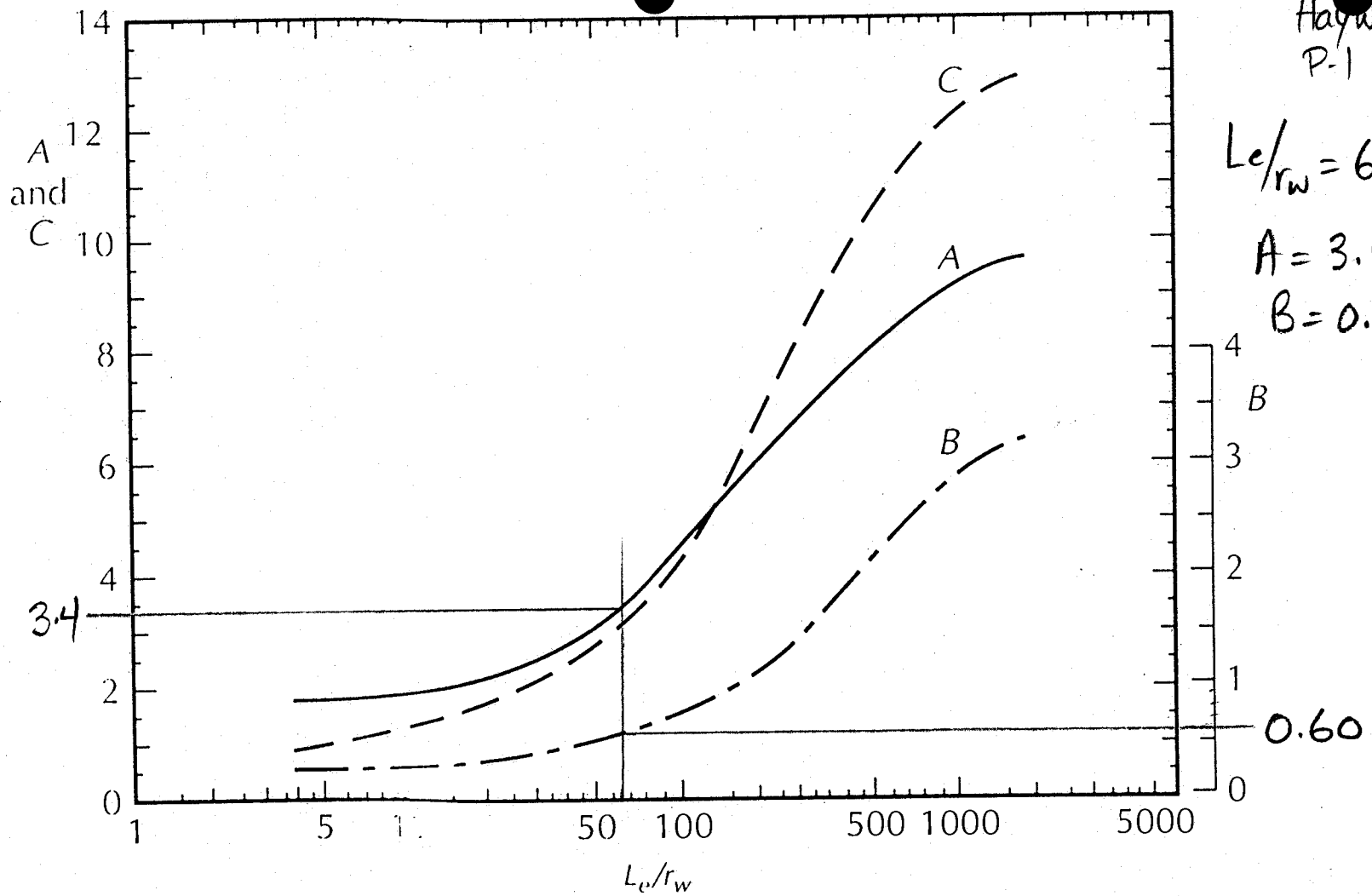
ln(Re/rw)= 0.6121

K=	5.6E-06	feet/sec
	0.000171	cm/sec
	176.76	feet/year
	53.88	meter/year

P-1 Bail-Down Test



Haywood
P-1



$L_e/r_w = 63.73$

$A = 3.4$

$B = 0.60$

FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-2)

Bail-Down Test Piezometer P-2

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 31.48
Depth to Water (feet) at to **(H)** 37.2
Initial Change in Head (feet), **(yo)** 5.72

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
10:23:19	0	0	0	37.20	5.72
10:23:23	00:04	4	4	37.15	5.67
10:23:27	00:04	4	8	37.10	5.62
10:23:30	00:03	3	11	37.05	5.57
10:23:34	00:04	4	15	37.00	5.52
10:23:43	00:09	9	24	36.90	5.42
10:23:53	00:10	10	34	36.80	5.32
10:24:02	00:09	9	43	36.70	5.22
10:24:13	00:11	11	54	36.60	5.12
10:24:25	00:12	12	66	36.50	5.02
10:24:38	00:13	13	79	36.40	4.92
10:24:53	00:15	15	94	36.30	4.82
10:25:07	00:14	14	108	36.20	4.72
10:25:22	00:15	15	123	36.10	4.62
10:25:37	00:15	15	138	36.00	4.52
10:25:54	00:17	17	155	35.90	4.42
10:26:11	00:17	17	172	35.80	4.32
10:26:26	00:15	15	187	35.70	4.22
10:26:52	00:26	26	213	35.60	4.12
10:27:15	00:23	23	236	35.5	4.02
10:27:36	00:21	21	257	35.4	3.92
10:27:55	00:19	19	276	35.3	3.82
10:28:13	00:18	18	294	35.2	3.72
10:28:30	00:17	17	311	35.1	3.62
10:28:53	00:23	23	334	35	3.52
10:29:09	00:16	16	350	34.9	3.42
10:29:33	00:24	24	374	34.8	3.32
10:30:00	00:27	27	401	34.7	3.22
10:32:42	00:24	24	425	34.6	3.12
10:33:07	00:25	25	450	34.5	3.02
10:33:27	00:20	20	470	34.4	2.92
10:33:48	00:21	21	491	34.3	2.82
10:34:02	00:14	14	505	34.2	2.72
10:34:17	00:15	15	520	34.1	2.62
10:34:34	00:17	17	537	34	2.52
10:34:56	00:22	22	559	33.9	2.42
10:35:10	00:14	14	573	33.8	2.32
10:35:28	00:18	18	591	33.7	2.22
10:35:48	00:20	20	611	33.6	2.12
10:36:07	00:19	19	630	33.5	2.02

10:36:28	00:21	21	651	33.4	1.92
10:36:47	00:19	19	670	33.3	1.82
10:37:09	00:22	22	692	33.2	1.72
10:37:30	00:21	21	713	33.1	1.62
10:37:54	00:24	24	737	33	1.52
10:38:16	00:22	22	759	32.9	1.42
10:38:43	00:27	27	786	32.8	1.32
10:39:08	00:25	25	811	32.7	1.22
10:39:29	00:21	21	832	32.6	1.12
10:39:46	00:17	17	849	32.5	1.02
10:40:05	00:19	19	868	32.4	0.92
10:40:28	00:23	23	891	32.3	0.82
10:40:56	00:28	28	919	32.2	0.72
10:41:44	00:48	48	967	32.1	0.62
10:42:45	01:01	61	1028	32	0.52
10:44:24	01:39	99	1127	31.9	0.42

Bouwer and Rice (P-2)

Bail-Down Calculations Piezometer P-2

Project Name: White Oak Landfill - Haywood County

Lithology: Clayey Silt and Partially Weathered Rock

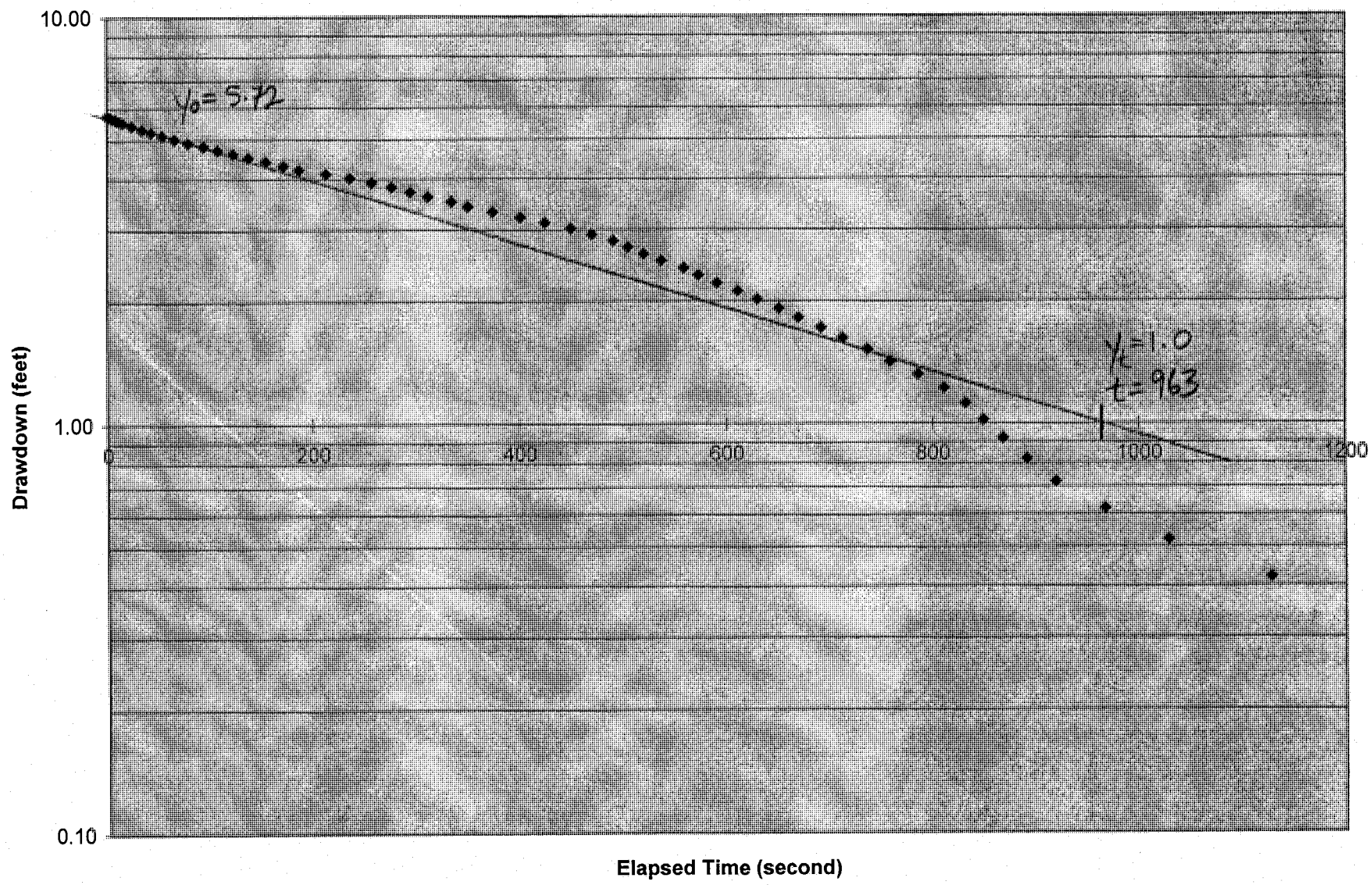
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.1928	**rc**	radius of the well casing (feet)
0.3281	**rw**	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
8.97	**Le**	the open section of the well through which water can enter (feet)
5.72	**yo**	drawdown at time = 0 (seconds)
1	**yt**	drawdown time at t = t (seconds)
963	**t**	elapsed time between yo and yt
2.4	**A**	dimensionless parameter
0.4	**B**	dimensionless parameter
8.97	**Lw**	initial water column in well

ln(Re/rw)= 0.7128

K=	2.67E-06	feet/sec
	8.15E-05	cm/sec
	84.35	feet/year
	25.71	meter/year

P-2 Bail-Down Test



Hay-wood
P-2

$L_e/r_w = 27.34$

$A = 2.4$
$B = 0.40$

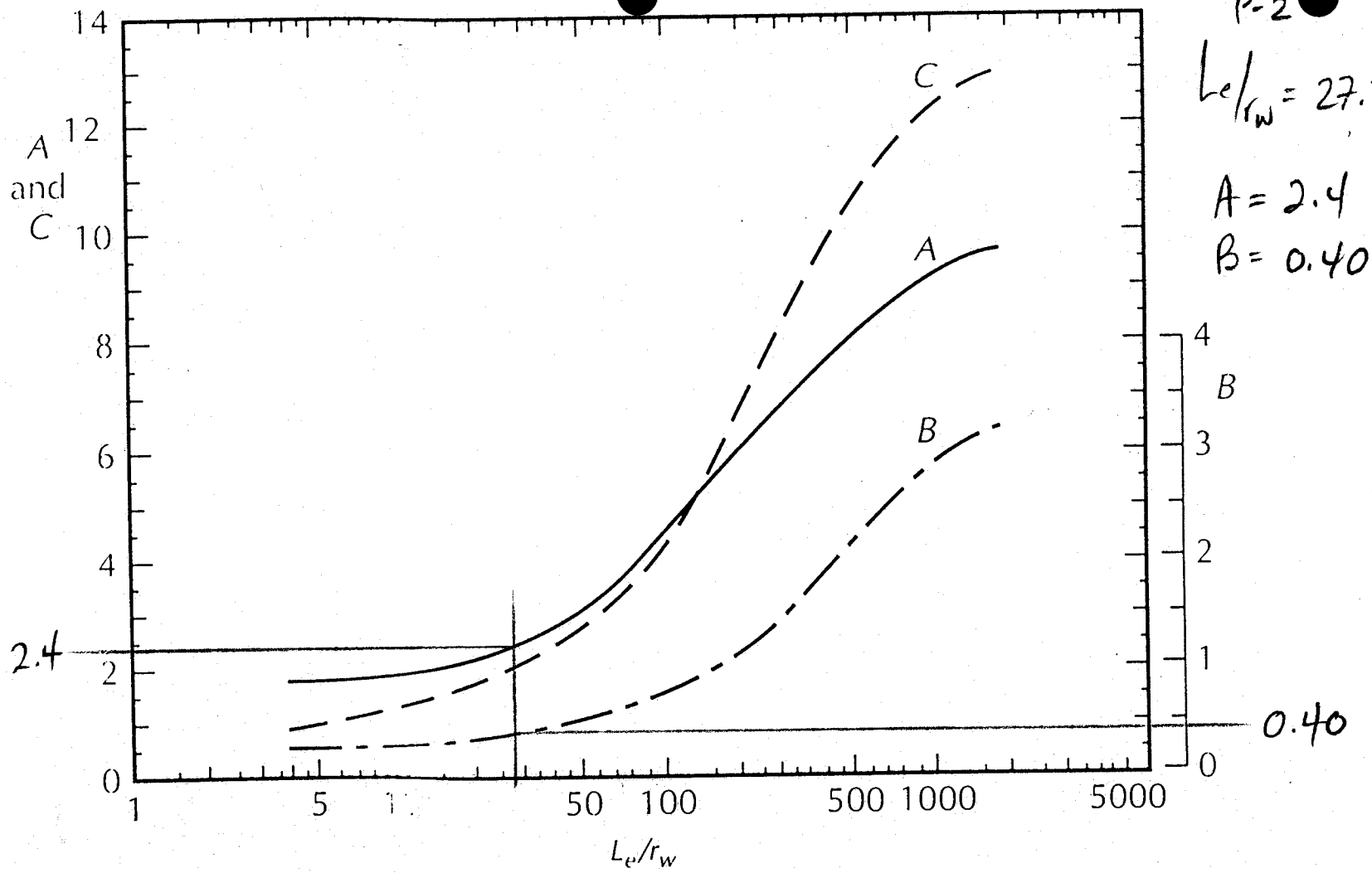


FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-5)

Bail-Down Test Piezometer P-5

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 27.05
Depth to Water (feet) at to **(H)** 38.2
Initial Change in Head (feet), **(yo)** 11.15

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
15:43:55	0	0	0	38.20	11.15
15:44:16	00:21	21	21	37.40	10.35
15:44:18	00:02	2	23	37.20	10.15
15:44:20	00:02	2	25	37.00	9.95
15:44:25	00:05	5	30	36.90	9.85
15:44:28	00:03	3	33	36.60	9.55
15:44:33	00:05	5	38	36.40	9.35
15:44:37	00:04	4	42	36.20	9.15
15:44:44	00:07	7	49	36.00	8.95
15:44:47	00:03	3	52	35.80	8.75
15:44:52	00:05	5	57	35.60	8.55
15:44:56	00:04	4	61	35.40	8.35
15:45:00	00:04	4	65	35.20	8.15
15:45:07	00:07	7	72	35.00	7.95
15:45:14	00:07	7	79	34.80	7.75
15:45:18	00:04	4	83	34.60	7.55
15:45:21	00:03	3	86	34.40	7.35
15:45:28	00:07	7	93	34.20	7.15
15:45:33	00:05	5	98	34.00	6.95
15:45:40	00:07	7	105	33.80	6.75
15:45:45	00:05	5	110	33.60	6.55
15:45:52	00:07	7	117	33.40	6.35
15:45:58	00:06	6	123	33.20	6.15
15:46:04	00:06	6	129	33.00	5.95
15:46:12	00:08	8	137	32.80	5.75
15:46:19	00:07	7	144	32.60	5.55
15:46:26	00:07	7	151	32.40	5.35
15:46:33	00:07	7	158	32.20	5.15
15:46:44	00:11	11	169	32.00	4.95
15:46:52	00:08	19	188	31.80	4.75
15:47:02	00:10	10	198	31.60	4.55
15:47:12	00:10	10	208	31.20	4.15
15:47:32	00:20	20	228	31.00	3.95
15:47:39	00:07	7	235	30.80	3.75
15:47:50	00:11	11	246	30.60	3.55
15:48:01	00:11	11	257	30.40	3.35
15:48:41	00:40	40	297	29.80	2.75
15:48:57	00:16	16	313	29.60	2.55
15:49:20	00:23	23	336	29.40	2.35
15:49:33	00:13	13	349	29.20	2.15

15:49:55	00:22	22	371	29.00	1.95
15:50:21	00:26	26	397	28.80	1.75
15:50:45	00:24	24	421	28.60	1.55
15:51:18	00:33	33	454	28.40	1.35
15:51:57	00:39	39	493	28.20	1.15
15:52:45	00:48	48	541	28.00	0.95

Bouwer and Rice (P-5)

Bail-Down Calculations Piezometer P-5

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

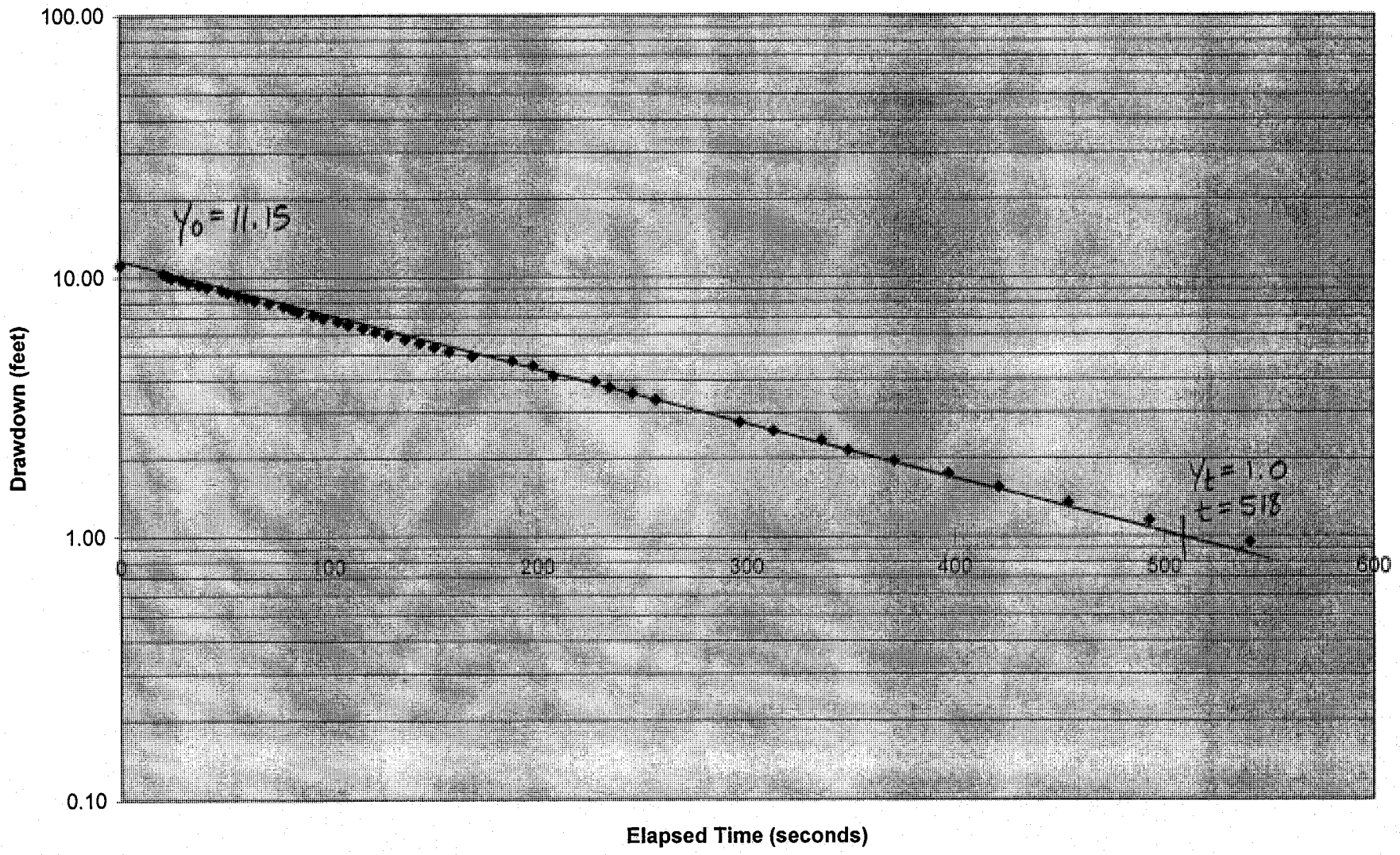
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.1039	**rc**	radius of the well casing (feet)
0.1406	**rw**	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	**Le**	the open section of the well through which water can enter (feet)
11.15	**yo**	drawdown at time = 0 (seconds)
1	**yt**	drawdown time at t = t (seconds)
518	**t**	elapsed time between yo and yt
3.6	**A**	dimensionless parameter
0.6	**B**	dimensionless parameter
16.94	**Lw**	initial water column in well

ln(Re/rw)= 0.5752

K=	1.45E-06	feet/sec
	4.41E-05	cm/sec
	45.58	feet/year
	13.89	meter/year

Bail-Down test P-5



Haywood
P-5

$l_e/r_w = 71.12$

A = 3.6
B = 0.60

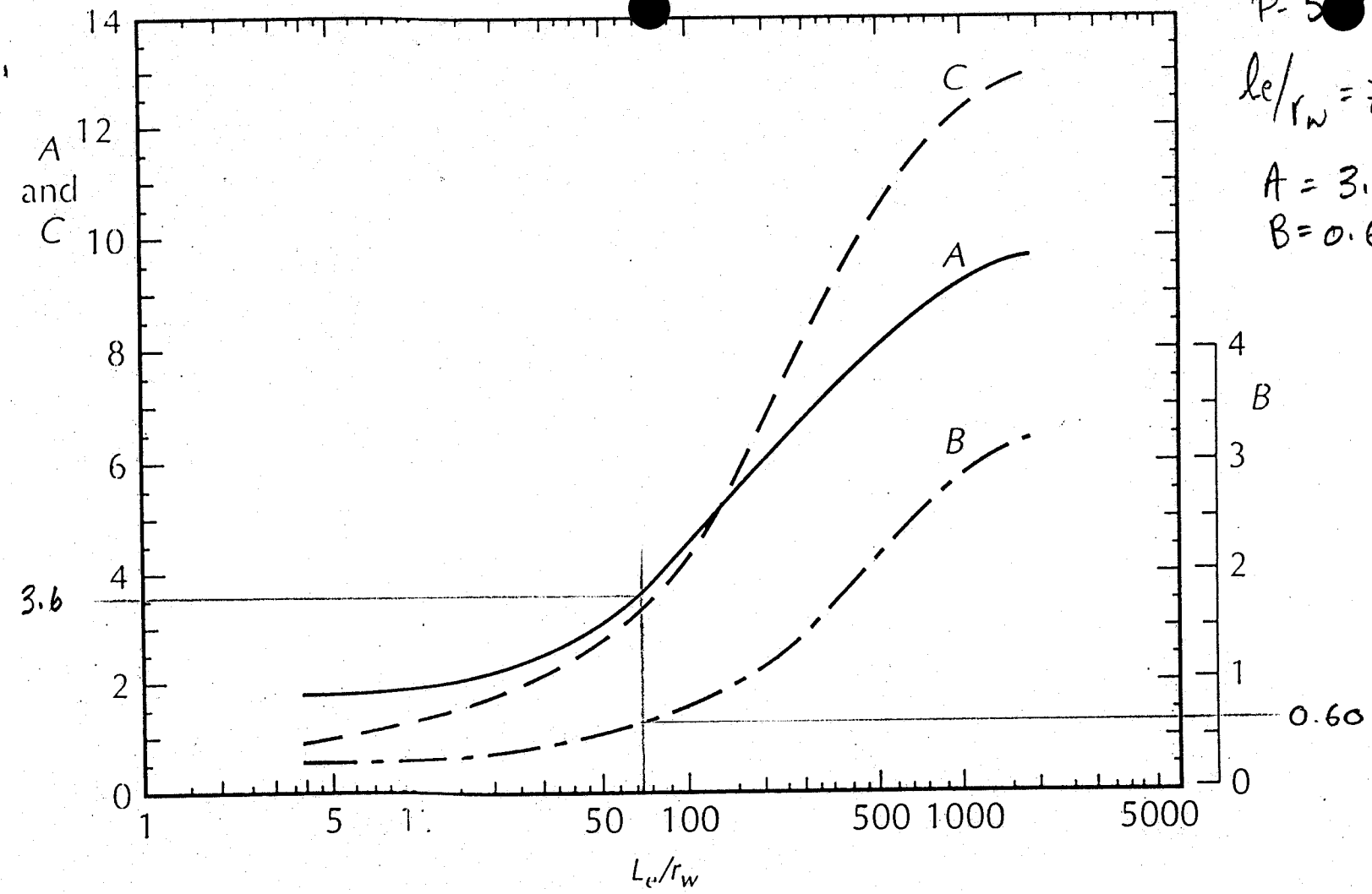


FIGURE 7.25 Dimensionless parameters *A*, *B*, and *C* plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-6)

Bail-Down Test Piezometer P-6

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 58.44
Depth to Water (feet) at to **(H)** 58.65
Initial Change in Head (feet), **(yo)** 0.21

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
14:53:09	0	0	0	58.65	0.21
14:53:35	00:26	26	26	58.63	0.19
14:54:40	01:05	65	91	58.62	0.18
14:56:24	01:44	104	195	58.61	0.17
14:58:44	02:20	140	335	58.60	0.16
15:01:15	04:51	291	486	58.59	0.15
15:03:58	02:43	183	669	58.58	0.14
15:08:37	04:39	279	948	58.57	0.13
15:13:26	04:49	289	1237	58.56	0.12
15:27:54	14:28	868	2105	58.55	0.11
15:59:20	31:26	1886	3991	58.52	0.08
16:37:45	38:25	2305	6296	58.52	0.08

Bouwer and Rice (P-6)

Bail-Down Calculations Piezometer P-6

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.0833	rc	radius of the well casing (feet)
0.1406	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
9.5	Le	the open section of the well through which water can enter (feet)
0.175	yo	drawdown at time = 0 (seconds)
0.05	yt	drawdown time at t = t (seconds)
2897	t	elapsed time between yo and yt
3.5	A	dimensionless parameter
0.55	B	dimensionless parameter
12.11	Lw	initial water column in well

ln(Re/rw)= 0.5895

K=	9.31E-08	feet/sec
	2.84E-06	cm/sec
	2.94	feet/year
	0.89	meter/year

TD 67.5'

SI 58-67.5

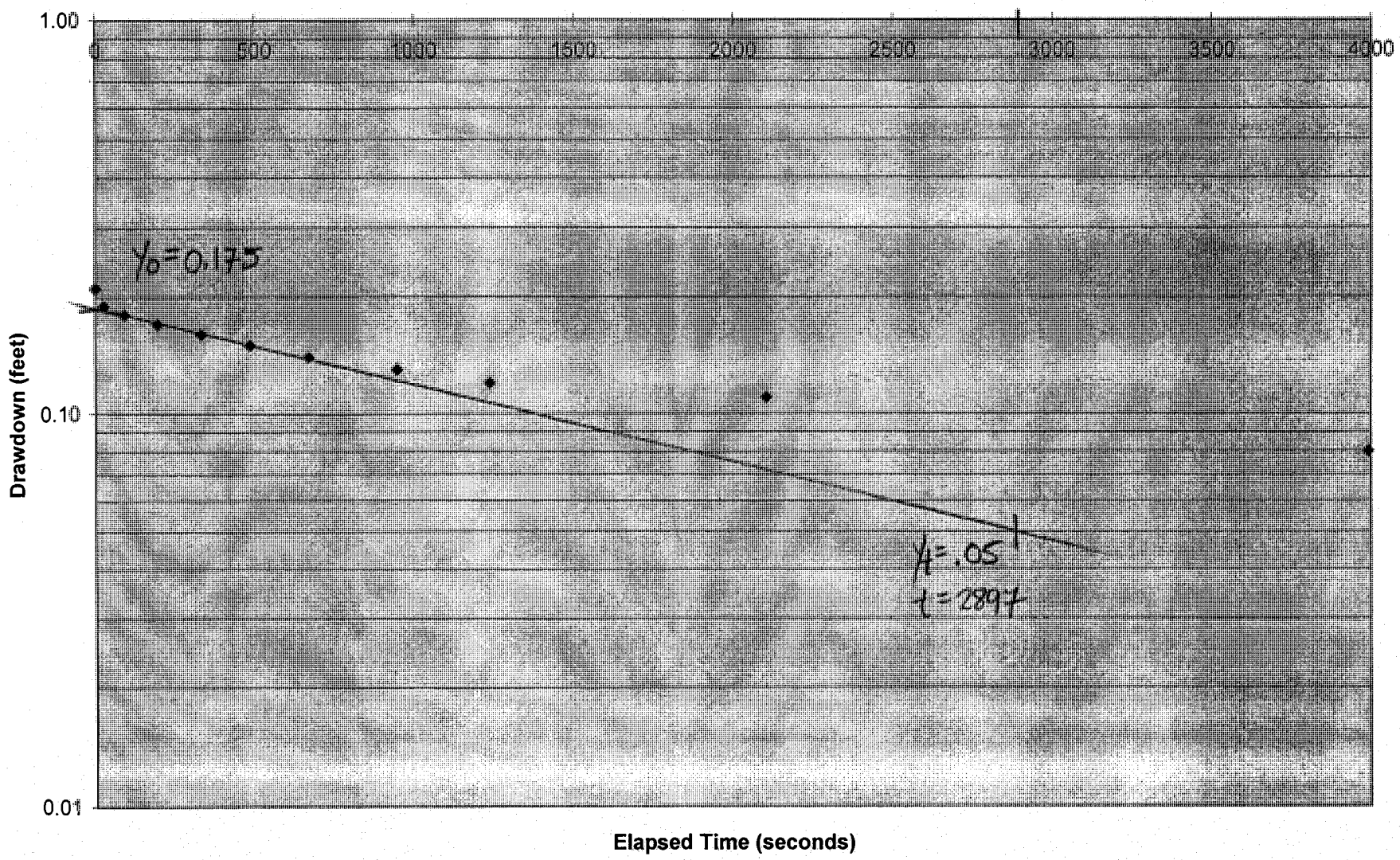
DTW 58.44

initial w/c 9.06'

Le s/b 9.06

Lw s/b 9.06

Bail-Down test P-6



Haywood
P.6

$l_e/r_w = 67.57$

A = 3.5
B = .55

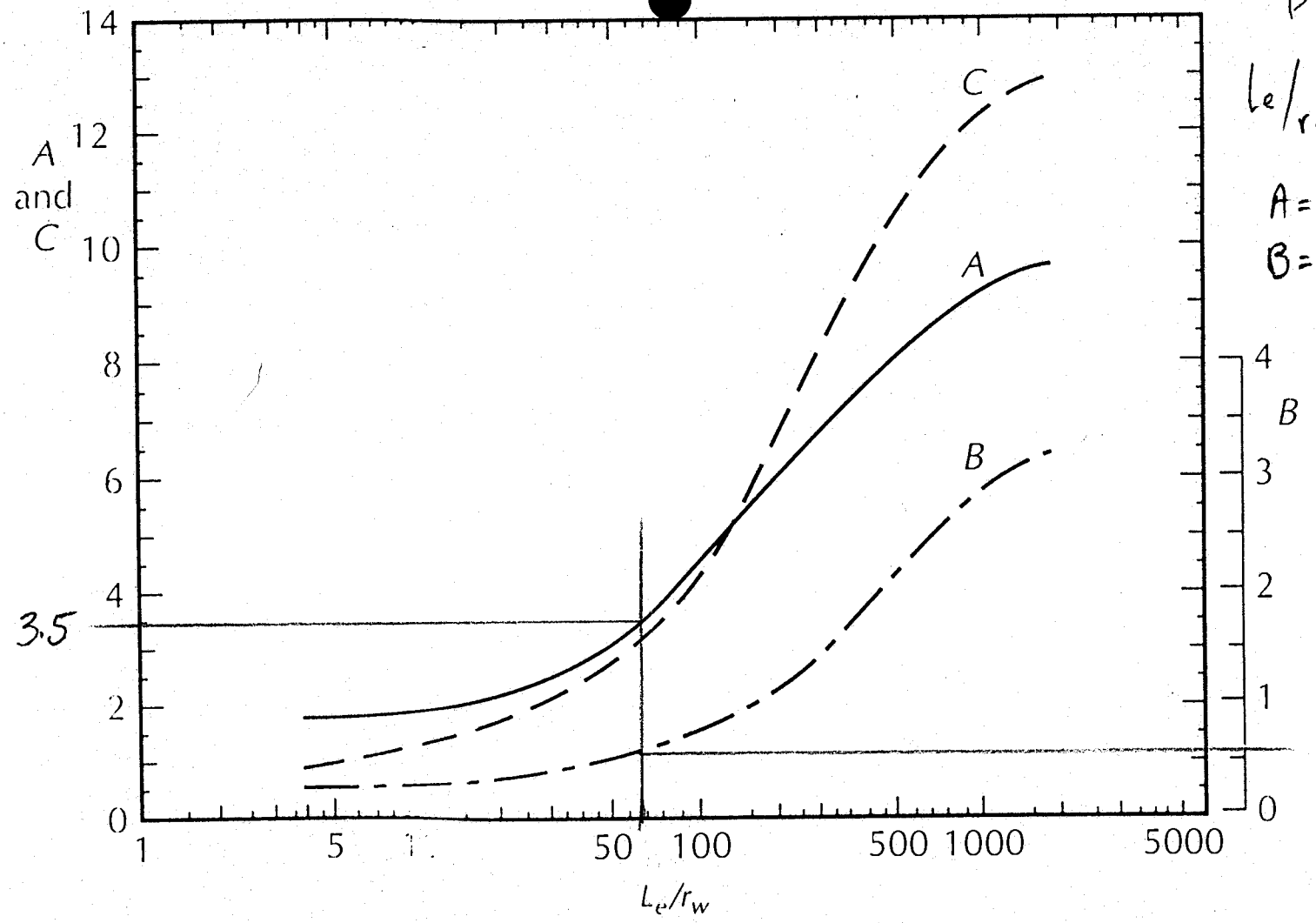


FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-7)

Bail-Down Test Piezometer P-7

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 33.92
Depth to Water (feet) at to **(H)** 35.13
Initial Change in Head (feet), **(yo)** 1.21

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
11:01:27	0	0	0	35.13	1.21
11:01:32	00:05	5	5	35.12	1.20
11:01:38	00:06	6	11	35.11	1.19
11:01:45	00:07	7	18	35.10	1.18
11:02:08	00:23	23	41	35.08	1.16
11:02:26	00:41	41	59	35.06	1.14
11:02:36	00:10	10	69	35.04	1.12
11:02:54	00:18	18	87	35.02	1.10
11:03:08	00:14	14	101	35.00	1.08
11:03:21	00:13	13	114	34.98	1.06
11:03:37	00:16	16	130	34.96	1.04
11:03:50	00:13	13	143	34.94	1.02
11:04:09	00:19	19	162	34.92	1.00
11:04:27	00:18	18	180	34.90	0.98
11:04:44	00:17	17	197	34.88	0.96
11:05:04	00:20	20	217	34.86	0.94
11:05:20	00:16	16	233	34.84	0.92
11:05:37	00:17	17	250	34.82	0.90
11:05:52	00:15	15	265	34.80	0.88
11:06:08	00:16	16	281	34.78	0.86
11:06:26	00:18	18	299	34.76	0.84
11:06:38	00:12	12	311	34.74	0.82
11:07:09	00:31	31	342	34.70	0.78
11:07:31	00:22	22	364	34.68	0.76
11:07:42	00:11	11	375	34.66	0.74
11:08:00	00:18	18	393	34.64	0.72
11:08:18	00:18	18	411	34.62	0.70
11:08:33	00:15	15	426	34.60	0.68
11:08:49	00:16	16	442	34.58	0.66
11:09:01	00:12	12	454	34.56	0.64
11:09:16	00:15	15	469	34.54	0.62
11:09:25	00:09	9	478	34.52	0.60
11:09:35	00:10	10	488	34.50	0.58
11:09:46	00:11	11	499	34.48	0.56
11:09:56	00:10	10	509	34.46	0.54
11:10:06	00:10	10	519	34.44	0.52
11:10:16	00:10	10	529	34.42	0.50
11:10:27	00:11	11	540	34.40	0.48
11:10:38	00:11	11	551	34.38	0.46
11:10:46	00:08	8	559	34.36	0.44

Bouwer and Rice (P-7)

11:10:58	00:12	12	571	34.34	0.42
11:11:08	00:10	10	581	34.34	0.42
11:11:22	00:14	14	595	34.32	0.40
11:11:32	00:10	10	605	34.30	0.38
11:11:43	00:11	11	616	34.28	0.36
11:11:55	00:12	12	628	34.26	0.34
11:12:08	00:13	13	641	34.24	0.32
11:12:24	00:16	16	657	34.22	0.30
11:12:38	00:14	14	671	34.2	0.28
11:12:50	00:12	12	683	34.18	0.26
11:13:04	00:14	14	697	34.16	0.24
11:13:17	00:13	13	710	34.14	0.22
11:13:30	00:13	13	723	34.12	0.20
11:13:45	00:15	15	738	34.1	0.18
11:14:00	00:15	15	753	34.08	0.16
11:14:17	00:17	17	770	34.06	0.14
11:14:34	00:17	17	787	34.04	0.12
11:14:47	00:13	13	800	34.02	0.10
11:15:04	00:17	17	817	34	0.08
11:15:27	00:23	23	840	33.98	0.06
11:15:50	00:23	23	863	33.96	0.04
11:16:11	00:21	21	884	33.92	0.00
11:16:36	00:25	25	909	33.9	-0.02
11:16:49	00:13	13	922	33.89	-0.03
11:17:02	00:13	13	935	33.88	-0.04
11:17:17	00:15	15	950	33.87	-0.05
11:17:32	00:15	15	965	33.86	-0.06
11:17:43	00:11	11	976	33.85	-0.07
11:17:52	00:09	9	985	33.84	-0.08
11:18:25	00:33	33	1018	33.82	-0.10
11:18:43	00:18	18	1036	33.81	-0.11
11:18:56	00:13	13	1049	33.8	-0.12
11:19:27	00:31	31	1080	33.78	-0.14
11:19:38	00:11	11	1091	33.77	-0.15
11:20:09	00:31	31	1122	33.76	-0.16
11:20:26	00:17	17	1139	33.75	-0.17

Bouwer and Rice (P-7)

Bail-Down Calculations Piezometer P-7

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

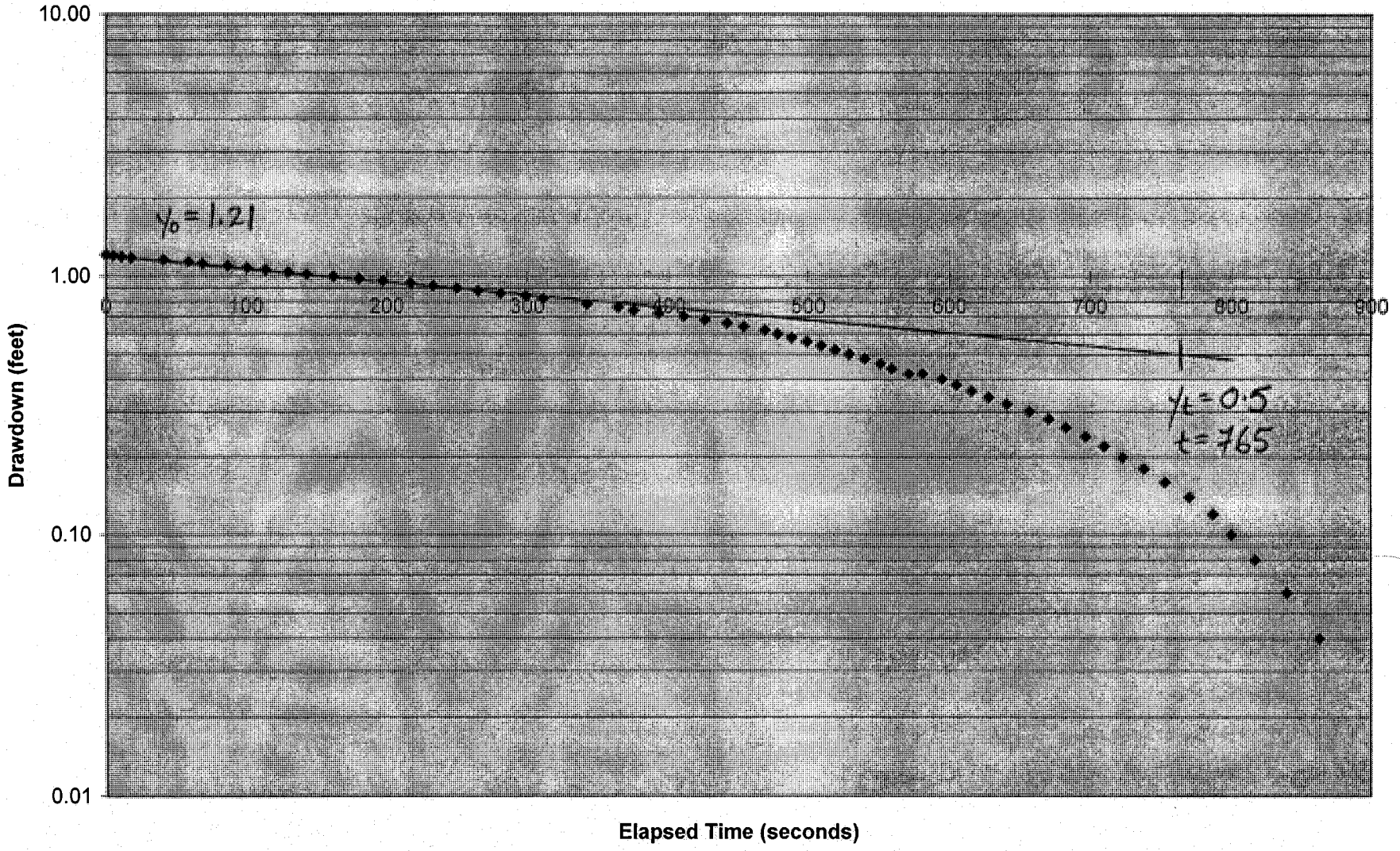
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.1039	**rc**	radius of the well casing (feet)
0.1406	**rw**	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	**Le**	the open section of the well through which water can enter (feet)
1.21	**yo**	drawdown at time = 0 (seconds)
0.5	**yt**	drawdown time at t = t (seconds)
765	**t**	elapsed time between yo and yt
3.6	**A**	dimensionless parameter
0.6	**B**	dimensionless parameter
10.71	**Lw**	initial water column in well

ln(Re/rw)= 0.5959

K=	3.72E-07	feet/sec
	1.13E-05	cm/sec
	11.72	feet/year
	3.57	meter/year

Bail-Down test P-7



Hayward
P-7

$l_e/r_w = 71.12$

A = 3.6
B = 0.60

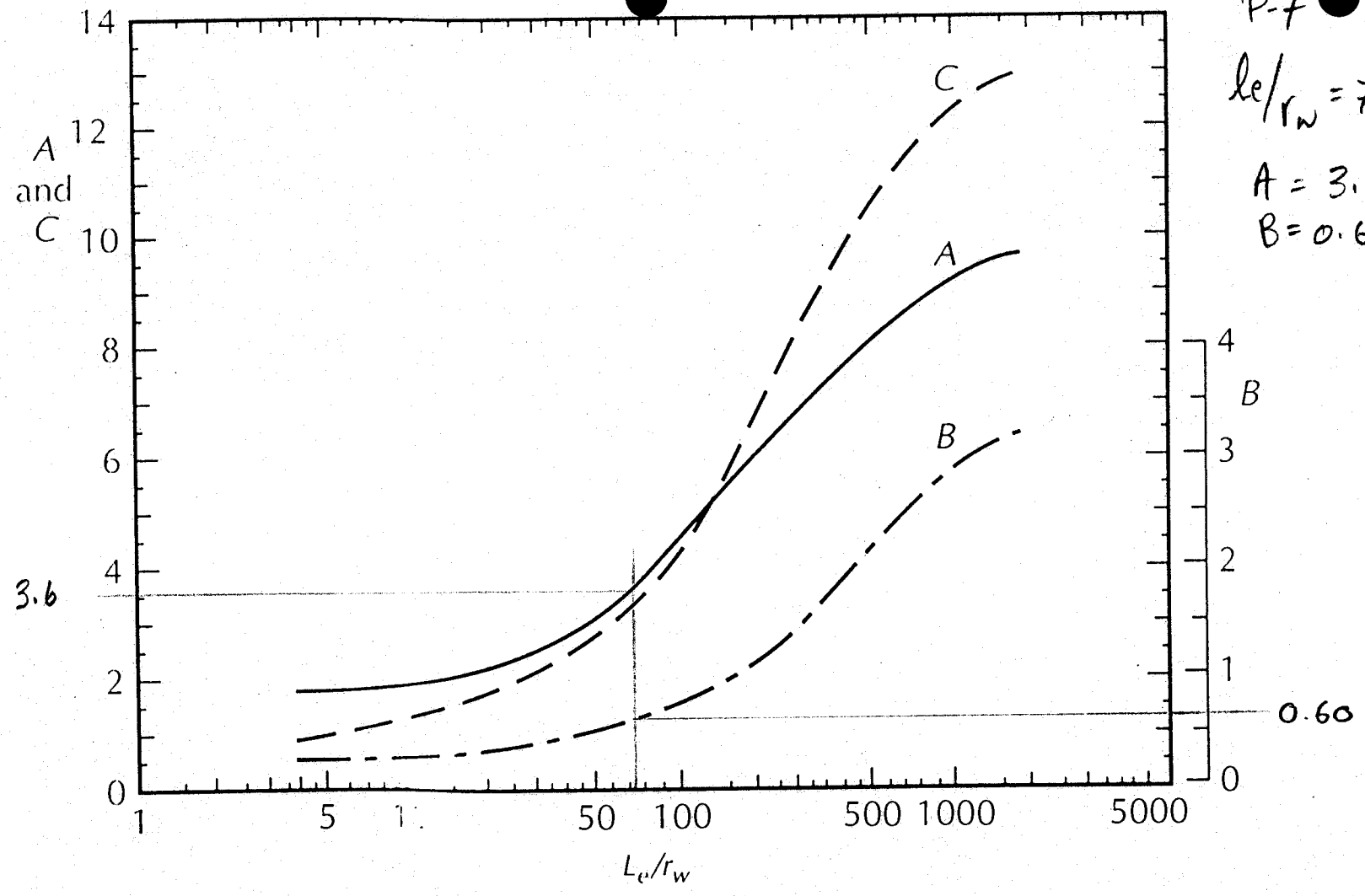


FIGURE 7.25 Dimensionless parameters *A*, *B*, and *C* plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-9)

Bail-Down Test Piezometer P-9

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 36.00
Depth to Water (feet) at to **(H)** 36.14
Initial Change in Head (feet), **(yo)** 0.14

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
8:53:33	0	0	0	36.14	0.14
8:53:54	00:21	21	21	36.13	0.13
8:54:20	00:26	26	47	36.12	0.12
8:55:06	00:46	46	93	36.11	0.11
8:55:56	00:50	50	143	36.10	0.10
8:56:50	01:44	104	197	36.09	0.09
8:58:38	01:48	108	305	36.08	0.08
9:00:56	02:18	138	443	36.07	0.07
9:03:51	02:55	195	638	36.06	0.06
9:06:20	02:29	149	787	36.05	0.05
9:09:58	03:38	218	1005	36.04	0.04
9:13:44	03:46	226	1231	36.03	0.03

Bouwer and Rice (P-9)

