Attachment A: Sources of Information and References

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2) Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating well., Water Resources Research, vol. 12, no3, pp 423-428.

3) ENSR Consulting and Engineering (NC), Inc. December 2002, City of Raleigh, Neuse River Waste Water Treatment Plant, Comprehensive Site Assessment.

4) ENSR Consulting and Engineering (NC), Inc. September 2003, City of Raleigh, Neuse River Waste Water Treatment Plant, Supplemental Site Assessment Report.

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16) USDA/NRCS National Soil Characterization Database (http://soils.usda.gov/survey/nscd/index.html)

17) Heath, Ralph, 1995, 1995 Letter Reports to Persimmon Hill Homeowner's Association (Included as Attachment B).

Attachment B: Ralph Heath Letter Report

RALPH C. HEATH

Consulting Hydrogeologist

4821 Kilkenny Place
Raleigh, N. C. 27612
(919) 782-0171

December 26, 1994

Mr. Larry Hicks
Persimmon Hill Homeowners Assn.
128 Persimmon Hill Trail
Pittsboro, N.C. 27312

Dear Larry:

This letter is written in response to your and Bruce Raymond's request, on behalf of the Persimmon Hill Homeowners Assn., that I evaluate the hydrogeologic conditions in the Persimmon Hill subdivision and in the adjoining proposed Norwood Aires subdivision. These two subdivisions are located in northern Chatham County, south of Manns Chapel Road about 3 miles west of U.S. Highways 15-501.

This letter is based on observations made on December 19 during a field tour of the area, on records of wells in the Persimmon Hill subdivision, on laboratory reports from the North Carolina Public Water Supply Section regarding the bacterial contamination of the well in the nearby Chatham subdivision, and on a review of reports on the geology and ground-water resources of the area. These reports include, among others, the report prepared by the U.S. Geological Survey on the Durham Area, which includes Chatham County.

For convenience in the following discussion, I will refer to the general area from Persimmon Hill to the Chatham Subdivision as *the area*. When referring to conditions in a specific area, I will use the specific name of that area.

Relative to geologic conditions, the area is underlain by bedrock composed of granite which is commonly referred to in well-driller reports as *Chapel Hill granite*. A rather striking geologic feature of the area is the numerous large granite boulders that occur on the land surface above elevations of about 500 ft. When roads, homes, and other structures are built in these areas, the boulders must be moved with the result that along parts of Manns Chapel Road the shoulder is lined with boulders a few to several feet in diameter. Yards near the south end of Persimmon Hill Trail are also bordered with boulders that had to be moved to build the homes and domestic-waste drain fields.

Attachment No. 1 shows the approximate area in the Persimmon Hill and Norwood Aires subdivisions in which large granite boulders are common on the land surface.

After observing the boulders on the upland surfaces, I expected to also find numerous granite outcrops along the stream channels in Norwood Aires. This, however, is not the case. No outcrops were observed and in only 2 or 3 places along the channels were scattered stones up to several inches in diameter observed. The geologic history of the area is too complex to cover in this letter but a few comments are certainly in order.

The granite that underlies the area formed at great depth below the land surface. Since then, erosion has removed the many thousands of feet of rock that originally existed between the land surface and the newly formed granite. In the process, great compressive stresses acting on the granite were relieved with the result that it expanded and broke along both a network of steeply-dipping "vertical" fractures and a network of "horizontal" fractures roughly parallel to the land surface.

These fractures serve as pathways along which ground water moves and, in the process, the ground water dissolves the most soluble minerals which gradually causes the granite to disintegrate into a loose, granular soil-like layer referred to as *saprolite* or *regolith*. As the granite disintegrates, it becomes susceptible to erosion by rain falling on the land surface.

The importance of these observations, relative to the area, is that the boulders and the ridges occur where the granite is the least fractured and the valleys occur where fractures are most abundant. This is believed to explain, in the simplest-possible terms, the presence of the large boulders on the upland (ridge) areas and the lack of bedrock outcrops along the streams.

With these geologic features in mind. I will now discuss the hydrologic conditions. Rain falling on the land surface either infiltrates into the ground or, if the rate exceeds the infiltration capacity, rain runs off over the land surface. Most of the rain that infiltrates into the ground remains in the soil zone from which it either evaporates or is withdrawn by plants during the growing season. The remainder moves downward to the water table as recharge to the *ground-water system* which is composed of both the regolith layer that underlies the land surface and the underlying fractured granite bedrock.

The water that reaches the water table moves downward and laterally through the ground-water system (thru the regolith and bedrock) to nearby streams where it returns to the land surface as seepage through the sides and bottom of the channels. The result of these recharge and discharge conditions is that the water table stands at a higher elevation beneath ridges than beneath valleys.

Ground-water recharge in forested areas, such as now exists in the Norwood Aires area, averages, over the course of a year, about 300,000 gallons per day per square mile. This recharge is not evenly distributed over the course of a year, however, because of the effect of evaporation and plant transpiration. Instead, about 70 percent of the recharge occurs in the 6 months from October through March and the remaining 30 percent during the remainder of the year. This uneven distribution of ground-water recharge causes a seasonal fluctuation of the water table that may exceed 10 ft beneath the ridges in the area.

The large recharge rate in forested areas results from the very porous nature of the soil and surface litter and to the presence of holes left in the soil zone by decayed tree roots. Conversion of the land surface to other uses destroys these features and thereby results in a substantial reduction in ground-water recharge. Not unexpectedly, the reduction in recharge rates is least in areas zoned for 2 acre and larger lots because more of the area is likely to be left in its natural state. On lots of 1 acre or less, most of the land surface is occupied by houses and driveways, which are non-recharge areas, and by lawns and other cleared areas which have recharge rates one-tenth, or less, that of forested areas.

With the above points in mind, it is important at this point to deal with the affect of development density on ground-water recharge. The proposed Norwood Aires subdivision contains about 70 acres or about 0.11 mi^2 (70 acres ÷ 640 acres/mi^2). Under the present natural conditions, with a recharge rate of 300,000 gpd/mi^2, the average daily recharge amounts to about 33,000 gallons per day.

The area is presently zoned for 1-acre lots and the preliminary development plan dated November 18, 1994, shows 59 lots. If the average size of families in the subdivision is 3 people and their average daily water use is 100 gallons per capita, the water use will total about 18,000 gallons per day, or only about 55 percent of the estimated present recharge.