Bail-Down Calculations Piezometer P-9

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

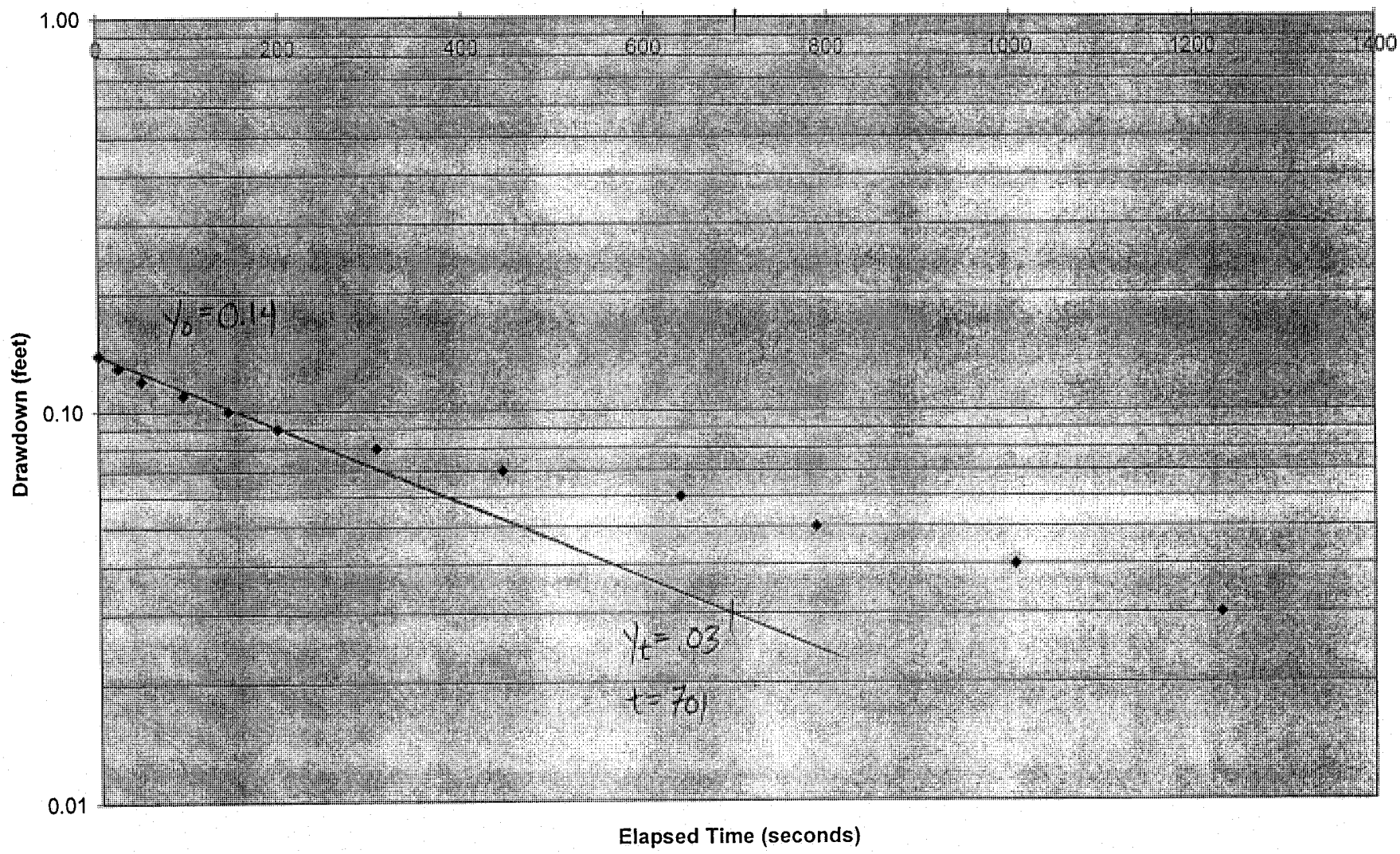
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.0833	rc	radius of the well casing (feet)
0.1406	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	Le	the open section of the well through which water can enter (feet)
0.14	yo	drawdown at time = 0 (seconds)
0.03	yt	drawdown time at t = t (seconds)
701	t	elapsed time between yo and yt
3.6	A	dimensionless parameter
0.6	B	dimensionless parameter
14.44	Lw	initial water column in well

ln(Re/rw)= 0.5820

K=	4.44E-07	feet/sec
	1.35E-05	cm/sec
	13.99	feet/year
	4.27	meter/year

Bail-Down test P-9



Haywood
P-9
$l_e/r_w = 71.12$
A = 3.6
B = 0.60

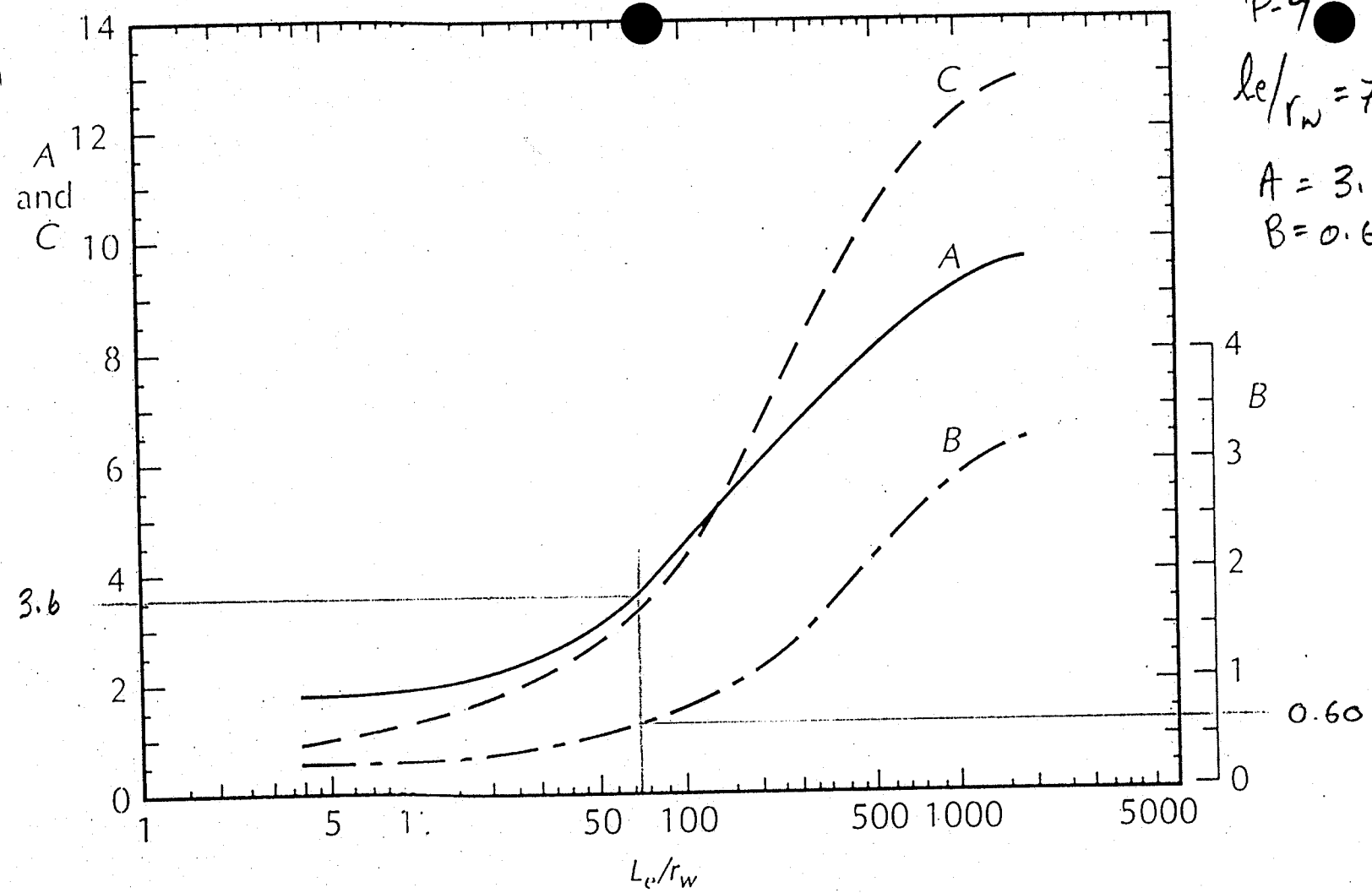


FIGURE 7.25 Dimensionless parameters *A*, *B*, and *C* plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-10)

Bail-Down Test Piezometer P-10

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 48.04
Depth to Water (feet) at to **(H)** 50.45
Initial Change in Head (feet), **(yo)** 2.41

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
10:03:23	0	0	0	50.45	2.41
10:03:31	00:08	8	8	50.36	2.32
10:03:33	00:02	2	10	50.31	2.27
10:03:36	00:03	3	13	50.27	2.23
10:03:56	00:20	20	33	49.90	1.86
10:03:58	00:22	22	35	49.85	1.81
10:04:01	00:03	3	38	49.80	1.76
10:04:05	00:04	4	42	49.75	1.71
10:04:13	00:08	8	50	49.65	1.61
10:04:18	00:05	5	55	49.60	1.56
10:04:22	00:04	4	59	49.55	1.51
10:04:29	00:07	7	66	49.50	1.46
10:04:33	00:04	4	70	49.45	1.41
10:04:40	00:07	7	77	49.40	1.36
10:04:47	00:07	7	84	49.35	1.31
10:04:56	00:09	9	93	49.30	1.26
10:05:06	00:10	10	103	49.25	1.21
10:05:16	00:10	10	113	49.20	1.16
10:05:28	00:12	12	125	49.15	1.11
10:05:43	00:15	15	140	49.10	1.06
10:06:02	00:19	19	159	49.05	1.01
10:06:30	00:28	28	187	49.00	0.96
10:07:08	00:38	38	225	48.95	0.91
10:08:03	00:55	55	280	48.80	0.76
10:09:54	01:51	111	391	48.85	0.81
10:10:28	00:34	34	425	48.84	0.80
10:10:57	00:29	2	427	48.83	0.79
10:11:55	00:58	58	485	48.82	0.78
10:12:50	00:55	55	540	48.81	0.77
10:13:43	00:53	53	593	48.80	0.76
10:15:18	01:35	95	688	48.79	0.75
10:19:51	04:33	273	961	48.76	0.72
10:25:56	06:05	365	1326	48.72	0.68
10:35:18	09:22	562	1888	48.68	0.64
10:43:38	08:20	500	2388	48.65	0.61

Bouwer and Rice (P-10)

Bail-Down Calculations Piezometer P-10

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

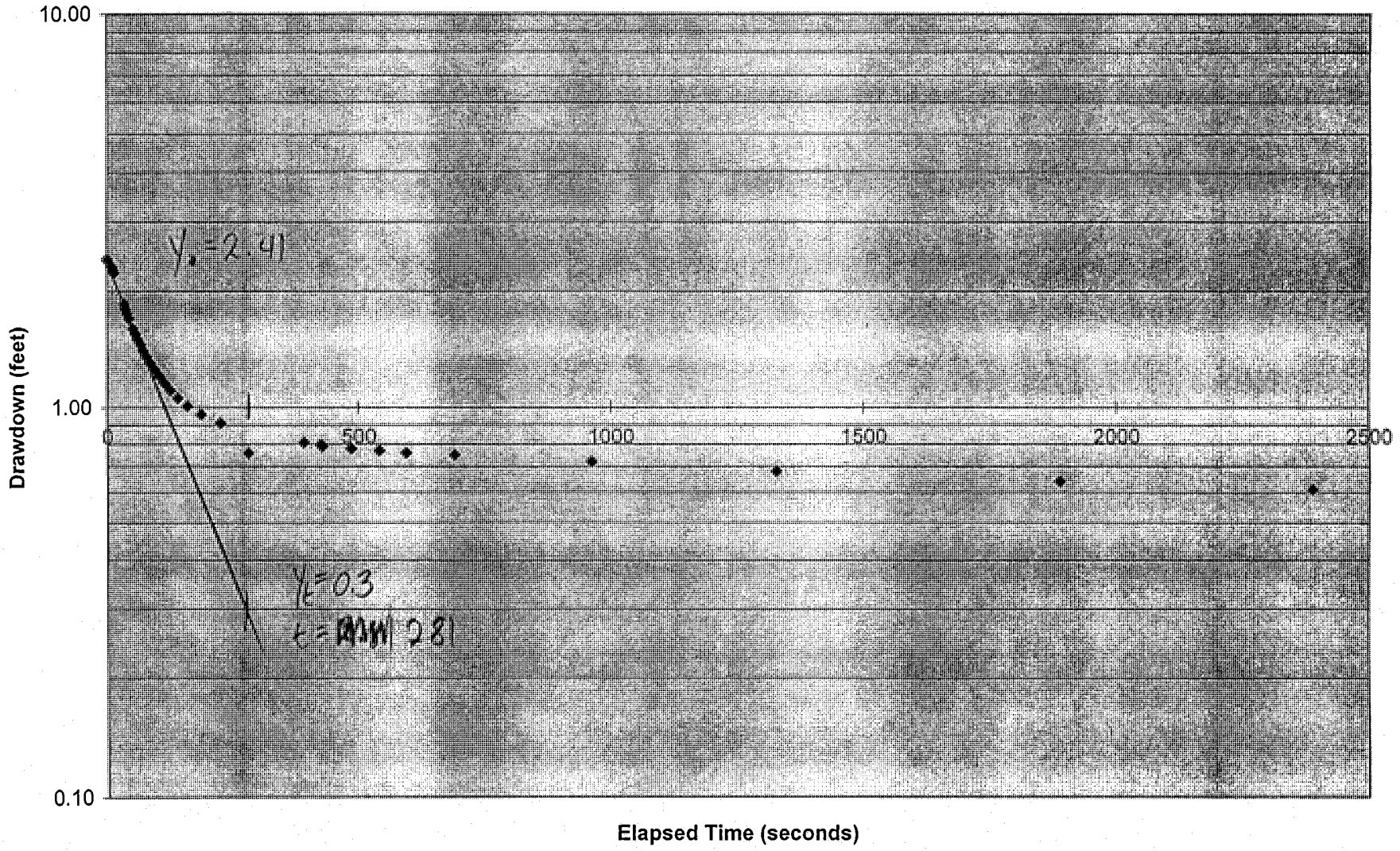
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.0833	rc	radius of the well casing (feet)
0.3281	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	Le	the open section of the well through which water can enter (feet)
2.41	yo	drawdown at time = 0 (seconds)
0.3	yt	drawdown time at t = t (seconds)
281	t	elapsed time between yo and yt
2.25	A	dimensionless parameter
0.3	B	dimensionless parameter
27.33	Lw	initial water column in well

ln(Re/rw)= 0.6177

K=	1.59E-06	feet/sec
	4.84E-05	cm/sec
	50.12	feet/year
	15.28	meter/year

Bail-Down Test P-10



Haywood
P. 10

$l_e/r_w = 30.48$

$A = 2.25$

$B = 0.30$

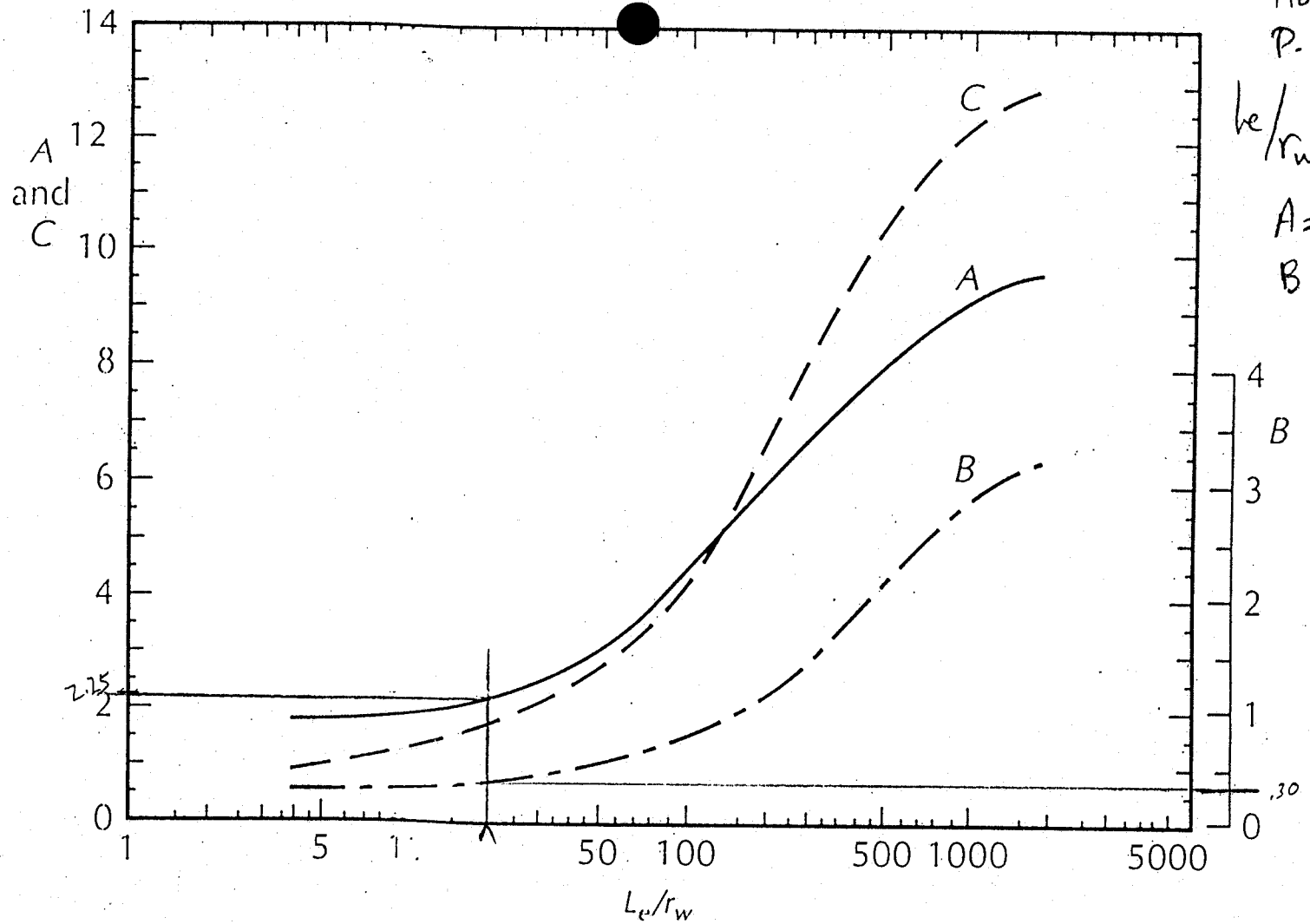


FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-11)

Bail-Down Test Piezometer P-11

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 16.2
Depth to Water (feet) at to **(H)** 17.75
Initial Change in Head (feet), **(yo)** 1.55

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
5:06:07	0	0	0	17.75	1.55
5:06:11	00:04	4	4	17.65	1.45
5:06:12	00:01	1	5	17.60	1.40
5:06:29	00:17	17	22	17.25	1.05
5:06:36	00:07	7	29	17.20	1.00
5:06:43	00:07	7	36	17.15	0.95
5:06:48	00:05	5	41	17.10	0.90
5:06:57	00:09	9	50	17.05	0.85
5:07:08	00:11	11	61	17.00	0.80
5:07:16	00:08	8	69	16.95	0.75
5:07:43	00:27	27	96	16.90	0.70
5:07:53	00:10	130	226	16.80	0.60
5:08:44	00:51	111	337	16.75	0.55
5:13:13	04:29	149	486	16.70	0.50
5:15:06	01:53	113	599	16.65	0.45
5:18:28	03:22	202	801	16.55	0.35
5:20:11	01:43	103	904	16.50	0.30
5:24:57	04:46	286	1190	16.45	0.25

Bouwer and Rice (P-11)

Bail-Down Calculations Piezometer P-11

Project Name: White Oak Landfill - Haywood County

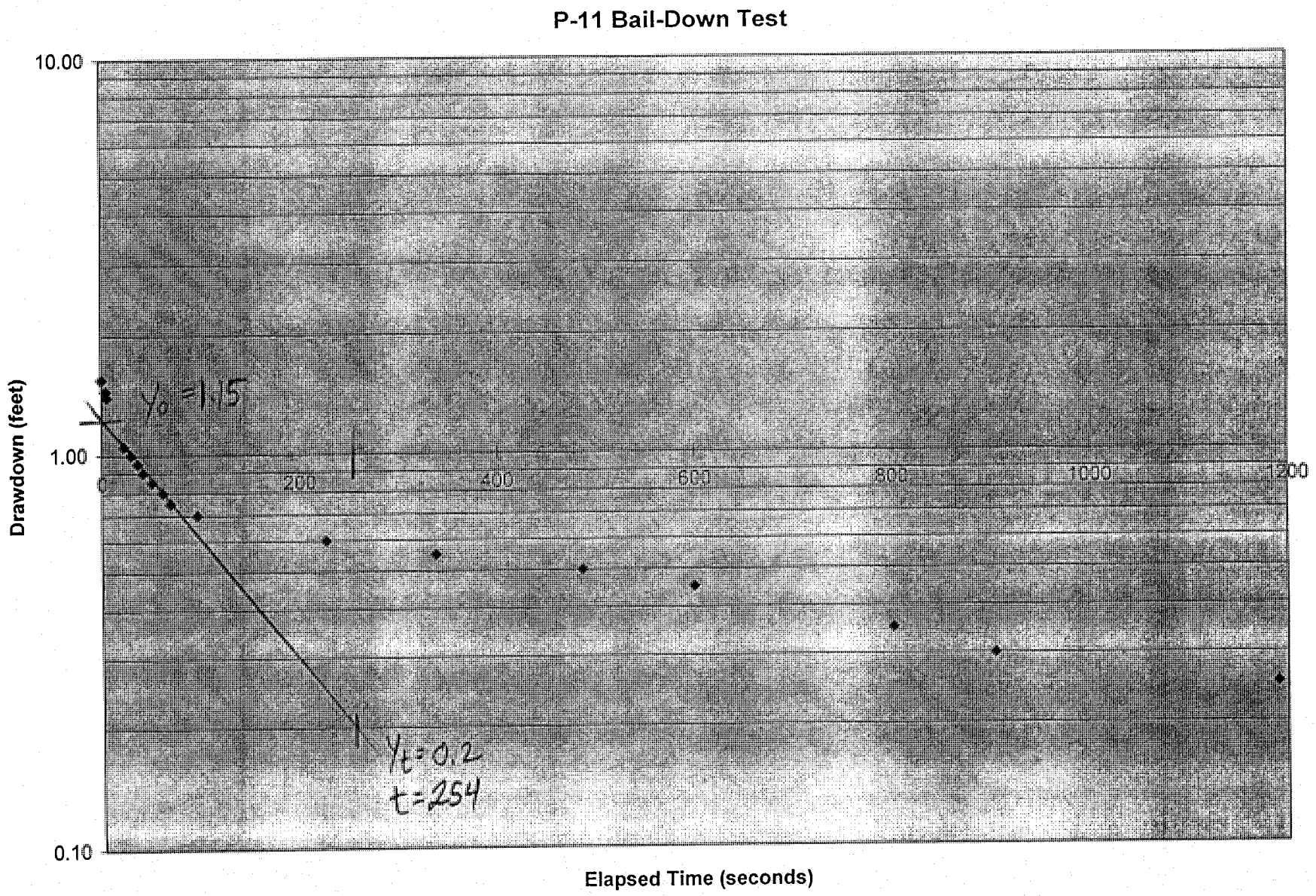
Lithology: Sandy Silt

Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.083	rc	radius of the well casing (feet)
0.3281	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	Le	the open section of the well through which water can enter (feet)
1.15	yo	drawdown at time = 0 (seconds)
0.2	yt	drawdown time at t = t (seconds)
254	t	elapsed time between yo and yt
2.25	A	dimensionless parameter
0.3	B	dimensionless parameter
11.8	Lw	initial water column in well

ln(Re/rw)= 0.6633

K=	1.57E-06	feet/sec
	4.8E-05	cm/sec
	49.62	feet/year
	15.12	meter/year


P-11 Bail-Down Test
10.00
1.00
0.10
Drawdown (feet)
200
400
600
800
1000
1200
Elapsed Time (seconds)
$Y_0 = 1.15$
$Y_t = 0.2$
$t = 254$

Hay ood
P. 11

$l_e/r_w = 30.48$

$A = 2.25$

$B = 0.30$

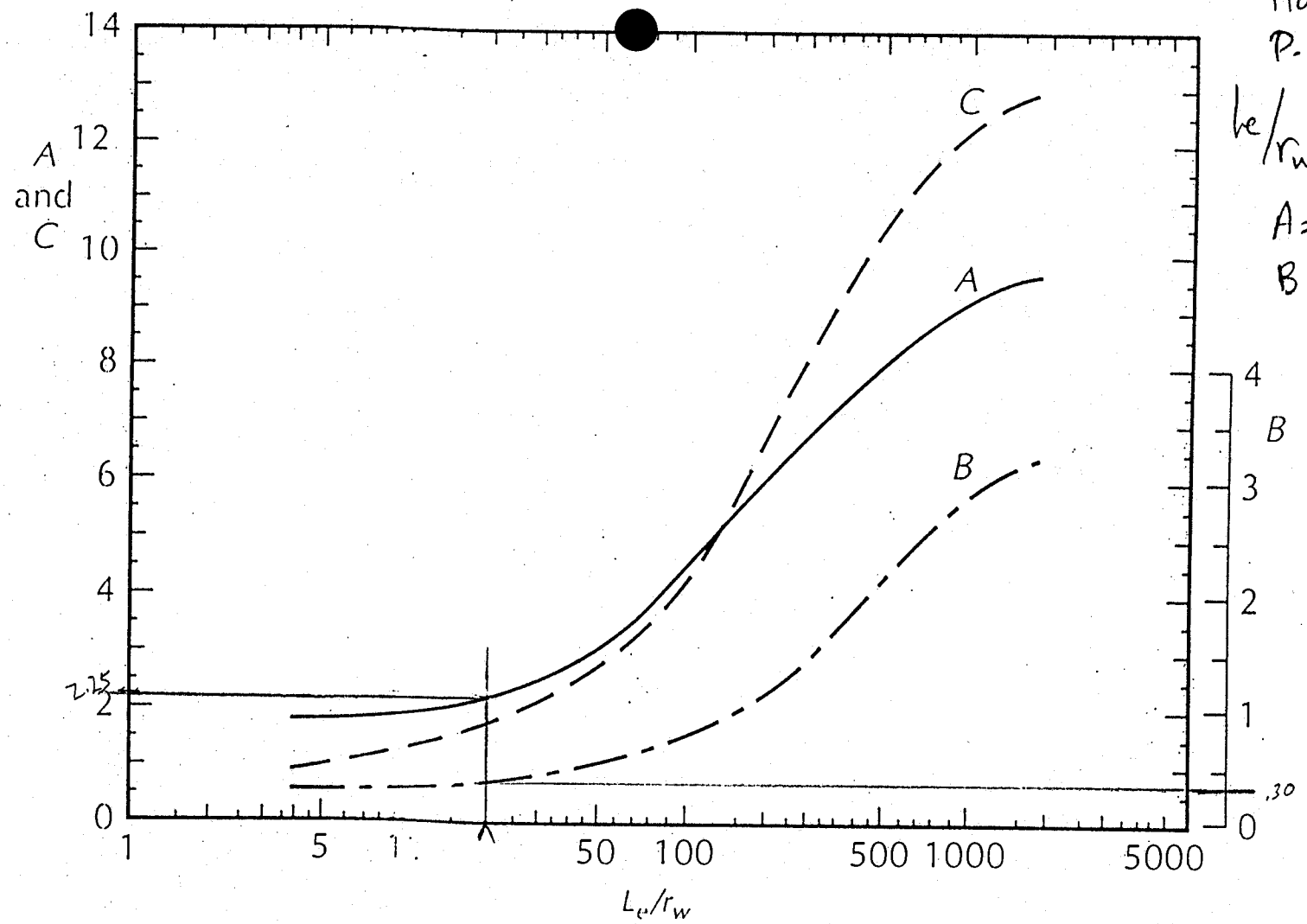


FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-12)

Bail-Down Test Piezometer P-12

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 8.35
Depth to Water (feet) at to **(H)** 12
Initial Change in Head (feet), **(yo)** 3.65

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
8:23:50	0	0	0	12.00	3.65
8:23:54	00:04	4	4	11.95	3.60
8:23:56	00:02	2	6	11.90	3.55
8:24:00	00:04	4	10	11.85	3.50
8:24:02	00:02	2	12	11.80	3.45
8:24:05	00:03	3	15	11.75	3.40
8:24:08	00:03	3	18	11.70	3.35
8:24:12	00:04	4	22	11.65	3.30
8:24:15	00:03	3	25	11.60	3.25
8:24:19	00:04	4	29	11.55	3.20
8:24:23	00:04	4	33	11.50	3.15
8:24:26	00:03	3	36	11.45	3.10
8:24:30	00:04	4	40	11.40	3.05
8:24:34	00:04	4	44	11.35	3.00
8:24:39	00:05	5	49	11.30	2.95
8:24:44	00:05	5	54	11.25	2.90
8:24:49	00:05	5	59	11.20	2.85
8:24:54	00:05	5	64	11.15	2.80
8:24:58	00:04	4	68	11.10	2.75
8:25:03	00:05	5	73	11.05	2.70
8:25:09	00:06	6	79	11.00	2.65
8:25:13	00:04	4	83	10.95	2.60
8:25:17	00:04	4	87	10.90	2.55
8:25:21	00:04	4	91	10.85	2.50
8:25:24	00:03	3	94	10.80	2.45
8:25:29	00:05	5	99	10.75	2.40
8:25:33	00:04	4	103	10.70	2.35
8:25:38	00:05	5	108	10.65	2.30
8:25:42	00:04	4	112	10.60	2.25
8:25:47	00:05	5	117	10.55	2.20
8:25:52	00:05	5	122	10.50	2.15
8:25:56	00:04	4	126	10.45	2.10
8:25:59	00:03	3	129	10.40	2.05
8:26:03	00:04	4	133	10.35	2.00
8:26:06	00:03	3	136	10.30	1.95
8:26:08	00:02	2	138	10.25	1.90
8:26:11	00:03	3	141	10.20	1.85
8:26:14	00:03	3	144	10.15	1.80
8:26:18	00:04	4	148	10.10	1.75
8:26:22	00:04	4	152	10.05	1.70

8:26:25	00:03	3	155	10.00	1.65
8:26:29	00:04	4	159	9.95	1.60
8:26:29	00:00	4	163	9.90	1.55
8:26:33	00:04	3	166	9.85	1.50
8:26:36	00:03	3	169	9.80	1.45
8:26:39	00:03	5	174	9.75	1.40
8:26:44	00:05	4	178	9.70	1.35
8:26:48	00:04	4	182	9.65	1.30
8:26:52	00:04	5	187	9.60	1.25
8:26:57	00:05	4	191	9.55	1.20
8:27:01	00:04	5	196	9.50	1.15
8:27:06	00:05	6	202	9.45	1.10
8:27:12	00:06	5	207	9.40	1.05
8:27:17	00:05	7	214	9.35	1.00
8:27:24	00:07	6	220	9.30	0.95
8:27:30	00:06	7	227	9.25	0.90
8:27:37	00:07	6	233	9.20	0.85
8:27:43	00:06	8	241	9.15	0.80
8:27:59	00:16	8	249	9.10	0.75
8:28:08	00:09	9	258	9.05	0.70
8:28:18	00:10	10	268	9.00	0.65
8:28:30	00:12	12	280	8.95	0.60
8:28:41	00:11	11	291	8.90	0.55
8:28:58	00:17	17	308	8.85	0.50
8:29:19	00:21	21	329	8.80	0.45
8:29:52	00:33	33	362	8.75	0.40
8:30:59	01:07	67	429	8.70	0.35

Bouwer and Rice (P-12)

Bail-Down Calculations Piezometer P-12

Project Name: White Oak Landfill - Haywood County

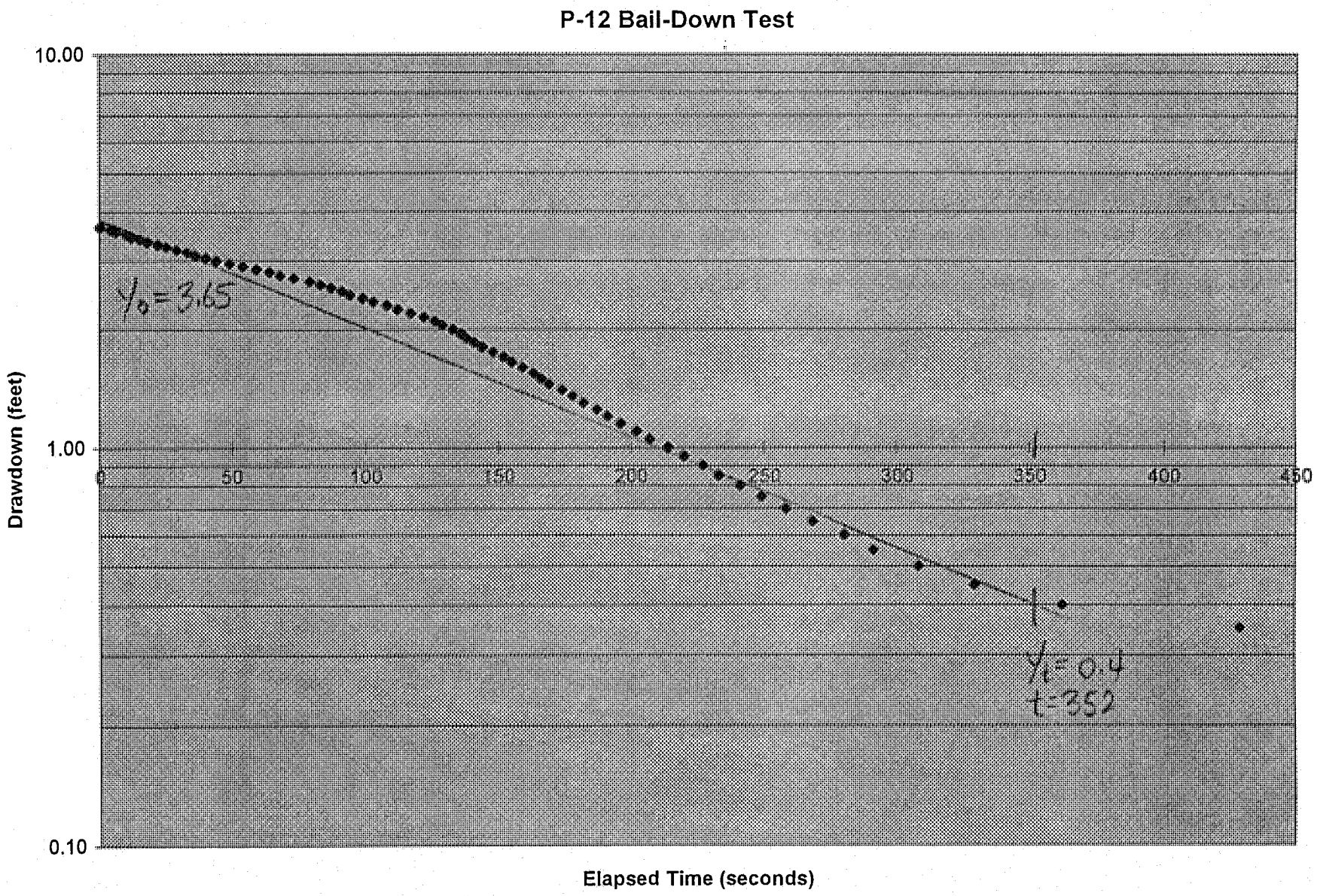
Lithology: Silty Sand and Silt

Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.1928	rc	radius of the well casing (feet)
0.3281	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	Le	the open section of the well through which water can enter (feet)
3.65	yo	drawdown at time = 0 (seconds)
0.4	yt	drawdown time at t = t (seconds)
352	t	elapsed time between yo and yt
2.25	A	dimensionless parameter
0.3	B	dimensionless parameter
11.92	Lw	initial water column in well

ln(Re/rw)= 0.6626

K=	7.74E-06	feet/sec
	0.000236	cm/sec
	243.95	feet/year
	74.36	meter/year


P-12 Bail-Down Test
10.00
1.00
0.10
Drawdown (feet)
0
50
100
150
200
250
300
350
400
450
Elapsed Time (seconds)
$y_0 = 3.65$
$y_t = 0.4$
$t = 352$

Hay ood
P. 1

$l_e/r_w = 30.48$

$A = 2.25$

$B = 0.30$

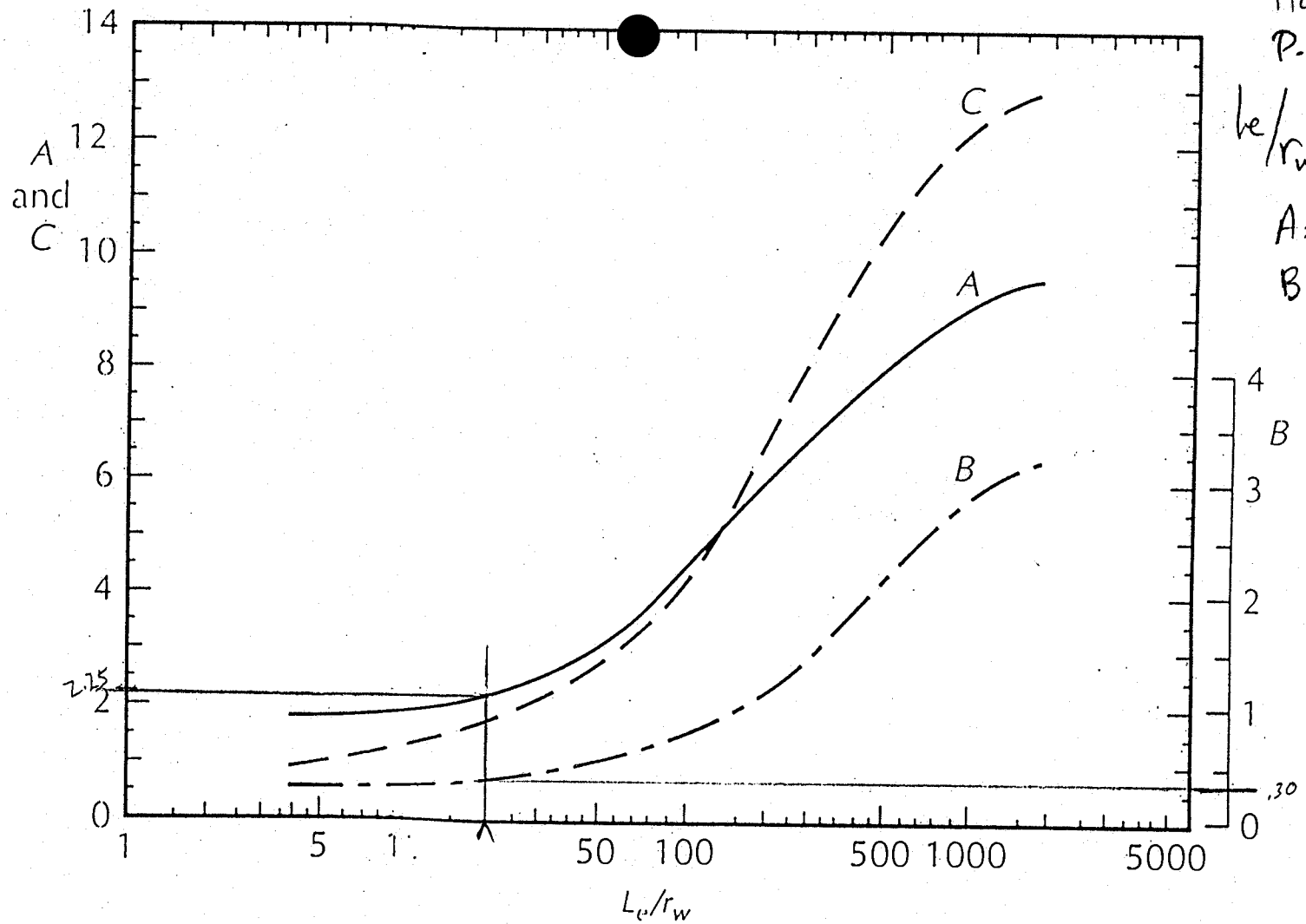


FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-13)

Bail-Down Test Piezometer P-13

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 75.87
Depth to Water (feet) at to **(H)** 84
Initial Change in Head (feet), **(yo)** 8.13

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
12:28:40	0	0	0	84.00	8.13
12:28:51	00:11	11	11	83.98	8.11
12:28:58	00:07	7	18	83.96	8.09
12:29:05	00:07	7	25	83.94	8.07
12:29:16	00:11	11	36	83.92	8.05
12:29:27	00:11	11	47	83.90	8.03
12:29:54	00:27	27	74	83.85	7.98
12:30:12	00:18	18	92	83.80	7.93
12:30:49	00:37	37	129	83.75	7.88
12:31:24	00:35	35	164	83.70	7.83
12:32:05	00:41	41	205	83.65	7.78
12:32:42	00:37	37	242	83.60	7.73
12:33:17	00:35	35	277	83.55	7.68
12:34:00	00:43	43	320	83.50	7.63
12:34:49	00:49	49	369	83.45	7.58
12:35:27	00:38	38	407	83.40	7.53
12:36:00	00:33	33	440	83.35	7.48
12:36:40	00:40	40	480	83.30	7.43
12:37:22	00:42	42	522	83.25	7.38
12:38:02	00:40	40	562	83.20	7.33
12:38:51	00:49	49	611	83.15	7.28
12:39:52	01:01	61	672	83.10	7.23
12:41:04	01:12	72	744	83.05	7.18
12:42:10	01:06	66	810	83.00	7.13
12:44:45	02:35	155	965	82.90	7.03
12:47:06	02:21	141	1106	82.80	6.93
12:49:28	02:22	144	1250	82.70	6.83
12:51:54	02:26	146	1396	82.60	6.73
12:54:28	02:34	154	1550	82.50	6.63
12:57:07	02:39	159	1709	82.40	6.53
12:59:50	02:43	163	1872	82.30	6.43
13:02:34	02:44	164	2036	82.20	6.33
13:05:38	03:04	184	2220	82.10	6.23
13:08:09	02:31	151	2371	82.00	6.13
13:11:07	02:58	178	2549	81.90	6.03
13:13:58	02:51	171	2720	81.80	5.93
13:17:14	03:16	196	2916	81.70	5.83
13:20:20	03:06	186	3102	81.60	5.73
13:23:36	03:16	196	3298	81.50	5.63
14:43:10	19:34	4774	8072	79.48	3.61

14:43:30	00:20	20	8092	79.47	3.60
14:44:30	01:00	60	8152	79.45	3.58
14:47:22	02:52	172	8324	79.40	3.53
14:50:22	03:00	180	8504	79.35	3.48
14:52:32	02:10	130	8634	79.30	3.43
14:55:15	02:43	163	8797	79.25	3.38
14:57:46	02:31	151	8948	79.20	3.33
15:00:37	02:51	171	9119	79.15	3.28
15:03:33	02:56	176	9295	79.10	3.23
15:06:23	02:50	170	9465	79.05	3.18
15:09:09	02:46	166	9631	79.00	3.13
15:11:15	02:06	126	9757	78.95	3.08
15:14:51	03:36	216	9973	78.90	3.03
15:17:59	03:08	188	10161	78.85	2.98
15:21:10	03:11	191	10352	78.80	2.93
15:23:55	02:45	165	10517	78.75	2.88
15:26:25	02:30	150	10667	78.70	2.83
15:30:00	03:35	215	10882	78.65	2.78
15:33:24	03:24	204	11086	78.60	2.73
15:36:48	03:24	204	11290	78.55	2.68
15:40:01	03:13	213	11503	78.50	2.63

Bail-Down Calculations Piezometer P-13

Project Name: White Oak Landfill - Haywood County

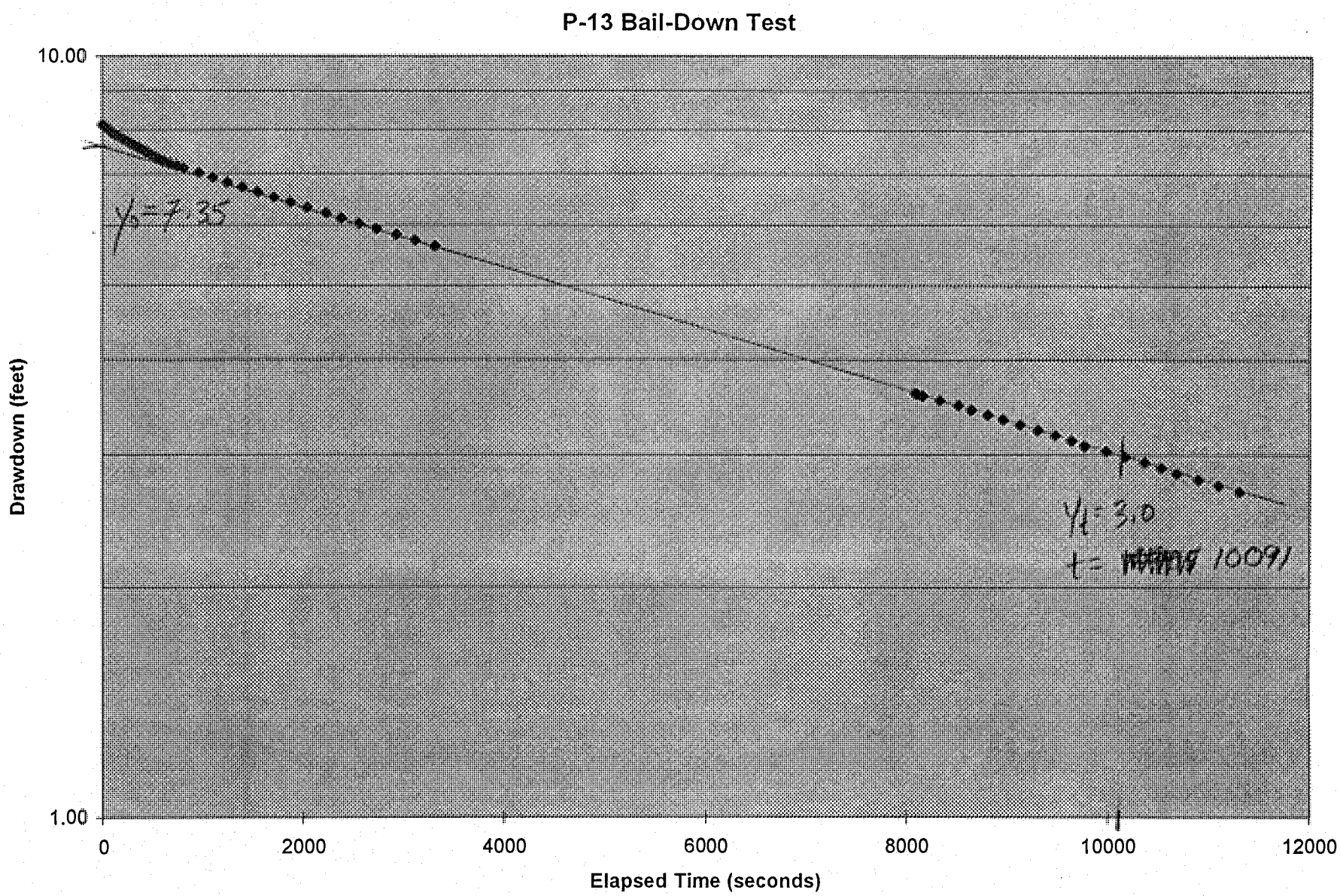
Lithology: Sandy Silt

Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.083	rc	radius of the well casing (feet)
0.3281	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	Le	the open section of the well through which water can enter (feet)
7.35	yo	drawdown at time = 0 (seconds)
3	yt	drawdown time at t = t (seconds)
10091	t	elapsed time between yo and yt
2.25	A	dimensionless parameter
0.3	B	dimensionless parameter
24.16	Lw	initial water column in well

ln(Re/rw)= 0.6235

K=	1.91E-08	feet/sec
	5.81E-07	cm/sec
	0.60	feet/year
	0.18	meter/year


P-13 Bail-Down Test
10.00
1.00
Drawdown (feet)
0
2000
4000
6000
8000
10000
12000
Elapsed Time (seconds)
Y0 = 7.35
Y2 = 3.0
t = 10091

Hay ood
P. 13

$l_e/r_w = 30.48$

$A = 2.25$

$B = 0.30$

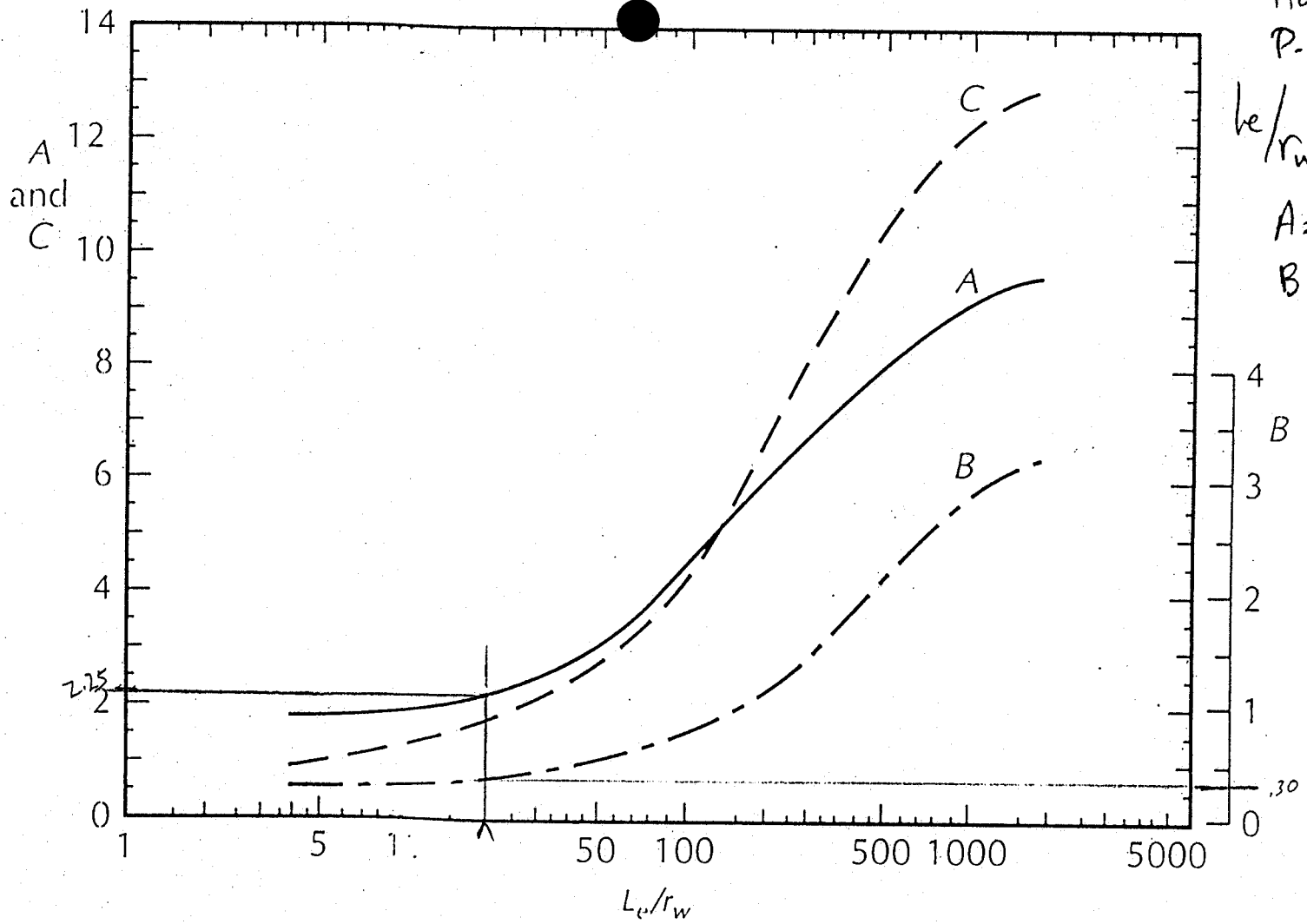


FIGURE 7.25 Dimensionless parameters *A*, *B*, and *C* plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-15)

Bail-Down Test Piezometer P-15

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 79.13
Depth to Water (feet) at to **(H)** 85.65
Initial Change in Head (feet), **(yo)** 6.52

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
13:40:42	0	0	0	85.65	6.52
13:41:02	00:20	20	20	85.60	6.47
13:41:16	00:14	14	34	85.55	6.42
13:41:31	00:15	15	49	85.50	6.37
13:41:49	00:18	18	67	85.45	6.32
13:42:06	00:35	35	84	85.40	6.27
13:42:26	00:20	20	104	85.35	6.22
13:42:45	00:19	19	123	85.30	6.17
13:43:06	00:21	21	144	85.25	6.12
13:43:26	00:20	20	164	85.20	6.07
13:43:44	00:18	18	182	85.15	6.02
13:44:10	00:26	26	208	85.10	5.97
13:44:27	00:17	17	225	85.05	5.92
13:44:49	00:22	22	247	85.00	5.87
13:45:10	00:21	21	268	84.95	5.82
13:45:36	00:26	26	294	84.90	5.77
13:45:57	00:21	21	315	84.85	5.72
13:46:16	00:19	19	334	84.80	5.67
13:46:43	00:27	27	361	84.75	5.62
13:47:08	00:25	25	386	84.70	5.57
13:47:35	00:27	27	413	84.65	5.52
13:48:02	00:27	27	440	84.60	5.47
13:48:25	00:23	23	463	84.55	5.42
13:48:53	00:28	28	491	84.50	5.37
13:49:10	00:17	17	508	84.40	5.27
13:49:33	00:23	23	531	84.35	5.22
13:50:00	00:27	27	558	84.30	5.17
13:50:23	00:23	23	581	84.25	5.12
13:50:49	00:26	26	607	84.20	5.07
13:51:16	00:27	27	634	84.15	5.02
13:51:42	00:26	26	660	84.10	4.97
13:52:04	00:22	22	682	84.10	4.97
13:52:40	00:36	36	718	84.05	4.92
13:53:00	00:20	20	738	84.00	4.87
13:53:27	00:27	27	765	83.95	4.82
13:53:59	00:32	32	797	83.90	4.77
13:54:28	00:29	29	826	83.85	4.72
13:54:58	00:30	30	856	83.80	4.67
13:55:24	00:26	26	882	83.75	4.62
13:55:53	00:29	29	911	83.70	4.57

13:56:24	00:31	31	942	83.65	4.52
13:56:51	00:27	27	969	83.60	4.47
13:57:24	00:33	33	1002	83.55	4.42
13:57:53	00:29	29	1031	83.50	4.37
13:58:26	00:33	33	1064	83.45	4.32
13:58:57	00:31	31	1095	83.40	4.27
13:59:28	00:31	31	1126	83.35	4.22
14:00:00	00:32	32	1158	83.30	4.17
14:00:32	00:32	32	1190	83.25	4.12
14:01:08	00:36	36	1226	83.20	4.07
14:01:37	00:29	29	1255	83.15	4.02
14:02:10	00:33	33	1288	83.10	3.97
14:02:46	00:36	36	1324	83.05	3.92
14:03:19	00:33	33	1357	83.00	3.87
14:03:55	00:36	36	1393	82.95	3.82
14:04:28	00:33	33	1426	82.90	3.77
14:05:10	00:42	42	1468	82.85	3.72
14:05:49	00:39	39	1507	82.80	3.67
14:06:31	00:42	42	1549	82.75	3.62
14:07:04	00:33	33	1582	82.70	3.57
14:07:33	00:29	29	1611	82.65	3.52
14:08:07	00:34	34	1645	82.60	3.47
14:08:47	00:40	40	1685	82.55	3.42
14:09:26	00:39	39	1724	82.50	3.37
14:10:05	00:39	39	1763	82.45	3.32
14:10:46	00:41	41	1804	82.40	3.27
14:11:25	00:39	39	1843	82.35	3.22
14:12:06	00:41	41	1884	82.30	3.17
14:12:51	00:45	45	1929	82.25	3.12
14:13:39	00:48	48	1977	82.20	3.07
14:14:18	00:39	39	2016	82.15	3.02
14:15:01	00:43	43	2059	82.10	2.97
14:15:50	00:49	49	2108	82.05	2.92
14:16:36	00:46	46	2154	82.00	2.87
14:17:22	00:46	46	2200	81.95	2.82
14:18:08	00:46	46	2246	81.90	2.77
14:18:57	00:49	49	2295	81.85	2.72
14:19:44	00:47	47	2342	81.80	2.67
14:20:36	00:52	52	2394	81.75	2.62
14:21:31	00:55	55	2449	81.70	2.57
14:22:20	00:49	49	2498	81.65	2.52
14:23:12	00:52	52	2550	81.60	2.47
14:24:06	00:54	54	2604	81.55	2.42
14:25:01	00:55	55	2659	81.50	2.37
14:25:57	00:56	56	2715	81.45	2.32
14:26:53	00:56	56	2771	81.40	2.27
14:27:47	00:54	54	2825	81.35	2.22
14:28:47	01:00	60	2885	81.30	2.17
14:29:49	01:02	62	2947	81.25	2.12
14:30:51	01:02	62	3009	81.20	2.07
14:31:50	00:59	59	3068	81.15	2.02

14:32:55	01:05	65	3133	81.10	1.97
14:33:58	01:03	63	3196	81.05	1.92
14:35:00	01:02	62	3258	81.00	1.87

Bouwer and Rice (P-15)

Bail-Down Calculations Piezometer P-15

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

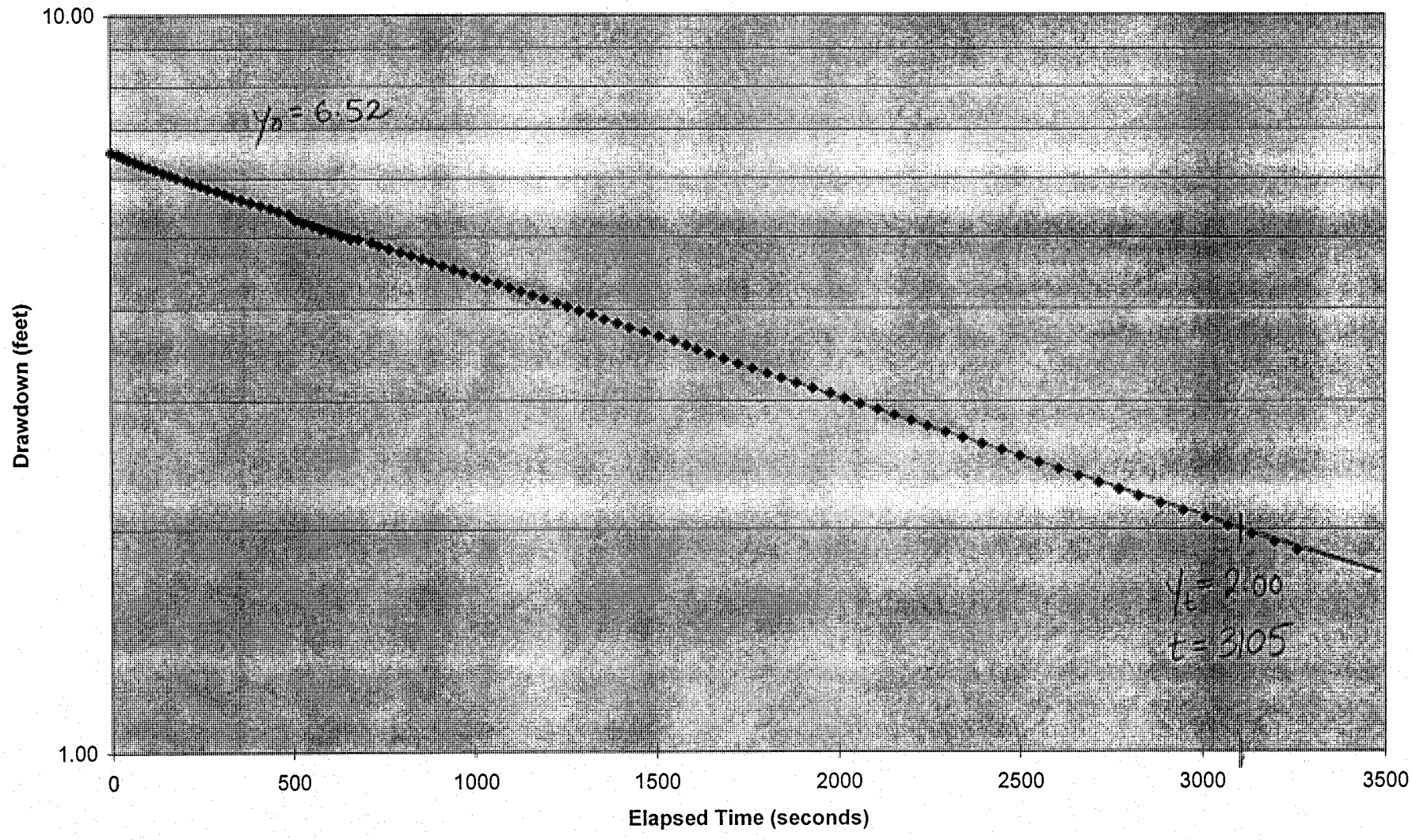
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.0833	rc	radius of the well casing (feet)
0.3281	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	Le	the open section of the well through which water can enter (feet)
6.52	yo	drawdown at time = 0 (seconds)
2	yt	drawdown time at t = t (seconds)
3105	t	elapsed time between yo and yt
2.25	A	dimensionless parameter
0.3	B	dimensionless parameter
27.89	Lw	initial water column in well

ln(Re/rw)= 0.6168

K=	8.14E-08	feet/sec
	2.48E-06	cm/sec
	2.57	feet/year
	0.78	meter/year

Bail-Down test P-15



Hay ood
P-15

$l_e/r_w = 30.48$

$A = 2.25$

$B = 0.30$

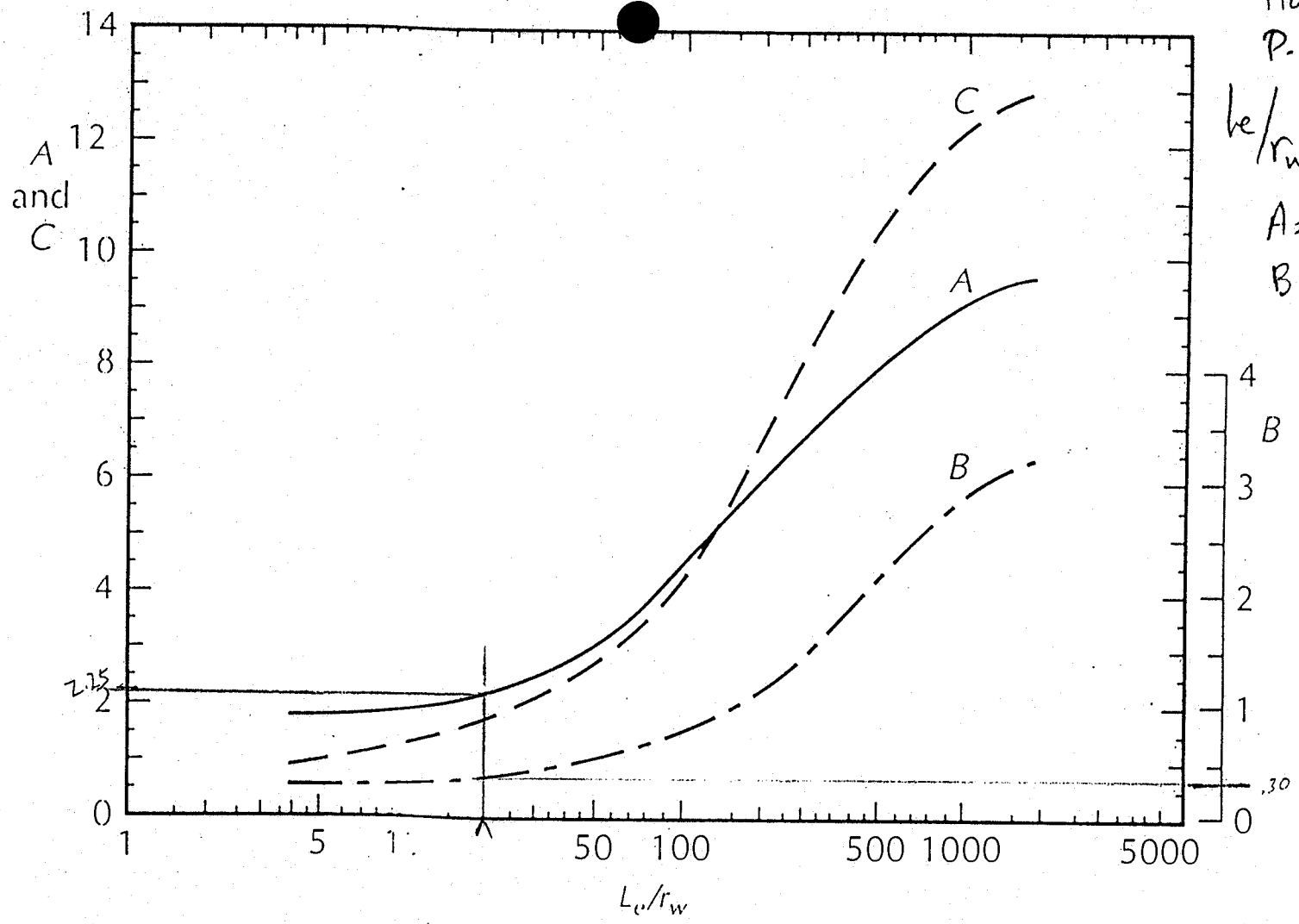


FIGURE 7.25 Dimensionless parameters *A*, *B*, and *C* plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-16)

Bail-Down Test Piezometer P-16

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 24.35
Depth to Water (feet) at to **(H)** 31.5
Initial Change in Head (feet), **(yo)** 7.15

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
11:44:52	0	0	0	31.50	7.15
11:44:57	00:05	5	5	31.30	6.95
11:44:59	00:02	2	7	31.20	6.85
11:45:02	00:03	3	10	31.10	6.75
11:45:04	00:02	2	12	31.00	6.65
11:45:07	00:03	3	15	30.90	6.55
11:45:10	00:03	3	18	30.80	6.45
11:45:13	00:03	3	21	30.70	6.35
11:45:15	00:02	2	23	30.60	6.25
11:45:18	00:03	3	26	30.50	6.15
11:45:21	00:03	3	29	30.40	6.05
11:45:25	00:04	4	33	30.30	5.95
11:45:28	00:03	3	36	30.20	5.85
11:45:31	00:03	3	39	30.10	5.75
11:45:35	00:04	4	43	30.00	5.65
11:45:39	00:04	4	47	29.90	5.55
11:45:43	00:04	4	51	29.80	5.45
11:45:47	00:04	4	55	29.70	5.35
11:45:50	00:03	3	58	29.60	5.25
11:45:55	00:05	5	63	29.50	5.15
11:45:59	00:04	4	67	29.40	5.05
11:46:03	00:04	4	71	29.30	4.95
11:46:07	00:04	4	75	29.20	4.85
11:46:12	00:05	5	80	29.10	4.75
11:46:17	00:05	5	85	29.00	4.65
11:46:22	00:05	5	90	28.90	4.55
11:46:27	00:05	5	95	28.80	4.45
11:46:33	00:06	6	101	28.70	4.35
11:46:38	00:05	5	106	28.60	4.25
11:46:44	00:06	6	112	28.50	4.15
11:46:50	00:06	6	118	28.40	4.05
11:46:57	00:07	7	125	28.30	3.95
11:47:05	00:08	8	133	28.20	3.85
11:47:10	00:05	5	138	28.10	3.75
11:47:18	00:08	8	146	28.00	3.65
11:47:27	00:09	9	155	27.90	3.55
11:47:36	00:09	9	164	27.80	3.45
11:47:43	00:07	7	171	27.70	3.35
11:47:53	00:10	10	181	27.60	3.25
11:48:03	00:10	10	191	27.5	3.15

11:48:14	00:11	11	202	27.40	3.05
11:48:26	00:12	12	214	27.30	2.95
11:48:37	00:11	11	225	27.20	2.85
11:48:49	00:12	12	237	27.10	2.75
11:49:03	00:14	14	251	27.00	2.65
11:49:18	00:15	15	266	26.90	2.55
11:49:34	00:16	16	282	26.80	2.45
11:49:51	00:17	17	299	26.70	2.35
11:50:10	00:19	19	318	26.60	2.25
11:50:31	00:21	21	339	26.50	2.15
11:50:53	00:22	22	361	26.40	2.05
11:51:21	00:28	28	389	26.30	1.95
11:51:48	00:27	27	416	26.20	1.85
11:52:16	00:28	28	444	26.10	1.75
11:52:53	00:37	37	481	26.00	1.65
11:53:32	00:39	39	520	25.90	1.55
11:54:13	00:41	41	561	25.80	1.45

Bouwer and Rice (P-16)

Bail-Down Calculations Piezometer P-16

Project Name: White Oak Landfill - Haywood County

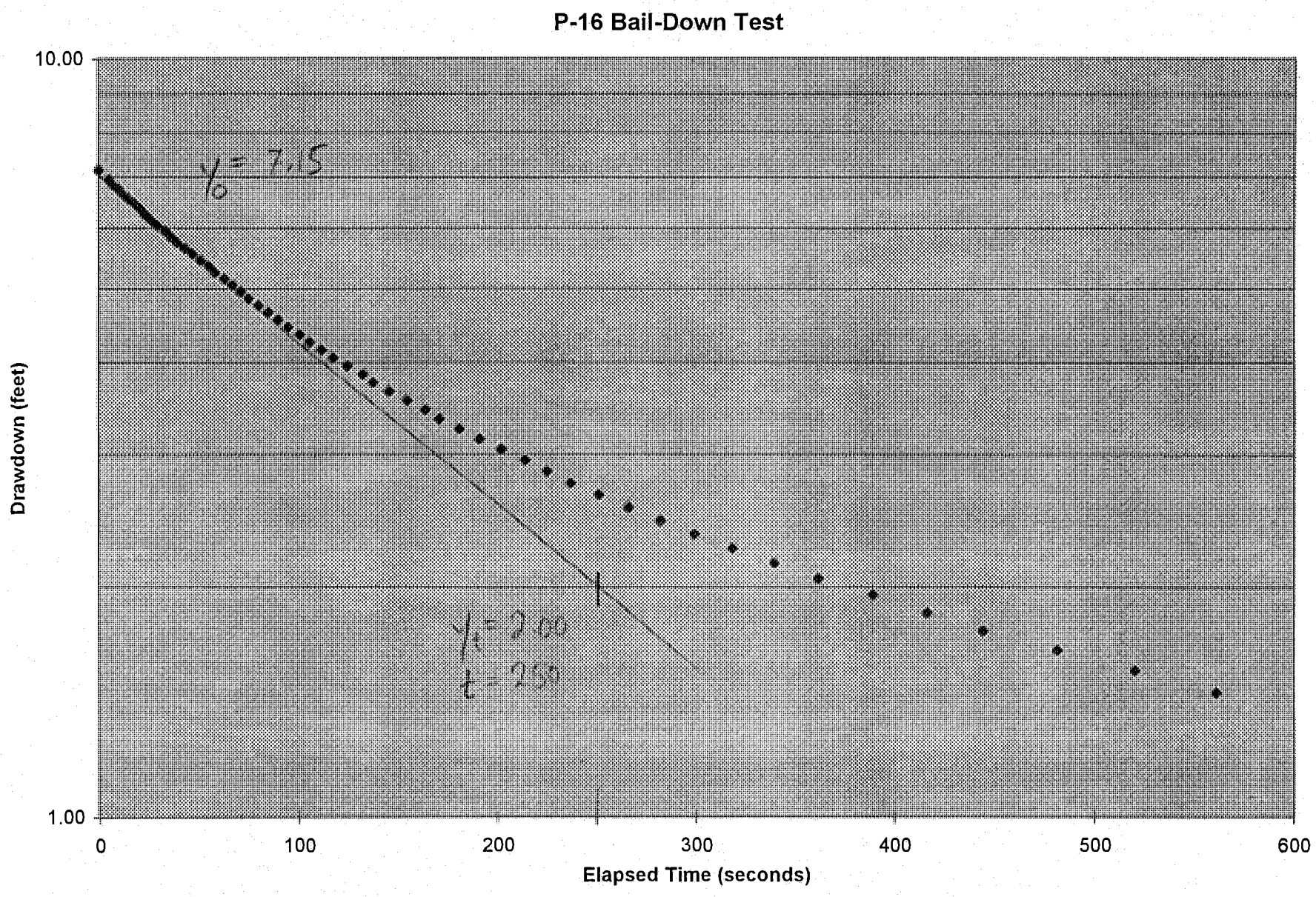
Lithology: fractured Gneissic Bedrock

Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.0833	rc	radius of the well casing (feet)
0.3281	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	Le	the open section of the well through which water can enter (feet)
7.15	yo	drawdown at time = 0 (seconds)
2	yt	drawdown time at t = t (seconds)
250	t	elapsed time between yo and yt
2.25	A	dimensionless parameter
0.3	B	dimensionless parameter
20.81	Lw	initial water column in well

ln(Re/rw)= 0.6308

K=	1.12E-06	feet/sec
	3.4E-05	cm/sec
	35.17	feet/year
	10.72	meter/year


P-16 Bail-Down Test
10.00
1.00
Drawdown (feet)
0
100
200
300
400
500
600
Elapsed Time (seconds)
y_0 = 7.15
y_t = 2.00
t = 250

Hayn d
P-16

$l_e/r_w = 30.48$

A = 2.25
B = 0.30

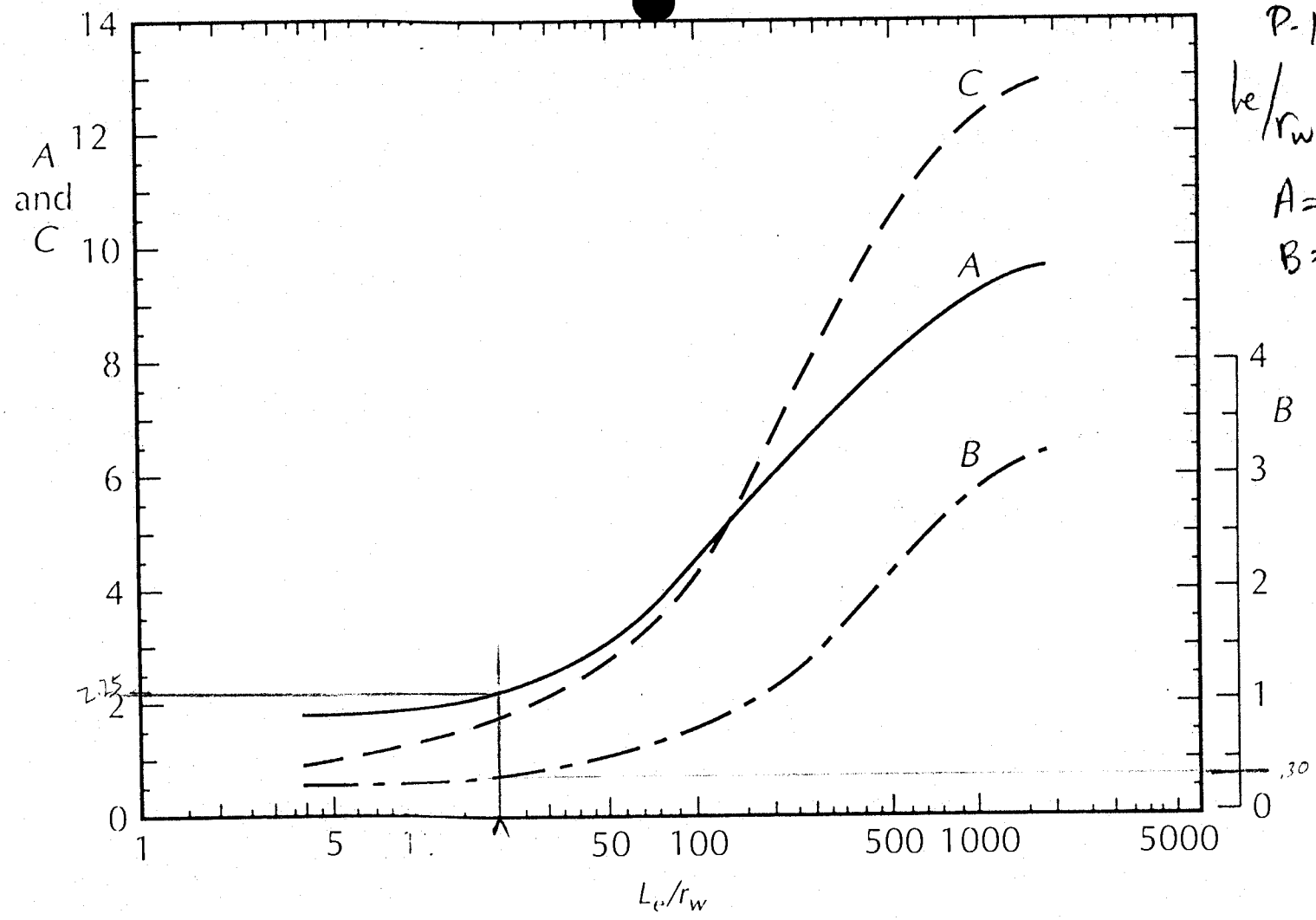


FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-17)

Bail-Down Test Piezometer P-17

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 80.90
Depth to Water (feet) at to **(H)** 82.35
Initial Change in Head (feet), **(yo)** 1.45

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
11:30:00	0	0	0	82.35	1.45
11:30:19	00:19	19	19	82.30	1.40
11:30:36	00:17	17	36	82.28	1.38
11:30:51	00:15	15	51	82.26	1.36
11:31:18	00:27	27	78	82.24	1.34
11:31:42	00:51	51	102	82.22	1.32
11:32:22	00:40	40	142	82.20	1.30
11:32:55	00:33	33	175	82.18	1.28
11:33:37	00:42	42	217	82.16	1.26
11:34:46	01:09	69	286	82.14	1.24
11:35:37	00:51	51	337	82.12	1.22
11:36:39	01:02	62	399	82.10	1.20
11:37:51	01:12	72	471	82.08	1.18
12:13:53	36:02	2162	2633	81.77	0.87
12:43:25	29:32	1772	4405	81.67	0.77
13:13:50	30:25	1825	6230	81.56	0.66
13:55:22	41:32	2492	8722	81.46	0.56

Bouwer and Rice (P-17)

Bail-Down Calculations Piezometer P-17

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.0833	**rc**	radius of the well casing (feet)
0.1406	**rw**	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	**Le**	the open section of the well through which water can enter (feet)
1.3	**yo**	drawdown at time = 0 (seconds)
0.2	**yt**	drawdown time at t = t (seconds)
7662	**t**	elapsed time between yo and yt
3.6	**A**	dimensionless parameter
0.6	**B**	dimensionless parameter
12.06	**Lw**	initial water column in well

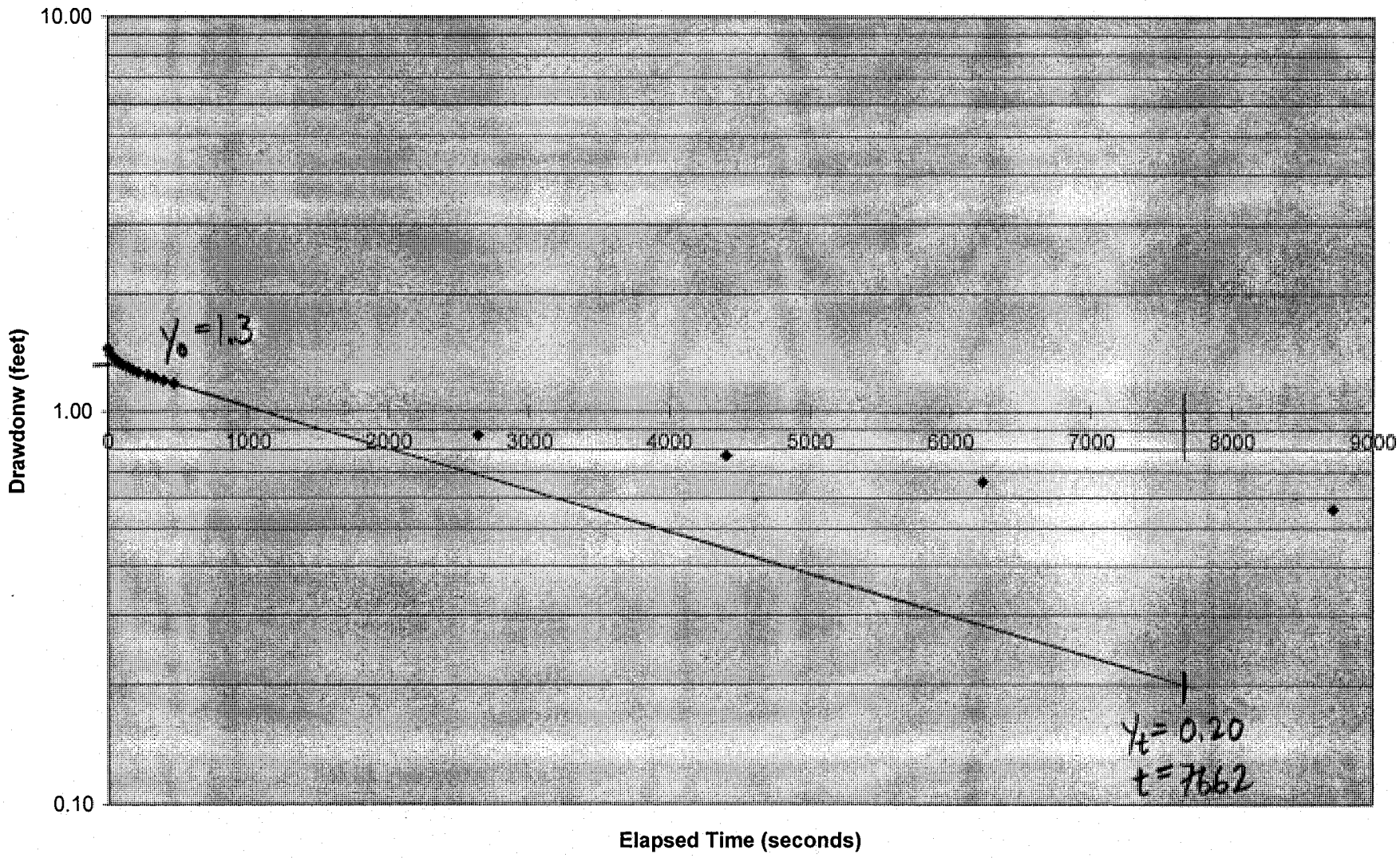
ln(Re/rw)= 0.5902

K=	5E-08	feet/sec
	1.52E-06	cm/sec
	1.58	feet/year
	0.48	meter/year

TD = 90'
SI 80'-90'
GP 70'-90'
DTW 80.90'
initial w/c 9.10'
Le s/b 9.10'
Lw s/b 9.10'

90.00
80.90
9.10

Bail-Down Test P-17



Haywood
P-17

$l_e/r_w = 71.12$

A = 3.6
B = 0.60

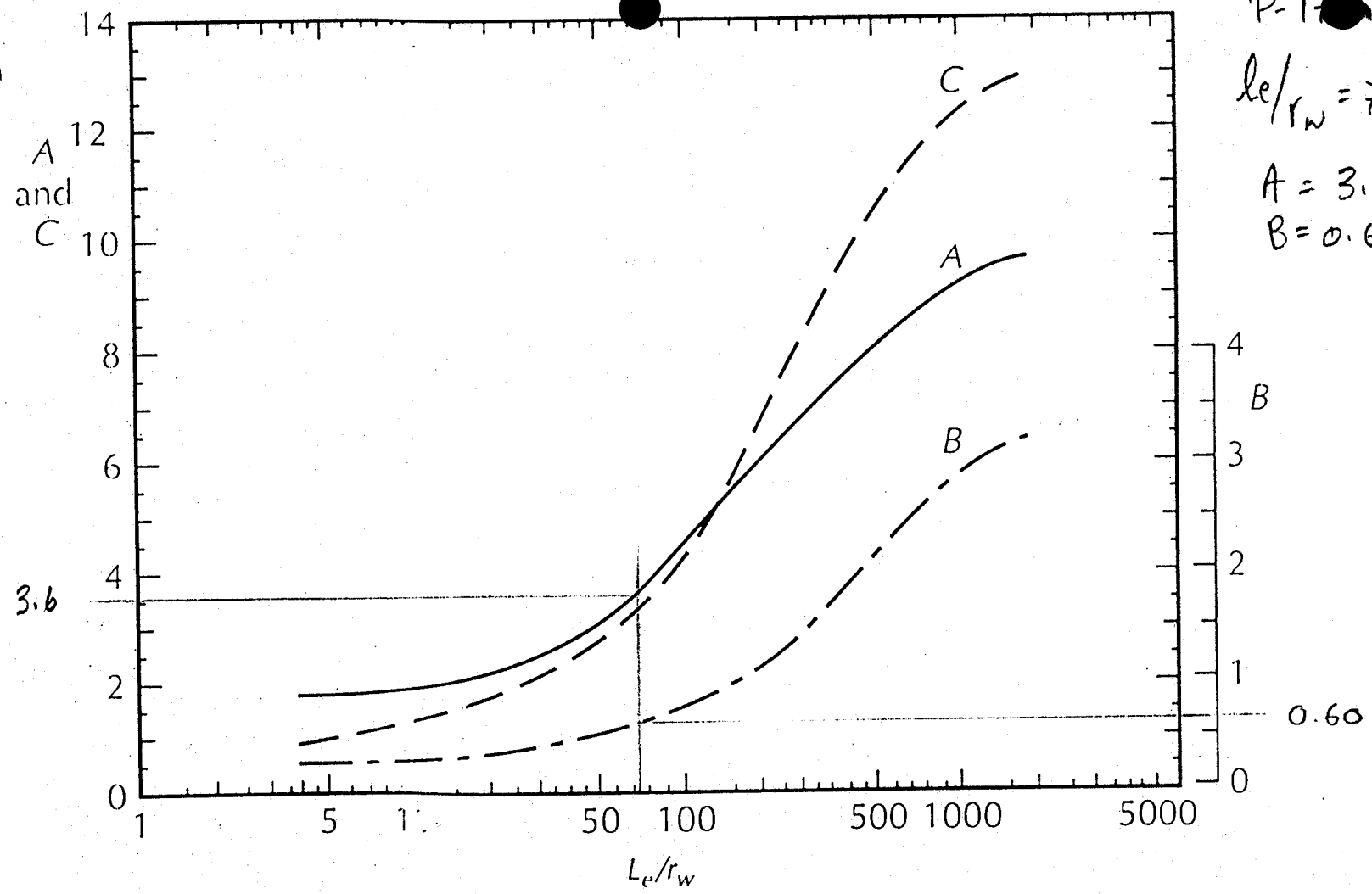


FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P-19)

Bail-Down Test Piezometer P-19

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 70.4
Depth to Water (feet) at to **(H)** 79.85
Initial Change in Head (feet), **(yo)** 9.45

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
11:00:45	0	0	0	79.85	9.45
11:00:50	00:05	5	5	79.80	9.40
11:00:55	00:05	5	10	79.75	9.35
11:01:01	00:06	6	16	79.70	9.30
11:01:08	00:07	7	23	79.65	9.25
11:01:13	00:05	5	28	79.60	9.20
11:01:18	00:05	5	33	79.55	9.15
11:01:25	00:07	7	40	79.50	9.10
11:01:33	00:08	8	48	79.45	9.05
11:01:40	00:07	7	55	79.40	9.00
11:01:47	00:07	7	62	79.35	8.95
11:01:57	00:10	10	72	79.30	8.90
11:02:05	00:08	8	80	79.25	8.85
11:02:16	00:11	11	91	79.20	8.80
11:02:27	00:11	11	102	79.15	8.75
11:02:40	00:13	13	115	79.10	8.70
11:02:54	00:14	14	129	79.05	8.65
11:03:10	00:16	16	145	79.00	8.60
11:03:28	00:18	18	163	78.95	8.55
11:03:49	00:21	21	184	78.90	8.50
11:04:39	00:50	50	234	78.80	8.40
11:05:32	00:53	53	287	78.75	8.35
11:06:31	00:59	59	346	78.70	8.30
11:07:54	01:23	83	429	78.65	8.25
11:09:34	01:40	100	529	78.60	8.20
12:09:28	59:54	3594	4123	77.77	7.37
12:19:49	10:21	621	4744	77.63	7.23
12:38:20	18:31	1111	5855	77.42	7.02

Bouwer and Rice (P-19)

Bail-Down Calculations Piezometer P-19

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

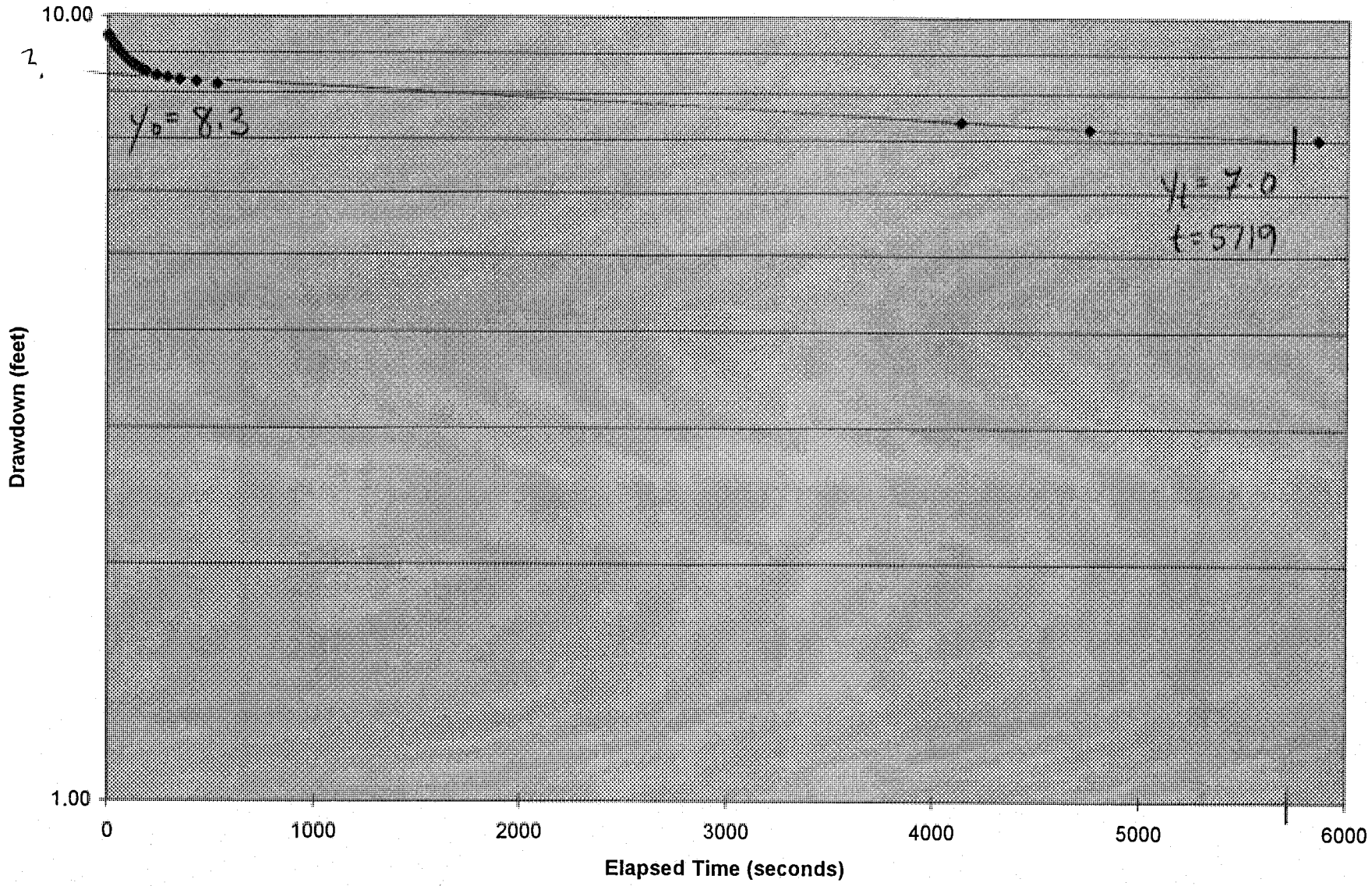
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.0833	rc	radius of the well casing (feet)
0.1406	rw	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
10	Le	the open section of the well through which water can enter (feet)
8.3	yo	drawdown at time = 0 (seconds)
7	yt	drawdown time at t = t (seconds)
5719	t	elapsed time between yo and yt
3.6	A	dimensionless parameter
0.6	B	dimensionless parameter
30.63	Lw	initial water column in well

ln(Re/rw)= 0.5528

K=	5.71E-09	feet/sec
	1.74E-07	cm/sec
	0.18	feet/year
	0.05	meter/year

P-19 Bail-Down Test



Haywood
P-1

$l_e/r_w = 71.12$

A = 3.6
B = 0.60

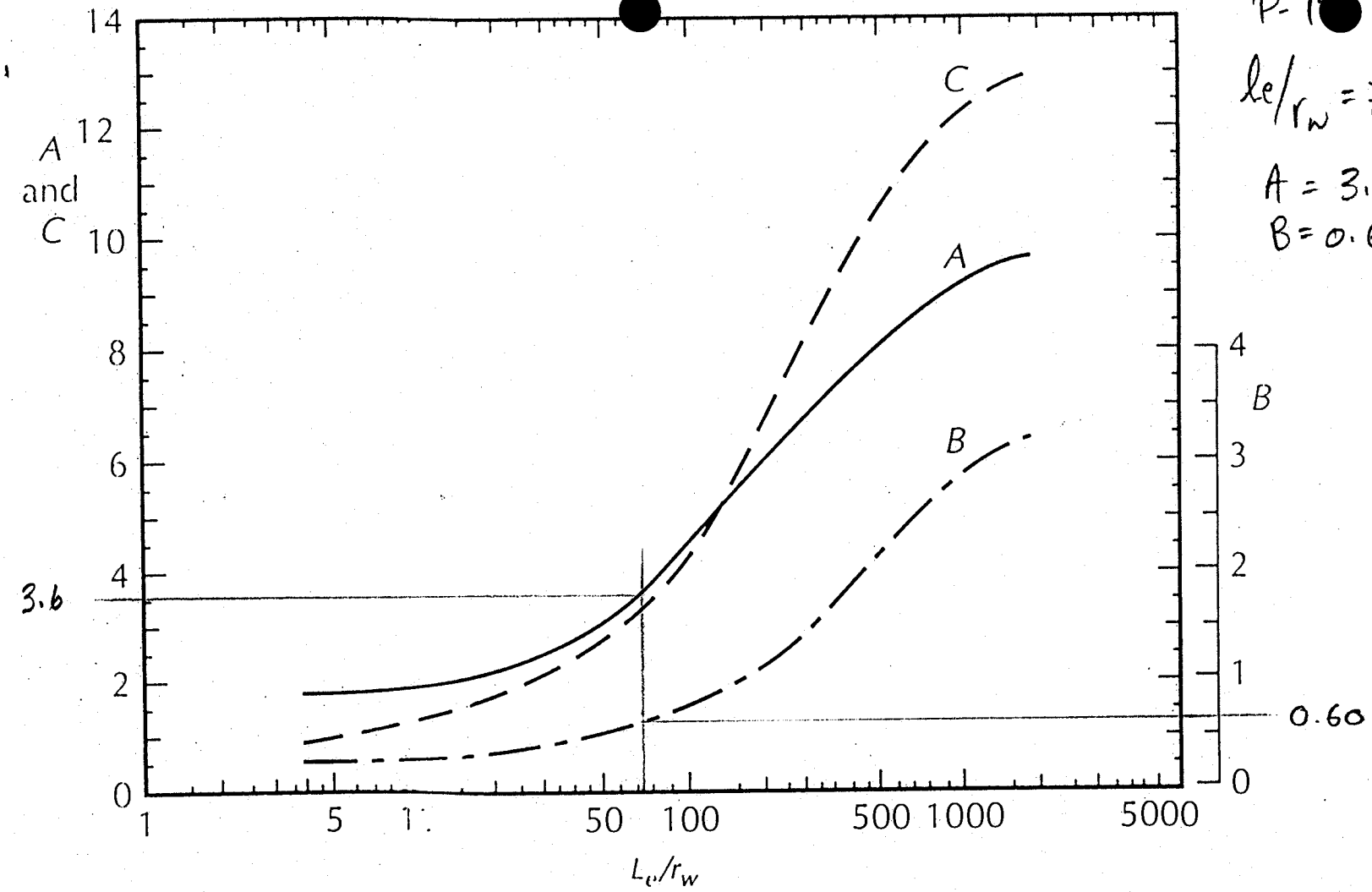


FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P2-1)

Bail-Down Test Piezometer P2-1

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)**	42.5
Depth to Water (feet) at to **(H)**	42.65
Initial Change in Head (feet), **(yo)**	0.15

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
12:53:03	0	0	0	42.65	0.15
12:53:06	00:03	3	3	42.63	0.13
12:53:07	00:01	1	4	42.62	0.12
12:53:14	00:07	7	11	42.60	0.10
12:53:18	00:04	4	15	42.59	0.09
12:53:28	00:10	10	25	42.58	0.08
12:58:18	04:50	290	315	42.57	0.07
13:46:23	48:05	2885	3200	42.55	0.05

Bouwer and Rice (P2-1)