At first glance, it would appear from this that the recharge is more than adequate to supply the water use. This conclusion, however, ignores the reduction in recharge that will result from the development. This reduction will be at least 75 percent, even if every effort is made to retain as much of the area as possible in its natural state, and is more likely to be as much as 90 percent. In other words, with the development of 1-acre lots, it is probable that the ground-water recharge will be reduced to substantially less than the water use. This does not necessarily mean that the area will "run short" of water because a large part of the water used will be returned to the ground-water system through septic tanks and domestic-waste drain fields. It does mean, however, that after a few years an ever-increasing percentage of the water drawn from the wells will be water that has passed through septic tanks.

The preceding discussions of recharge to the ground-water system and movement of ground water from the upland areas to the streams to discharge deal with the pipeline, or conduit, function of the ground-water system. An equally important aspect relates to the storage, or reservoir, function. Most of the water "in storage" in the ground-water system is in the regolith layer. The volume of water in storage in the fracture openings in the granite is so much smaller that it can be ignored.

The ground water contained in the regolith in the Norwood Aires subdivision serves two very important functions. First, it is the source of the water drawn by wells during the growing season when recharge is small or nonexistent. Second, it serves to dilute the domestic wastes introduced into the system through septic tanks and drain fields. Thus, whether a shortage of water develops during the summer or whether the domestic wastes result in an undesirable deterioration in water quality depends on the volume of water in storage in the regolith.

The presence of the large boulders on the surface in the upland areas suggest that the storage in the regolith in these areas is small. In an effort to verify this, I prepared the cross sections shown in Attachment No. 2. The lines of these cross sections are shown on Attachment No. 1.

The upper cross section on Attachment 2 shows the land-surface profile, based on the U.S. Geological Survey topographic map, through the Norwood Aires Subdivision. The lower cross section shows the land-surface profile, together with the water-table profile, the position of the bedrock surface, and the apparent nature of the regolith near the east side of the Persimmon Hill subdivision. The water table and the geologic features shown on this profile are based on the well-record reports that you furnished me. I believe that the conditions in the Norwood Aires subdivision will be very similar to those shown on the Persimmon Hill cross section.

The general geologic and hydrologic features discussed in the preceding paragraphs, such as the position of the water table, are shown on this cross section. However, the two most significant features are the nature of the regolith and the position of the water table relative to the top of the fractured bedrock. Relative to the regolith, the presence of boulders on the land surface indicates that a large part of the regolith in this area is also composed of large masses of solid granite. The presence of these masses results in a much smaller storage capacity in the regolith than would be the case if the granite were completely disintegrated.

Relative to the position of the water table in relation to the top of the bedrock, note that at the well on Lot 18 the top of the bedrock, as indicated by the depth of the casing, is only 26 ft below land surface. The well driller reports the water level in the well was 35 ft below land surface, or 9 ft below the bottom of the casing. Although no dates are shown on the well record, I suspect the well may have been drilled in late summer. In any case, the record suggests that in parts, and possibly in large parts, of the upland areas of Persimmon Hill and, presumably, Norwood Aires, there is little or no ground-water storage in the regolith. (Note that on the cross section, I show the water table at Lot 18 to be about 25 ft below land surface to make it consistent with the other wells.)

The preceding parts of this letter cover the most important features of the geologic and hydrologic conditions that I wanted to call to your attention. I have gone into more detail in some cases than may have been necessary, but I did this in anticipation that your Association will send copies to the Planning Board and to the Board of County Commissioners none of whom, I assume, are either geologists or hydrologists.

My conclusion, based on my observations and from analysis of the well data for the Persimmon Hill subdivision, is that it will not be wise to develop the Norwood Aires subdivision with 1-acre lots, if each lot is to be served by a well and a septic tank and drain field. After such development, I do not believe the ground-water recharge and the ground-water storage in the regolith will be adequate to meet the water needs and to provide sufficient dilution of the domestic wastes. The fact that the regolith and the bedrock in the area can be overloaded with domestic wastes has recently been demonstrated by the contaminated supply well in the Chatham subdivision.

I suspect, from my studies in northern Chatham County, that decisions related to zoning and development density are based largely on the infiltration studies related to septic tanks and drain fields. This is certainly an important consideration. However, the thickness and storage characteristics of the regolith and the effect of development density on recharge may, in the long run, be equally, if not more, important.

From the standpoint of the Persimmon Hill Homeowners Association, I think your concern about the potential effect of the Norwood Aires development on your water supply are well founded. Water and wastes from that development will exit through the tributary to Wilkenson Creek which flows through the Persimmon Hill subdivision. During dry summers, water from this tributary may be drawn into nearby Persimmon Hill wells and, if the water is contaminated, the wells will be also contaminated.

I hope that the above satisfactorily answers the questions raised by your Association. However, if there are any points that I failed to address, let me know.