Bail-Down Calculations Piezometer P2-1

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

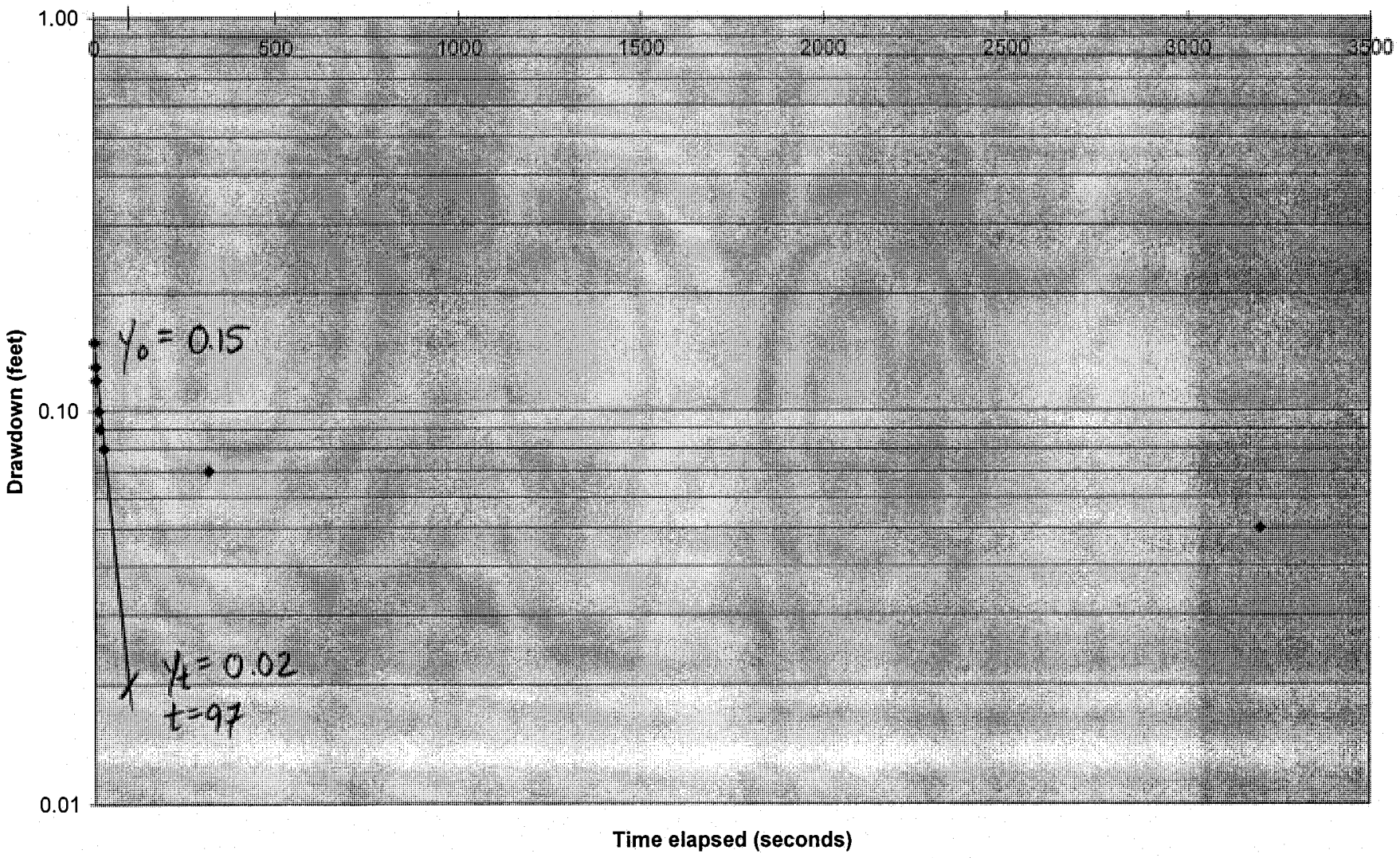
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.1039	**rc**	radius of the well casing (feet)
0.1406	**rw**	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
13.19	**Le**	the open section of the well through which water can enter (feet)
0.15	**yo**	drawdown at time = 0 (seconds)
0.02	**yt**	drawdown time at t = t (seconds)
97	**t**	elapsed time between yo and yt
4.3	**A**	dimensionless parameter
0.75	**B**	dimensionless parameter
13.19	**Lw**	initial water column in well

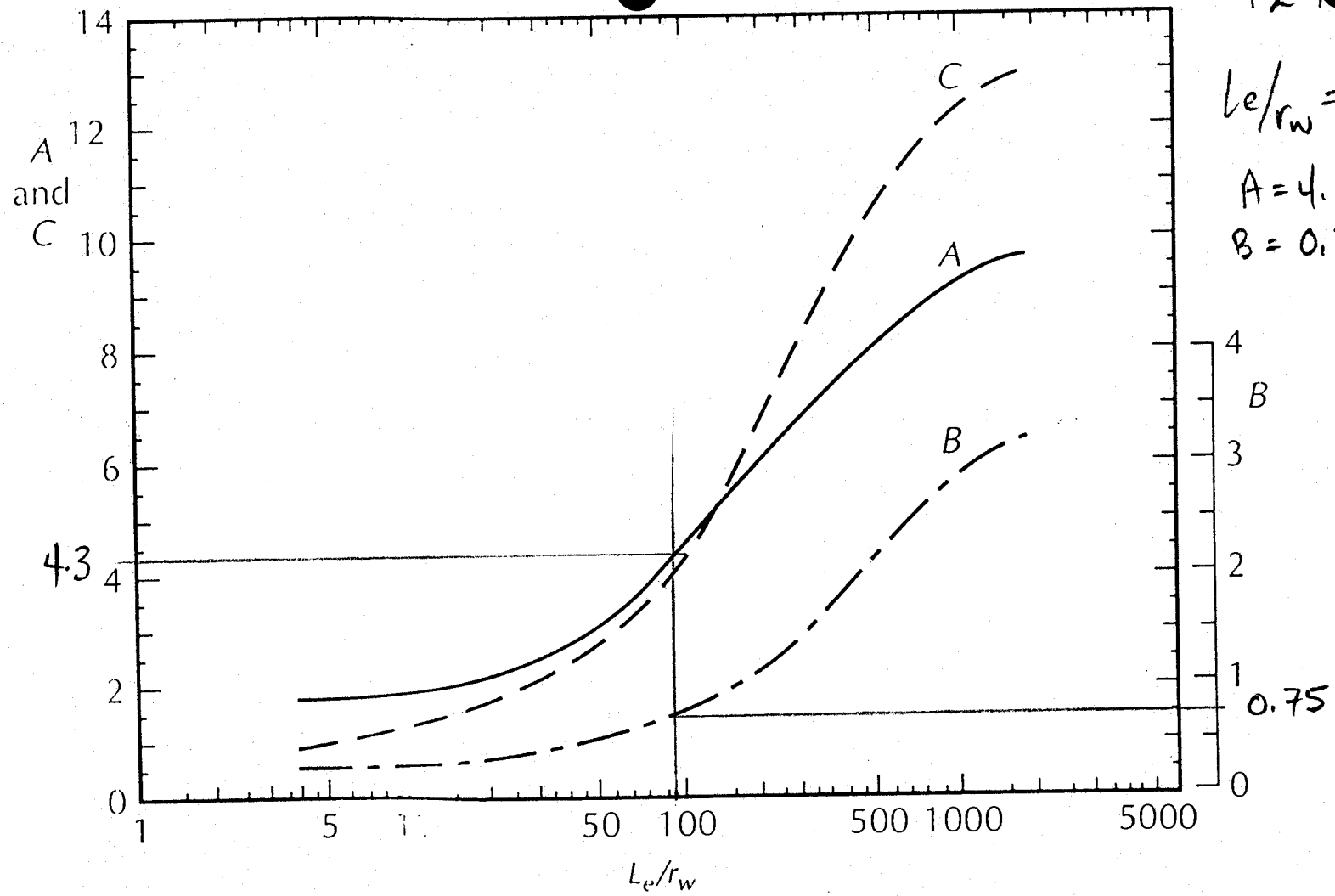
ln(Re/rw)= 0.5797

K=	4.93E-06	feet/sec
	0.00015	cm/sec
	155.39	feet/year
	47.36	meter/year

Bail-Down test (P2-1)



Haywood
P2-



$L_e/r_w = 93.81$

$A = 4.3$

$B = 0.75$

FIGURE 7.25 Dimensionless parameters A, B, and C plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

Bouwer and Rice (P2-2)

Bail-Down Test Piezometer P2-2

Project Name White Oak Landfill - Haywood County

Initial Depth to Water (feet) **(Ho)** 42.6
Depth to Water (feet) at to **(H)** 42.85
Initial Change in Head (feet), **(yo)** 0.25

Time (h:mm:ss)	Time (mm:ss)	Time (sec)	Time Elapsed (sec)	DTW (ft) [H]	Change (ft) [H-Ho]
13:18:15	0	0	0	42.85	0.25
13:18:47	00:32	32	32	42.84	0.24
13:19:18	00:31	31	63	42.83	0.23
13:19:50	00:32	32	95	42.82	0.22
13:20:30	00:40	40	135	42.81	0.21
13:21:25	00:55	55	190	42.80	0.20
13:22:58	01:33	93	283	42.79	0.19
13:23:29	00:31	31	314	42.78	0.18
13:23:57	00:28	28	342	42.77	0.17
13:24:55	00:58	58	400	42.76	0.16
13:26:14	01:19	79	479	42.75	0.15
13:27:41	01:27	87	566	42.74	0.14
13:29:09	01:28	88	654	42.73	0.13
13:31:23	02:14	134	788	42.72	0.12
13:33:44	02:21	141	929	42.71	0.11
13:36:17	02:33	152	1081	42.70	0.10
13:40:29	04:12	252	1333	42.69	0.09
13:45:24	04:55	295	1628	42.68	0.08
13:53:20	07:56	476	2104	42.67	0.07
14:13:30	20:10	1210	3314	42.66	0.06

Bouwer and Rice (P2-2)

Bail-Down Calculations Piezometer P2-2

Project Name: White Oak Landfill - Haywood County

Lithology: Fractured Gneissic Bedrock

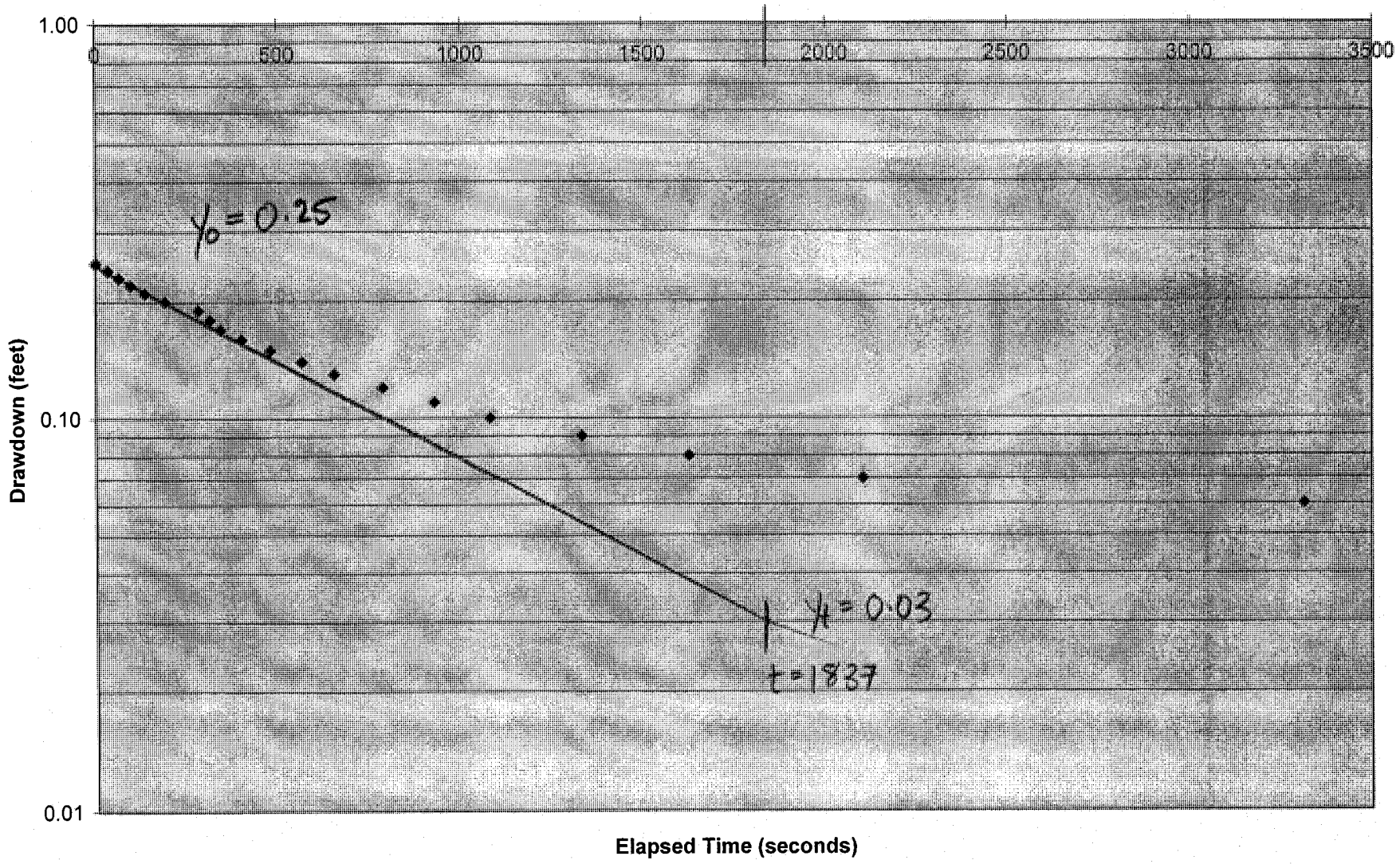
Hydraulic Conductivity by Bouwer and Rice (1976)

	K	hydraulic conductivity
0.1039	**rc**	radius of the well casing (feet)
0.1406	**rw**	radius of the gravel pack (feet)
	Re	effective radius over which head is dissipated (feet)
5.17	**Le**	the open section of the well through which water can enter (feet)
0.25	**yo**	drawdown at time = 0 (seconds)
0.03	**yt**	drawdown time at t = t (seconds)
1837	**t**	elapsed time between yo and yt
2.65	**A**	dimensionless parameter
0.42	**B**	dimensionless parameter
5.17	**Lw**	initial water column in well

ln(Re/rw)= 0.6676

K=	8.05E-07	feet/sec
	2.45E-05	cm/sec
	25.37	feet/year
	7.73	meter/year

Bail-Down test P2-2



Haywood
P 2-8
$L_e/r_w = 36.77$
A = 2.65
B = 0.42

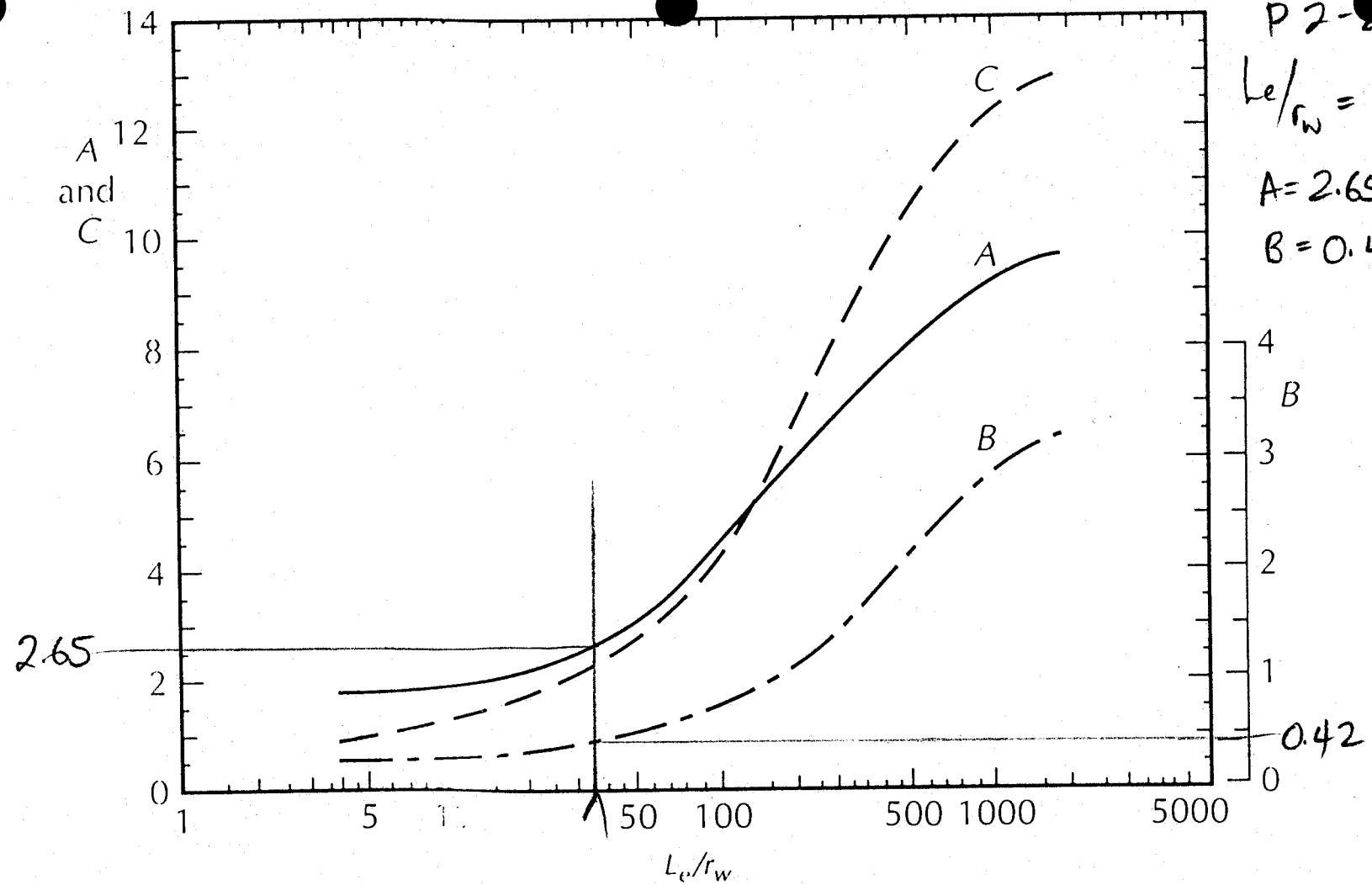


FIGURE 7.25 Dimensionless parameters *A*, *B*, and *C* plotted as a function of L_e/R. These parameters are used in the determination of $\ln(R_e/R)$ in Equations 7–87 and 7–88. Source: Herman Bouwer, *Ground Water* 27 (1989): 304–309. Used with permission. © 1989, Ground Water Publishing Company.

P2-1
HAYWOOD
10-12'
Silty Sand
n = 13

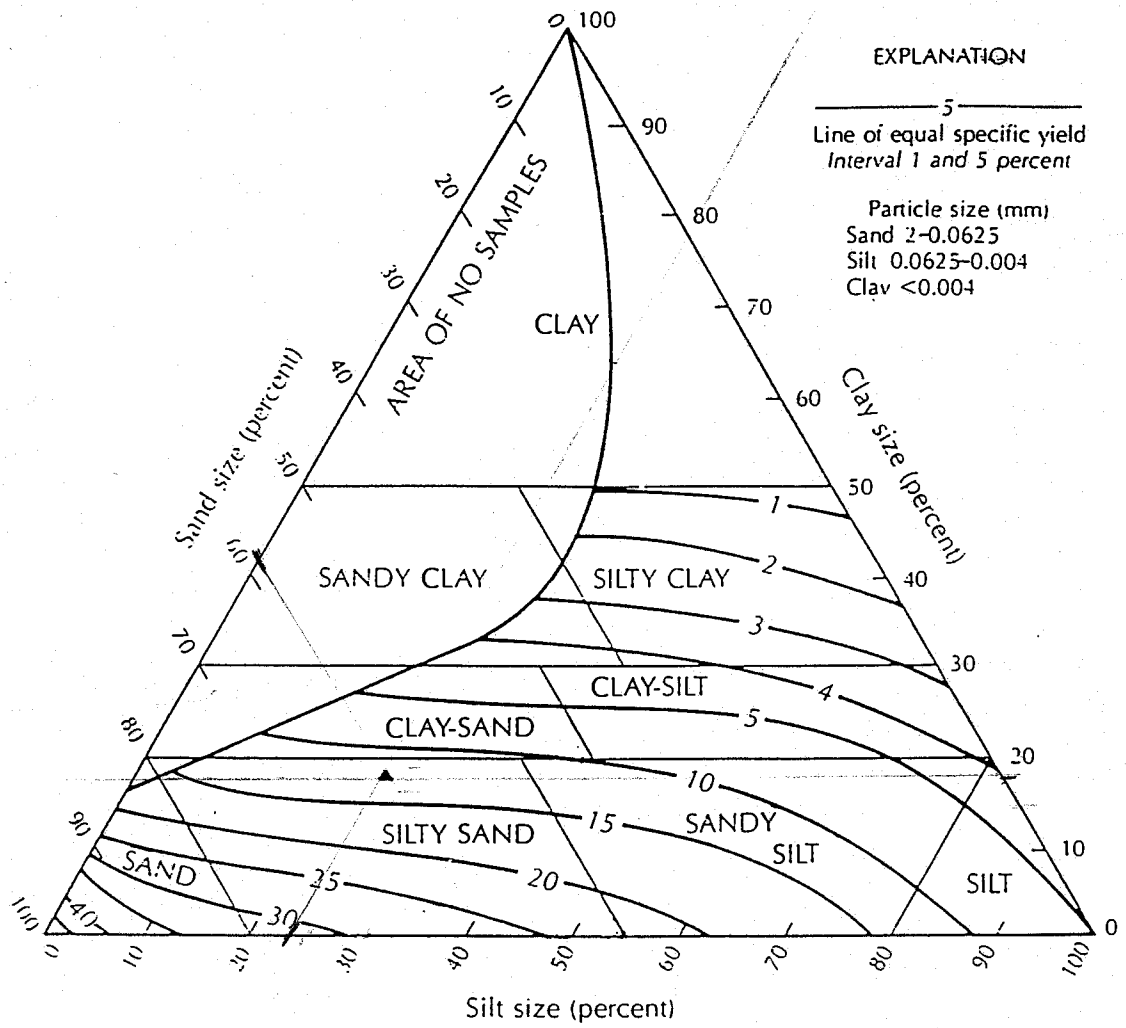


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P2-1
HAYWOOD
21-23
Layey Sand
n=6

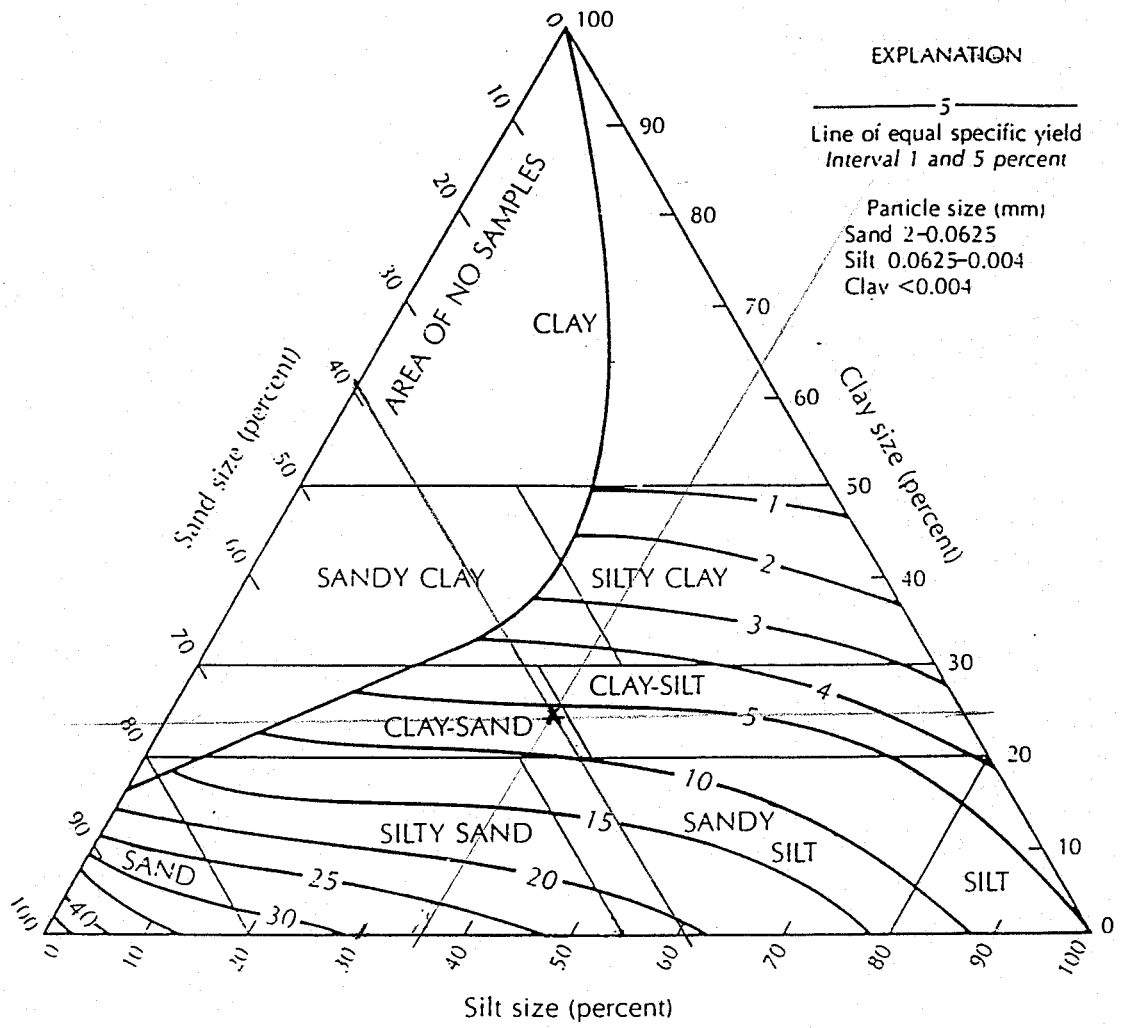


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P2-2
HAYWOOD
3-4
Sand
n = 14.5

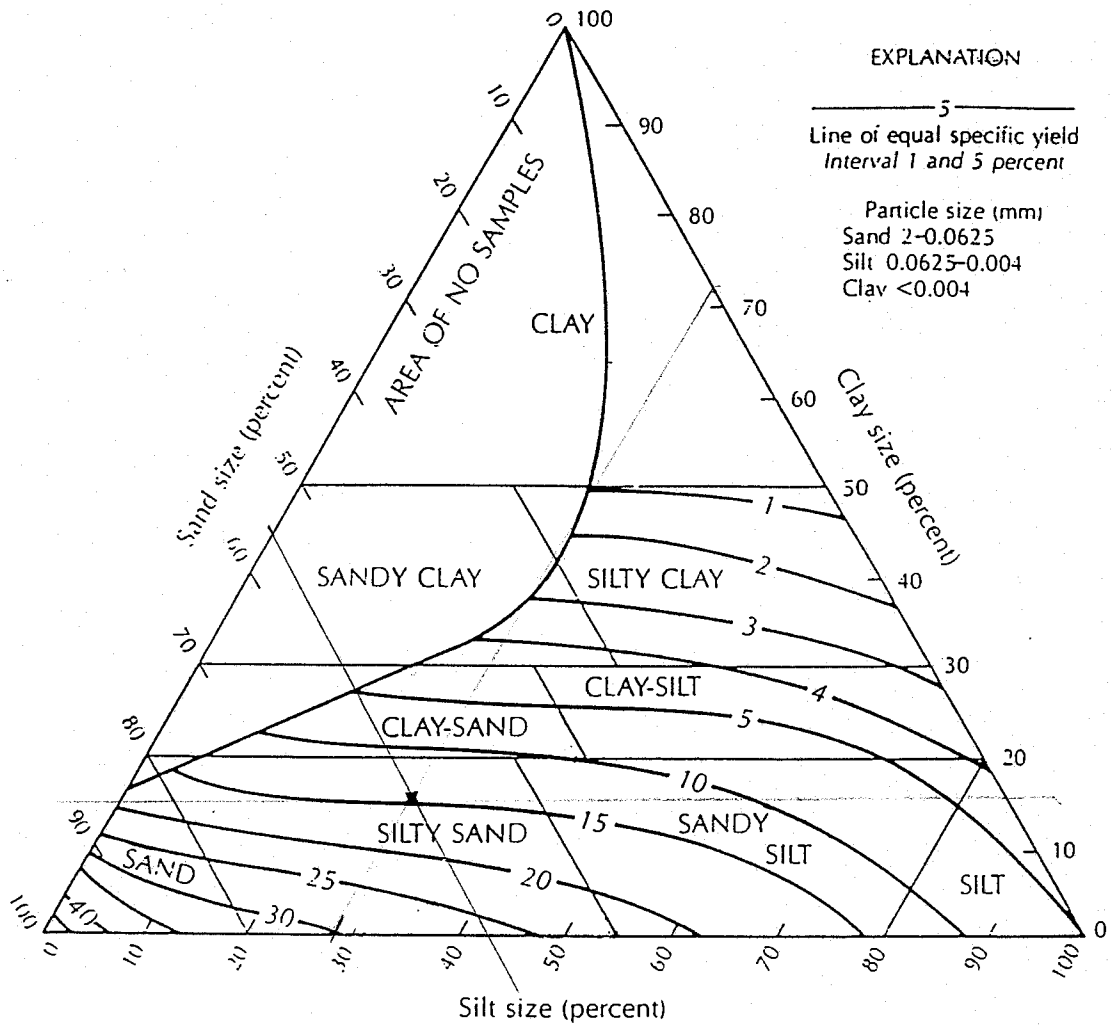


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P-1
Split Spoon @ 3-5'
n = 15.5
Silt Sand

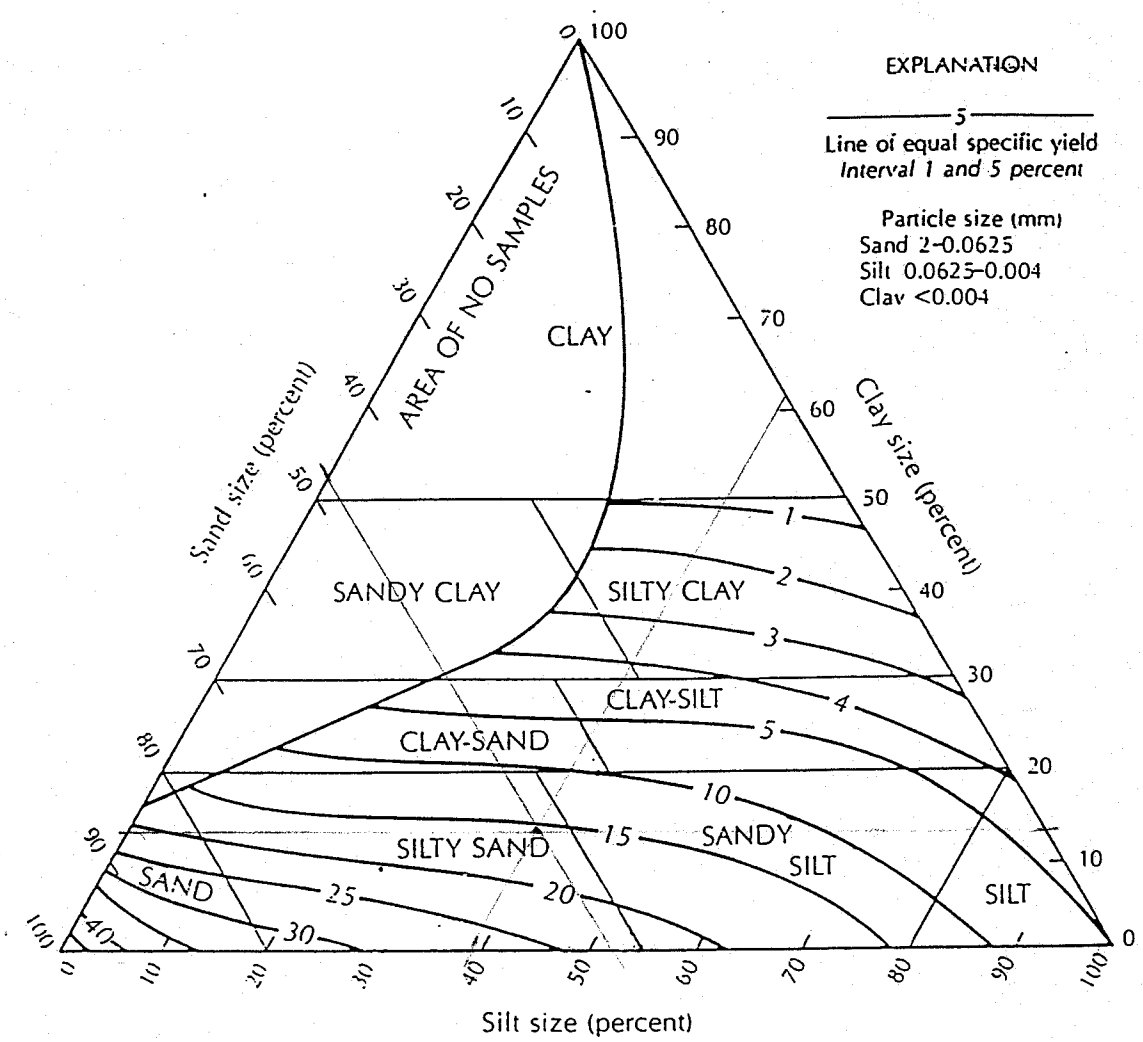


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P-8
Shelby Tube @ 39'
n = 14.5
Silty Sand

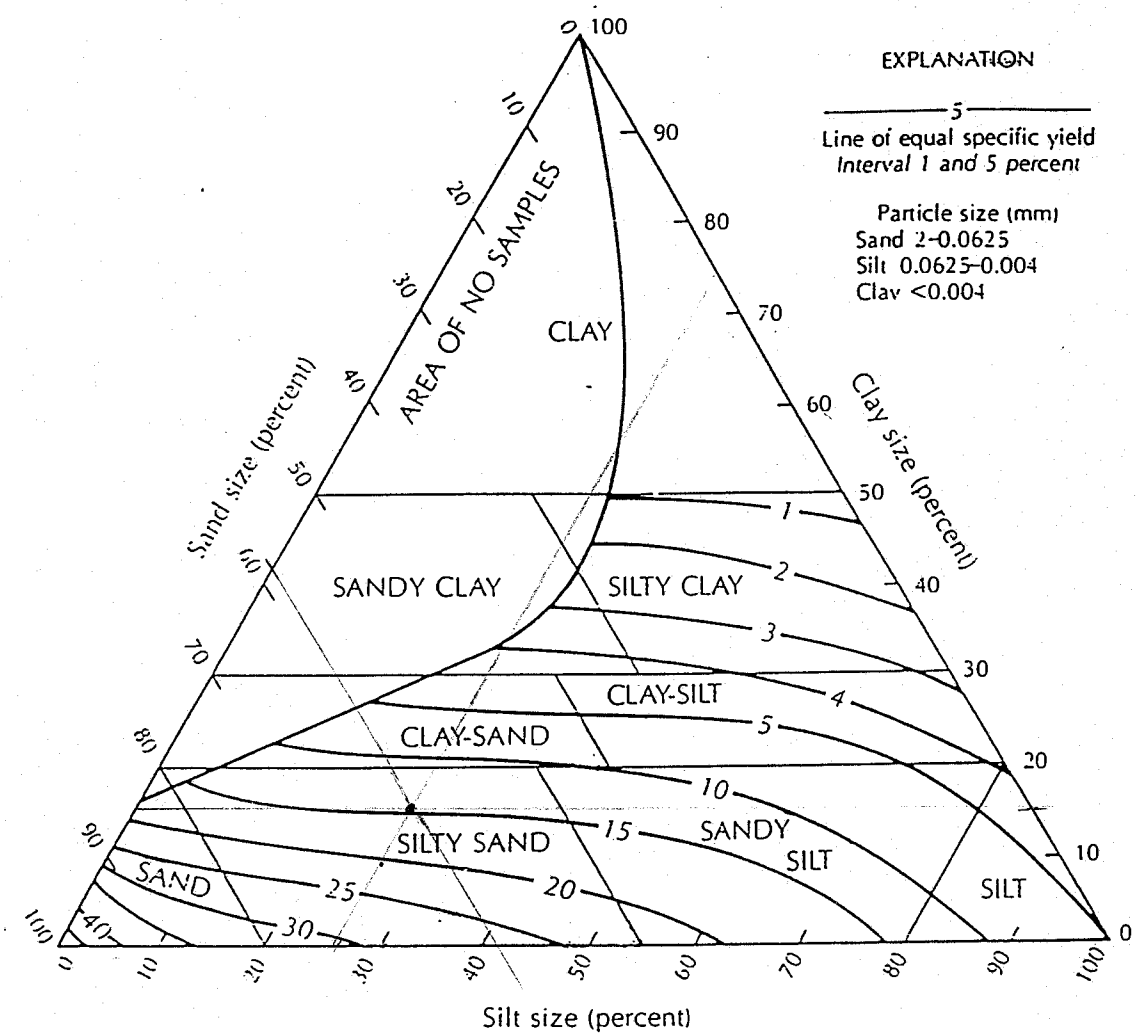


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P-8
Split Spoon @ 44-46'
n=8
clay silt

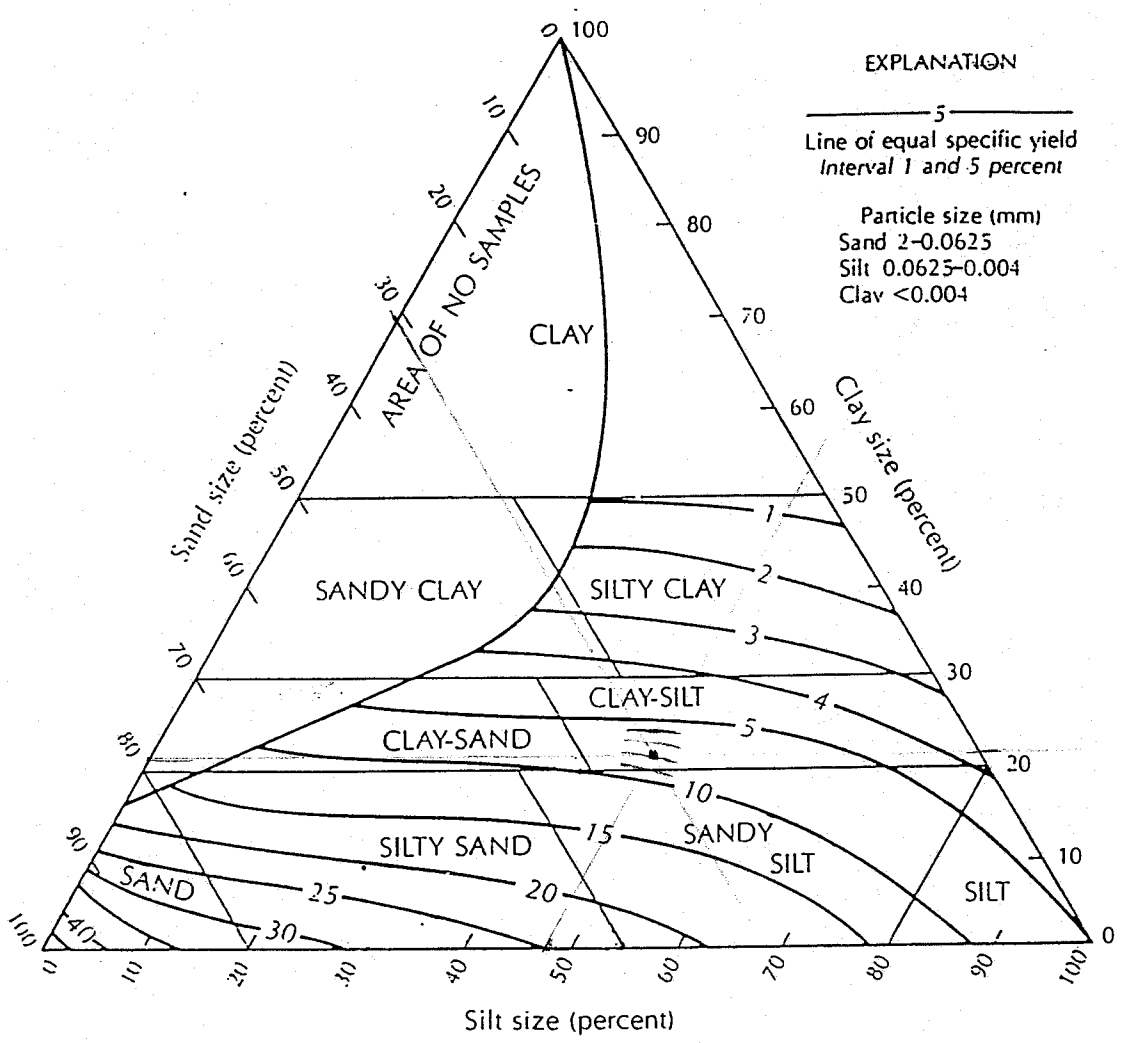


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P-9
Split Spoon @ 0-2'
n=1
Sandy Clay

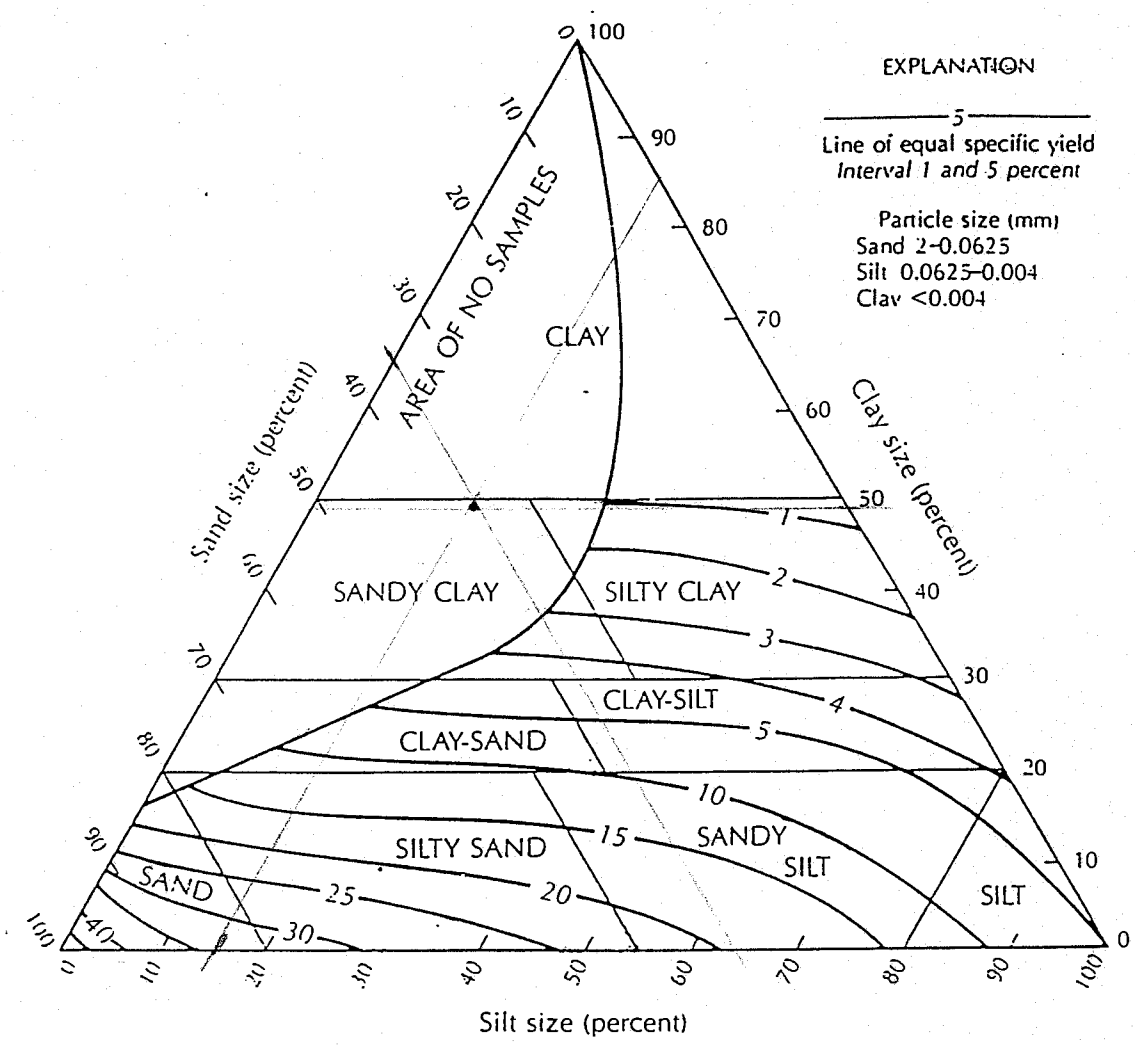


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P-9
Shelby Tube @ 8'
n=16
Silty Sand

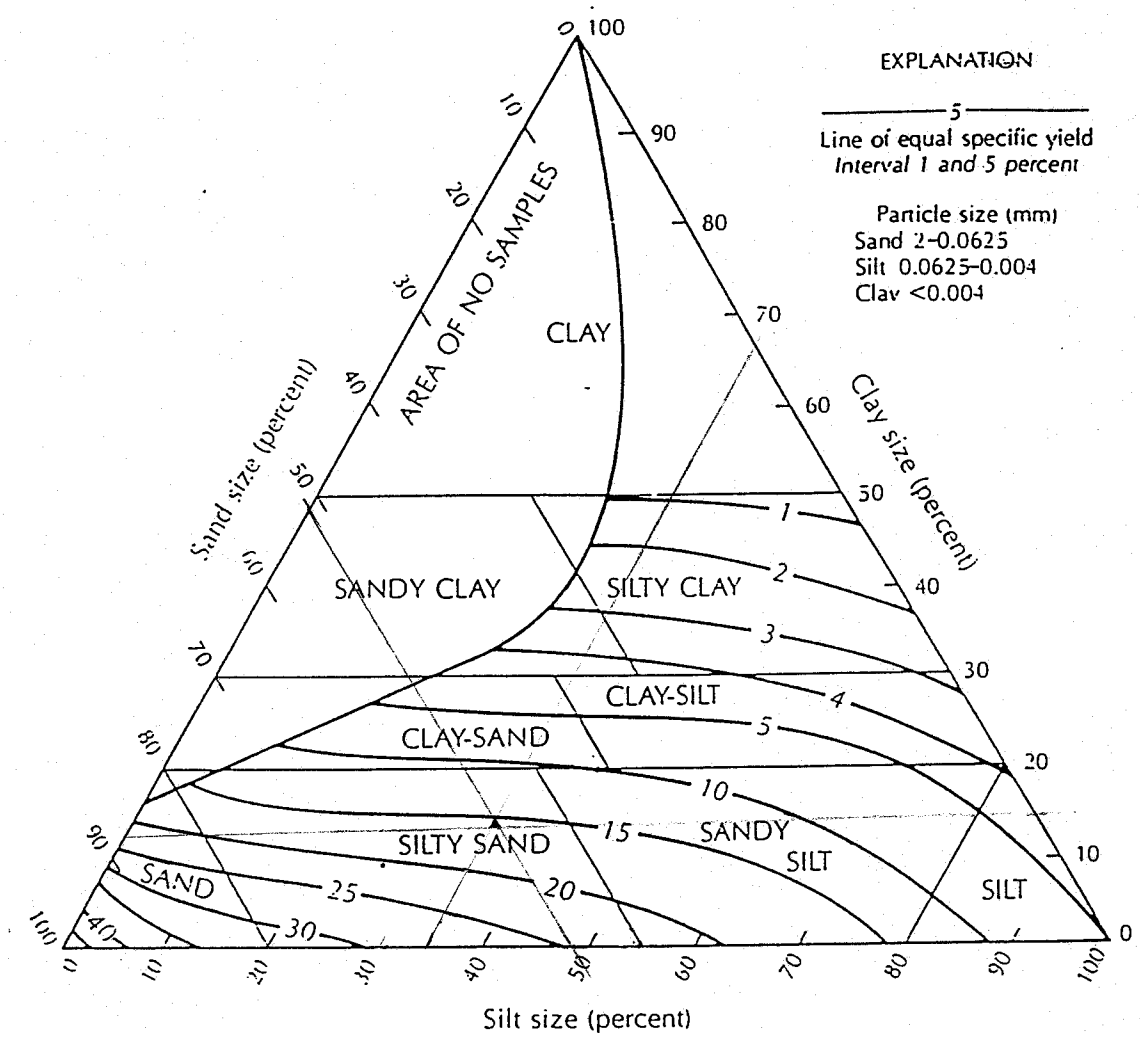


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P-14
Split Spoon @ 0-2'
n= 9.5
[illegible]y Silt

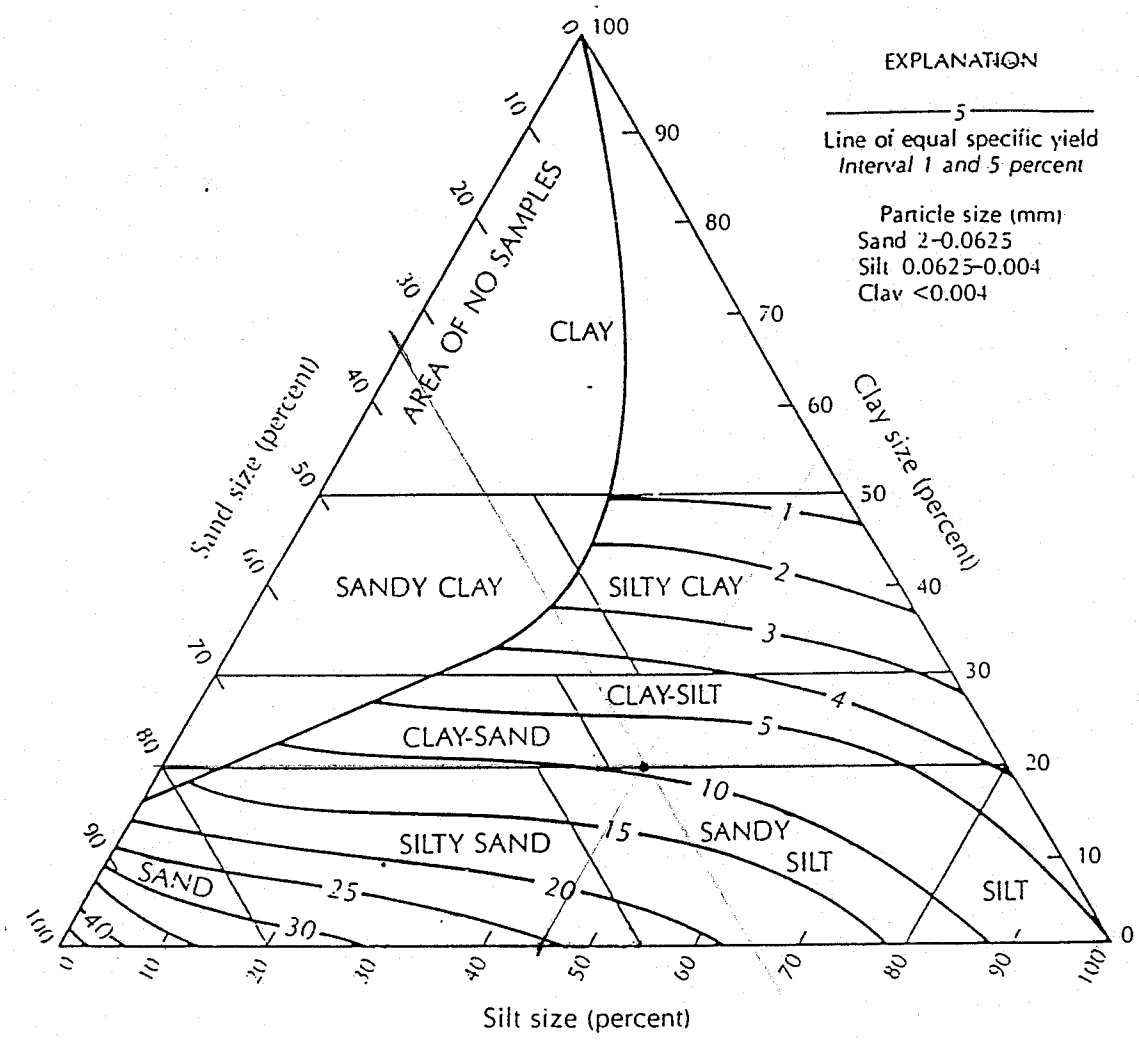


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

P-15.
Split Spoon @ 13-15'
n = 15.5
^ [illegible]dy Silt

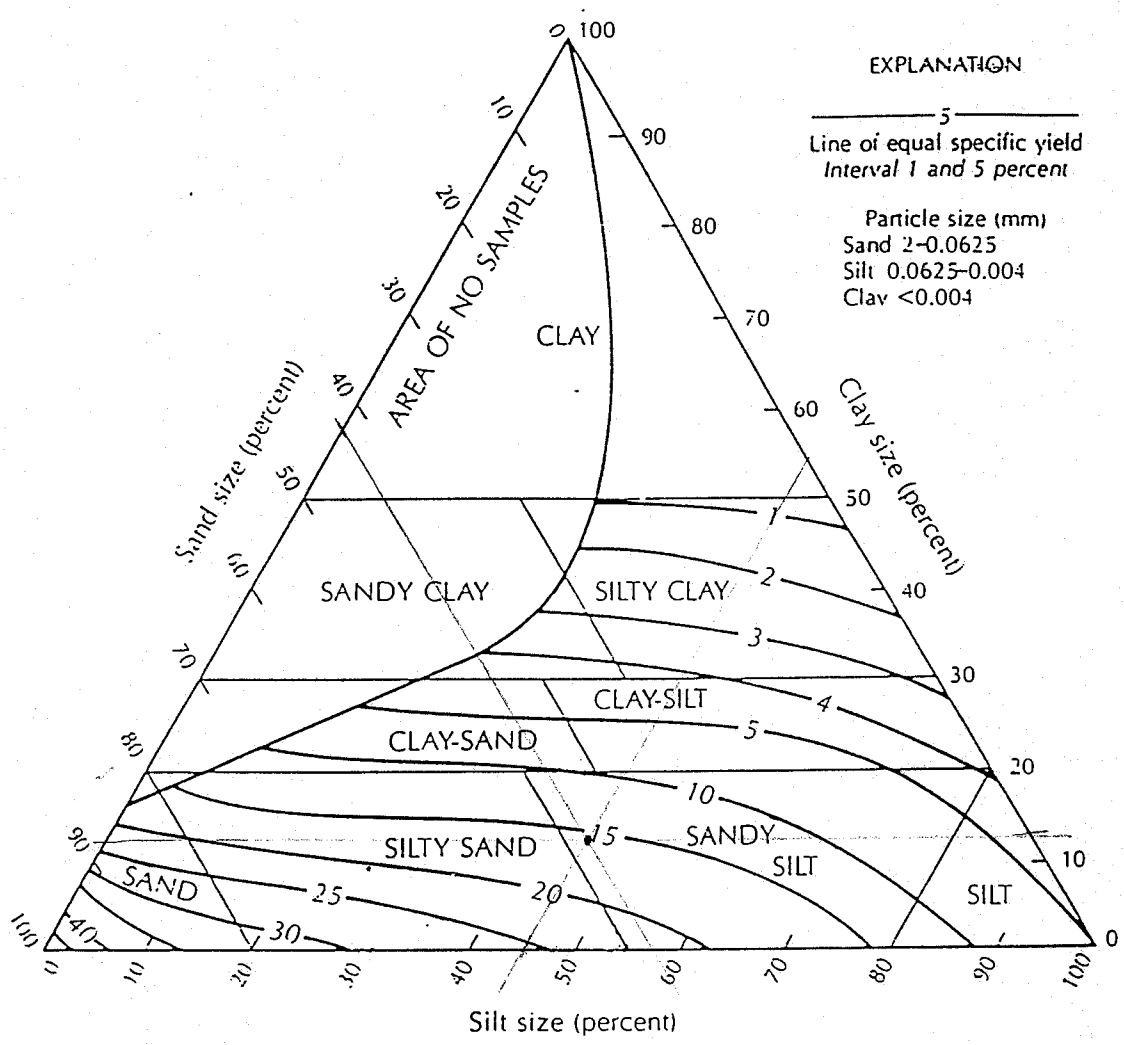


FIGURE 4.11 Textural classification triangle for unconsolidated materials showing the relation between particle size and specific yield. Source: A. I. Johnson, U.S. Geological Survey Water-Supply Paper 1662-D, 1967.

VAN DER HORST

GEOTECHNICAL ENGINEERING, P.C.
CONSTRUCTION MONITORING
MATERIALS TESTING
EXPLORATORY DRILLING

June 20, 1998

Mr. Jim Skinner
Municipal Engineering Services
P.O. Box 97
Garner, NC 27529

Re: Geotechnical soils Laboratory Test Summary
Haywood County Landfill
Haywood, NC
VNC-98-018.002

Dear Jim:

VANDERHORST Geotechnical Engineering, PC is pleased to present our laboratory test results for the above referenced project. Laboratory testing was conducted on samples delivered to our office on 06/05/98.

The attached table presents laboratory test results for natural moisture content (ASTM D-2216), grain-size with hydrometer(ASTM D-442), atterberg limits (ASTM D-4318), specific gravity (ASTM D-854) and shelby tube permeability (ASTM D-5084). Also attached please find laboratory test reports presenting the grain-size distribution, Atterberg Limits, natural moisture content and hydraulic conductivity.

The tube permeability tests were conducted at confining pressure that were approximate to the in-situ confining pressure for the depths that the samples were obtained, and a hydraulic gradient of 5.

Should you have any questions or need additional information, please do not hesitate to contact our office.

Respectfully Submitted,

Robert L. Mashewske

Robert L. Mashewske, P.E.
Regional Manager / Senior Engineer

535 Summit Point Drive
[illegible] NY [illegible]

3101 Stonybrook Drive, Suite 156
Raleigh NC 27604

VAN DER HORST

HAYWOOD COUNTY LANDFILL
VNC-98-018.002

Laboratory Testing Summary

Test Method	98-219 (P-9@ 8')	98-220 (P-8@ 39')	98-221 (P-1@ 3-5')	98-222 (P-8@ 44-46')	98-223 (P-9@ 0-2')	98-224 (P-14 @ 0-2')	98-225 (P-15@ 13-15')
Natural Moisture Content (ASTM D-2216)	22.2%	26.3%	21.7%	23.6%	26.6%	28.3%	13.4%
Atterberg Limits (ASTM D-4318)							
LL	37	48	NP	44	47	40	NP
PL	36	48	NP	41	28	36	NP
PI	1	0	NP	3	19	4	NP
Grain-size Analysis (ASTM D-442)							
% Gravel	0.0	0.0	0.0	0.1	0.5	0.0	0.0
% Sand	51.2	58.4	47.7	31.3	35.5	34.1	42.6
% Silt	34.3	26.3	39.2	47.5	15.3	45.7	45.0
% Clay	14.5	15.3	13.1	21.1	48.8	20.0	12.4
Specific Gravity (ASTM D-854)	2.72	2.73	2.83	2.74	2.68	2.75	2.65
USCS Soil Classification	SM	SM	SM	ML	ML	ML	ML
Shelby Tube Permeability (ASTM D-5084)							
Dry Density (pcf)	82.4	82.5	--	--	--	--	--
Moisture (%)	22.2	26.9	--	--	--	--	--
Permeability (cm/sec)	1.5×10^{-4}	2.2×10^{-5}	--	--	--	--	--

Note: The atterberg for samples 98-219 & 98-220 were prepared using the wet method, all other atterberg samples were prepared using the dry method due to limited sample provided.

VAN DER HORST

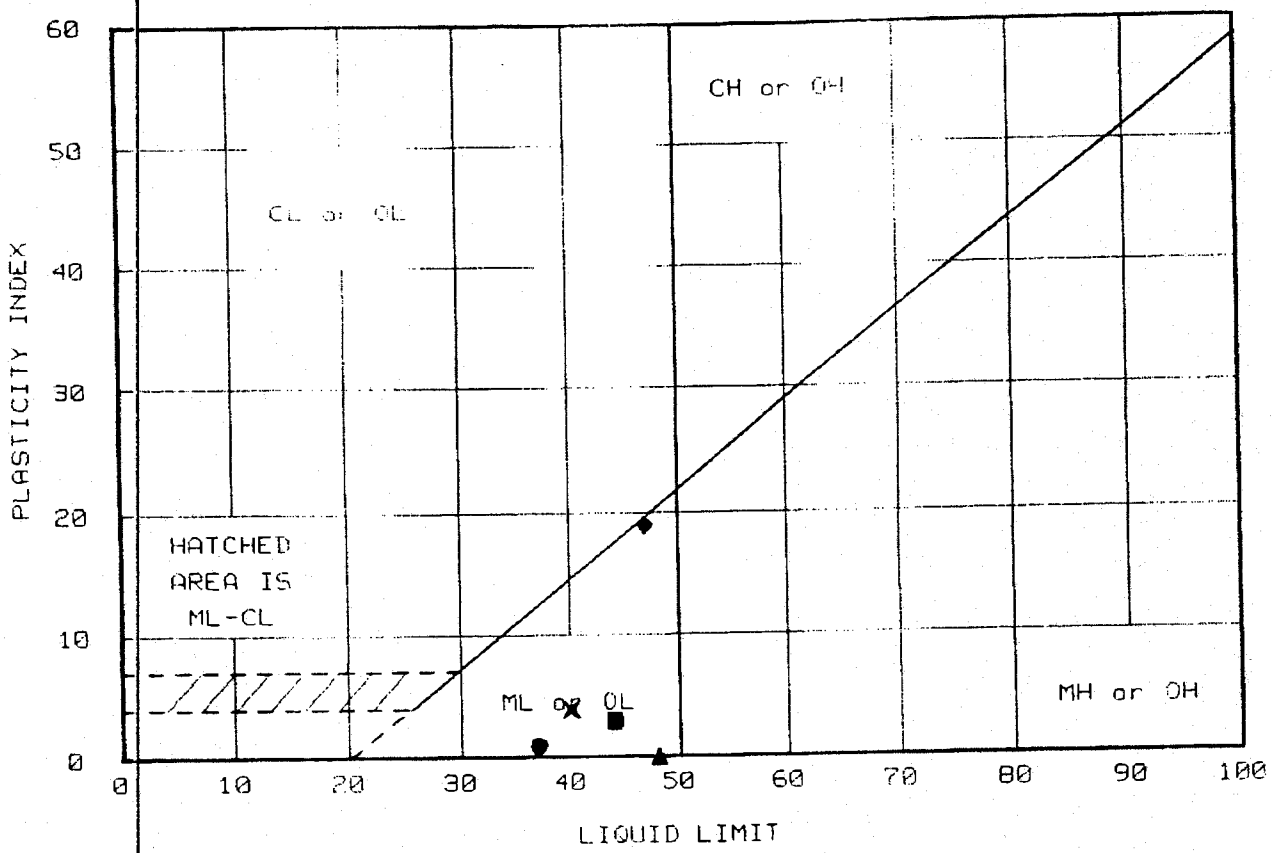
NATURAL MOISTURE CONTENT

DATE: 6-19-98
TECHNICIAN: W. Lupi
JOB NUMBER: VNC-98-018

HOLE NO.	P-9	P-8	P-1	P-8	P-9	P-14	P-15		
SAMPLE NO.	98-219	98-220	98-221	98-222	98-223	98-224	98-225		
DEPTH	8.0'	39.0'	3-5'	44-46'	0-2'	0-2'	13-15'		
TARE NO.	G-7	G-5	G-6	G-9	LD	G-3	PC		
TARE WEIGHT	153.77	152.88	153.65	154.17	189.48	158.20	191.67		
W(^) + TARE	663.2	655.5	864.8	652.9	979.7	869.7	933.3		
W(S) + TARE	486.4	550.6	737.8	557.7	813.5	712.6	845.4		
W(w)	176.8	104.9	127.0	95.2	166.2	157.1	87.9		
W(s)	332.63	397.72	584.75	403.53	624.02	554.4	653.73		
W - % WATER CONTENT	22.2	26.3	21.7	23.6	26.6	28.3	13.4		

HOLE NO.									
SAMPLE NO.									
DEPTH									
TARE NO.									
TARE WEIGHT									
W(^) + TARE									
W(S) + TARE									
W(w)									
W(s)									
W - % WATER CONTENT									

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location +	Description	LL	PL	PI	-200	ASTM D 2487-90
●	IL-219 P-9 (tube)	@ -8.0'	37	36	1	48.8	SM, Silty sand
▲	98-220 P-6 (tube)	@ -39'	48	48	0	35.6	SM, Silty sand
■	98-222 P-8 @ 44-46 '		44	41	3	68.6	ML, Sandy silt
◆	98-223 P-9 @ 0-2'		47	28	19	64.2	ML, Sandy silt
×	98-224 P-14 @ 0-2'		40	36	4	65.8	ML, Sandy silt

Project No.: VNC-98-018
Project: Haywood Landfill

Client: MESCO
Location: Haywood

Date: 6-19-98

Remarks:
Samples delivered to VAN DER HORST and identified as indicated.

LIQUID AND PLASTIC LIMITS TEST REPORT

VAN DER HORST ENGINEERING

Fig. No. 219

VANDERHORST

PERMEABILTY TEST REPORT
ASTM D5084

Date: 06/15/98
Report No.: P-001

Project No.: VNC-98-018
Sample No. 98-219

Project: Haywood Landfill
Client: MESCO

Test Summary

Permeability	1.46E-04	cm/sec
% Moisture	22.2	%
Dry Density	82.4	pcf

Sample Information

Specimen Type:
Remolded ____
Tube X

Date Sampled: 06/10/98
Location: P-9 @ -8 feet

Specimen Data

Lenght (in):	4.023
Diameter (in.):	2.88
Area (sq. in.):	6.526
Volume (cu. in.):	26.25
Wet Weight (grams):	693.5
Dry Weight (grams):	567.6
Dry Density (pcf):	82.4

Moisture Content Test Data

Wet weight	133.03
Dry Weight	112.89
Tare weight	22.11
% Moisture	22.2

Test Data

Confining Pressure 7.0 psi

△T	H	Inflow (B)	Outflow (C)	B/C ratio	Q	k
1.25	27.69	3.20	3.10	0.97	3.15	1.46E-04
0.75	27.69	2.60	2.60	1.00	2.60	2.01E-04
1.5	27.69	3.40	3.20	0.94	3.30	1.27E-04
1	27.69	1.90	1.90	1.00	1.90	1.10E-04

△T	Change in time (minutes)
H	Driving head (inches)
Inflow (B)	Flow in (cubic cemtimeters)
Inflow (C)	Flow out (cubic centimeters)
Q	Flow (cubic centimeters)

Permeability (k) **1.46E-04** cm/sec

Respecfully submitted R. Mashewske
Robert L. Mashewske, P.E.
Regional Manager

VANDERHORST

PERMEABILTY TEST REPORT
ASTM D5084

Date: 06/15/98
Report No.: P-002

Project No.: VNC-98-018
Sample No. 98-220

Project: Haywood Landfill
Client: MESCO

Test Summary

Permeability	2.22E-05	cm/sec
% Moisture	26.9	%
Dry Density	82.5	pcf

Sample Information

Specimen Type:
Remolded
Tube X

Date Sampled: 06/10/98
Location: P-8 @ -39 feet

Specimen Data

Lenght (in):	3.847
Diameter (in.):	2.839
Area (sq. in.):	6.341
Volume (cu. in.):	24.39
Wet Weight (grams):	670.2
Dry Weight (grams):	528.0
Dry Density (pcf):	82.5

Moisture Content Test Data

Wet weight	127.71
Dry Weight	105.27
Tare weight	21.92
% Moisture	26.9

Test Data

Confining Pressure 32.0 psi

△T	H	Inflow (B)	Outflow (C)	B/C ratio	Q	k
2	30.46	1.10	0.95	0.86	1.03	2.65E-05
3	30.46	1.40	1.35	0.96	1.38	2.37E-05
4	30.46	1.35	1.35	1.60	1.35	1.75E-05
5	30.46	2.05	2.05	1.00	2.05	2.12E-05

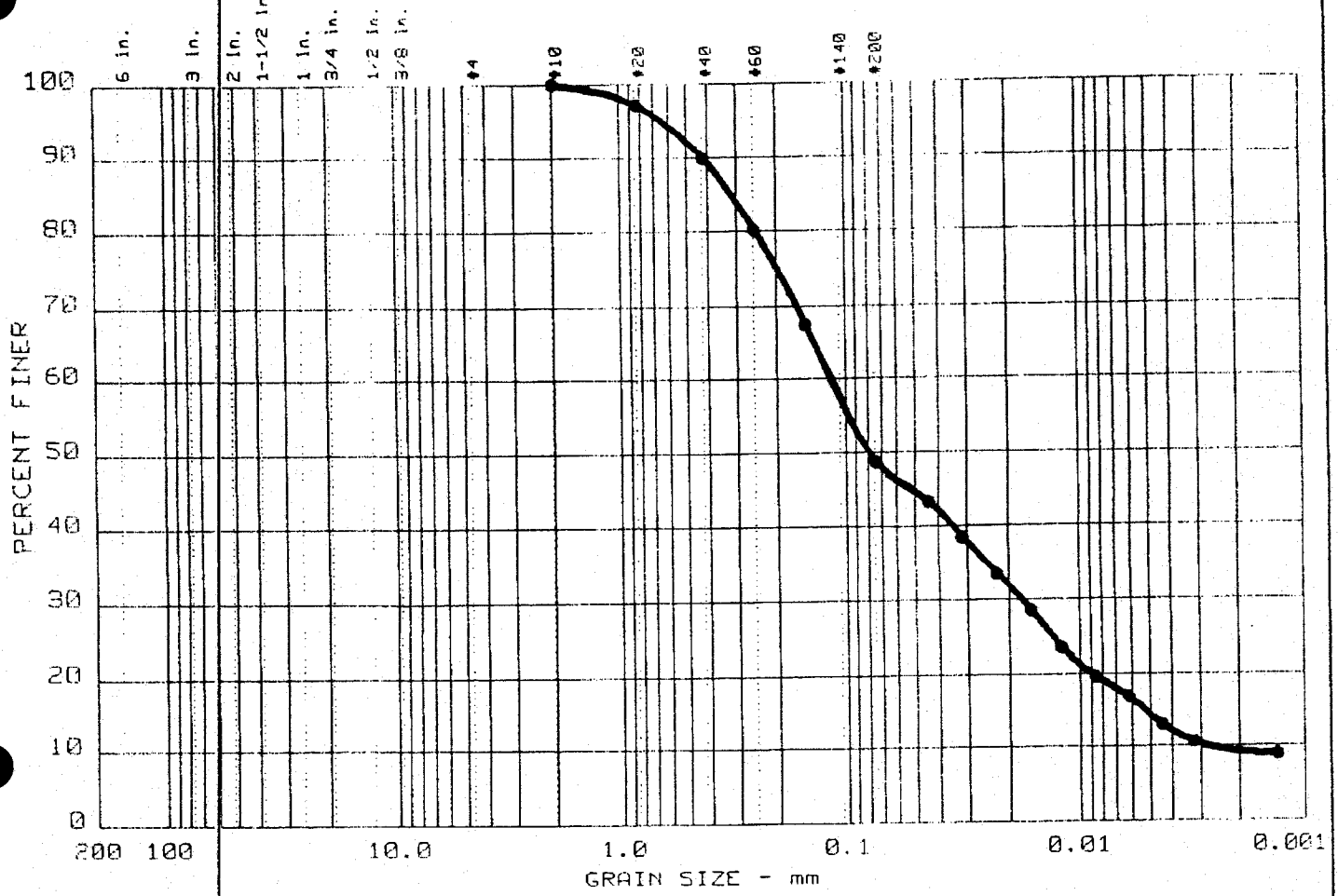
△T Change in time (minutes)
H Driving head (inches)
Inflow (B) Flow in (cubic cemtimeters)
Inflow (C) Flow out (cubic centimeters)
Q Flow (cubic centimeters)

Permeability (k) **2.22E-05** cm/sec

Respecfully submitted

Robert L. Mashewske, P.E.
Regional Manager

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	0.0	51.2	34.3	14.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	37	1	0.32	0.12	0.08	0.017	0.0052	0.0025	1.05	45.8

	MATERIAL DESCRIPTION	USCS	AASHTO
●	silty Sand, trace gravel	SM	

Project No.: VNC-98-018 / 98-219
Project: Haywood Landfill
Location: P-9 (Tube Sample) -8 Feet

Date: 6-18-98

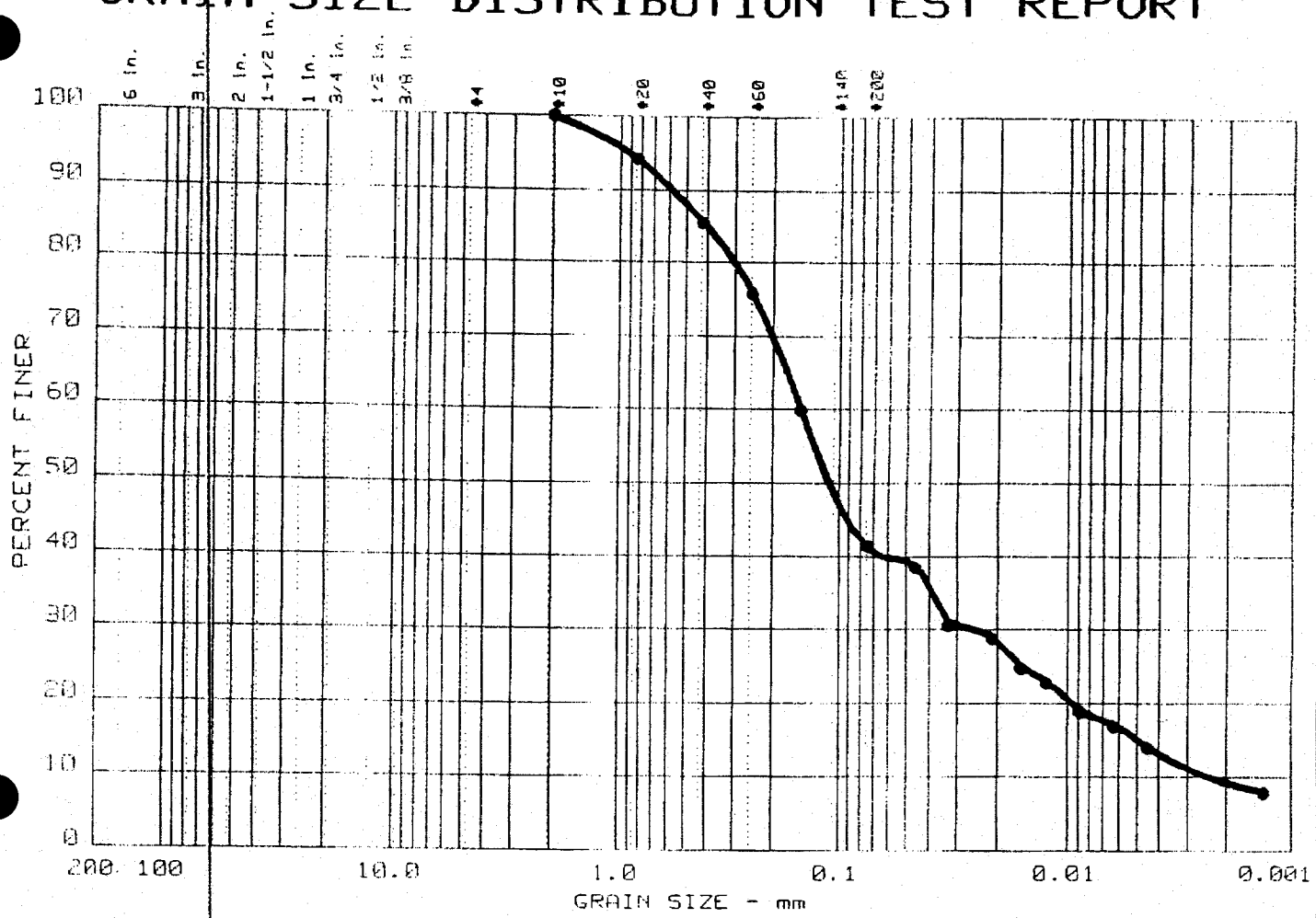
Remarks:
Sample delivered to VAN DER HORST by client.

GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Figure No. 219

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	0.0	58.4	26.3	15.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	48	0	0.40	0.15	0.11	0.025	0.0048	0.0023	1.86	66.1

MATERIAL DESCRIPTION	USCS	AASHTO
● Silty SAND, trace gravel (weathered rock)	SM	

Project No.: VNC-98-018 / 98-220
Project: Haywood Landfill
● Location: P-3 (Tube Sample) -39 Feet

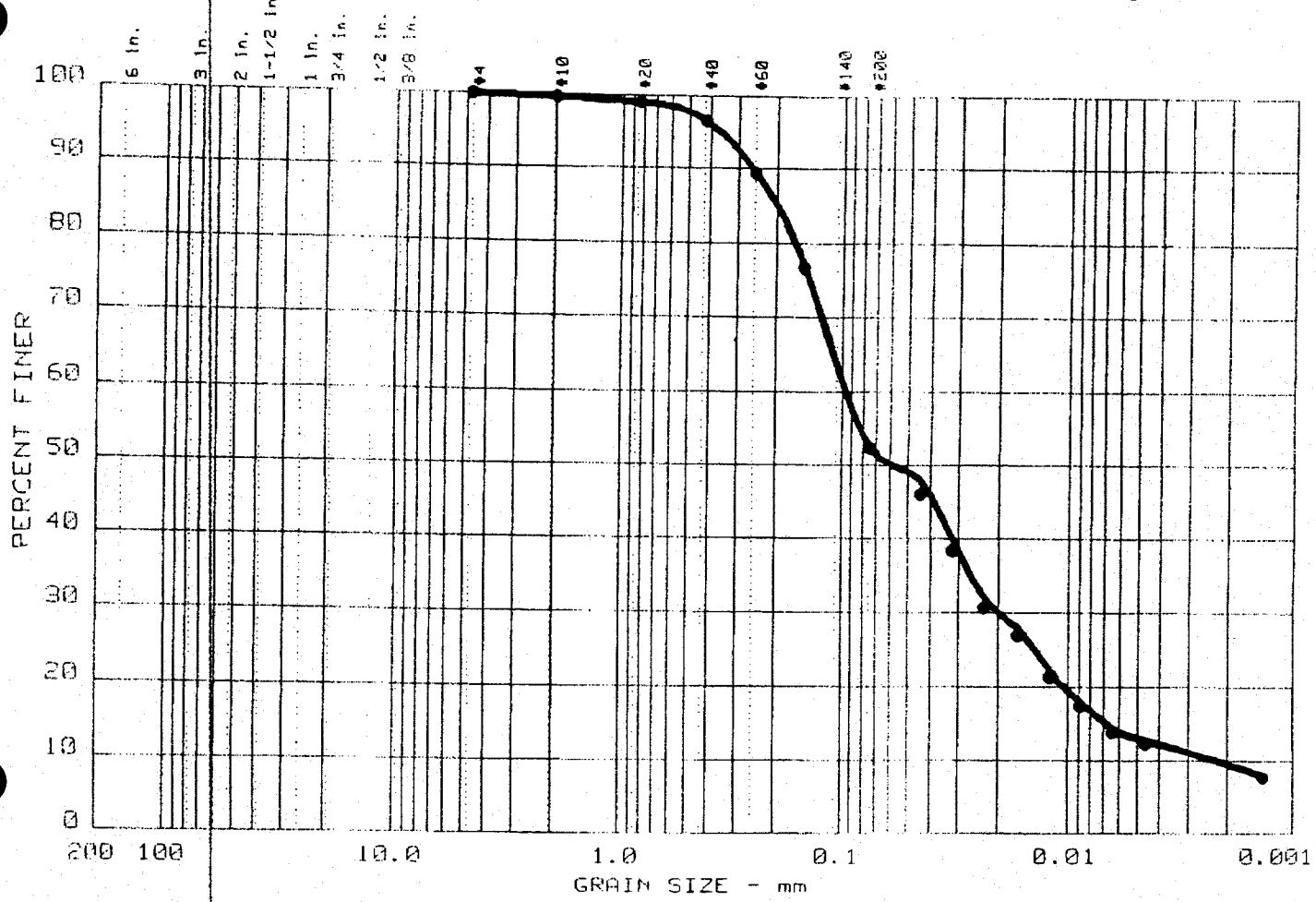
Date: 6-18-98

Remarks:
Sample delivered to VAN DER HORST by client.

GRAIN SIZE DISTRIBUTION TEST REPORT
VAN DER HORST ENGINEERING

Figure No. 220

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	0.0	47.7	39.2	13.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	0.20	0.10	0.06	0.020	0.0068	0.0021	1.88	45.2

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown SAND & SILT	SM	

Project No.: VNC-98-018 / 98-221
Project: Haywood Landfill
● Location: P-1 @ 3-5 feet

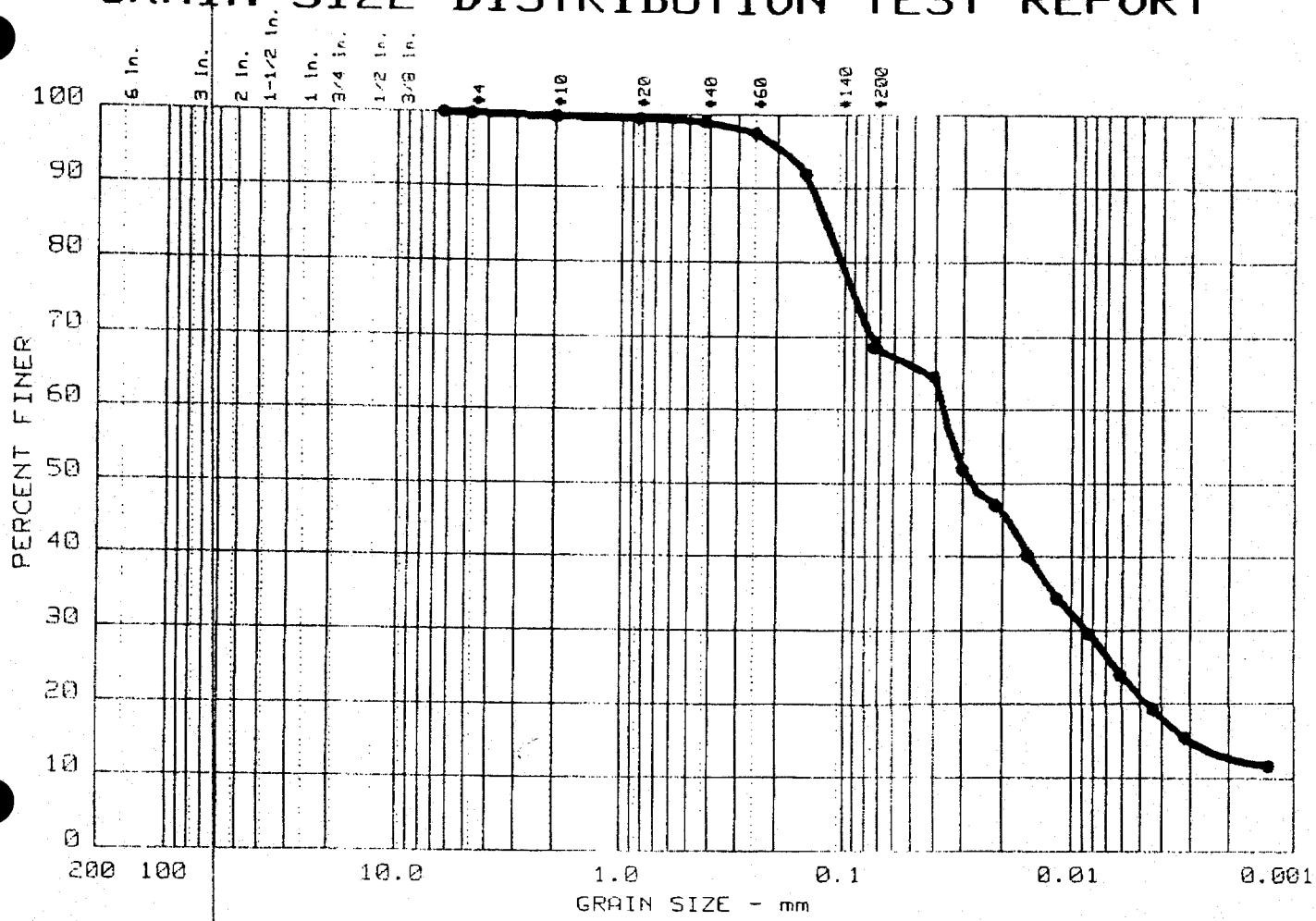
Date: 6-18-98

Remarks:
Sample delivered to VAN DER HORST by client.

GRAIN SIZE DISTRIBUTION TEST REPORT
VAN DER HORST ENGINEERING

Figure No. 221

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	13	0.0	0.1	31.3	47.5	21.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	44	3	0.12		0.03	0.009	0.0024			

MATERIAL DESCRIPTION	USCS	AASHTO
● Sandy SILT	ML	

Project No.: VNC-98-018 - 98-222
Project: Haywood Landfill
● Location: P-8 @ 44-46 feet

Date: 6-19-98

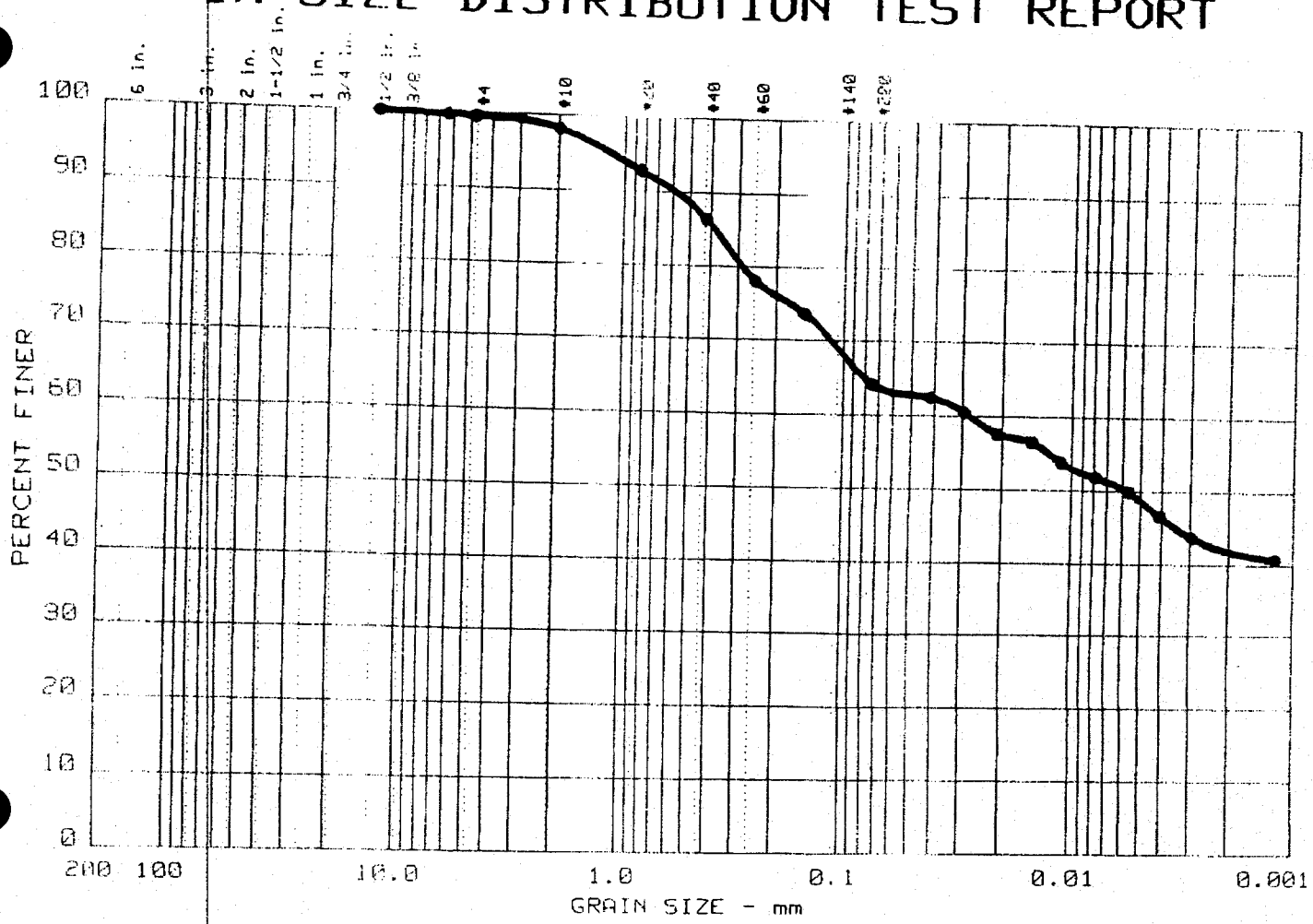
Remarks:
Sample delivered to VAN DER HORST by client.

GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Figure No. 222

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	14	0.0	0.4	35.5	15.3	48.8

	LL	PI	D_{65}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	47	19	0.38		0.01					

MATERIAL DESCRIPTION	USCS	AASHTO
● Sandy SILT	ML	

Project No.: VNC-98-018 / 98-223
Project: Haywood Landfill
● Location: P-9 @ 0-2 Feet

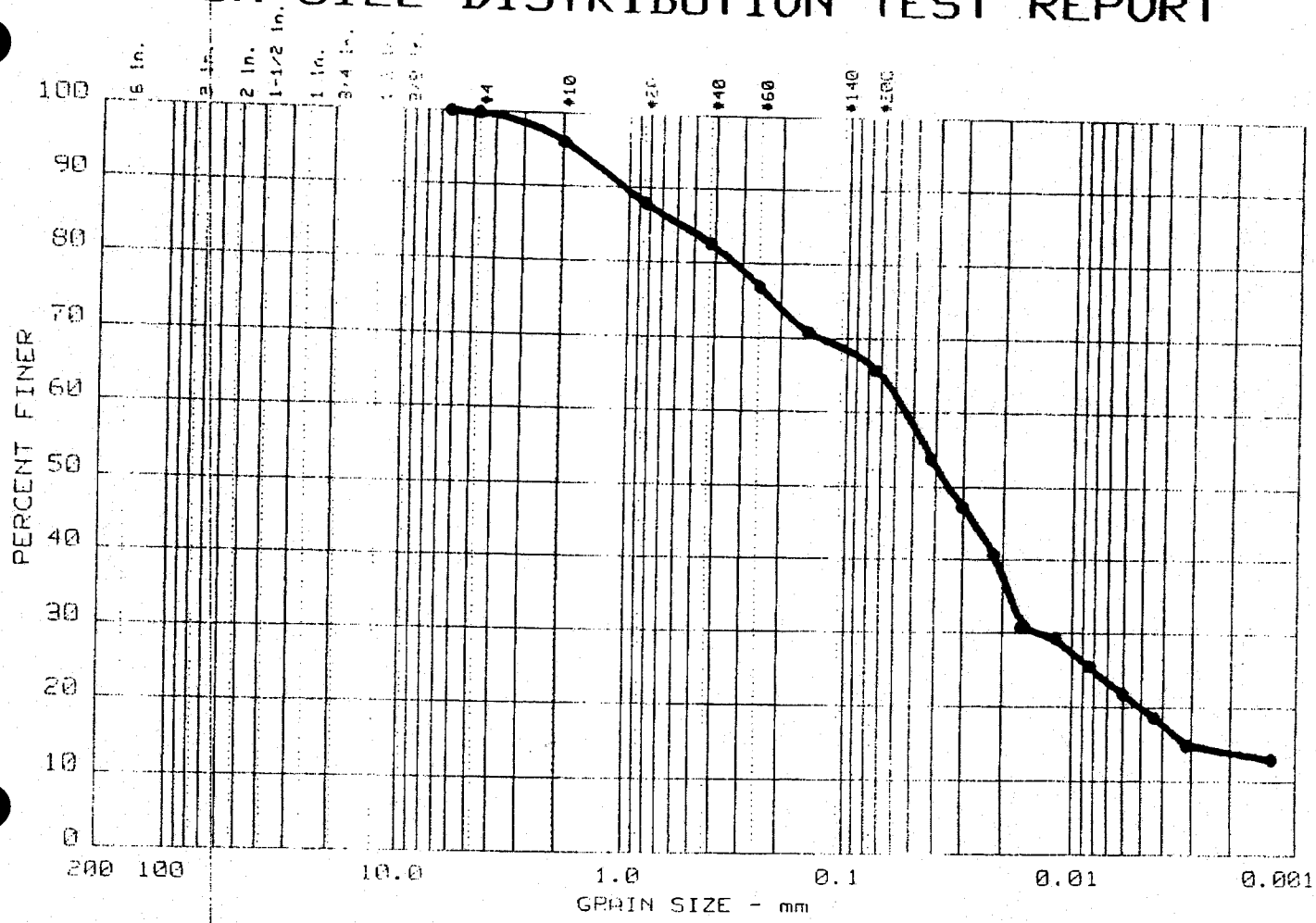
Date: 6-19-98

Remarks:
Sample delivered to VAN DER HORST by client.

GRAIN SIZE DISTRIBUTION TEST REPORT
VAN DER HORST ENGINEERING

Figure No. 223

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	15	0.0	0.2	34.1	45.7	20.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	40	4	0.57		0.04	0.013	0.0031			

MATERIAL DESCRIPTION	USCS	AASHTO
● Sandy SILT	ML	

Project No.: VNC-98-018 / 98-224
Project: Haywood Landfill
● Location: P-14 @ 0-2 Feet

Date: 6-19-98

Remarks:

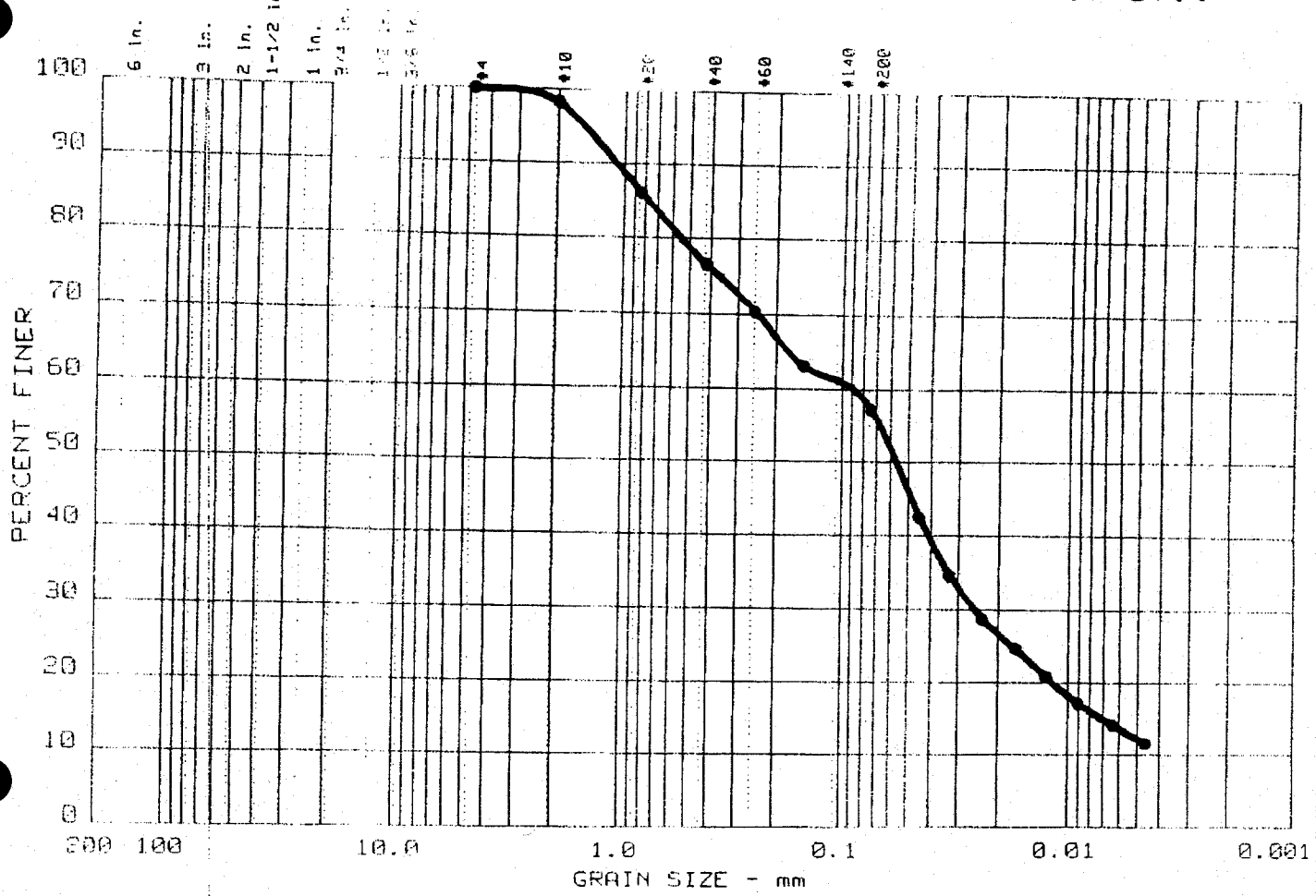
Sample delivered to VAN DER HORST by client.

GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Figure No. 224

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	16	0.0	0.0	42.6	45.0	12.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	0.78	0.09	0.06	0.025	0.0070			

MATERIAL DESCRIPTION	USCS	AASHTO
● sandy SILT	ML	

Project No.: VNC-98-018 / 98-225
Project: Haywood Landfill
● Location: P-15 @ 13-15 feet

Date: 6-19-98

Remarks:
Sample delivered to VAN DER HORST by client.

GRAIN SIZE DISTRIBUTION TEST REPORT
VAN DER HORST ENGINEERING

Figure No. 225

VAN DER HORST
GEOTECHNICAL ENGINEERING, P.C.
CONSTRUCTION MONITORING
MATERIALS TESTING
EXPLORATORY DRILLING

MUNICIPAL ENGINEERING SERVICES COMPANY
RECEIVED
MAY 22 1998

May 19, 1998

Mr. Jim Skinner
Municipal Engineering Services
P.O. Box 97
Garner, NC 27529

Re: Drilling Samples - Laboratory Test Summary
Haywood County Landfill
Haywood, NC
VNC-98-018.001

Dear Jim:

VANDERHORST Geotechnical Engineering, PC is pleased to present our laboratory test results for the above referenced project. Laboratory testing was conducted on samples picked up from your office on 05/04/98.

The attached table presents laboratory test results for natural moisture content (ASTM D-2216), grain-size with hydrometer(ASTM D-442), atterberg limits (ASTM D-4318), specific gravity (ASTM D-854) and shelby tube permeability (ASTM D-5084). Also attached please find laboratory test reports presenting the grain-size distribution and the atterberg limits.

The tube permeability tests were conducted at confining preasures that were equlivent with the depths that the samples were obtained, and a hydraulic gradient of 5.

Should you have any questions or need additional information, please do not hesitate to contact our office.