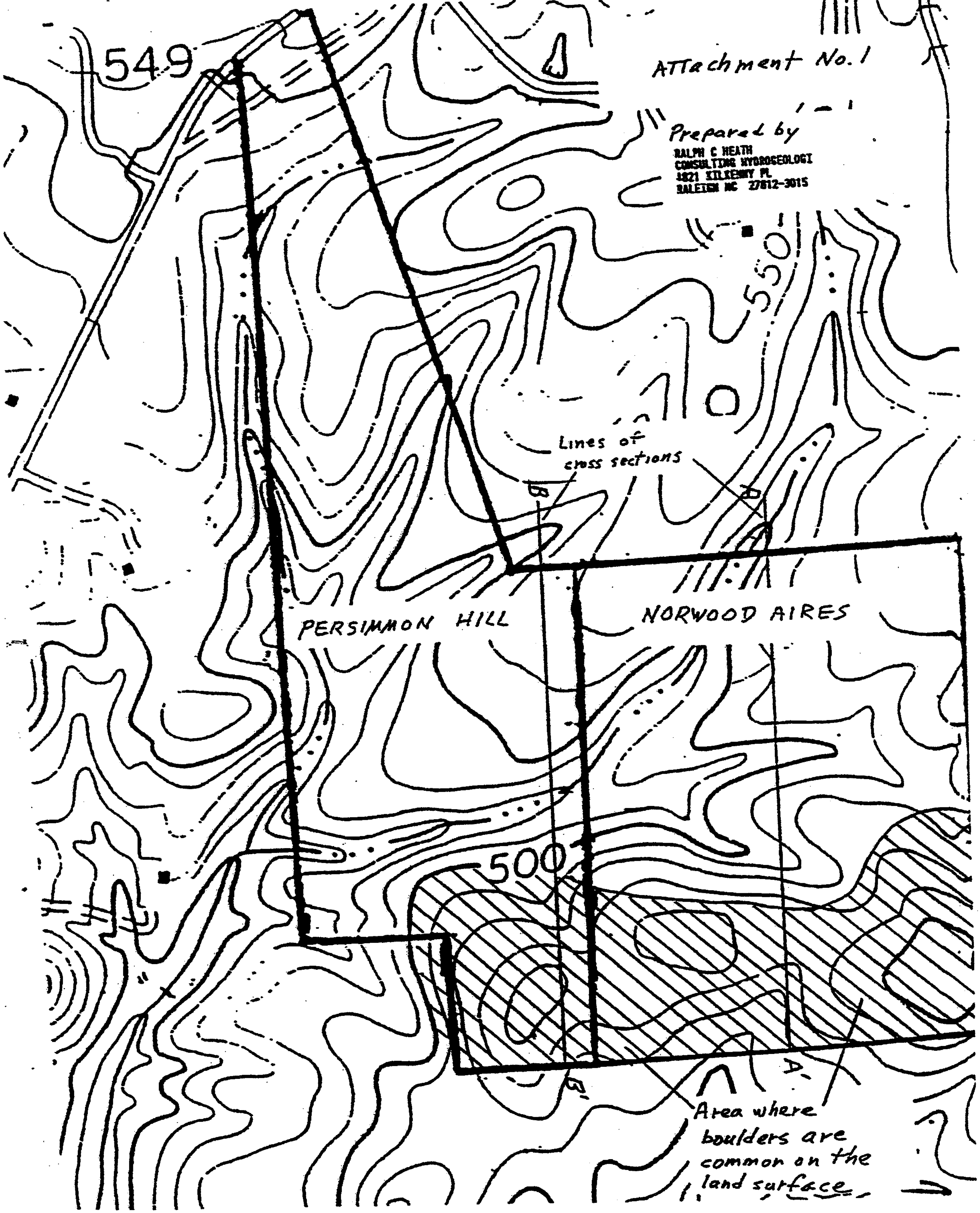
Sincerely,

Ralph C. Heath

rch/mh

NORTH CAROLINA LICENSED GEOLOGIST SEAL 225 RALPH C. HEATH

AMERICAN INSTITUTE OF HYDROLOGY Certificate Number 104 RALPH C. HEATH Professional Hydrogeologist


Attachment No. 1
Prepared by
RALPH C HEATH
CONSULTING HYDROGEOLOGI
1821 KILKENNY PL
RALEIGH NC 27612-3015
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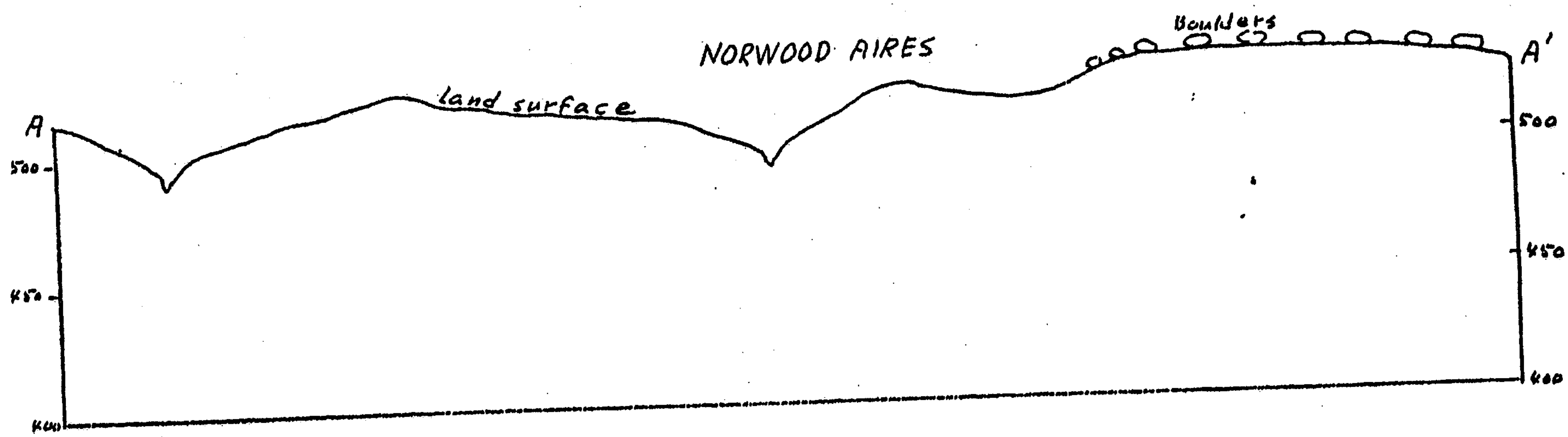
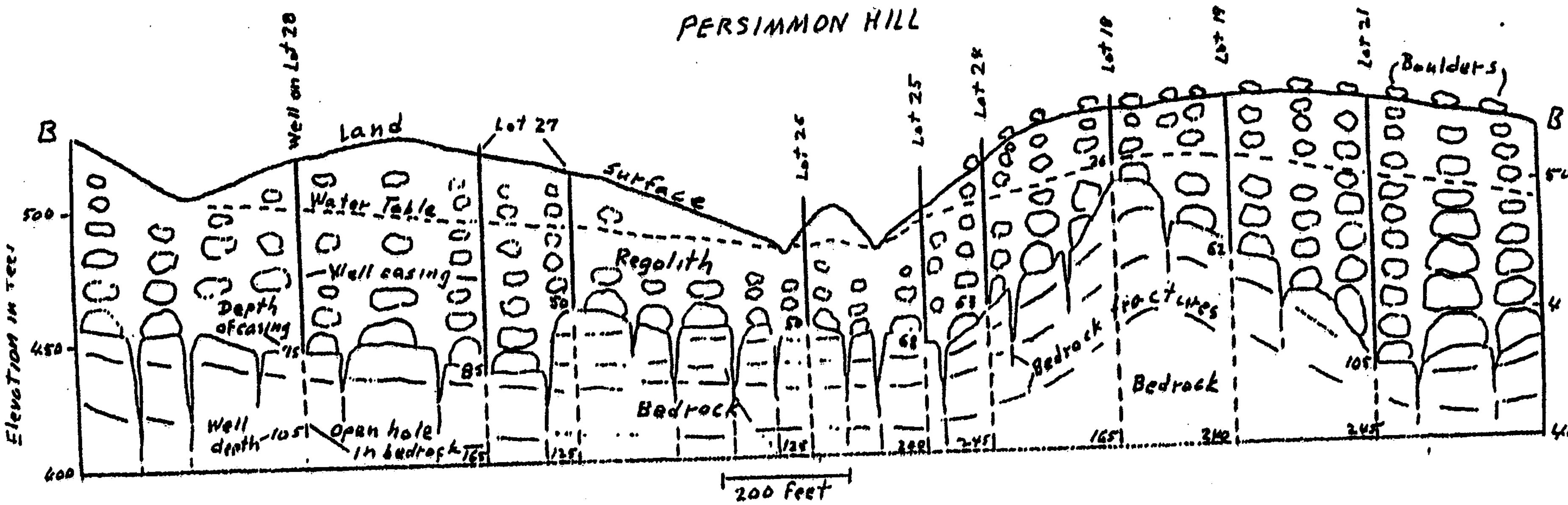
Lines of cross sections
B
A
PERSIMMON HILL
NORWOOD AIRES
500
B'
A'
Area where boulders are common on the land surface