Respectfully Submitted,

William M. Lupi

William M. Lupi, EIT
Staff Engineer

535 Summit Point Drive
enrietta, NY 14467
6/359-2730
: 716/359-9668

3101 Stonybrook Drive, Suite 156
Raleigh, NC 27604
919/876-0405
Fax 919/876-0460

VAN DER HORST

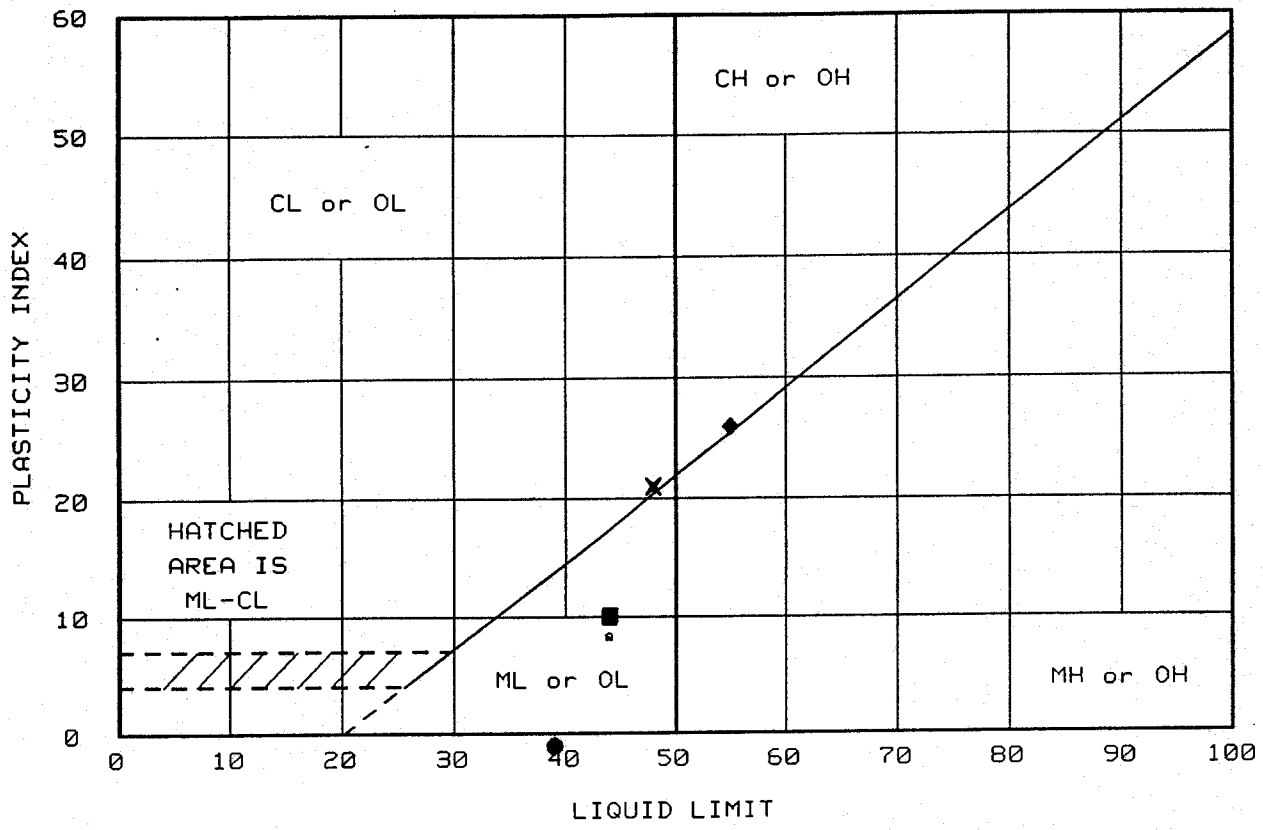
HAYWOOD COUNTY LANDFILL
VNC-98-018.001

Laboratory Testing Summary

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

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

LIQUID AND PLASTIC LIMITS TEST REPORT



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

NP - Non-Plastic

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

Client: MUNICIPAL ENGINEERING
Location: HAYWOOD, NORTH CAROLINA

Date: 05/13/98

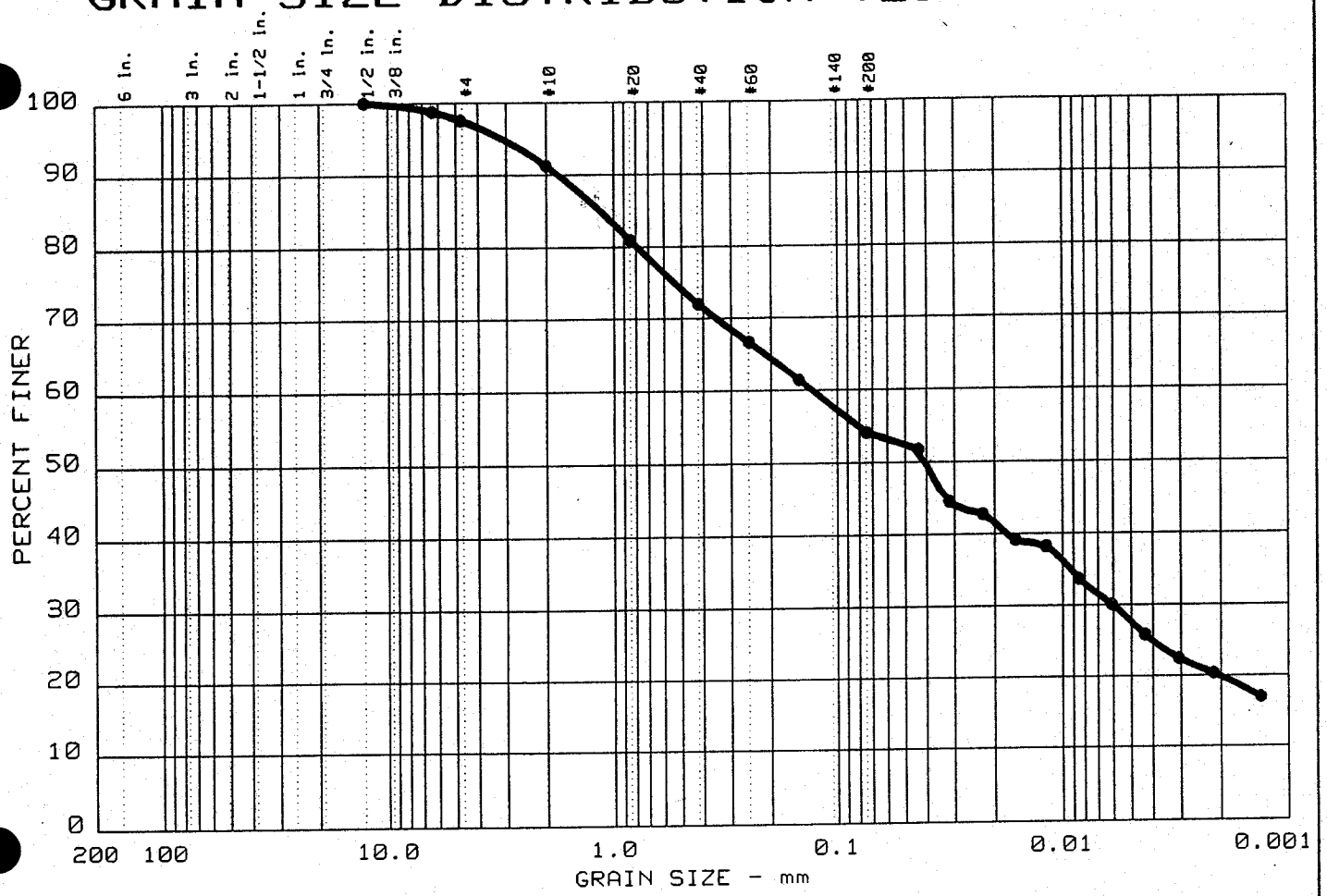
Remarks:
SAMPLES TAKEN FROM SHELBY TUBES AND DRILL CUTTINGS DELIVERED TO VANDERHORST ON 05/04/98.

LIQUID AND PLASTIC LIMITS TEST REPORT

VAN DER HORST ENGINEERING

Fig. No. 173

GRAIN SIZE DISTRIBUTION TEST REPORT



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

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

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

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

Date: 05/13/98

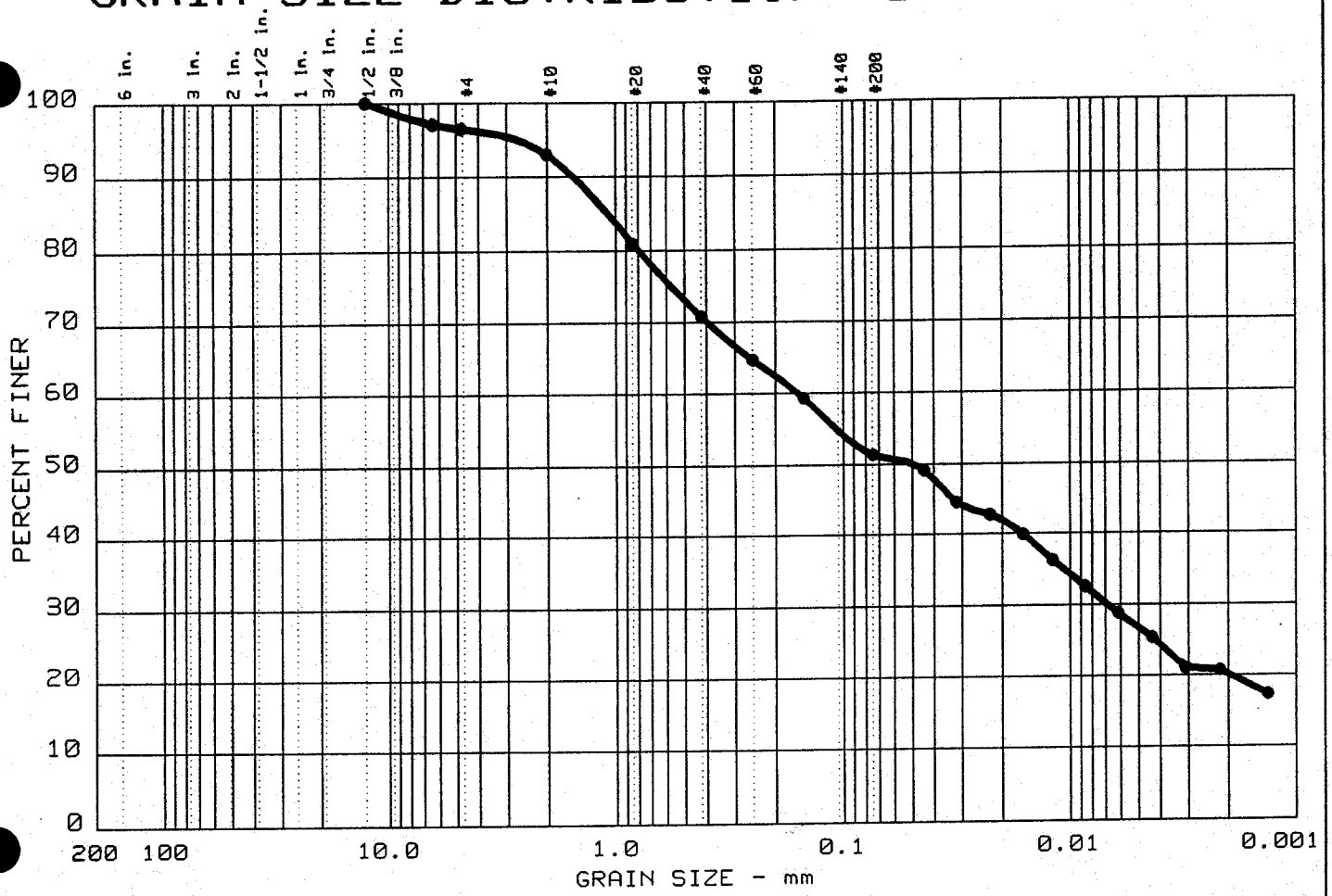
Remarks:
DRILL CUTTINGS SAMPLE
P2-1 @ 1-5', DELIVERED
TO VANDERHORST ON
05/04/98.

GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Figure No. 176

GRAIN SIZE DISTRIBUTION TEST REPORT



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

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

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

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

Date: 05/13/98

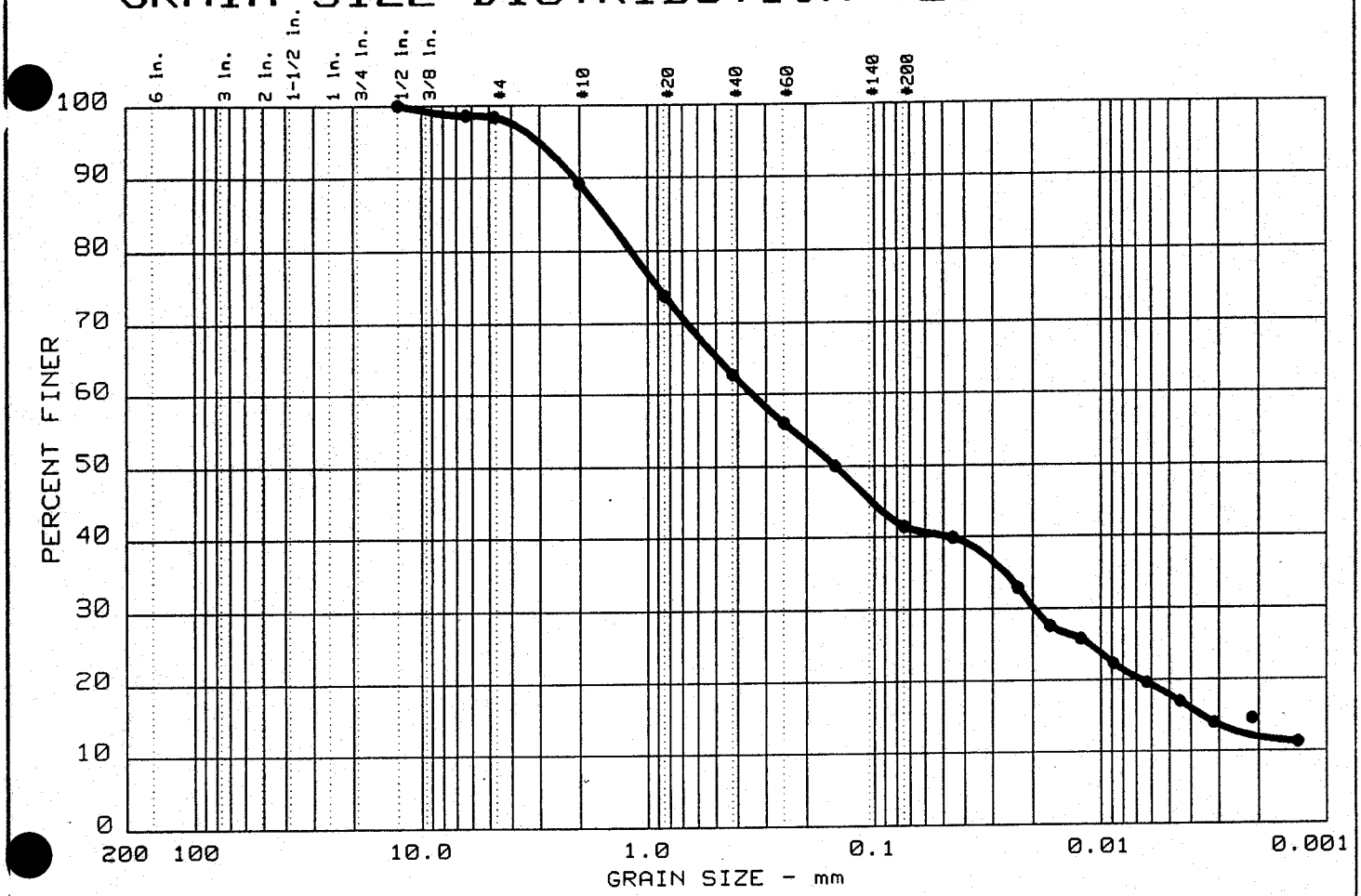
Remarks:
DRILL CUTTINGS SAMPLE
P2-1 @ 6-10', DELIVERED
TO VANDERHORST ON
05/04/98.

GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Figure No. 177

GRAIN SIZE DISTRIBUTION TEST REPORT



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

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

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

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

Date: 05/13/98

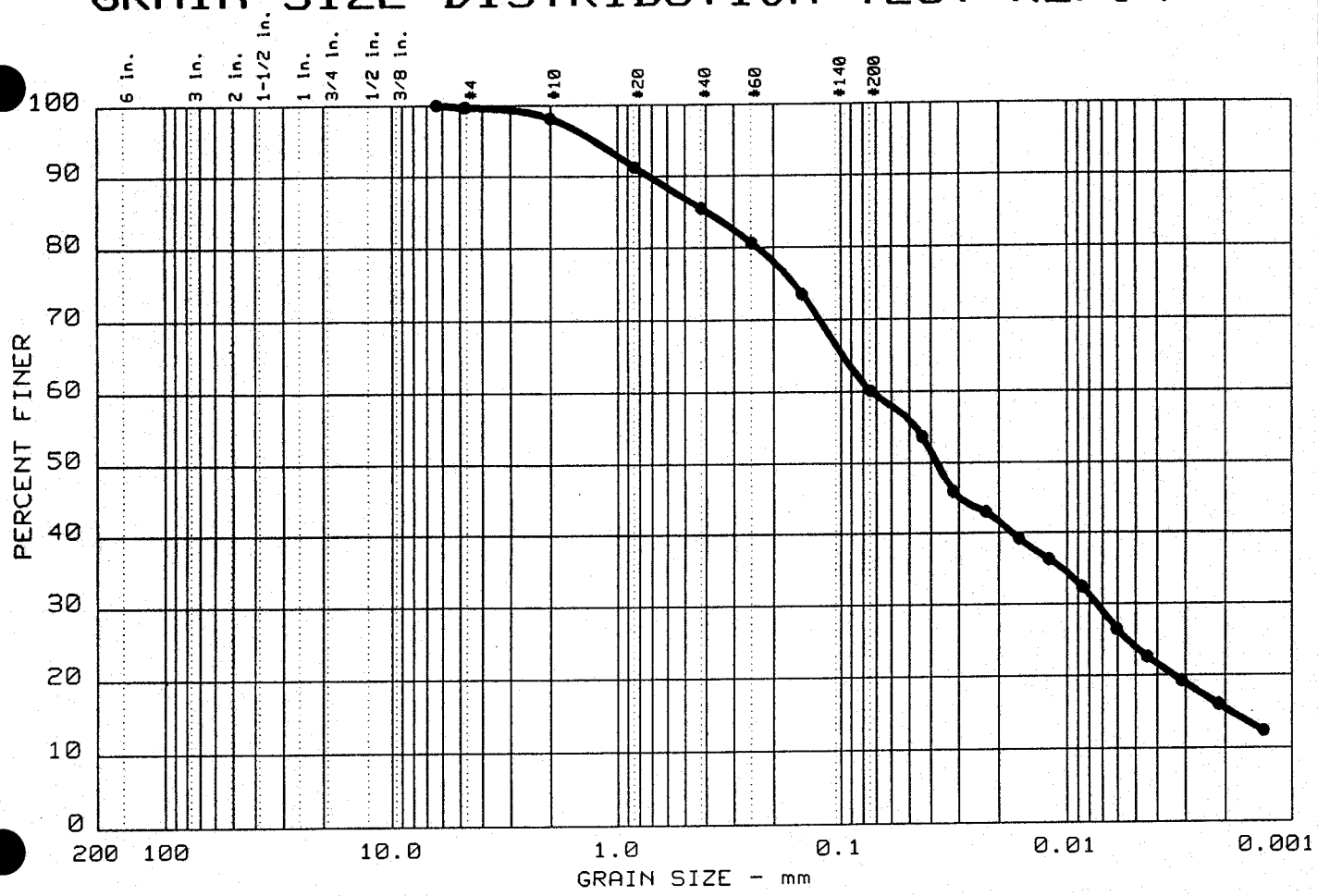
Remarks:
SHELBY TUBE SAMPLE
P2-1 @ 10-12', DELIVERED
TO VANDERHORST ON
05/04/98.

GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

Figure No. 173

GRAIN SIZE DISTRIBUTION TEST REPORT



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

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

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

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

te: 05/13/98

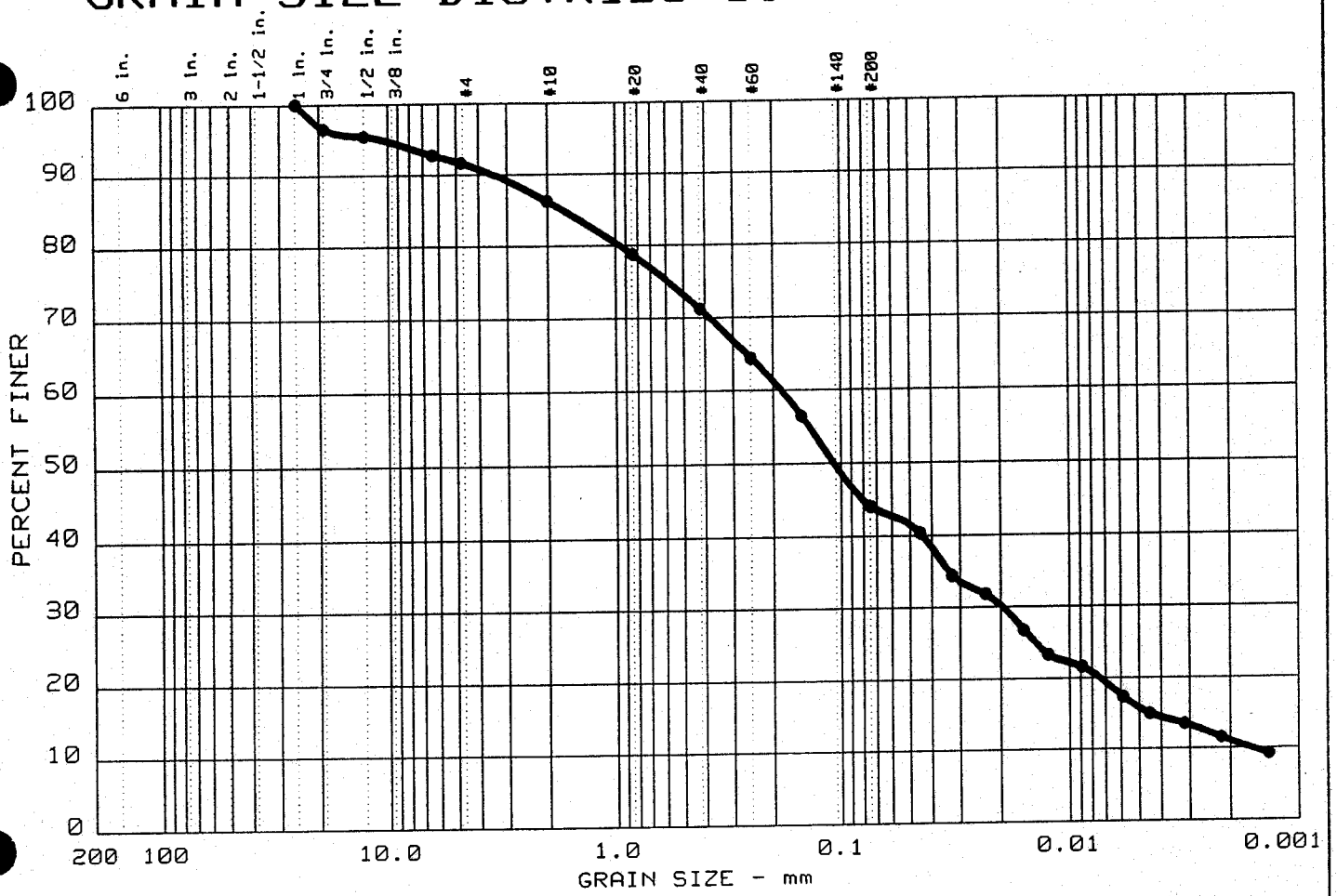
GRAIN SIZE DISTRIBUTION TEST REPORT

VAN DER HORST ENGINEERING

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

Figure No. 174

GRAIN SIZE DISTRIBUTION TEST REPORT



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

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

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

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

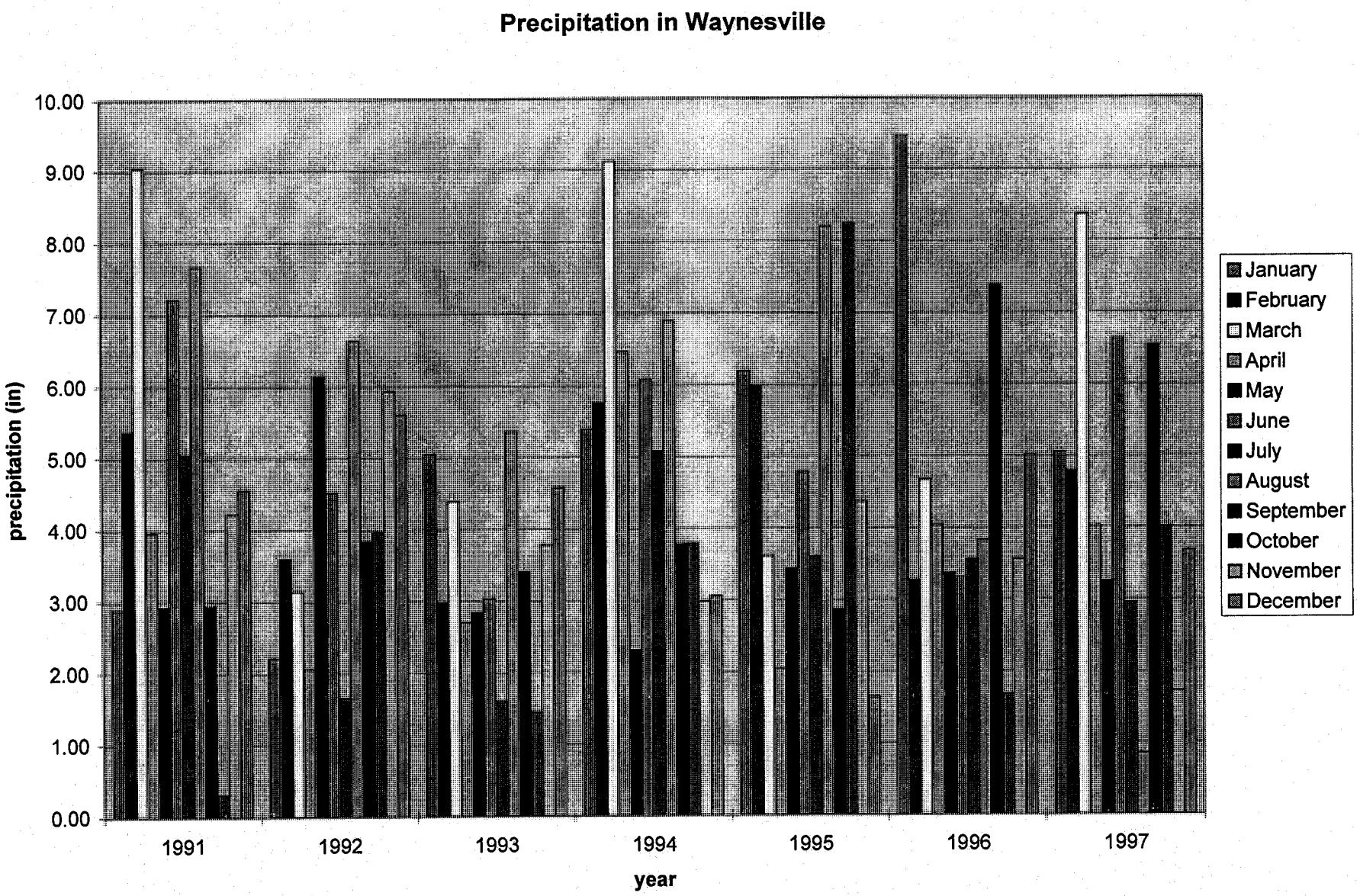
Date: 05/13/98

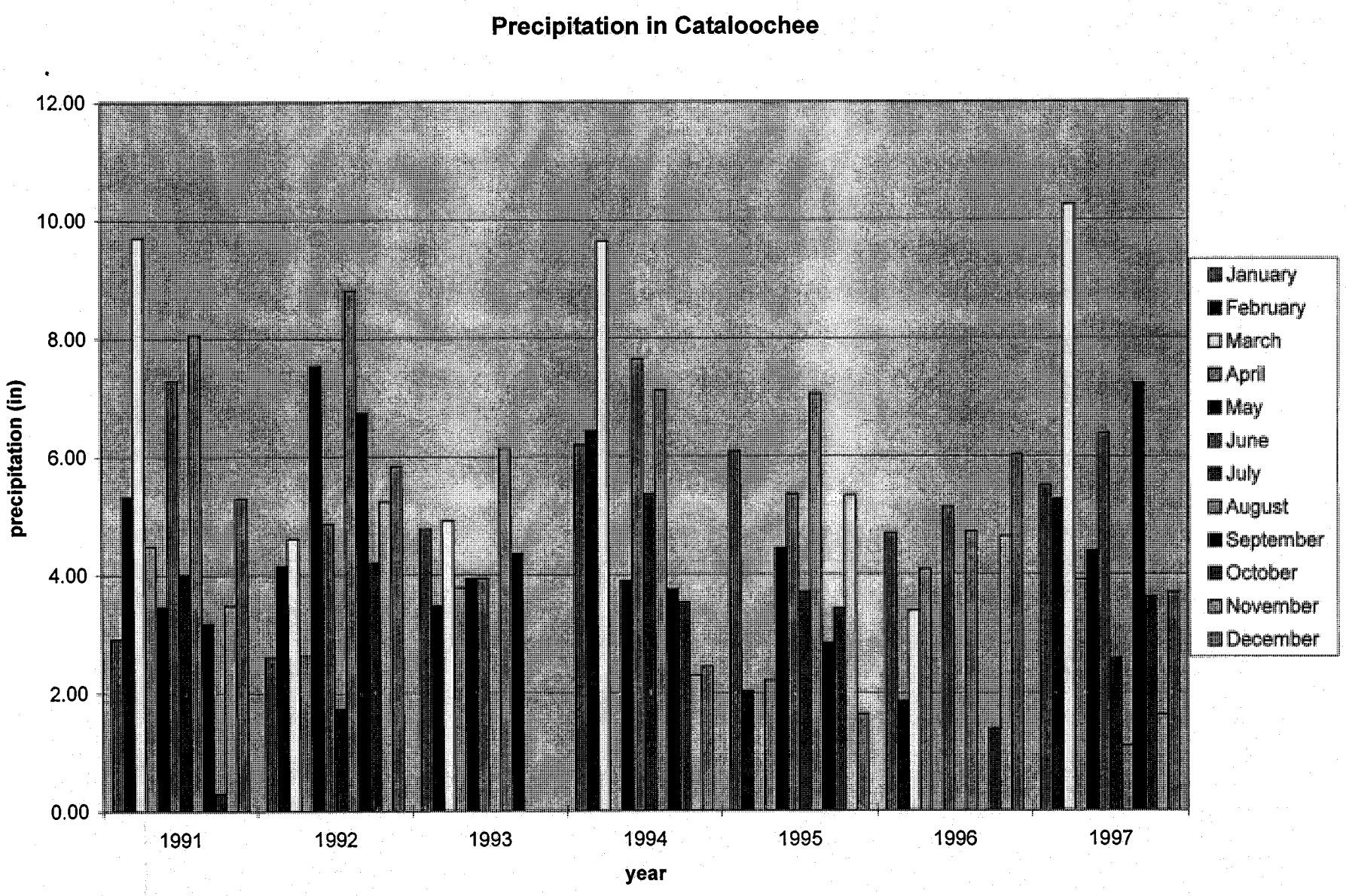
Remarks:
SHELBY TUBE SAMPLE
P2-2 @ 3-4', DELIVERED
TO VANDERHORST ON
05/04/98.

GRAIN SIZE DISTRIBUTION TEST REPORT

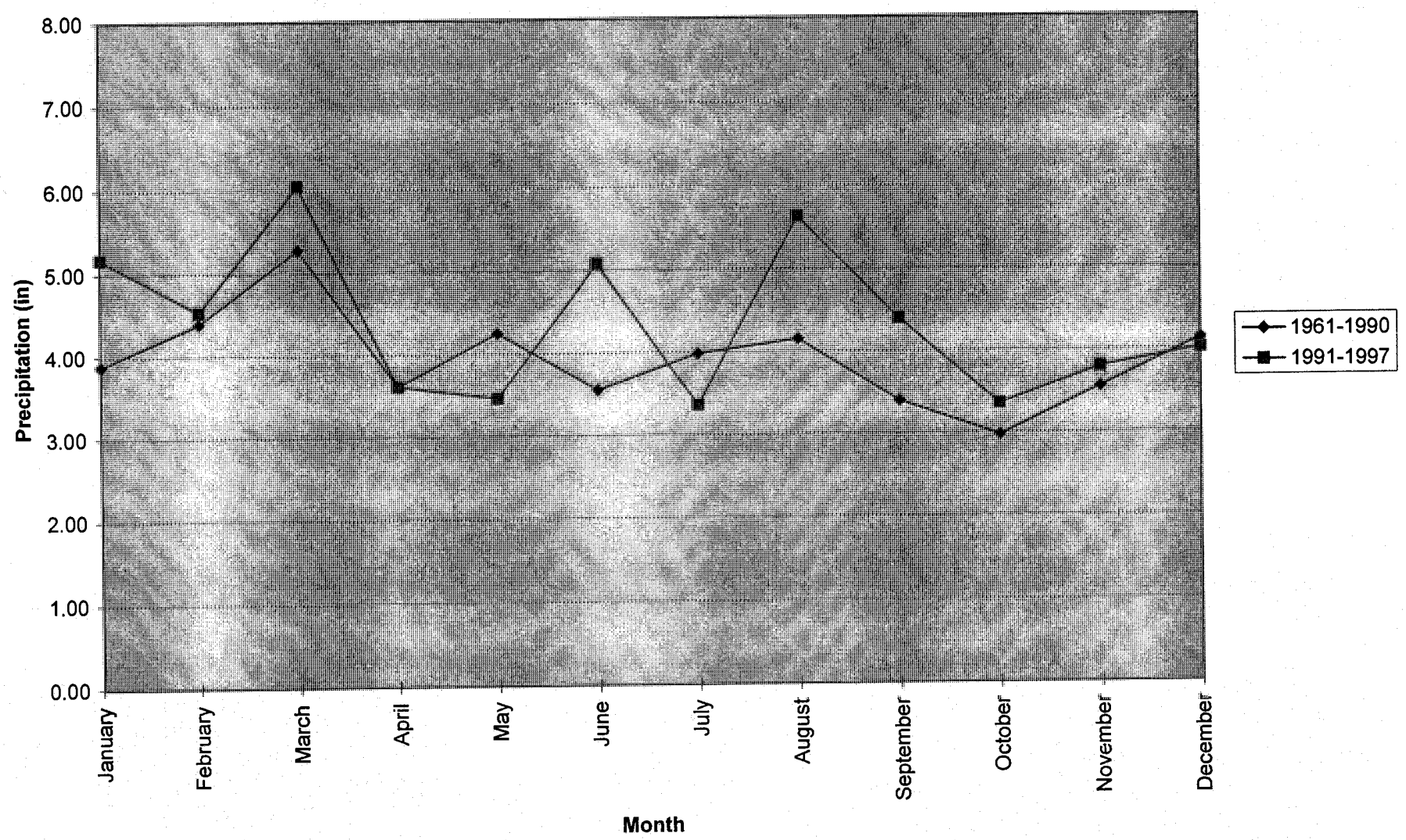
VAN DER HORST ENGINEERING

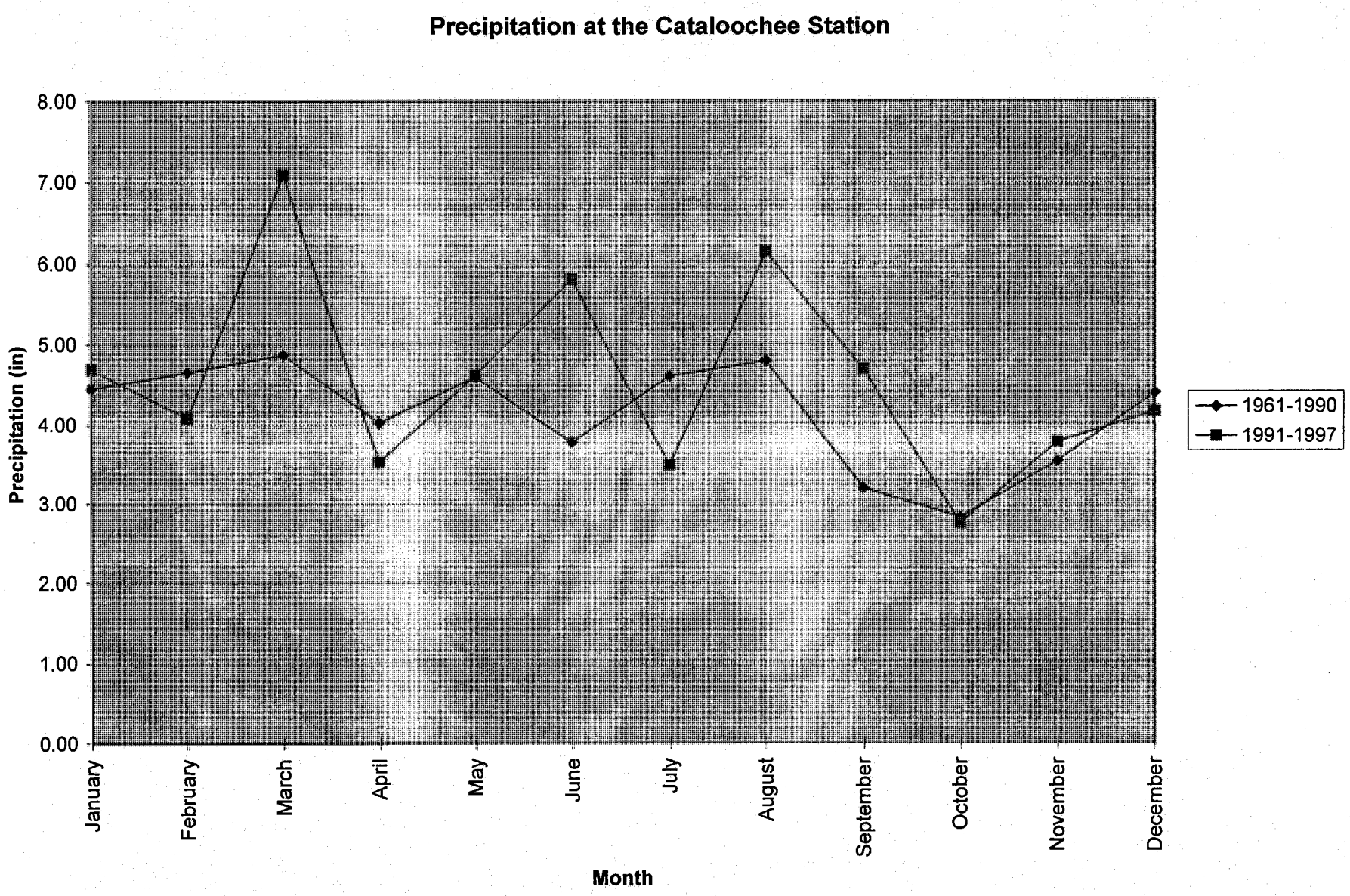
Figure No. 175


Precipitation in Waynesville
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
precipitation (in)
1991
1992
1993
1994
1995
1996
1997
year
January
February
March
April
May
June
July
August
September
October
November
December


Precipitation in Cataloochee
12.00
10.00
8.00
6.00
4.00
2.00
0.00
precipitation (in)
1991
1992
1993
1994
1995
1996
1997
year
January
February
March
April
May
June
July
August
September
October
November
December

Precipitation at the Waynesville Station




Precipitation at the Cataloochee Station
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Precipitation (in)
January
February
March
April
May
June
July
August
September
October
November
December
Month
1961-1990
1991-1997

Station: (319147) WAYNESVILLE_EXP_STN Element: Precipitation (in)	1961-1990	1991	1992	1993	1994	1995	1996	1997	1998	1991-1997
January	3.88	2.89	2.22	5.04	5.39	6.19	9.46	5.05	10.02	5.18
February	4.39	5.37	3.59	2.98	5.75	5.99	3.27	4.78	7.31	4.53
March	5.28	9.04	3.14	4.39	9.12	3.61	4.67	8.36	2.98	6.05
April	3.61	3.96	2.06	2.70	6.46	2.04	4.03	4.02	8.54	3.61
May	4.25	2.92	6.14	2.83	2.30	3.43	3.36	3.24	-	3.46
June	3.55	7.21	4.52	3.03	6.08	4.78	3.30	6.63	-	5.08
July	3.98	5.06	1.66	1.60	5.08	3.60	3.56	2.94	-	3.36
August	4.15	7.67	6.63	5.36	6.89	8.20	3.82	0.85	-	5.63
September	3.39	2.94	3.84	3.40	3.78	2.86	7.38	6.53	-	4.39
October	2.97	0.31	3.96	1.45	3.79	8.24	1.67	4.01	-	3.35
November	3.55	4.22	5.93	3.77	2.98	4.37	3.56	1.71	-	3.79
December	4.13	4.55	5.60	4.58	3.05	1.64	5.01	3.67	-	4.01

Station: (311564) CATALOOCHEE Element: Precipitation (in)	1961-1990	1991	1992	1993	1994	1995	1996	1997	1998	1991-1997
January	4.45	2.92	2.61	4.78	6.20	6.09	4.70	5.51	7.13	4.69
February	4.65	5.32	4.15	3.48	6.43	2.03	1.85	5.27	6.35	4.08
March	4.87	9.70	4.62	4.92	9.64	-	3.39	10.26	-	7.09
April	4.02	4.49	2.64	3.79	-	2.21	4.09	3.91	-	3.52
May	4.59	3.46	7.53	3.93	3.89	4.45	-	4.40	-	4.61
June	3.77	7.28	4.87	3.94	7.65	5.36	5.14	6.39	-	5.80
July	4.60	4.01	1.73	-	5.36	3.71	-	2.59	-	3.48
August	4.79	8.06	8.80	6.14	7.12	7.06	4.73	1.10	-	6.14
September	3.19	3.19	6.74	4.36	3.75	2.85	-	7.23	-	4.69
October	2.82	0.30	4.20	-	3.53	3.43	1.38	3.62	-	2.74
November	3.53	3.49	5.24	-	2.30	5.34	4.65	1.62	-	3.77
December	4.39	5.30	5.84	-	2.45	1.64	6.03	3.69	-	4.16

HAYWOOD COUNTY

352315082484401. Local number, NC-40.

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

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

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

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

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

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

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

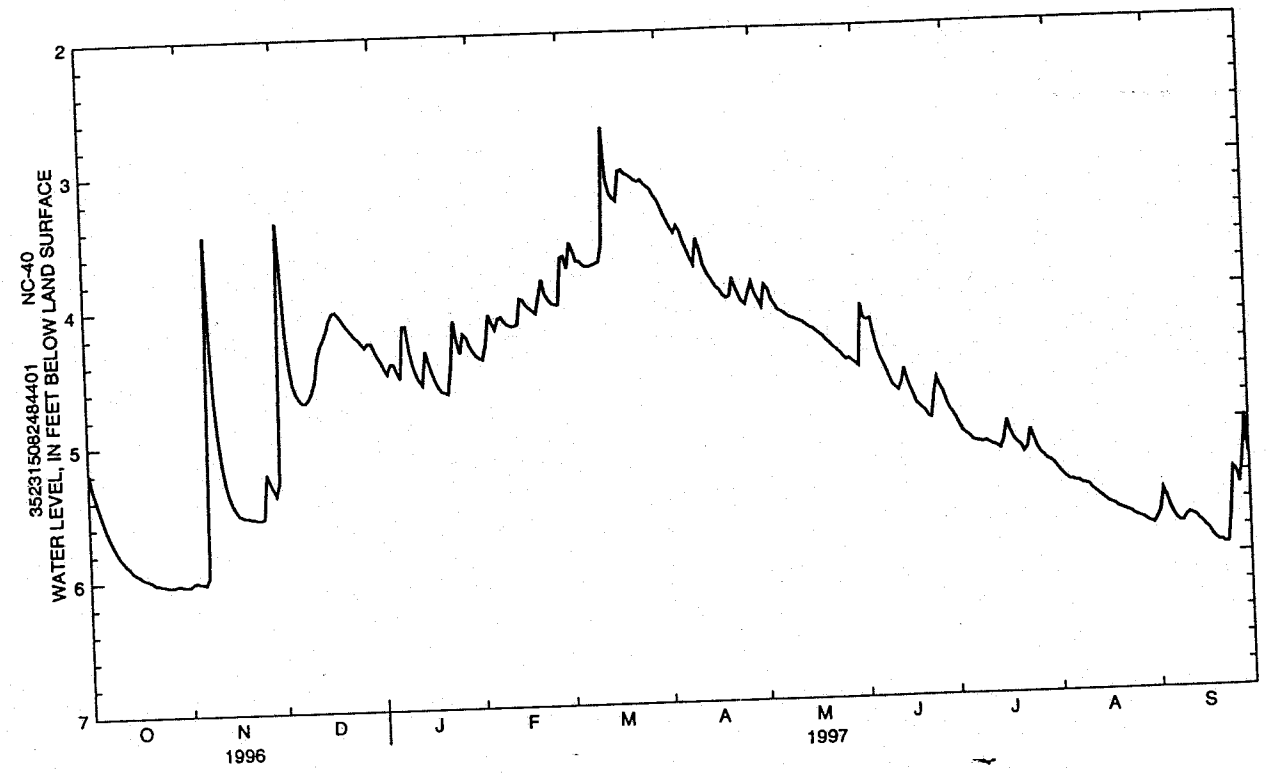
EXTREMES FOR PERIOD OF RECORD.--Highest water level recorded, 1.24 ft below land-surface datum, Mar. 12, 1977; lowest water level recorded, 6.90 ft below land-surface datum, Oct. 7, 8, and 9, 1986.

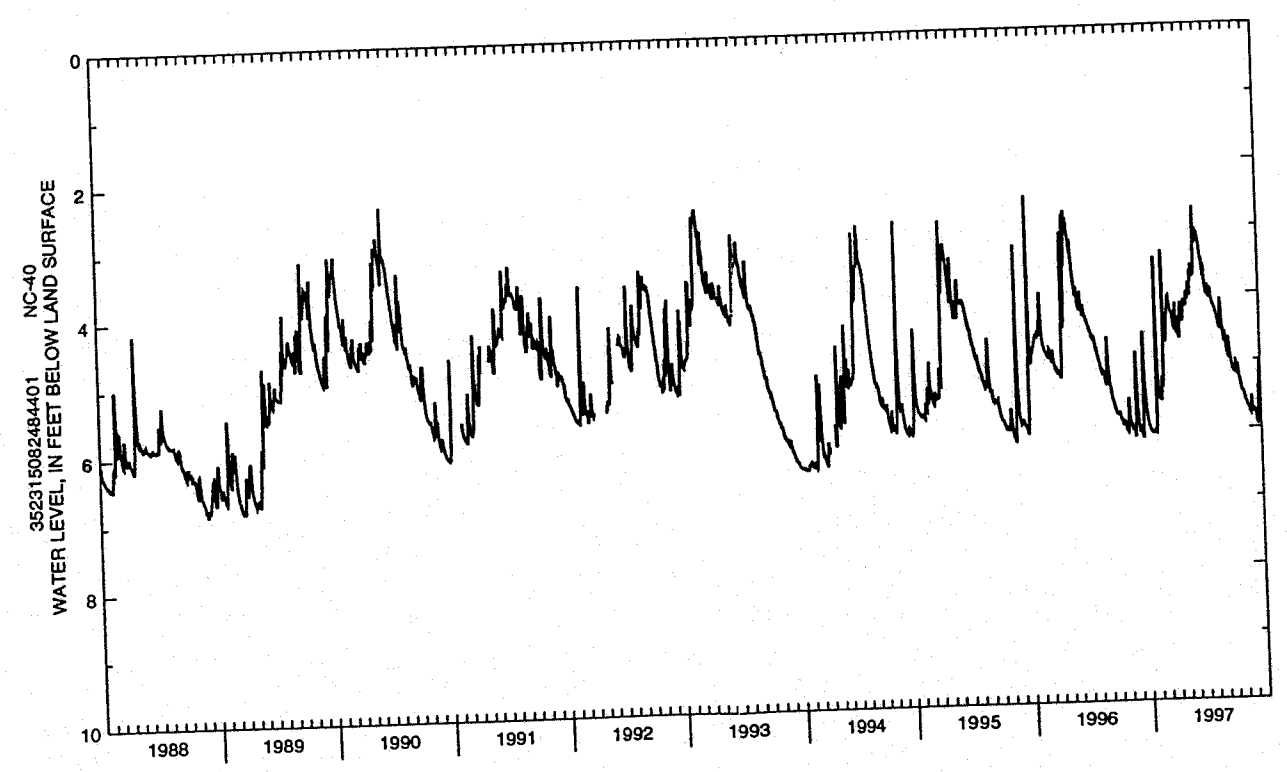
WATER LEVEL, IN FEET BELOW LAND SURFACE DATUM, WATER YEAR OCTOBER 1996 TO SEPTEMBER 1997

DAILY MEAN VALUES

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

WTR YR 1997 MEAN 4.71 HIGH 2.71 LOW 6.04





TRANSYLVANIA COUNTY

351808082374302. Local number NC-144.

LOCATION.--Lat 35°18'08", long 82°37'43", Hydrologic Unit 06010105, at Blantyre, 0.25 mi northwest of U.S. Highway 64 on King Road (Secondary Road 1502). Owner: U.S. Geological Survey.

AQUIFER.--Unconfined saprolite derived from gneiss of Paleozoic age.

WELL CHARACTERISTICS.--Drilled observation well, drilled to 70 ft, diameter 4 in., cased to 58 ft, casing perforated from 15 to 58 ft, gravel filter pack from 5 to 58 ft, backfilled with gravel and saprolite from 58 to 70 ft.

INSTRUMENTATION.--Digital recorder with a 60-minute punch interval. Digital recorder replaced with electronic data logger on Dec. 10, 1996.

DATUM.--Land-surface datum is 2,147.11 ft above sea level. Measuring point: Top of casing, 1.30 ft above land-surface datum.

REMARKS.--In September 1984, well replaced nearby NC-127. Well is part of terrane-effects network.

PERIOD OF RECORD.--October 1981 to current year.

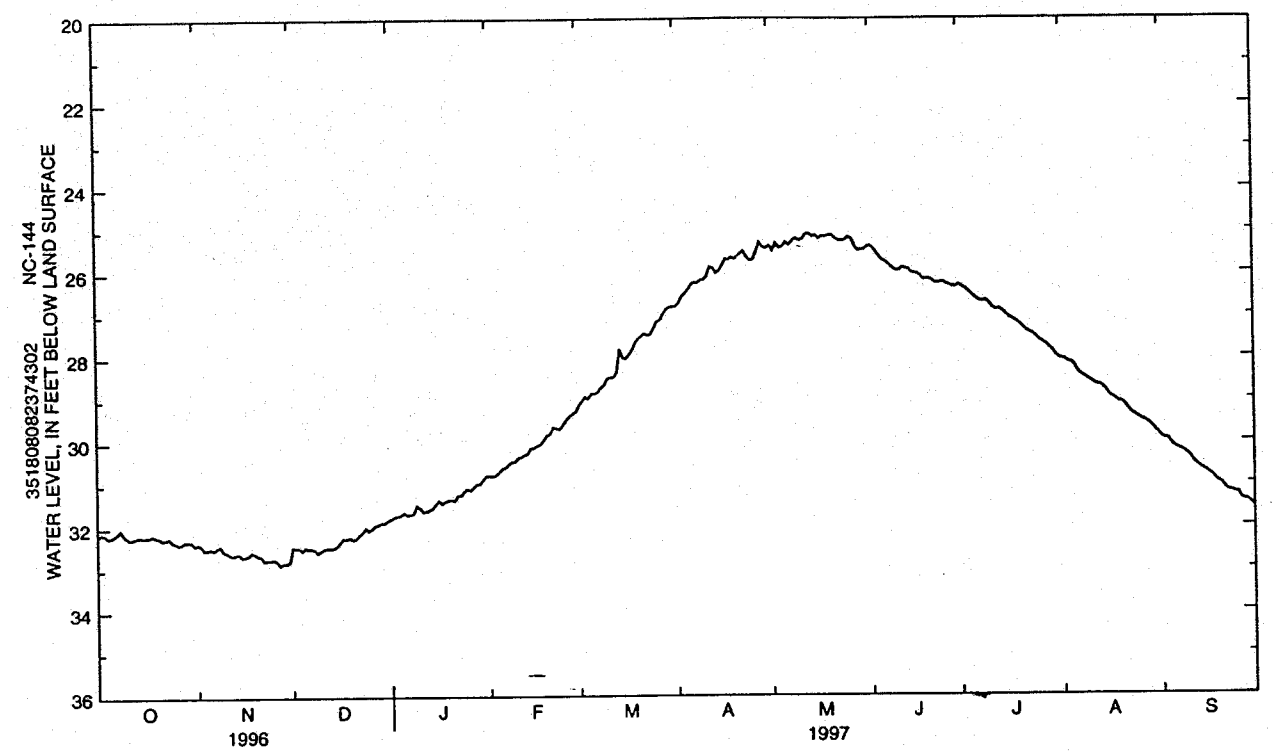
EXTREMES FOR PERIOD OF RECORD.--Highest water level recorded, 22.20 ft below land-surface datum, Apr. 26, 1993; lowest water level recorded, 37.95 ft below land-surface datum, Dec. 23 and 24, 1981.

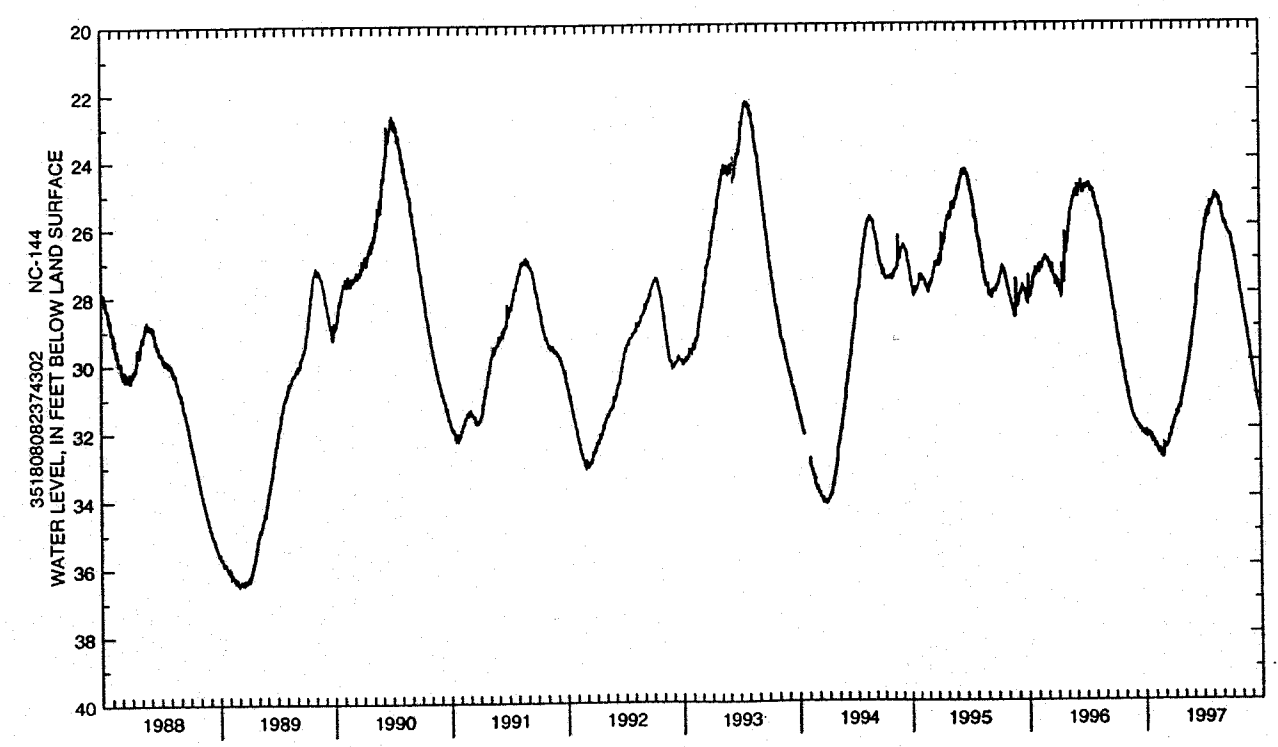
WATER LEVEL, IN FEET BELOW LAND SURFACE DATUM, WATER YEAR OCTOBER 1996 TO SEPTEMBER 1997

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	32.16	32.38	32.46	31.79	30.78	29.11	26.80	25.37	25.38	26.30	28.07	29.92
2	32.13	32.42	32.48	31.74	30.79	29.03	26.72	25.49	25.44	26.35	28.08	29.96
3	32.14	32.52	32.48	31.72	30.76	28.93	26.56	25.31	25.54	26.40	28.14	29.96
4	32.21	32.51	32.54	31.70	30.69	28.97	26.50	25.43	25.64	26.47	28.15	30.07
5	32.20	32.49	32.46	31.65	30.60	28.85	26.41	25.41	25.72	26.55	28.23	30.15
6	32.16	32.52	32.50	31.70	30.58	28.85	26.29	25.29	25.75	26.62	28.37	30.19
7	32.10	32.46	32.49	31.69	30.50	28.82	26.24	25.36	25.81	26.68	28.44	30.22
8	32.03	32.43	32.52	31.66	30.44	28.71	26.25	25.26	25.88	26.70	28.49	30.26
9	32.15	32.55	32.59	31.48	30.44	28.65	26.18	25.20	25.94	26.67	28.54	30.32
10	32.22	32.57	32.53	31.53	30.35	28.50	26.18	25.25	25.97	26.75	28.58	30.39
11	32.25	32.62	32.49	31.62	30.33	28.47	26.08	25.23	25.95	26.86	28.64	30.51
12	32.24	32.65	32.48	31.61	30.28	28.47	25.87	25.11	25.89	26.89	28.68	30.58
13	32.21	32.62	32.48	31.58	30.25	28.35	25.90	25.09	25.92	26.88	28.69	30.64
14	32.19	32.61	32.47	31.54	30.12	27.81	26.02	25.16	25.93	26.94	28.74	30.69
15	32.21	32.69	32.43	31.44	30.12	28.01	25.96	25.13	26.01	27.02	28.82	30.73
16	32.20	32.67	32.33	31.36	30.06	28.03	25.84	25.21	26.03	27.09	28.93	30.79
17	32.20	32.65	32.25	31.43	30.04	27.93	25.69	25.15	26.03	27.13	28.98	30.85
18	32.17	32.58	32.26	31.38	29.93	27.83	25.71	25.16	26.08	27.18	29.03	30.94
19	32.21	32.61	32.23	31.35	29.83	27.65	25.65	25.13	26.17	27.24	29.09	31.00
20	32.23	32.66	32.27	31.34	29.79	27.56	25.69	25.13	26.17	27.33	29.09	31.04
21	32.28	32.67	32.25	31.36	29.64	27.50	25.62	25.21	26.16	27.40	29.17	31.15
22	32.27	32.78	32.17	31.23	29.66	27.44	25.56	25.25	26.19	27.44	29.27	31.20
23	32.24	32.76	32.10	31.24	29.68	27.49	25.50	25.26	26.25	27.48	29.36	31.21
24	32.32	32.77	32.00	31.14	29.58	27.46	25.65	25.24	26.26	27.55	29.41	31.25
25	32.35	32.74	32.07	31.08	29.46	27.30	25.73	25.17	26.25	27.63	29.46	31.25
26	32.39	32.79	32.01	31.12	29.38	27.15	25.71	25.21	26.23	27.67	29.51	31.39
27	32.37	32.88	31.94	31.04	29.32	27.12	25.51	25.39	26.28	27.72	29.54	31.43
28	32.31	32.83	31.92	30.97	29.27	26.97	25.30	25.49	26.31	27.80	29.59	31.42
29	32.33	32.84	31.88	30.97	---	26.86	25.41	25.47	26.34	27.86	29.66	31.50
30	32.33	32.80	31.88	30.86	---	26.82	25.44	25.47	26.35	27.97	29.75	31.56
31	32.41	---	31.82	30.78	---	26.80	---	25.41	---	28.04	29.83	---

WTR YR 1997 MEAN 29.21 HIGH 25.09 LOW 32.88





TRANSYLVANIA COUNTY--Continued

351709082434101. Local number, NC-147.

LOCATION.--Lat 35°17'09", long 82°43'41", Hydrologic Unit 06010105, 3.5 mi north of Brevard on U.S. Highway 276, 700 ft northwest of U.S. Forest Service Ranger Station in Pisgah National Forest. Owner: U.S. Geological Survey.

AQUIFER.--Unconfined alluvial sand.

WELL CHARACTERISTICS.--Drilled observation well, drilled to 25 ft, diameter 4 in., cased to 11.6 ft, screened interval from 11.6 to 21.6 ft; measured depth 22.9 ft, June 1985.

INSTRUMENTATION.--Digital recorder with a 60-minute punch interval. Digital recorder replaced with electronic data logger on Dec. 10, 1996.

DATUM.--Land-surface datum is 2,176.70 ft above sea level. Measuring point: Top of casing, 2.24 ft above land-surface datum.

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

PERIOD OF RECORD.--June 1985 to current year.

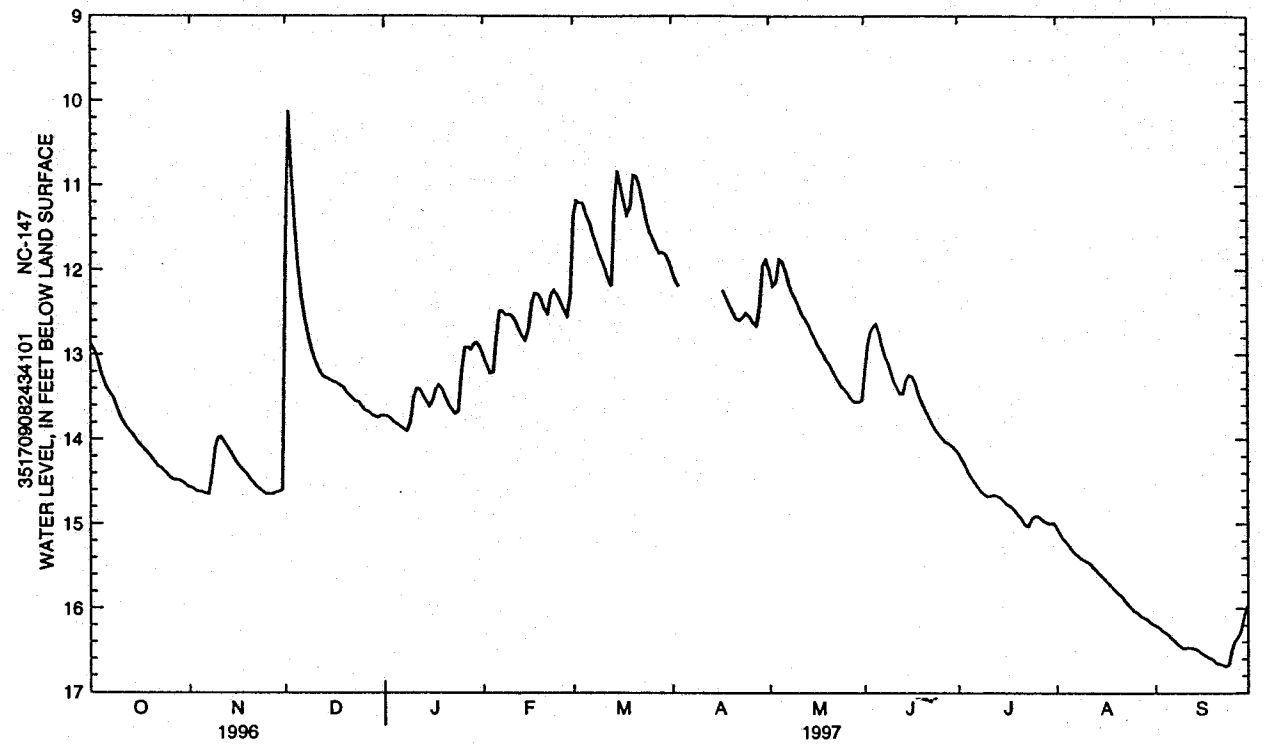
EXTREMES FOR PERIOD OF RECORD.--Highest water level recorded, 7.43 ft below land-surface datum, Oct. 2, 1989; lowest water level recorded, 17.66 ft below land-surface datum, Oct. 8 and 9, 1986.

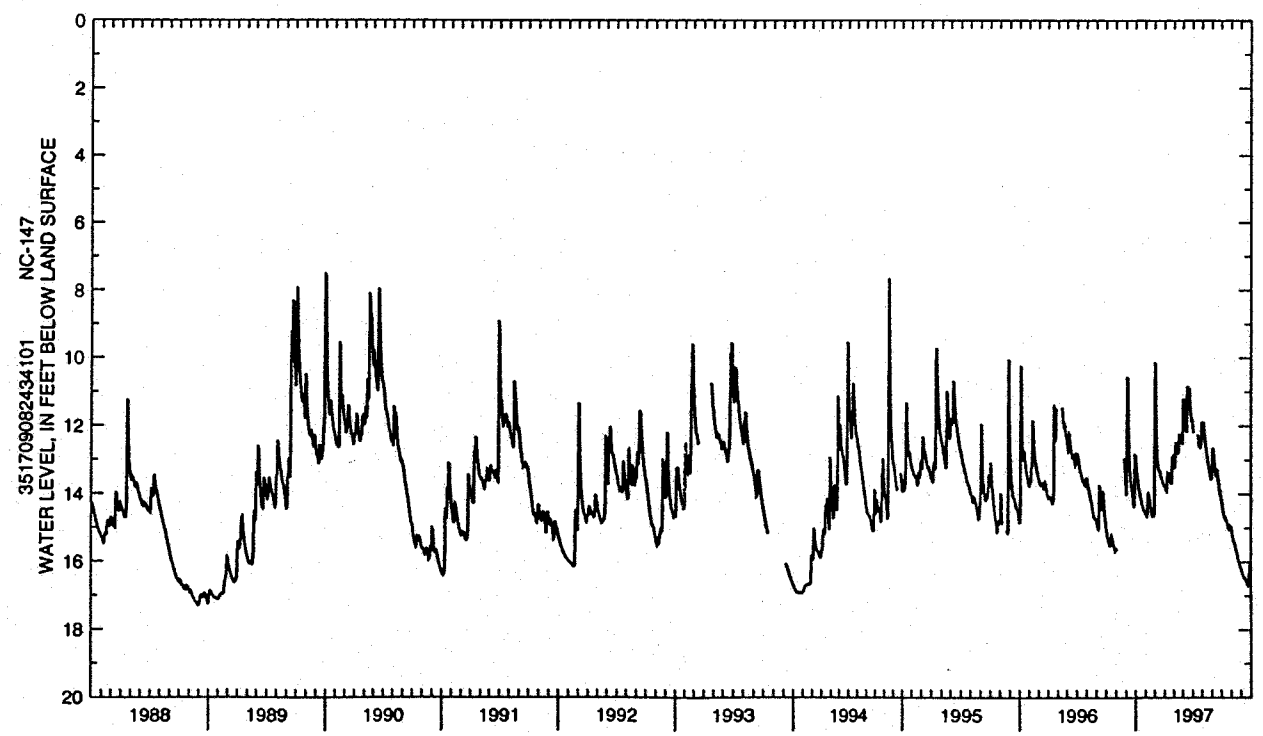
WATER LEVEL, IN FEET BELOW LAND SURFACE DATUM, WATER YEAR OCTOBER 1996 TO SEPTEMBER 1997

DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	12.88	14.57	11.82	13.72	13.03	11.37	12.02	12.01	13.21	14.17	15.05	16.21
2	12.95	14.58	10.12	13.73	13.13	11.18	12.13	12.19	12.89	14.24	15.12	16.23
3	13.06	14.61	10.83	13.76	13.22	11.21	12.19	12.15	12.74	14.31	15.18	16.27
4	13.20	14.62	11.50	13.80	13.21	11.21	---	11.87	12.67	14.40	15.22	16.29
5	13.31	14.62	11.98	13.82	12.79	11.34	---	11.90	12.64	14.46	15.27	16.32
6	13.40	14.64	12.33	13.85	12.48	11.43	---	12.02	12.75	14.51	15.32	16.36
7	13.46	14.65	12.57	13.88	12.48	11.56	---	12.17	12.90	14.57	15.36	16.39
8	13.51	14.43	12.76	13.90	12.53	11.67	---	12.27	13.02	14.62	15.39	16.43
9	13.62	14.10	12.92	13.80	12.52	11.79	---	12.34	13.10	14.65	15.42	16.46
10	13.72	13.98	13.05	13.51	12.54	11.88	---	12.43	13.21	14.68	15.44	16.48
11	13.79	13.97	13.14	13.40	12.61	11.98	---	12.52	13.32	14.67	15.46	16.47
12	13.85	14.03	13.22	13.41	12.70	12.11	---	12.58	13.39	14.66	15.50	16.47
13	13.90	14.09	13.26	13.48	12.78	12.19	---	12.64	13.46	14.67	15.54	16.48
14	13.94	14.15	13.28	13.55	12.83	11.25	---	12.73	13.46	14.69	15.58	16.49
15	14.00	14.22	13.30	13.61	12.70	10.83	---	12.80	13.30	14.73	15.62	16.52
16	14.05	14.28	13.32	13.54	12.39	11.01	---	12.88	13.24	14.77	15.66	16.55
17	14.09	14.33	13.33	13.41	12.27	11.20	12.24	12.94	13.26	14.79	15.70	16.57
18	14.13	14.37	13.36	13.36	12.28	11.35	12.33	13.00	13.35	14.82	15.74	16.59
19	14.17	14.41	13.38	13.41	12.35	11.26	12.42	13.07	13.48	14.87	15.78	16.61
20	14.22	14.47	13.44	13.50	12.46	10.88	12.50	13.12	13.58	14.91	15.82	16.65
21	14.27	14.51	13.48	13.59	12.51	10.90	12.58	13.19	13.66	14.96	15.85	16.66
22	14.32	14.56	13.52	13.65	12.29	11.02	12.60	13.26	13.74	15.02	15.90	16.67
23	14.34	14.59	13.55	13.70	12.24	11.22	12.56	13.32	13.82	15.03	15.95	16.69
24	14.38	14.62	13.56	13.67	12.30	11.41	12.51	13.38	13.89	14.94	15.99	16.67
25	14.42	14.65	13.62	13.21	12.38	11.55	12.55	13.41	13.94	14.91	16.03	16.49
26	14.46	14.65	13.66	12.92	12.47	11.63	12.62	13.45	13.99	14.91	16.05	16.39
27	14.48	14.65	13.67	12.91	12.54	11.73	12.66	13.51	14.03	14.94	16.09	16.34
28	14.48	14.63	13.71	12.94	12.29	11.80	12.43	13.55	14.05	14.97	16.11	16.26
29	14.49	14.62	13.73	12.87	---	11.79	11.94	13.56	14.08	14.99	16.13	16.08
30	14.51	14.60	13.74	12.86	---	11.82	11.88	13.56	14.12	15.00	16.16	15.97
31	14.55	---	13.72	12.93	---	11.91	---	13.54	---	14.99	16.19	---

WTR YR 1997 MEAN 13.69 HIGH 10.12 LOW 16.69





HAYWOOD COUNTY

NORTH CAROLINA

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

SCALE
1 0 1 2 3 4 MILES
0 0.5 1 MILE
SCALE FOR ENLARGEMENTS

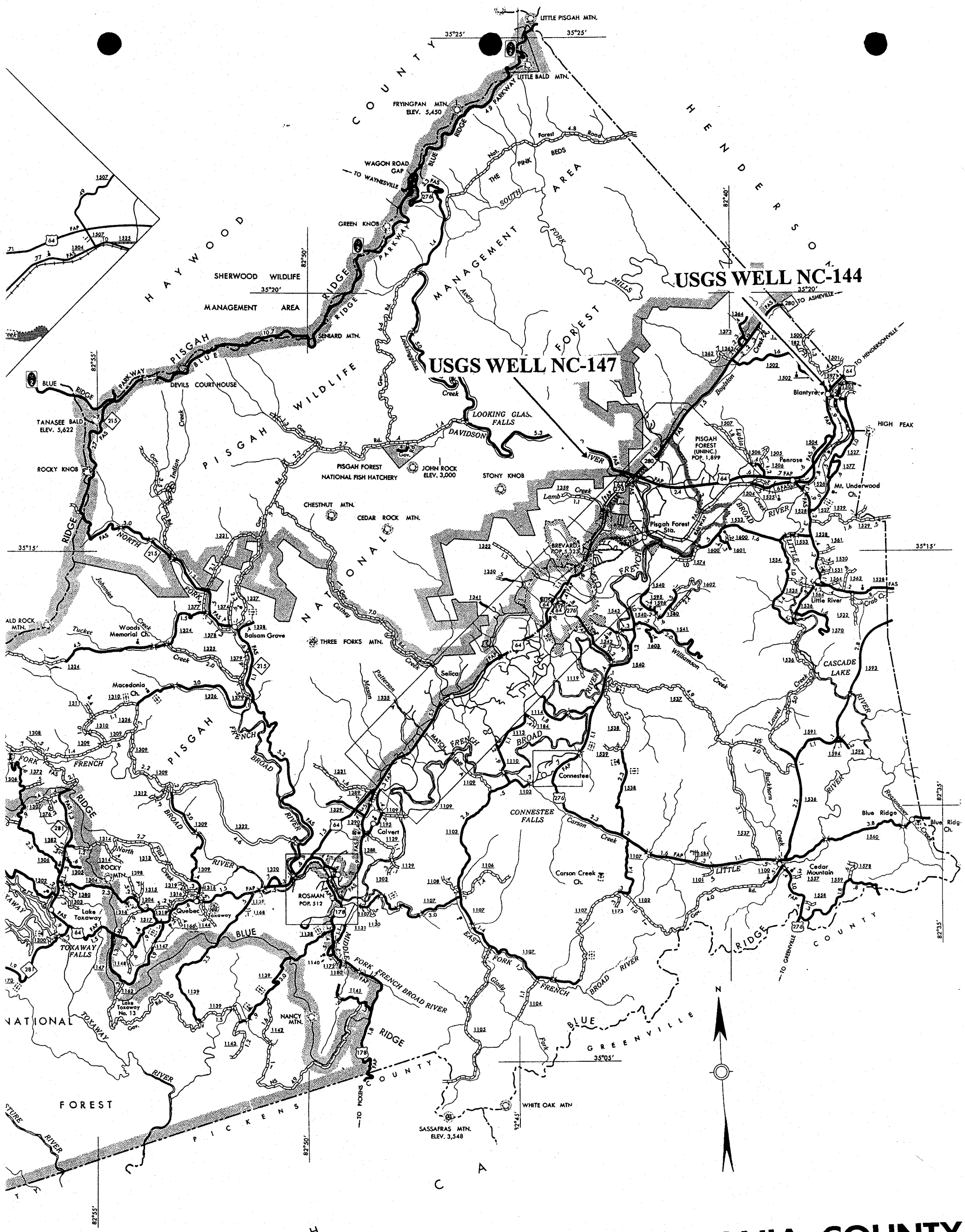
10,000 FOOT GRID BASED ON NORTH CAROLINA PLANE COORDINATE SYSTEM
POLYCONIC PROJECTION

WHITE OAK LANDFILL

USGS WELL NC-40

KEY TO COUNTY ROAD NUMBERS
ALSO NUMBER 1004

NOTE: MAP INCLUDES ONLY
OR IMPORTANT NON
MILEAGE NOT SHOW
ROADS SHOWN AS (



TRANSYLVANIA COUNTY

NORTH CAROLINA

PREPARED BY THE

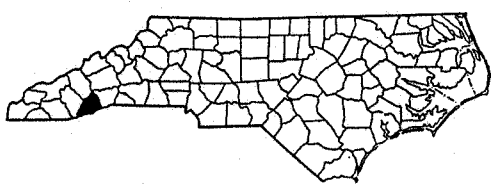
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS—PLANNING AND RESEARCH BRANCH

IN COOPERATION WITH THE

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION



SCALE

1 0 1 2 3 4 MILES

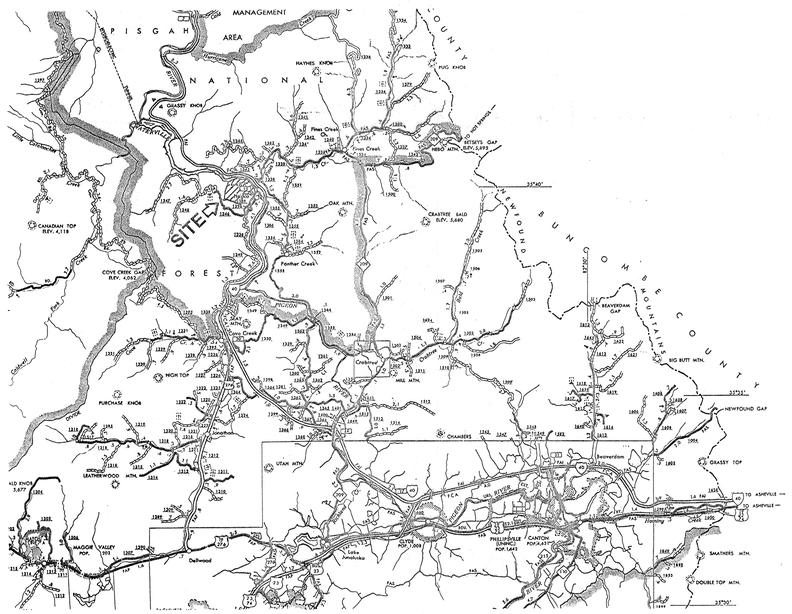
0 0.5 1 MILE

SCALE FOR ENLARGEMENTS

INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION
01	T1	TITLE SHEET
02	E1	EXISTING CONDITIONS
03	E2	SUBGRADE
04	E3	LEACHATE COLLECTION SYSTEM
05	E4	FINAL FILL PLAN

HAYWOOD COUNTY MUNICIPAL SOLID WASTE LANDFILL FACILITY PLAN



BOARD OF COMMISSIONERS

CHAIRMAN - Edwin Russell
VICE-CHAIRMAN - Bill Edwards
COMMISSIONNERS:
Grover L. Bradshaw
Robert Forga
Jack J. Rice

COUNTY MANAGER

JACK HORTON

SOLID WASTE MANAGER

JOE WALKER

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

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODLIEF

by _____ 11/4/98
Professional Engineer

Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27629 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (704) 262-1767

SCALE:	NTS
DATE:	10/20/98
DRWN. BY:	B. BADEY
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G98010
DRAWING NO. T1	SHEET NO. 1 of 5

G:\HAYWOOD\98010-01 Wed Oct 28 11:28:56 1998 BWB

LEGEND:

- EIP = EXISTING IRON PIPE OR PIN
- IPS = IRON PIPE OR PIN SET
- R/R SPIKE = RAILROAD SPIKE SET
- FC = FENCE CORNER
- MH = MAN HOLE
- WM = WATER METER
- PP = POWER SERVICE POLE
- —— P —— = AERIAL POWER LINE
- P/O = PART OF
- DB = DEED BOOK
- PG = PAGE
- = FENCE LINE
- = BRANCH OR STREAM
- GWM-7 = EXISTING GROUNDWATER MONITOR
- P-7 = EXISTING PIEZOMETER
- = PROPERTY LINE
- = 300' BUFFER
- = PROPOSED ANCHOR TRENCH
- = PROPOSED PHASELIMITS
- = EXISTING LANDFILL
- = CELL 4
- = PROPOSED CONTOURS
- = EXISTING CONTOURS
- = TREE LINE
- = ARCHAEOLOGICAL SITE
- = WETLANDS

Municipal Engineering Services Company, P.A.
P.O. BOX 97, GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 849 BOONE, N.C. 28607 (828) 262-1707

MUNICIPAL SOLID WASTE LANDFILL
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

FACILITY PLAN
EXISTING CONDITIONS

SCALE:	1" = 200'
DATE:	10/22/98
DRWN. BY:	B. BADEY
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G98010
DRAWING NO.	E1
SHEET NO.	2 OF 5

NORTH CAROLINA PROFESSIONAL SEAL 5202 ENGINEER TIMMY D. WOODIE 11/4/98

G:\Map_Acad\G98010-02 Wed Oct 28 10:46:50 1998 BWB

LEGEND:

- EIP = EXISTING IRON PIPE OR PIN
- IPS = IRON PIPE OR PIN SET
- R/R SPIKE = RAILROAD SPIKE SET
- FC = FENCE CORNER
- MH = MAN HOLE
- WM = WATER METER
- PP = POWER SERVICE POLE
- —— P —— = AERIAL POWER LINE
- P/O = PART OF
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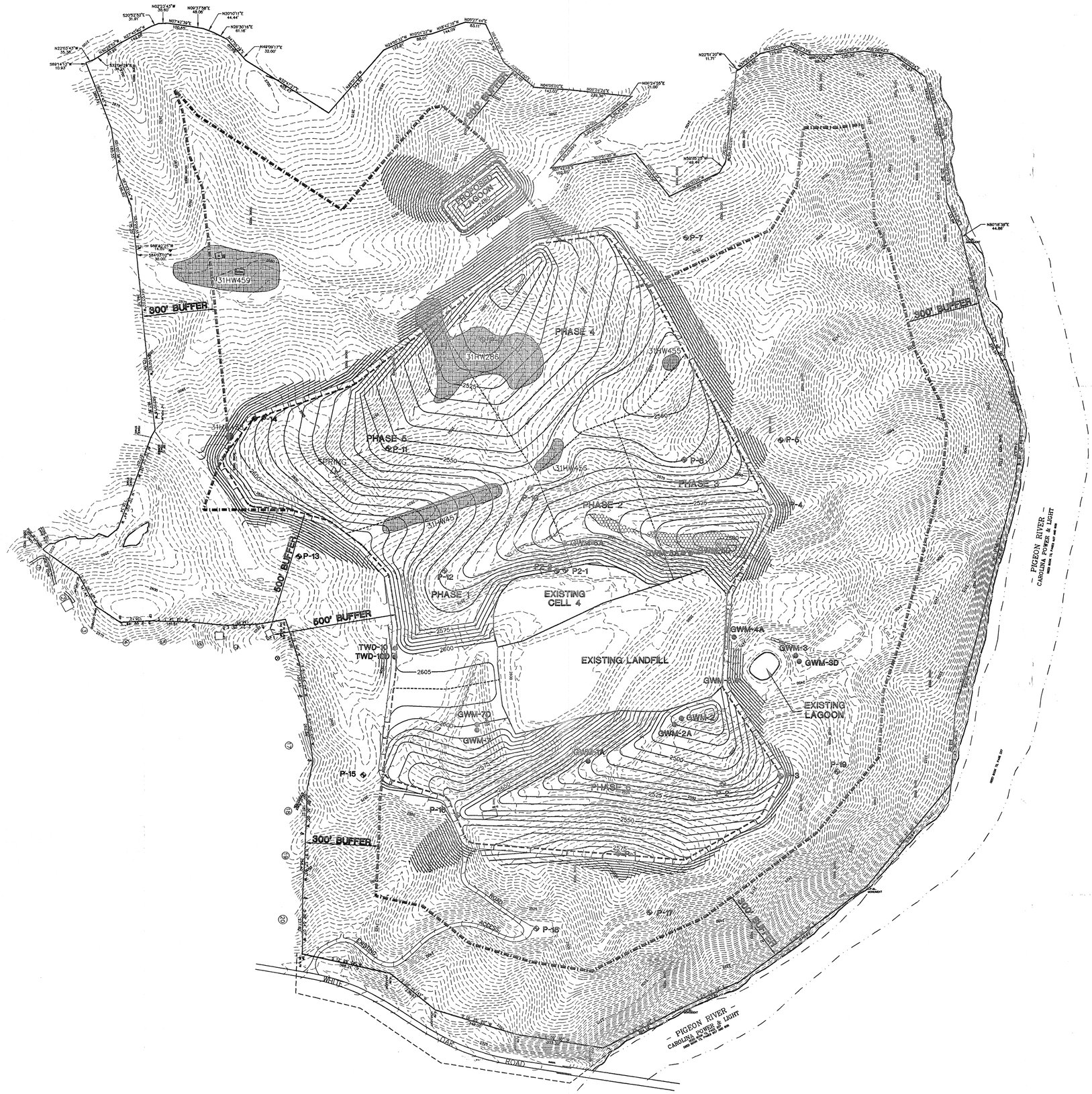
- P-7 = EXISTING PIEZOMETER
- = PROPERTY LINE
- = 300' BUFFER
- = PROPOSED ANCHOR TRENCH
- = PROPOSED PHASELIMITS
- = EXISTING LANDFILL
- = CELL 4
- = PROPOSED CONTOURS
- = EXISTING CONTOURS
- = ARCHAEOLOGICAL SITE
- = WETLANDS



Municipal Services Engineering Company, P.A.
P.O. BOX 97, GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 549 BOONE, N.C. 28607 (828) 262-1701

MUNICIPAL SOLID WASTE LANDFILL
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

FACILITY PLAN
PROPOSED SUBGRADE

SCALE:	1"= 200'
DATE:	10/22/98
DRWN. BY:	B. BADEY
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G98010
DRAWING NO.	E2
SHEET NO.	3 OF 5

NORTH CAROLINA PROFESSIONAL SEAL 4282 ENGINEER JIMMY D. WOODIE
11/04/98

G:\hayw0ss\98010-03 Wed Oct 28 10:13:30 1998 BWB

LEGEND:

- EIP = EXISTING IRON PIPE OR PIN
- IPS = IRON PIPE OR PIN SET
- R/R SPIKE = RAILROAD SPIKE SET
- FC = FENCE CORNER
- MH = MAN HOLE
- WM = WATER METER
- PP = POWER SERVICE POLE
- P — = AERIAL POWER LINE
- P/O = PART OF
- DB = DEED BOOK
- PG = PAGE
- = FENCE LINE
- = BRANCH OR STREAM
- GWM-7 = EXISTING GROUNDWATER MONITOR
- P-7 = EXISTING PIEZOMETER
- = PROPERTY LINE
- = 300' BUFFER
- = PROPOSED ANCHOR TRENCH
- = PROPOSED PHASE LIMITS
- = EXISTING LANDFILL
- = CELL 4
- = PROPOSED CONTOURS
- = EXISTING CONTOURS
- = PROPOSED LEACHATE COLLECTION SYSTEM

GRID NORTH

100 50 0 100 200 300

SCALE IN FEET

Municipal Engineering Services Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393

P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1727

MUNICIPAL SOLID WASTE LANDFILL
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

FACILITY PLAN
PROPOSED LEACHATE SYSTEM

SCALE:	1"= 200'
DATE:	10/22/98
DRWN. BY:	B. BADEY
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G98010
DRAWING NO.	E3
SHEET NO.	4 OF 5

NORTH CAROLINA PROFESSIONAL SEAL ENGINEER JIMMY D. WOODIE

11/04/98

G:\HAYWOOD\98010-04 Thu Nov 05 12:26:00 1998 BHB

LEGEND:

EIP = EXISTING IRON PIPE OR PIN
IPS = IRON PIPE OR PIN SET
R/R SPIKE = RAILROAD SPIKE SET
FC = FENCE CORNER
MH = MAN HOLE
WM = WATER METER
PP = POWER SERVICE POLE
—— P —— = AERIAL POWER LINE
P/O = PART OF
DB = DEED BOOK
PG = PAGE
—x—x—x— = FENCE LINE
= BRANCH OR STREAM
= PROPERTY LINE
= 300' BUFFER
= PROPOSED ANCHOR TRENCH
= PROPOSED PHASELIMITS
= EXISTING LANDFILL
= CELL 4
= EXISTING CONTOURS
= PROPOSED FINAL FILL
= PROPOSED SUBGRADE

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

MUNICIPAL SOLID WASTE LANDFILL
HAYWOOD COUNTY
NORTH CAROLINA

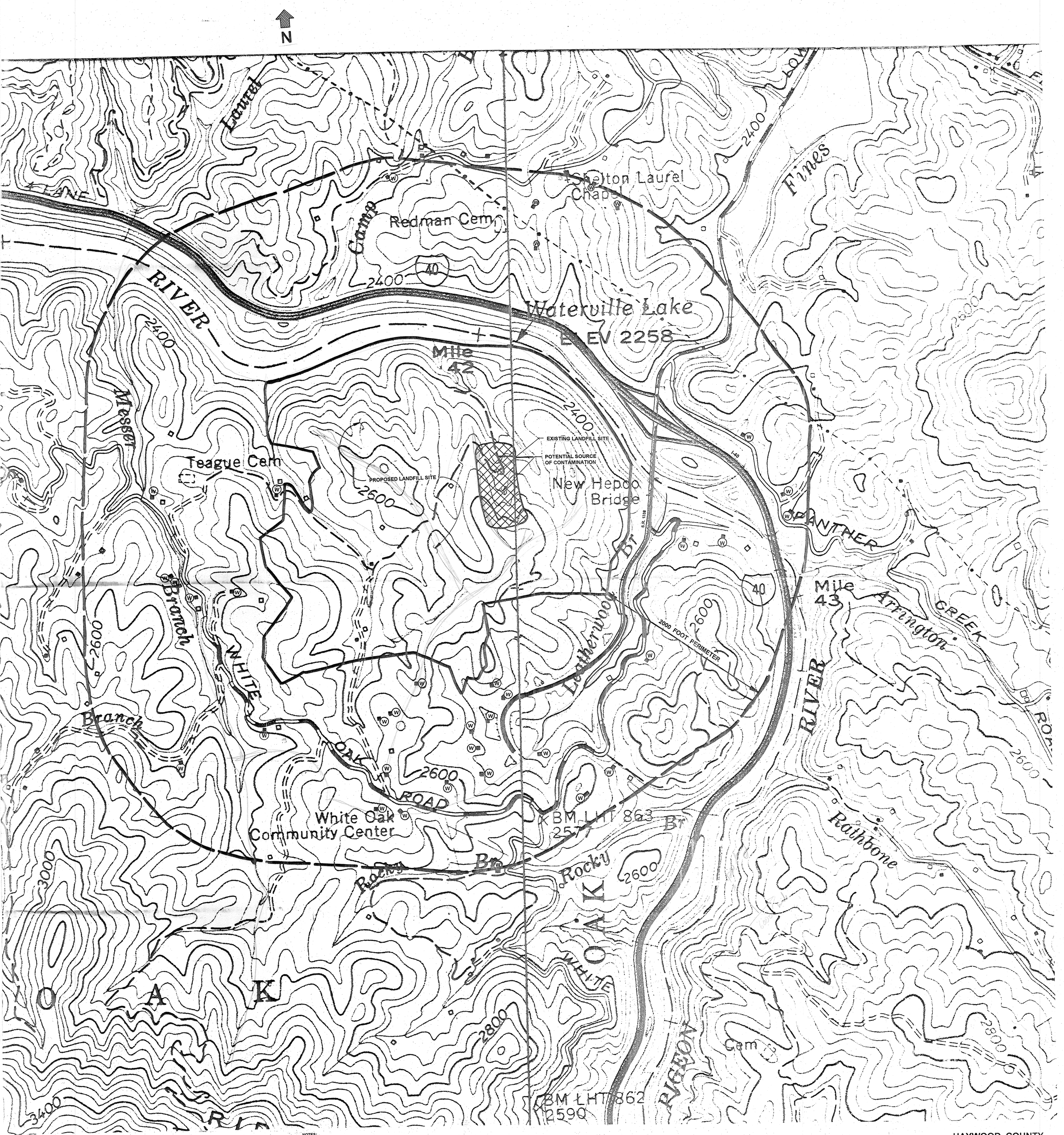
DATE	BY	REV.	DESCRIPTION

FACILITY PLAN
PROPOSED FINAL FILL

SCALE:	1"= 200'
DATE:	10/22/98
DRWN. BY:	B. BADEY
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G98010
DRAWING NO.	E4
SHEET NO.	5 OF 5

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE
11/4/98

\haywood\98010-05 Wed Oct 28 08:59:06 1998 BHB



NOTES:

1. ENTIRE PROPERTY IS SHOWN ON THIS MAP.
2. PROPERTY IS CURRENTLY BEING USED AS LANDFILL AND FARM LAND. THE PROPERTY IS NOT ZONED.
3. PRIVATE RESIDENCES ARE SHOWN ON THIS MAP AND THERE ARE NO SCHOOLS LOCATED WITHIN THE 2000' PERIMETER.
4. THERE ARE NO COMMERCIAL OR INDUSTRIAL BUILDINGS LOCATED WITHIN THE 2000' PERIMETER. THE EXISTING LANDFILL IS A POTENTIAL SOURCE OF CONTAMINATION.
5. POTABLE WELLS ARE SHOWN ON THIS MAP.
6. HISTORIC SITES ARE LISTED AND SHOWN IN THE STUDY DONE BY GARROW AND ASSOCIATES.
7. EXISTING TOPOGRAPHY AND FEATURES OF THE DISPOSAL SITE INCLUDING: GENERAL SURFACE WATER DRAINAGE PATTERNS AND WATER SHEDS ARE SHOWN ON THIS MAP. 100-YEAR FLOODPLAINS, PERENNIAL AND INTERMITTENT STREAMS, RIVERS, AND LAKES ARE SHOWN ON THE FLOOD INSURANCE MAP.

LEGEND:

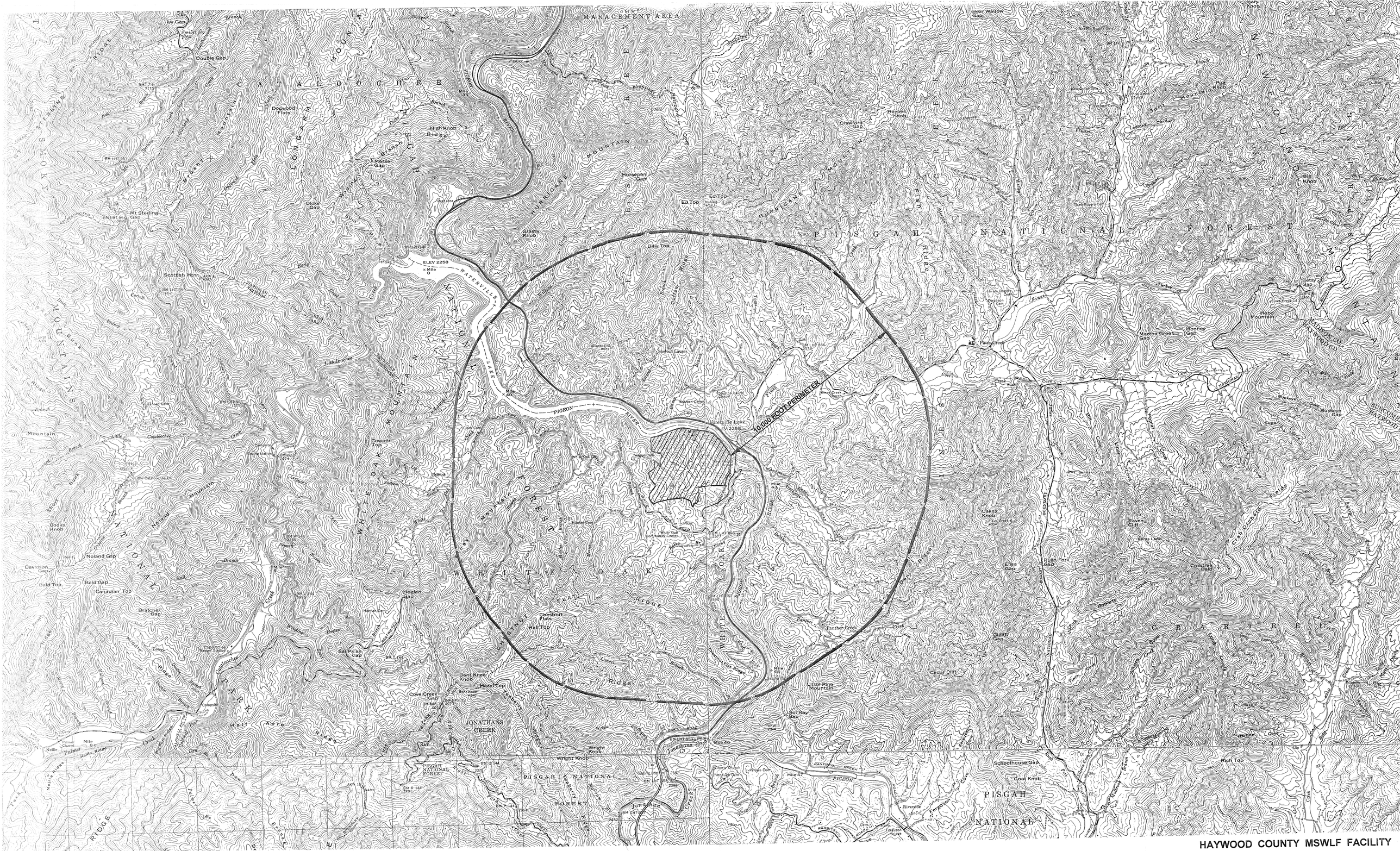
- PROPERTY BOUNDARY
- 2000 FOOT PERIMETER
- RESIDENCES
- BARNS
- (W) POTABLE WELLS

HAYWOOD COUNTY MSWLF FACILITY SITE STUDY

LOCAL CHARACTERIZATION STUDY

2000 FOOT PERIMETER MAP

SCALE: 1" = 400'

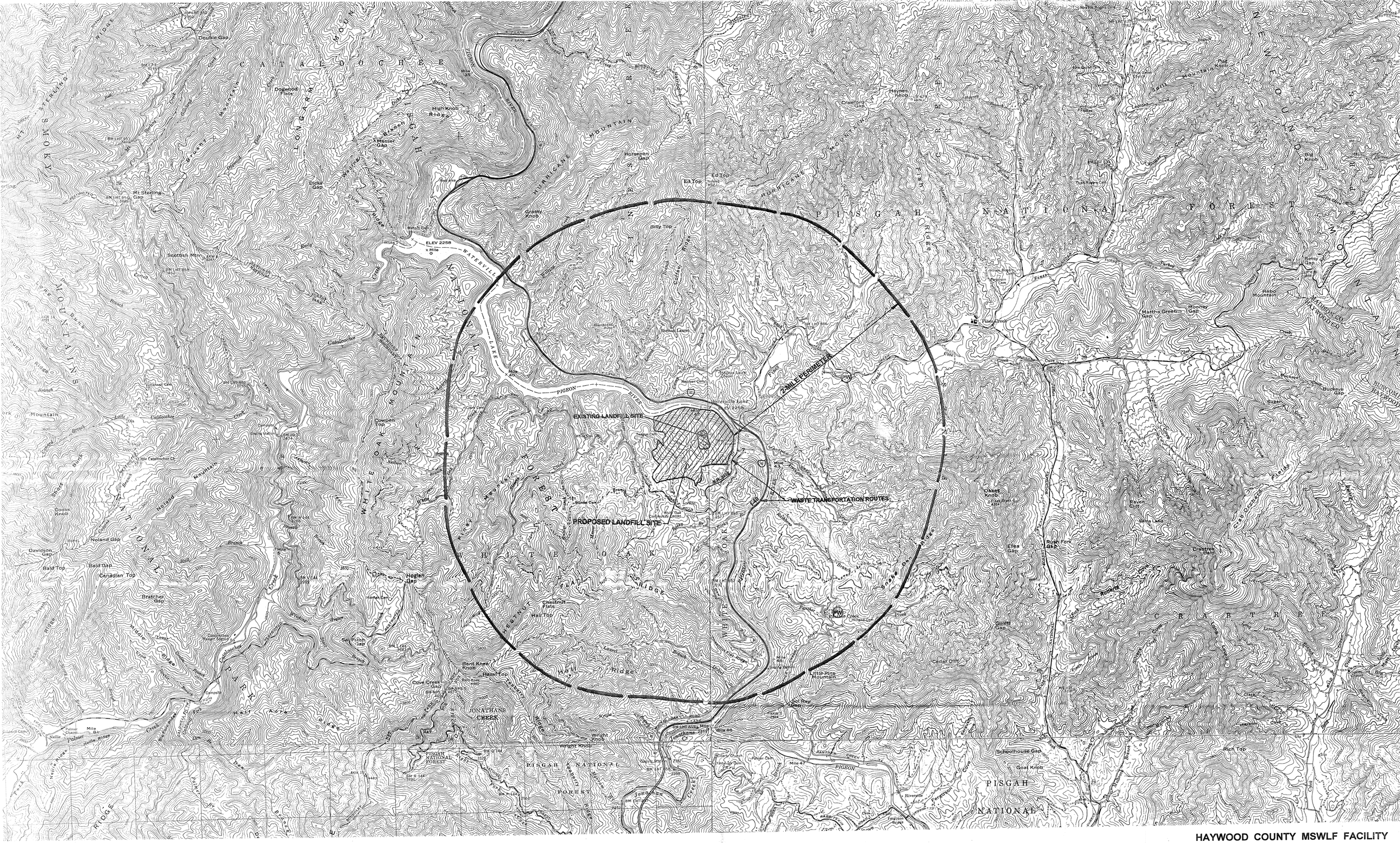


HAYWOOD COUNTY MSWLF FACILITY SITE STUDY

10,000 FOOT PERIMETER MAP

NOTE: THER ARE NO PUBLIC USE AIRPORTS LOCATED WITHIN THE 10,000 FOOT PERIMETER.