Attachment No. 2





Attachment No. 2

Prepared by

RALPH C HEATH
CONSULTING HYDROGEOLOGY
4821 KILKENNY PL
RALEIGH NC 27612-3016

RALPH C. HEATH is an internationally-recognized authority on hydrogeology and has received several awards for his outstanding ability to explain complex ground-water concepts. After graduating from the University of North Carolina at Chapel Hill, he worked 34 years for the U.S. Geological Survey in Florida, New York, New England, and North Carolina. His positions with the USGS included those of District Geologist for New York and southern New England and District Chief for both New York and North Carolina. Since retiring from the USGS in 1982, he has served as Adjunct Professor of Civil Engineering at North Carolina State University and Lecturer at Duke University.

He is the author of more than 50 publications on ground water and hydrology, including *Ground-Water Regions of the United States* and *Hydrogeologic Maps of North America* and college-level textbooks entitled *Introduction to Ground-Water Hydrology* and *Basic Ground-Water Hydrology*.

In addition to his current work as a self-employed Consulting Hydrogeologist, he lectures at National Science Foundation short courses for college teachers and has taught advanced short courses for the staff of the North Carolina Groundwater Section.

He is a recipient of the Award for Distinguished Service in Hydrogeology from the Geological Society of America and served, in 1990, as the Henry Darcy Lecturer of the Association of Ground Water Scientists and Engineers. He is also a member of the Board of Registration of the American Institute of Hydrology, served as the first Chairman of the Board in 1983-84, and received the first Founders Award of the Institute in 1991.

RALPH C. HEATH

Consulting Hydrogeologist

4821 Kilkenny Place
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March 11, 1995

Mr. Bruce Raymond
127 Persimmon Hill
Pittsboro, N.C. 27312

Dear Bruce:

I am enclosing two copies of a map of the Norwood Heirs area of Chatham County on which have been drawn, in colored pencil, stream channels in which there was flow on March 4, 1995, as observed by you, Larry Hicks, Paul Ford, and me. After the map was finished, it occurred to me that it would be desirable to differentiate between stretches where the flow was occurring in shallow surface depressions and stretches where the flow was in entrenched channels. I used "whiteout" to form a dashed line to show approximately where the flow was in shallow depressions. I will discuss what I think the hydrologic significance is of the different types of channels in a following paragraph. The map also shows observations of the depth to water in soil borings and, in red ink, the position of the water level in the hole left by a decayed tree trunk. More on these later.

The reason we visited the area on March 4, as you know, was to observe surface runoff at a time near the seasonal high position of the water table. I believe we were successful because the National Weather Service at the Raleigh-Durham Airport recorded 8.3 inches of rain in January and February, or about 0.56 inch above normal for the year. Following 0.4 inch of rain on March 1, there was no further rain before the time of our visit. Thus, by March 4, there had been 3 days without rain, which was sufficient time for water on the land surface to infiltrate into the soil zone.

Relative to the runoff (streamflow) conditions that we observed, I was surprised to see surface runoff occurring in the shallow surface depressions uphill from the entrenched stream channels. I believe this runoff resulted from lateral flow through the soil zone in the process referred to by hydrologists as *interflow*. Interflow occurs in hilly areas, such as Chatham County, where the soil zone is more permeable than the underlying clay-rich "C" horizon. As a result, when rain infiltrates into the soil zone at a faster rate than it can move vertically downward through the C horizon to the water table, lateral flow occurs through the soil zone to surface depressions and down these to the well-defined (entrenched) stream channels. The term *interflow* was adopted by hydrologists for this condition because the flow occurs between (1) flow over the land surface, when the rate at which rain occurs exceeds the rate of infiltration into the soil, and (2) the lateral flow through the underlying ground-water zone. Interflow, incidentally, is the principal reason why forested areas are not subject to large and devastating floods.

Another somewhat surprising feature of the Norwood Heirs area, and one that I had observed earlier, is the "entrenched" nature of the stream channels. That is, the channels have nearly vertical sides 3 to about 6 feet below the normal land surface. Also, it seems significant that these channels do not gradually get deeper in a downstream direction but, instead, begin abruptly at a point that resembles a spring head. On March 4, channel flow that clearly represents ground-water discharge, began at the head of the entrenched sections. The flow of these streams will continue as long as the water table stands higher than the elevation of the channels and, even on the smaller streams, this should be well into the growing season.

I believe that the entrenched streams may be significant, from the standpoint of the proposed Norwood Heirs subdivision, in at least two respects. First, the bedrock outcrops along the channels, which Dr. Spruill and I observed, suggests that bedrock occurs at a relatively shallow depth beneath the channels. Thus, ground water moving down the slope of the water table, movement which occurs largely through the regolith, encounters a decreasing thickness of regolith which forces it (the ground water) to the land surface where it has formed the vertical-sided entrenched channels.

The second feature that may be significant is the relatively close spacing of the entrenched channels, especially in the central part of the area. If these channels are being supplied by ground water, as my observations indicate, their close spacing suggests that they will be very effective in depleting ground-water storage between rains. This may adversely affect the availability of ground water to domestic wells in the subdivision during the summer and early fall when recharge is minimal. In this regard, you will recall that I have previously expressed concern about whether ground-water storage in the regolith, especially in the southern part of the area where large boulders are common on the land surface, will be adequate to meet the water needs and to provide sufficient dilution for domestic wastes.

Finally, relative to the data shown on the enclosed map, we observed water in the soil-test holes, previously augered in the area, at depths ranging from 1 to 2 feet below land surface. Water was also at land surface in one hole that appeared to have once been occupied by a tree. These shallow depths to water level 3 days after the last rain suggests that problems may be encountered in at least parts of the area with the disposal of domestic wastes.

The observations that we made on March 4 were very instructive relative to the hydrologic conditions in the area. They certainly show, if nothing else, how important it is for officials involved in subdivision approval to visit an area during the "high water-table season."

Sincerely,

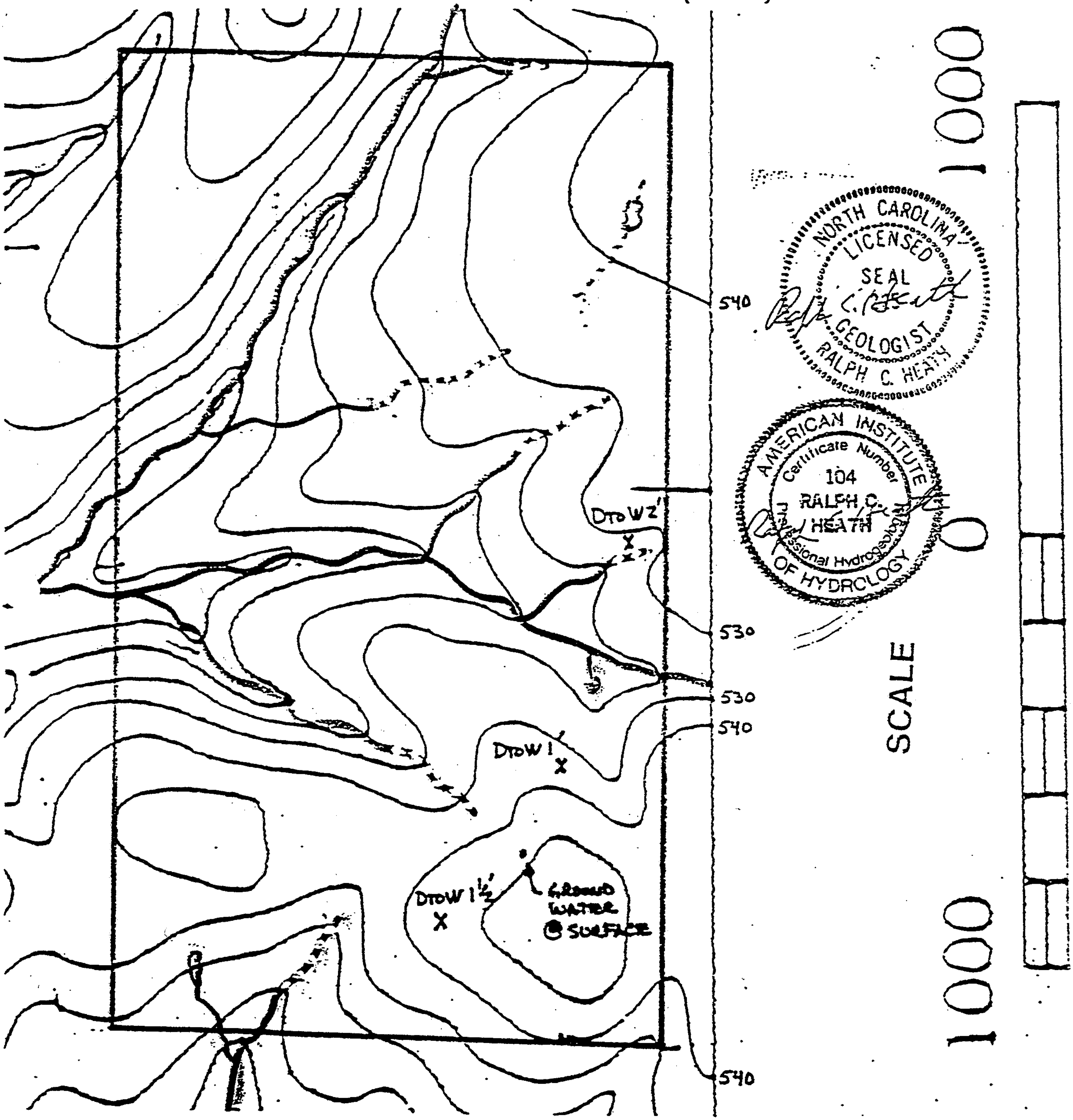
Ralph C. Heath

rch/mh

NORTH CAROLINA LICENSED SEAL 625 GEOLOGIST RALPH C. HEATH

AMERICAN INSTITUTE OF HYDROLOGY Certificate Number 104 RALPH C. HEATH Professional Hydrogeologist

ENLARGED FROM U.S. GEOLOGICAL SURVEY
BYNUM QUADRANGLE (1968)



LEGEND:

—— PROPERTY BOUNDARY

~~ STREAM/SURFACE WATER

X EXISTING SOIL TEST HOLE (36' DEEP)