SCALE: 1" = 2000'



LEGEND:

- PROPERTY BOUNDARY
- 2-MILE PERIMETER
- EXISTING LANDFILL
- PW — PUBLIC WATER SUPPLY

NOTES:

1. GENERAL TOPOGRAPHY AND FEATURES ARE SHOWN ON THIS MAP (USGS QUADRANGLES: COVE CREEK GAP, FINES CREEK, DELLWOOD AND CLYDE.
2. PROPOSED LANDFILL FACILITY IS SHOWN.
3. THERE ARE 2 PUBLIC WATER SUPPLY WELLS LOCATED WITHIN THE 2-MILE PERIMETER: FINES CREEK METHODIST CHURCH AND PANTHER CREEK BAPTIST CHURCH.
4. THERE ARE NO RESIDENTIAL SUBDIVISIONS LOCATED WITHIN THE 2-MILE PERIMETER.
5. THE WASTE TRANSPORTATION ROUTES ARE I-40 AND S.R. 1338.
6. THERE ARE NO PUBLIC USE AIRPORTS OR RUNWAYS LOCATED WITHIN THE 2-MILE PERIMETER.

HAYWOOD COUNTY MSWLF FACILITY SITE STUDY

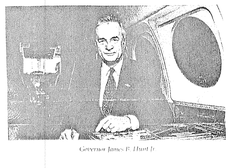
REGIONAL CHARACTERIZATION STUDY
2 -MILE PERIMETER MAP

SCALE: 1" = 2000'

1996 North Carolina
AERONAUTICAL CHART

Wright Brothers National Memorial, Kill Devil Hills, N.C.

North Carolina Department of Transportation
DIVISION OF AVIATION



Governor James B. Hunt Jr.

WELCOME TO NORTH CAROLINA

In the 92 years since North Carolina became "First in Flight" off the sands of Kitty Hawk, aviation has been an important part of the history of our state. It has become an integral part of North Carolina's economic, professional and social structure.

North Carolina, from the mountains to the shore, is very accessible due to a well-planned and developed transportation system including airports. Serving both commercial and general aviation travelers, our airport system is under continuous development to meet the growing demands of our people. Nearly every airport in the state has benefited from airfield improvements, terminals and navigational aids under the *State Aid to Airports Program*. Furthermore, we are improving aviation efficiency and safety by developing reliever airports for our larger metropolitan areas.

These improvements help bring investments and visitors, as well as serve as catalysts for growth. North Carolina is fortunate to have 78 public airports, as well as more than 15,000 pilots and bases for all branches of military service.

The aviation industry touches our lives in various ways. Whether it's helping a business to grow, bringing tourists to enjoy the state's many scenic attractions or supporting families through good jobs, the future is bright for a continued strong aviation system in North Carolina.

As we approach the 100th anniversary of powered flight, we are reminded of our state's rich aviation heritage and accomplishments. We hope you will find this complimentary aviation chart useful and take pride in joining the large group of special people who traverse the skies of North Carolina.

James B. Hunt Jr., Governor
Garland B. Garrett, Jr., Secretary, N.C. Department of Transportation
David D. King, Deputy Secretary for Transit, Rail and Aviation
Willard G. Plentl, Director of Aviation

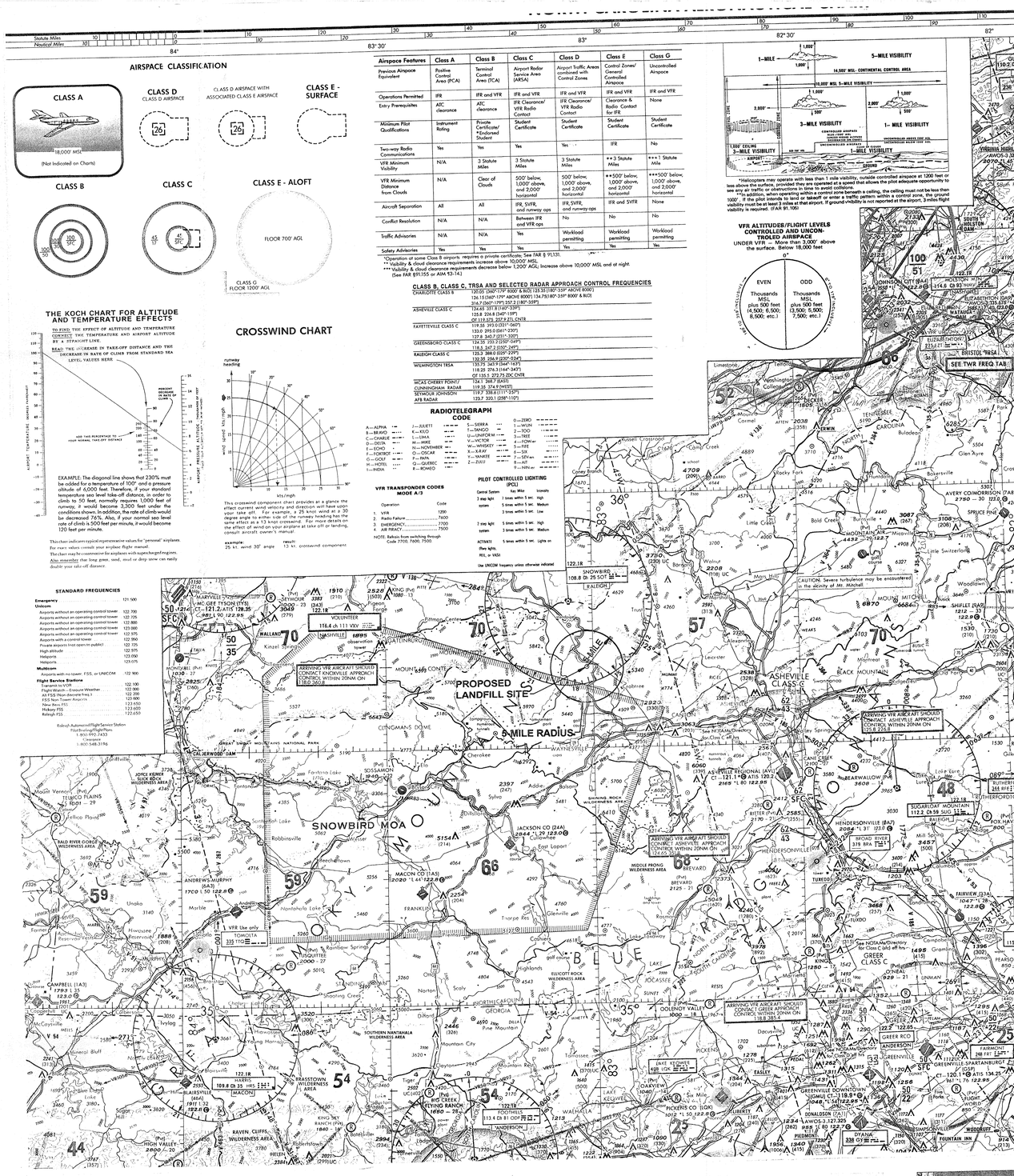
Aeronautics Council

Eddie C. Smith, Chairperson
Russell B. Barringer, Jr.
Mary Mac Bradshaw
David K. Clark
Jack L. Dellinger
David H. Henderson
Beth H. Hopkins
W.J. McLamb
Gene A. Miller
M.W. Mullinix, Sr.
Joe R. Randall
Doreen K. Richter
William N. Schultz, Jr.
Russell G. Walker

LIGHT SIGNAL PROCEDURES FOR AIRPORT TRAFFIC CONTROL

Signals from a portable traffic control light shall mean the following:

COLOR AND TYPE OF SIGNAL	ON THE GROUND	IN FLIGHT
Steady Green	Clear for takeoff	Cleared to land
Flashing Green	Cleared to taxi	Return for landing(to be followed by steady green at proper time)
Steady Red	Stop	Give way to other aircraft and continue circling
Flashing Red	Taxi clear of landing area (runway) in use	Airport unsafe - do not land
Flashing White	Return to starting point on airport	(No Assigned Meaning)

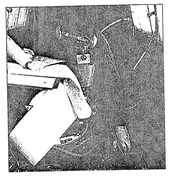


Welcome to the Birthplace of Aviation
North Carolina proudly proclaims

North Carolina Department of Transportation
DIVISION OF AVIATION

Developing airports

The Aviation Development Section coordinates the state program for planning, design and construction assistance to public airports. It



construction, lighting, navigational aids and public terminals. The Division of Aviation also participates in the *State Block Grant Program*, which allows the state to administer federal grants for general aviation airports.

Support Services

The Support Services Section administers all funds for the Aviation Division and provides administrative support for the other sections. It manages the finances of all federal and state grants for local airport sponsors, as well as internal state and federal project funding. The section also oversees and develops special projects such as the aviation expositions which are held periodically throughout the state.

HAYWOOD COUNTY MSWLF FACILITY SITE STUDY

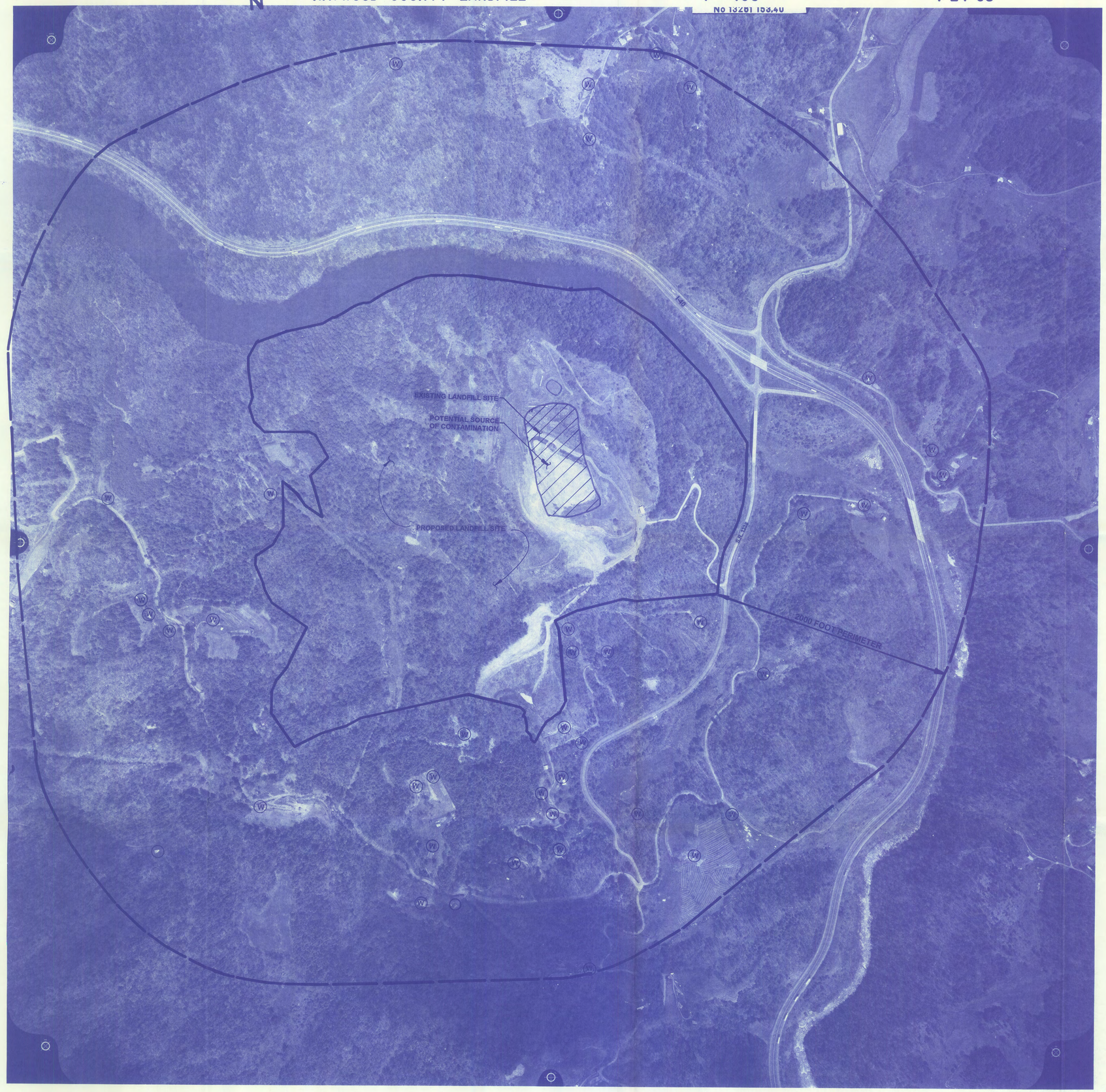
THERE ARE NO PUBLIC USE AIRPORTS LOCATED WITHIN THE 5-MILE RADIUS.

N

HAYWOOD COUNTY LANDFILL

1" = 400'

4-24-98



NOTES:

1. ENTIRE PROPERTY IS SHOWN ON THIS MAP.
2. PROPERTY IS CURRENTLY BEING USED AS LANDFILL AND FARM LAND. THE PROPERTY IS NOT ZONED.
3. PRIVATE RESIDENCES ARE SHOWN ON THIS MAP AND THERE ARE NO SCHOOLS LOCATED WITHIN THE 2000' PERIMETER.
4. THERE ARE NO COMMERCIAL OR INDUSTRIAL BUILDINGS LOCATED WITHIN THE 2000' PERIMETER. THE EXISTING LANDFILL IS A POTENTIAL SOURCE OF CONTAMINATION.
5. POTABLE WELLS ARE SHOWN ON THIS MAP.
6. HISTORIC SITES ARE LISTED AND SHOWN IN THE STUDY DONE BY GARROW AND ASSOCIATES.
7. EXISTING TOPOGRAPHY AND FEATURES OF THE DISPOSAL SITE INCLUDING: GENERAL SURFACE WATER DRAINAGE PATTERNS AND WATER SHEDS ARE SHOWN ON THIS MAP. 100 -YEAR FLOODPLAINS PERENNIAL AND INTERMITTENT STREAMS, RIVERS, AND LAKES ARE SHOWN ON THE FLOOD INSURANCE MAP.

LEGEND:

PROPERTY BOUNDARY

2000 FOOT PERIMETER

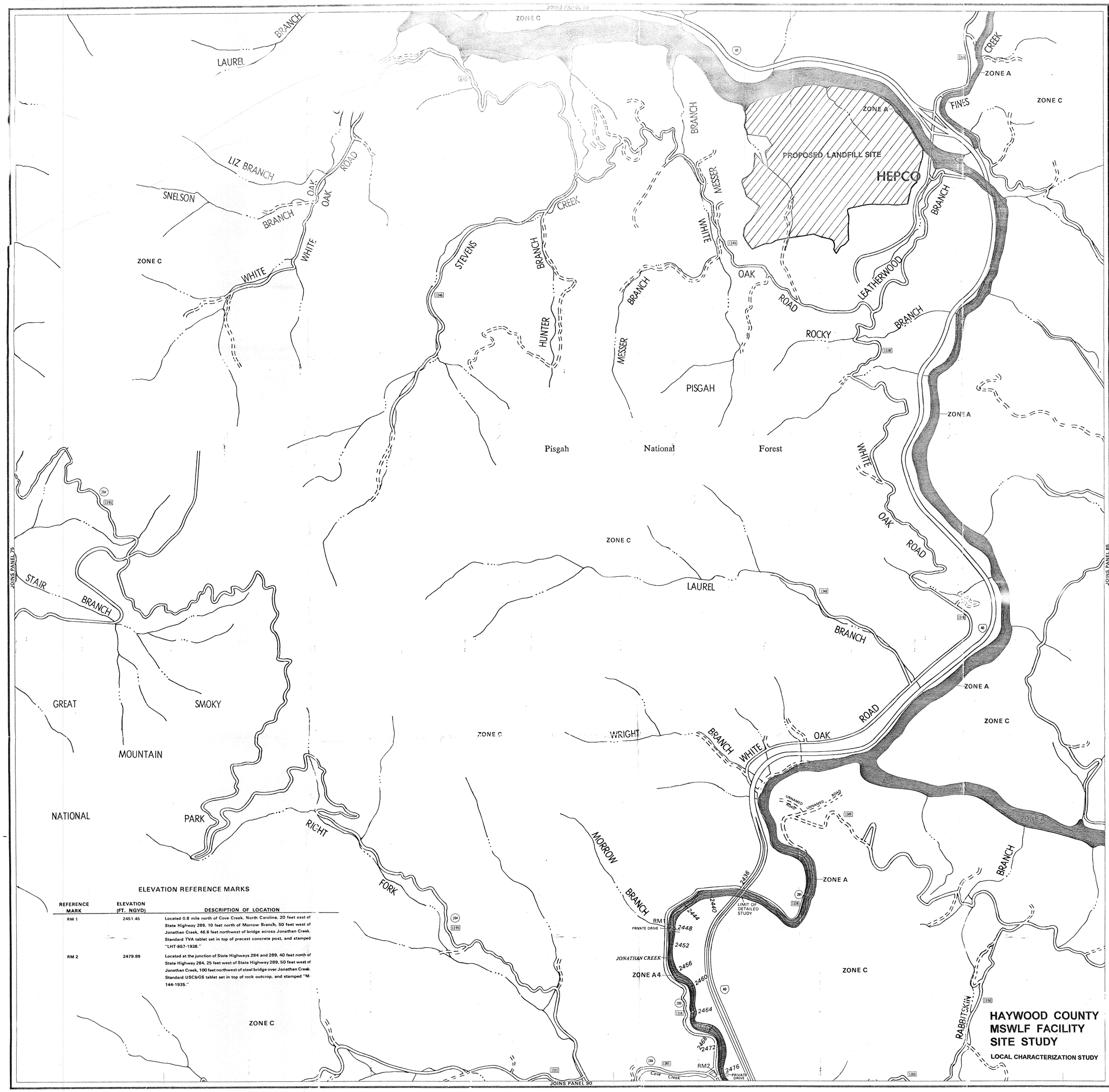
(W) RESIDENCES AND POTABLE WELLS

HAYWOOD COUNTY MSWLF FACILITY SITE STUDY

LOCAL CHARACTERIZATION STUDY

2000 FOOT PERIMETER MAP

SCALE: 1" = 400'



ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FT. NGVD)	DESCRIPTION OF LOCATION
RM 1	2451.45	Located 0.8 mile north of Cove Creek, North Carolina, 20 feet east of State Highway 289, 10 feet north of Morrow Branch, 50 feet west of Jonathan Creek, 46.6 feet northwest of bridge across Jonathan Creek. Standard TVA tablet set in top of precast concrete post, and stamped "LHT-857-1938."
RM 2	2479.89	Located at the junction of State Highways 284 and 289, 40 feet north of State Highway 284, 25 feet west of State Highway 289, 50 feet west of Jonathan Creek, 100 feet northwest of steel bridge over Jonathan Creek. Standard USC&GS tablet set in top of rock outcrop, and stamped "M-144-1935."

KEY TO MAP

500-Year Flood Boundary	
100-Year Flood Boundary	
Zone Designations*	ZONE B / ZONE B
100-Year Flood Boundary	
500-Year Flood Boundary	
Base Flood Elevation Line With Elevation In Feet**	513
Base Flood Elevation in Feet Where Uniform Within Zone**	(EL 987)
Elevation Reference Mark	RM7×
Zone D Boundary	
River Mile	•M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

*EXPLANATION OF ZONE DESIGNATIONS

ZONE	EXPLANATION
A	Areas of 100-year flood; base flood elevations and flood hazard factors not determined.
A0	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.
AH	Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.
A1-A30	Areas of 100-year flood; base flood elevations and flood hazard factors determined.
A99	Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.
B	Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)
C	Areas of minimal flooding. (No shading)
D	Areas of undetermined, but possible, flood hazards.
V	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.
V1-V30	Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.

NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

INITIAL IDENTIFICATION:
JUNE 23, 1978

FLOOD INSURANCE RATE MAP EFFECTIVE:
JULY 15, 1984

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE
1000 0 1000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

HAYWOOD COUNTY, NORTH CAROLINA
(UNINCORPORATED AREAS)

PANEL 80 OF 250
(SEE MAP INDEX FOR PANELS NOT PRINTED)

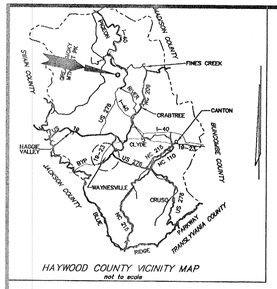
COMMUNITY-PANEL NUMBER
370120 0080 B

EFFECTIVE DATE:
JULY 15, 1984

Federal Emergency Management Agency

HAYWOOD COUNTY MSWLF FACILITY SITE STUDY

LOCAL CHARACTERIZATION STUDY



LEGEND:

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

PLATE 1

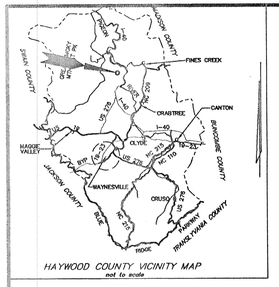
Municipal Services Engineering Company, P.A.
P.O. BOX 87, GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 348, BOONE, N.C. 28607 (828) 262-1797

MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SITE SUITABILITY STUDY
GENERAL SITE MAP

SCALE:	1"= 200'
DATE:	10/2/98
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G98010
DRAWING NO.	GS
SHEET NO.	1 OF 1



LEGEND:

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

PLATE 5

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

MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SITE SUITABILITY STUDY
CROSS SECTIONS

SCALE:	1"= 200'
DATE:	10/2/98
DRWN. BY:	L. HAMPTON
CHKD. BY:	L. SKINNER
PROJECT NUMBER	G98010
DRAWING NO.	CS
SHEET NO.	1 OF 6

LEGEND:

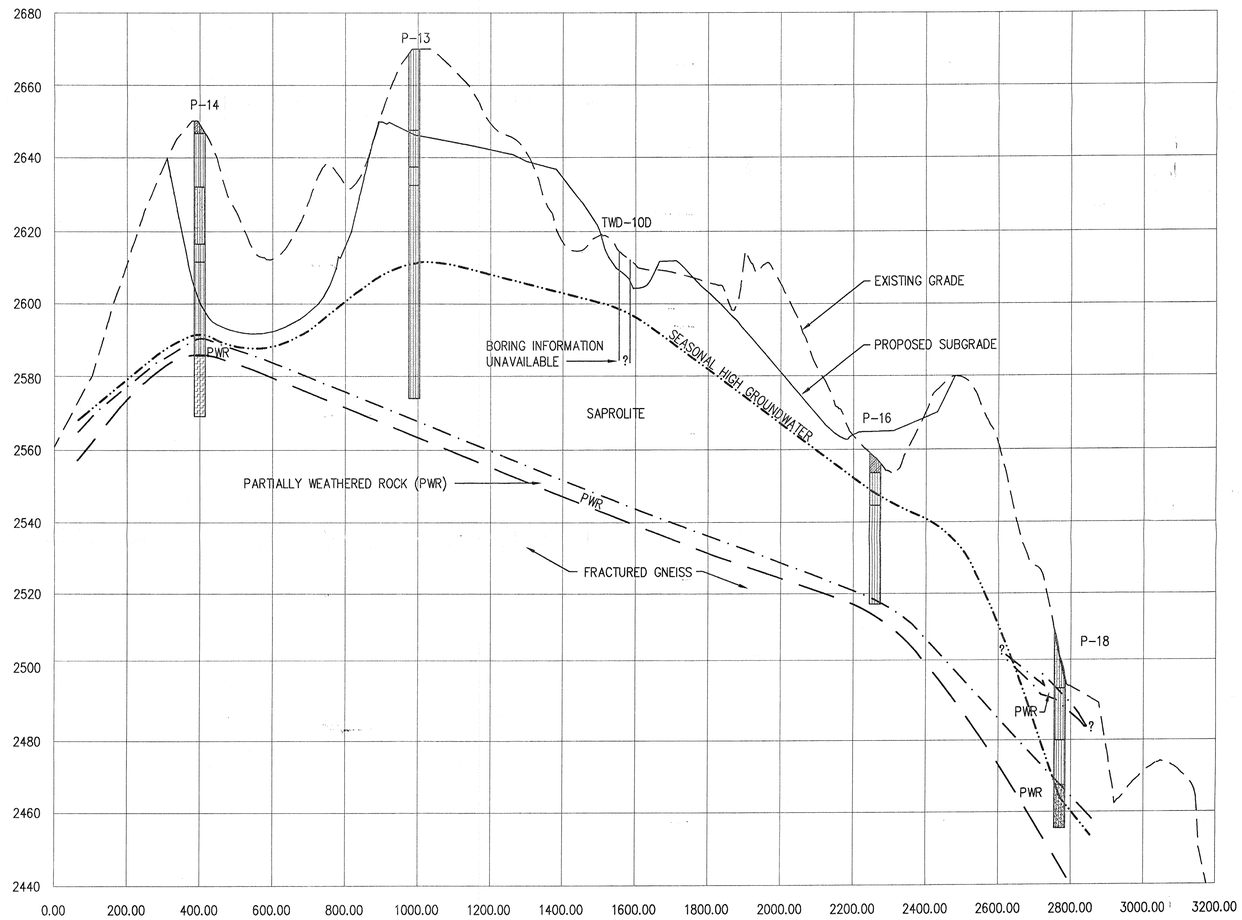
- EXISTING GRADE
- PROPOSED SUBGRADE
- SEASONAL HIGH GROUNDWATER
- PARTIALLY WEATHERED ROCK
- TOP OF ROCK

SOIL TYPE LEGEND:

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

NOTE:

ALL BOUNDARIES ARE APPROXIMATE.
INFERRED BETWEEN BORING LOCATIONS.



SECTION A-A'

SCALE: HORIZONTAL = 1" = 200'
VERTICAL = 1" = 20'

PLATE 5A

Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 348 BOONE, N.C. 28607 (828) 262-1707

MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

CROSS SECTIONS (CONT.)
SECTION A-A'

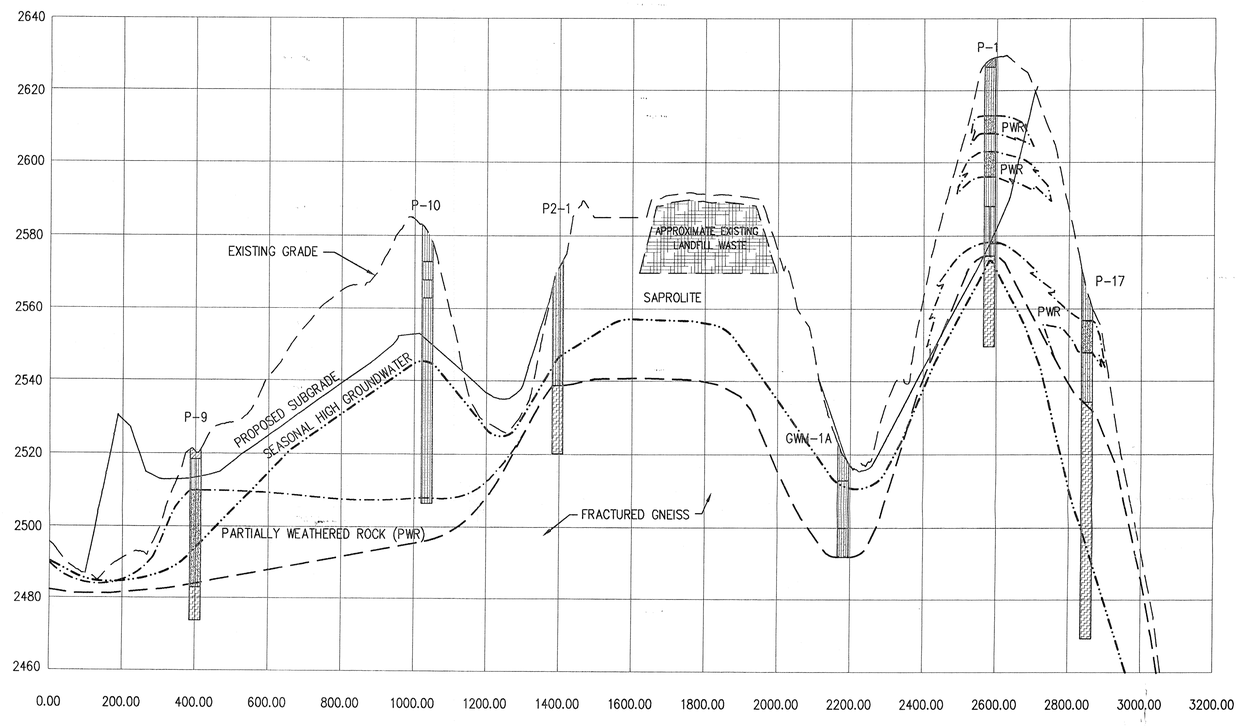
SCALE:	AS SHOWN
DATE:	10/2/98
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. SKINNER
PROJECT NUMBER	G98010
DRAWING NO.	CS1
SHEET NO.	2 OF 6

LEGEND:

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

SOIL TYPE LEGEND

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



SECTION B-B'

SCALE: HORIZONTAL = 1" = 200'
VERTICAL = 1" = 20'

NOTE:

ALL BOUNDARIES ARE APPROXIMATE.
INFERRED BETWEEN BORING LOCATIONS.

PLATE 5B

Municipal Engineering Services Company, P.A.
P.O. BOX 97, GARNER, N.C. 27622 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1707

MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

CROSS SECTIONS (CONT.)
SECTION B-B'

SCALE:	AS SHOWN
DATE:	10/2/98
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. SKINNER
PROJECT NUMBER	G98010
DRAWING NO.	CS1
SHEET NO.	3 OF 6

LEGEND:

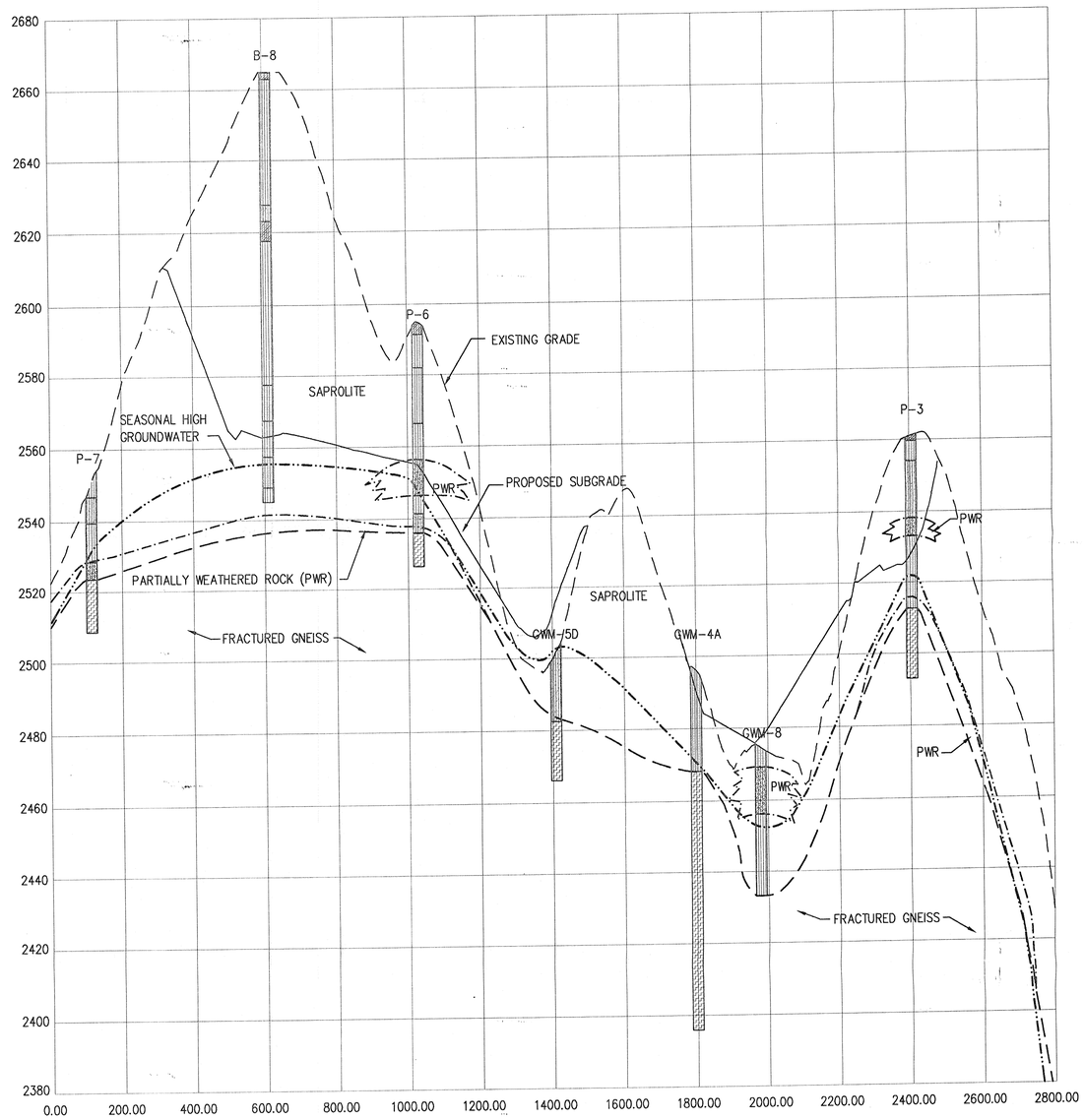
- EXISTING GRADE
- PROPOSED SUBGRADE
- SEASONAL HIGH GROUNDWATER
- PARTIALLY WEATHERED ROCK
- TOP OF ROCK

SOIL TYPE LEGEND

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

NOTE:

ALL BOUNDARIES ARE APPROXIMATE.
INFERRED BETWEEN BORING LOCATIONS.



SECTION C-C'

SCALE: HORIZONTAL = 1" = 200'
VERTICAL = 1" = 20'

PLATE 5C

Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-6563
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1707

MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

CROSS SECTIONS (CONT.)
SECTION C-C'

SCALE:	AS SHOWN
DATE:	10/2/98
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. SKINNER
PROJECT NUMBER	G98010
DRAWING NO.	CS1
SHEET NO.	4 OF 6

LEGEND:

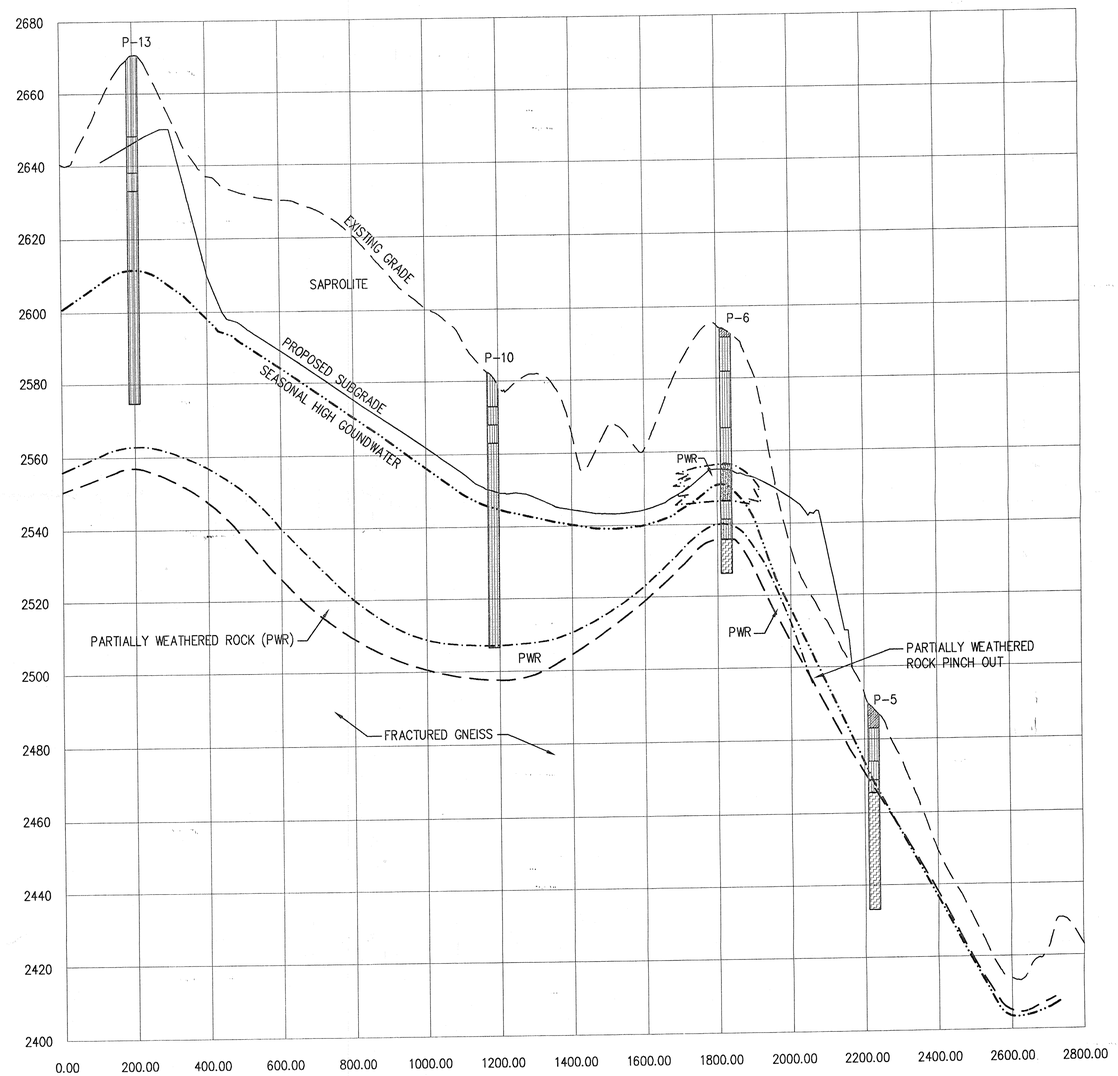
- EXISTING GRADE
- PROPOSED SUBGRADE
- SEASONAL HIGH GROUNDWATER
- PARTIALLY WEATHERED ROCK
- TOP OF ROCK

SOIL TYPE LEGEND

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

NOTE:

ALL BOUNDARIES ARE APPROXIMATE.
INFERRED BETWEEN BORING LOCATIONS.



SECTION D–D'

SCALE: HORIZONTAL = 1" = 200'
VERTICAL = 1" = 20'

PLATE 5D

Municipal Services Engineering Company, P.A.
P.O. BOX 67 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 849 BOONE, N.C. 28607 (828) 262-1767

MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

CROSS SECTIONS (CONT.)
SECTION D–D'

SCALE:	AS SHOWN
DATE:	10/2/98
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. SKINNER
PROJECT NUMBER	G98010
DRAWING NO.	CS1
SHEET NO.	5 OF 6

LEGEND:

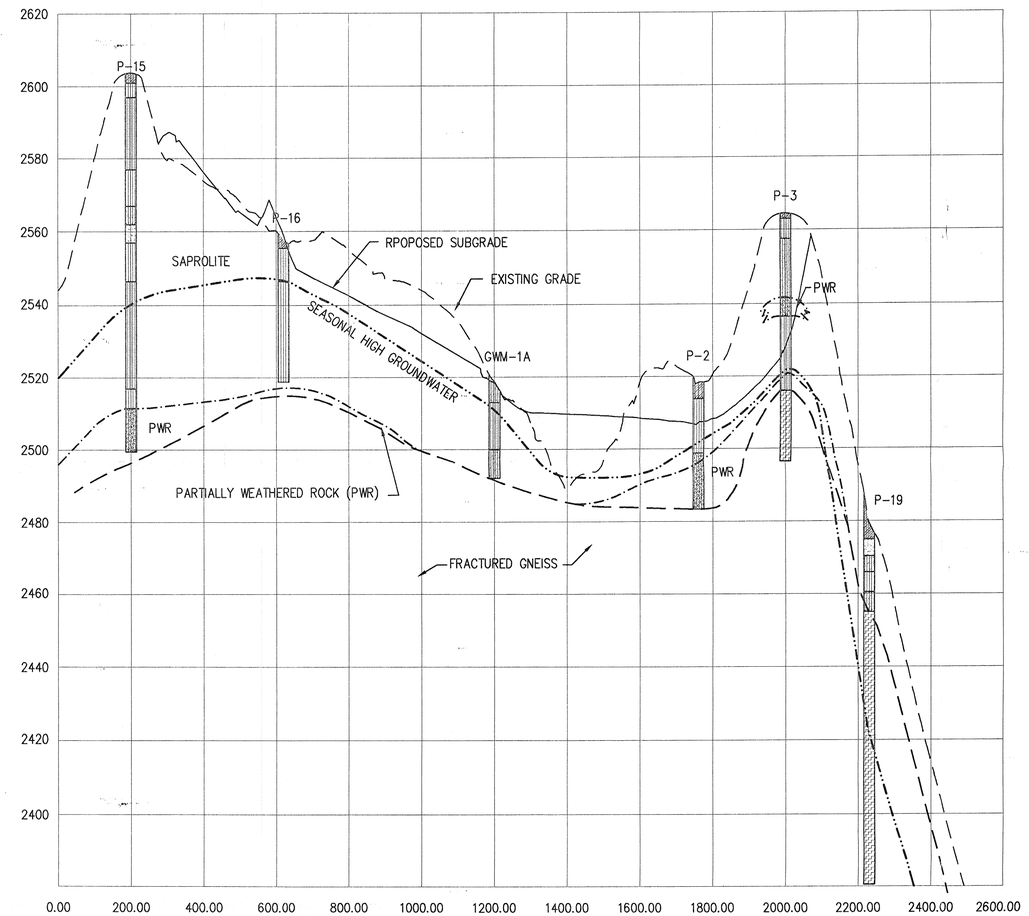
- EXISTING GRADE
- PROPOSED SUBGRADE
- SEASONAL HIGH GROUNDWATER
- PARTIALLY WEATHERED ROCK
- TOP OF ROCK

SOIL TYPE LEGEND

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

NOTE:

ALL BOUNDARIES ARE APPROXIMATE.
INFERRED BETWEEN BORING LOCATIONS.



SECTION E-E'

SCALE: HORIZONTAL = 1" = 200'
VERTICAL = 1" = 20'

PLATE 5E

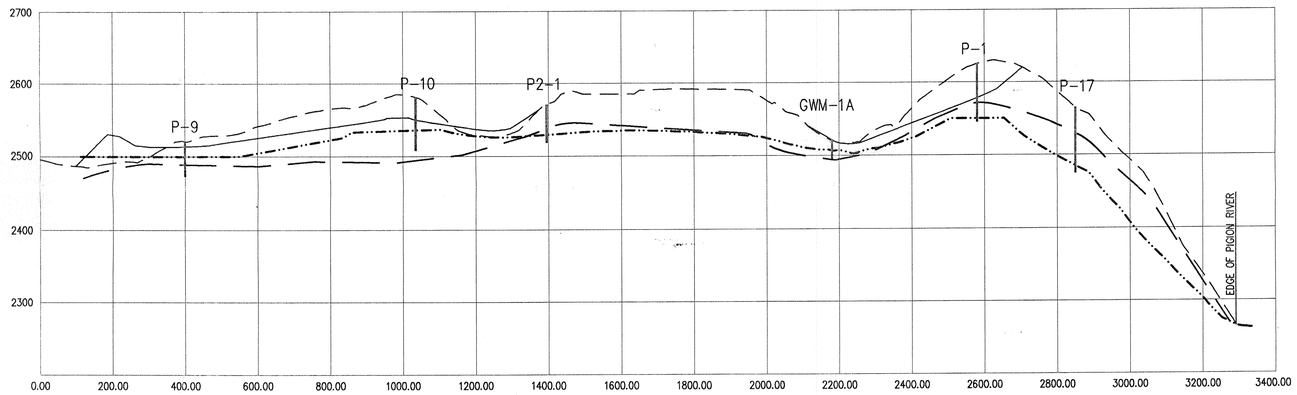
Municipal Services Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 848 BOONE, N.C. 28607 (828) 262-1707

MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

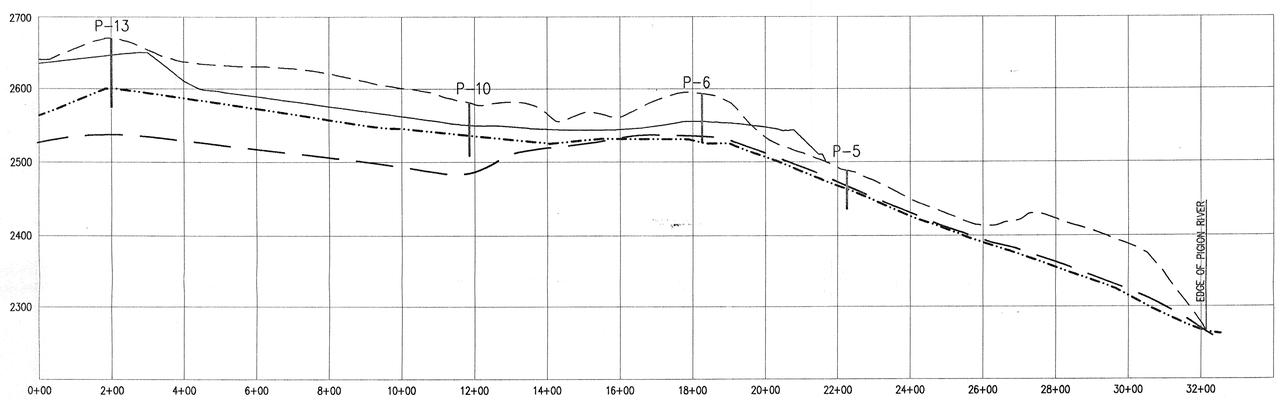
CROSS SECTIONS (CONT.)
SECTION E-E'

SCALE:	AS SHOWN
DATE:	10/2/98
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. SKINNER
PROJECT NUMBER	G98010
DRAWING NO.	CS1
SHEET NO.	6 OF 6



SECTION B–B'

SCALE: HORIZONTAL = 1" = 200'
VERTICAL = 1" = 100'



SECTION D–D'

SCALE: HORIZONTAL = 1" = 200'
VERTICAL = 1" = 100'

LEGEND:

- EXISTING GRADE
- PROPOSED SUBGRADE
- SINGLE DAY GROUNDWATER
- TOP OF ROCK

PLATE 6

Municipal Services Engineering Company, P.A.
P.O. BOX 67, GARNER, N.C. 27529 (919) 772-5303
P.O. BOX 549 BOONE, N.C. 28607 (828) 262-1797

MUNICIPAL SOLID WASTE LANDFILL FACILITY
HAYWOOD COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SITE SUITABILITY STUDY
GENERAL PROFILE

SCALE:	AS SHOWN
DATE:	10/1/98
DRWN. BY:	L. HAMPTON
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G98010
DRAWING NO.	GP1
SHEET NO.	1 OF 1