DtoW DISTANCE to WATER

Attachment C: Logs of Geoprobe® borings

Attachment C Logs of Geoprobe® Borings

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-1	-	0.8	Topsoil	
	0.8	1.3	V. F. Sandy Silt	Tan/Brown
	1.3	2.3	V. F. Silty Sand/Clayey	Red Brown/White
	2.3	5.0	V. F. Silty Sand	Red Brown/Tan/White
	5.0	8.0	Fine to Med. Silty Sand	Red Brown/Tan
	8.0	8.9	No Sample	
	8.9	14.0	Fine to Med/Coarse Silty Sand, w/vertical Biotite vein	
PZ-2	1.0	3.1	V.F. Sandy Silt	Red Brown/Tan
	3.1	6.7	V.F. Sandy Silt	Red Brown/Tan/Black
	6.7	11.9	V.F. Silty Sand	Tan/White/Black
PZ-2A	1.0	3.1	V.F. Sandy Silt	Red Brown/Tan
	3.1	6.7	V.F. Sandy Silt	Red Brown/Tan/Black
	6.7	11.9	V.F. Silty Sand	Tan/White/Black
PZ-3	-	0.5	Sandy Clay	Tan
	0.5	2.0	Clay	Red
	2.0	4.0	Sandy Clay	Red
	4.0	4.5	Clay w/ Peatlike Fibers	Red
	4.5	8.0	Sandy Clay	Red and Tan
	8.0	9.0	Sandy Clay w/ Peat-loke Fibers	Red
	9.0	12.0	Silty Sand	Red and Tan
	12.0	14.0	Sandy Clay w/Peatlike Fibers	Yellow and White
	14.0	15.0	Clayey Sand w/Peatlike Fibers	Gold and Black
	15.0	16.8	Sandy Clay w/ Weathered Black Minerals	Gold and Black

Attachment C (Continued) Logs of Geoprobe® Borings

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-4	-	0.5	Topsoil	Brown Black
	0.5	2.0	Sandy Clay	Tan
	2.0	4.0	Clay	Tan/Red
	4.0	6.0	Clay w/ weathered chunks of green and black rock	Tan/Red w/ weathered green and black
	6.0	8.0	Med. To Coarse Silty Sand wi/ weathered black chunks	Tan/Red w/ weathered green and black
	8.0	9.0	Sandy Clay	Orange
	9.0	12.0	Med.-Coarse Silty Sand	Tan
	12.0	13.0	Clayey Sand	Tan
	13.0	16.0	Med.-coarse Silty Sand w/weathering	Tan w/black spots of weathering
	16.0	17.0	Clayey Sand	Tan/Orange
	17.0	20.0	Med.-Coarse Silty Sand w/Black Weathering	Tan/Orange with Black Weathering Spots
	20.0	21.0	Sandy Clay	Tan w/Brown Weathering
	21.0	24.0	Med.-Coarse Silty Sand	Tan w/Black Weathering
	24.0	25.3	Wet Sandy Clay	Tan
	25.3	28.0	Med.-coarse Silty Sand	Tan
	28.0	29.0	Wet Sand and Gravel	Tan
	29.0	31.0	Moist Sand and Gravel, Some Clay	Tan
PZ-5	-	1.0	Topsoil w/Roots	Darlk Brown
	1.0	2.1	Sandy Silty Clay	Red Brown/Green Grey
	2.1	4.4	V.F. Silty Sand, Clayey	Grey/Green/Orange, Mottled
	4.4	10.0	V.F. to Fine Silty Sand	Green Grey/Orange, Mottled
	10.0	13.0	Fine to Coarse Sand	Mottled
	13.0	14.9	V.F to Fine Silty Sand	Green Grey/Orange Mottled
	14.9	16.0	Fine to Coarse Sand	Mottled
	16.0	16.4	V.F. Sandy Silt, Wet to Saturated	
	16.4	16.9	V.F. Sandy Silt	Dark Brown/Maroon/Black
	16.9	20.0	V.F. to Coarse Silty Sand	Brown/Maroon/White/Orange
	20.0	20.9	V.F. Silty Sand, Saturated	
	20.9	21.9	V.F. to Coarse Silty Sand	Grey/Orange
	21.9	24.0	V.F. to Med. Silty Sand, Wet to Saturated	
	24.0	24.7	Med. To Coarse Sand, Saturated	
	24.7	25.5	Fine to Med. Silty Sand	
	25.5	28.0	Fine to Coarse Silty Sand, Dry and Hard	

Attachment C (Continued) Logs of Geoprobe® Borings

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-6	-	0.3	Topsoil	Dark Brown
	0.3	0.9	Sandy Silt	Tan/White
	0.9	4.8	Silty, Sandy Clay	Red/Yellow/White, Mottled
	4.8	10.4	V.F. Silty Sand, Clayey	Light Tan/Red Brown
	10.4	16.9	V.F. Silty Sand	Green Grey/Tan
	16.9	18.7	V.F. to Med. Silty Sand	Light Tan-White/Green Grey
	18.7	24.0	V.F. to Med. Silty Sand w/streaks of weathered Biotite	Light Tan-White/Green Grey/Black
	24.0	27.5	V.F. to Med. Silty Sand w/streaks of weathered Biotite, Dryer	Light Tan-White/Green Grey/Black
PZ-7	-	1.0	Topsoil	Dark Brown
	1.0	1.6	Sandy Silt	Green Grey/Red Brown
	1.6	3.0	V.F. Silty Sand	Red Brown/Green Grey
	3.0	8.5	V.F. Silty Sand	Red Brown-Tan/Green Grey
	8.5	8.7	Weathered Biotite	Dark Black
	8.7	18.5	V. F. Silty Sand, Dry and Hard	Red Brown/Green Grey
PZ-8	-	0.1	Topsoil	Brown
	0.1	0.7	Silty Clay	Red Brown
	0.7	1.6	Sandy Silt	Red Brown/Tan
	1.6	2.6	Hard Fine to Coarse Grained Granite	Grey
	2.6	2.7	Clay	Red
	2.7	3.1	Silty Sand	Brown/Tan
	3.1	3.6	Silty Sand	Grey
	3.6	4.0	Clay	Red Brown
	4.0	4.8	Silty Sand	Grey
	4.8	5.1	Clay	Red
	5.1	5.7	Silty Sand	Grey Green
	5.7	6.4	Sandy Clay	Red Brown
	6.4	7.4	Silty Sand	Red Brown/Dark Brown
	7.4	8.0	Silty Sand, Dry, Hard	Tan/Brown

Attachment C (Continued) Logs of Geoprobe® Borings

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-8A	-	0.4	Silty Sand	Red Brown
	0.4	0.7	Silty Sand	Red Brown/White/Dark Brown
	0.7	2.1	Silty Sand	Red Brown/Green Grey/Dark Brown Streak
	2.1	2.7	Silty Coarse Sand	Dark Brown/Green Grey
	2.7	3.2	Silty Sand	Green Grey
	3.2	3.3	Clay	Red
	3.3	3.5	Silty Sand	Green Grey
	3.5	3.6	Clay	Red
	3.6	4.6	Silty Sand	Green Grey
	4.6	4.8	Silty Sand	Dark Brown/Green Grey
	4.8	5.1	Clay	Red
	5.1	5.8	Sand	Dark Brown/Tan
	5.8	6.2	Fine Grained Granite Fragments, 1"	Grey
	6.2	6.3	Clay	Red
	6.3	7.6	Sand	Dark Brown/Tan
	7.6	7.8	Silty Sand	Tan/Dark Brown
	7.6	7.8	Silty Sand	Tan/Dark Brown
	8.0	10.1	Coarse Sand/Rock Fragments, Dry	Brown/Green Grey
PZ-10	-	0.3	Topsoil	Dark Brown
	0.3	0.9	Clay	Red Brown
	0.9	1.4	V.F. Sandy Silt	Red Brown
	1.4	1.6	Clay	Red Brown
	1.6	2.4	Sandy Silt	Red Brown
	2.4	2.9	Clay	Red Brown
	2.9	3.3	Silty Sand	Red Brown/Tan
	3.3	5.2	Silty Sand	Red Brown/Tan
	5.2	5.7	Silty Clayey Sand	Red Brown/Tan
	5.7	6.0	Sandy Clay	Red Brown/Tan
	6.0	9.2	V.F. Silty Sand	Tan/White
	9.2	10.0	Silty Sand	Dark Brown/Tan/White
	10.0	11.1	Silty Sand	Dark Tan/Brown/Dark Brown
	11.1	11.4	Clay	Tan
	11.4	25.0	Silty Sand	Tan/White
	25.0	25.1	Clay	Grey/Pink
	25.1	28.0	Silty Sand	Tan/White

Attachment C (Continued) Logs of Geoprobe® Borings

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-11	-	0.5	Topsoil	Dark Brown
	0.5	0.7	Very Fine Sand	Tan
	0.7	1.1	Very Fine Sandy Silt	Red Brown
	1.1	1.6	Clay	Red Brown
	1.6	1.9	Sandy Silt,Clayey	Red Brown/Tan
	1.9	3.6	V.F. Sandy Silt	Yellow/Tan
	3.6	4.0	V.F. Sandy Silt	Yellow/Tan/black Streaks
	4.0	4.1	Sandy Clay	Yellow/Brown
	4.1	10.0	V.F. Sandy Silt	Yellow/Brown/Black Streaks
	10.0	12.0	V.F. Sandy Silt/Root Crack	Yellow/Brown/Black Streaks
	12.0	14.6	V.F. Sandy Silt	Yellow/Brown/Black Streaks
PZ-12	-	0.8	Topsoil	Brown
	0.8	1.6	Silty Sandy Clay	Tan
	1.6	2.9	V.F. Silty Sand	Tan/White
	2.9	5.1	V.F.Sandy Silt	Tan/Green Grey
	5.1	9.8	Fine-Med. Silty Sand	Red Brown/Tan-white
	9.8	15.1	Med. To Coarse Silty Sand, Dry	Brown/Red Brown/Black Streaks
PZ-13	-	1.2	V.F Sandy Silt	Redto Red Brown/Tan
	1.2	3.4	V.F. Silty Sand	Tan/Light Red Brown
	3.4	4.7	V.F. Silty Clayey Sand	Tan/Light Red Brown
	4.7	6.5	V.F. Silty Sand	Dark Brown to Tan, Mottled
	6.5	7.8	V.F. Sandy Silt	Grey/White/Red Brown
	7.8	8.0	V.F. Sandy Silt	Very Dark Brown/Tan/Red Brown
	8.0	8.5	V.F. Sandy Silt, Moist	Very Dark Brown/Tan/Red Brown
	8.5	10.7	V.F. Silty Sand	Red Brown/White
	10.7	12.5	Fractured Fine Grained Dry Granite	White/Grey
	12.5	14.1	V.F. Silty Sand	Tan/Red Brown
	14.1	14.9	V.F. Silty Sand	Grey/White
	14.9	15.9	V.F. Silty Sand	Tan/Red Brown
	15.9	16.5	V.F. Sandy Silt, Moist	Tan/Red Brown
	16.5	17.8	V.F. Sandy Silt	Tan/Red Brown
PZ-14	-	1.5	Soil/Rocks	Dark Brown
	1.5	2.0	Topsoil	Dark Brown
	2.0	3.0	V.F. Sandy Silt	Brown
	3.0	4.4	Sandy Silt	Red Brown
	4.4	5.8	V.F. Sandy Silt	Yellow/Red Brown
	5.8	6.0	Sandy Clay	Red Brown
	6.0	6.8	V.F. Sandy Silt	Red Brown/Tan
	6.8	11.0	V.F. Silty Sand	Dark Brown/Tan

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-14A	-	1.0	Topsoil	Dark Brown
	1.0	2.0	Clay	Red Brown/White Streaks
	2.0	3.1	Clayey Silt	Red Brown/Tan
	3.1	6.3	Silty Sand	Red Brown/Tan
	6.3	17.0	Silty Sand	Dark Brown/Tan/Black Streaks
	17.0	18.0	Silty Sand (Easier Pushing)	Dark Brown/Green Grey
	18.0	19.7	Silty Sand (Water in Bottom of Hole)	Brown/Tan
PZ-15	-	1.0	Topsoil	Dark Brown
	1.0	5.5	Clayey Soil, Moist from 4 to 4.5	Red Brown
	5.5	8.0	V.F. Sand Saprolite, Hornblend Crystals at 8'	Grey and Pink
	8.0	12.0	V.F.-Fine Silty Sand, Very Dry'	Red Brown to White
	12.0	18.5	V.F.-Fine Silty Sand Saprolite	Tan to Brown

Attachment C (Continued) Logs of Geoprobe® Borings

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-16	-	0.9	Topsoil	Dark Brown
	0.9	1.5	V.F. Silty Sand, Clayey Moist to Wet	Green Grey
	1.5	2.5	V.F. Silty Sand, Wet/Saturated at 2.5	Mottled Orange, Dark Tan
	2.5	4.8	Silty Clay/Clayey Silt, Moist to Wet	Mottled Orange/Tan
	4.8	6.7	V.F. Sandy Silt	Red Brown/Orange and Tan Mottled
	6.7	7.7	V.F. Sandy Silt	Tan/White/Pink Mottled
	7.7	8.4	Weathered Biotite	Dark Brown/Black
	8.4	10.7	Fine Sandy Silt	Green/Grey/Orange
	10.7	16.3	Sandy Silt	Green/Grey/Orange, Mottled
	16.3	16.5	Silty Clay, Moist	Red/Orange
	16.5	19.2	V.F. Silty Sand w/weathered Biotite	Green Grey/Orange
	19.2	20.0	V.F. Silty Sand w/weathered Biotite, wetter	Green Grey/Orange
	20.0	20.6	Silty Clay	Green Grey
	20.6	25.1	V.F. Silty Sand w/weathered Biotite	Green Grey/Orange
	25.1	26.3	V.F. Silty Sand	Orange/Green Grey
	26.3	28.0	V.F. Silty Sand, 1/2 inch vertical weathered Biotite Seam	Orange/Green Grey
	28.0	29.3	V.F. Silty Sand, 1/2 inch vertical weathered Biotite Seam, Saturated	Orange/Green Grey
	29.3	32.0	V.F. Silty Sand, Saturated 1/2 inch vertical weathered Biotite Seam	Orange/Green Grey
	32.0	32.8	Saturated Sandy Silt	Green Grey
	32.8	33.9	Sandy Silt, vertical Biotite Seam	Green Grey
	33.9	36.0	Fine Silty Sand	Grey/Orange/Black
	36.0	42.5	No Sample	
	42.5	43.0	Silty Sand, Moist to Wet	Green Grey
PZ-19	-	0.5	Silty Sand	Brown/Tan
	0.5	2.0	Silty Sand	Green Grey/Brown
	2.0	6.0	Silty Sand	Green Grey/Red Brown Stains/Dark Black Streaks
	6.0	6.9	Silty Sand	Green Grey/Dark Brown, Mottled
	6.9	8.0	Sandy Silt	Red Brown/Tan, Mottled
	8.0	19.0	Sandy Silt	Red Brown/Green Grey bands

Attachment C (Continued) Logs of Geoprobe® Borings

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-20	-	1.2	Dark Brown topsoil	Dark Brown
	1.2	3.1	Silt and Sand	Tan Brown
	3.1	5.8	Silty Sand	Tan Brown
	5.7	5.8	Silty Sand w/1.5" rock Fragments	Red Brown
	5.8	10.9	Sand and Silt	Red Brown/green Gray
	10.9	12.0	Silty Sand	Brown/Tan/white
PZ-21	-	0.3	Moist Sandy Clay	Brown
	0.3	5.0	Silty Clay	Orange
	5.0	7.0	Sandy Clay	Tan
	7.0	8.5	Sandy Silt	Yellow Tan
	8.5	12.0	Silty Sand	Tan w/Black
	12.0	12.5	Silty Clay	Orange
	12.5	16.0	Silty Sand	Tan w/Black
	16.0	16.5	Silty Clay	Tan
	16.5	19.0	Silty Med. To Coarse Sand	Tan
	19.0	20.0	Sandy Silt	Yellow
	20.0	22.0	Sandy Silt	White/Tan w/Black Mottling
	22.0	23.0	Sandy Silt	Tan
	23.0	25.0	Silty Med. Sand	Tan/White
	25.0	26.0	Wet Sandy Silt	Tan
	26.0	28.0	Med. To Coarse Sand	Tan
PZ-23	-	1.1	Topsoil/Sandy Silt	Dark Brown
	1.1	1.9	Sandy Silt	Dark Brown/Tan
	1.9	3.1	V.F. Sandy Silt	Dark Brown/Yellow/Tan
	3.1	4.6	V.F. Sandy Silt	Green Grey/Tan-Red Brown
	4.6	8.4	V.F. Silty Sand	Green Grey/Red Brown
	8.4	9.5	Silty Sand	Red Brown
	9.5	13.0	Silty Sand	Red Brown/Tan/Dark Brown
	13.0	14.4	V.F. Silty Sand	Green Grey/White/Black Streaks
	14.4	15.6	Silty Sand	Dark Brown/Red Brown
	15.6	16.0	Silty Sand, Very Hard	Tan/Red Brown
	16.0	16.8	V.F Silty Sand, Saturated	
	16.8	17.6	V.F Silty Sand, Wet	Dark Brown/Green Grey
	17.6	19.0	Silty Sand Saprolite/Rock	Green Grey/Brown
PZ-24	-	1.0	Topsoil	
	1.0	1.5	V.F. Sandy Silt, Wet/Saturated	Dark Brown
	1.5	5.1	V.F. Sand, Saturated	Brown
	5.1	6.0	Silty Clay	Dark Brown/Grey
	6.0	7.0	V.F. Sand	Grey/Red Brown
	7.0	8.0	V.F. Sand, Wetter at 8'	Grey/Red Brown
	8.0	9.5	V.F. Sand, Saturated	Grey/Red Brown
	9.5	10.0	Coarse Weathered Granite, Dry	

Attachment C (Continued) Logs of Geoprobe® Borings

Site ID	Interval		Lithology	Color
	Top ft	Bottom ft		
PZ-24A	-	0.5	Topsoil	
	0.5	1.3	Moist Sandy Silt	Dark Brown
	1.3	1.5	Moist Sandy Silt	Brown
	1.5	4.0	No Sample (Running Sands)	
	4.0	5.2	Very Fine Saturated Sand	Brown/Tan
	5.2	7.0	Clayey Sand	Grey/Red Brown
	7.0	9.5	Very Fine Silty Sand	Grey/Brown
	9.5	10.0	Very Fine Clayey Sand	Grey/Orange
	10.0	11.0	Fine to Coarse Sand	Grey/Red Brown
PZ-26	-	0.4	Topsoil	Dark Brown
	0.4	1.1	Sandy Silt	Red Brown
	1.1	2.1	Sandy Silty Clay	Red Brown
	2.1	6.0	V.F. Sandy Clay	Red Brown/White Tan
	6.0	8.0	Silty Sand, pebbles to 1/2" at 6.5' and 7.4'	Red Brown/Green Grey
	8.0	8.2	Clay	Red Brown
	8.2	9.8	Silty Sand	Brown/Red Brown/Tan
	9.8	16.0	Silty Sand	Tan/White/Dark Brown Streaks
	16.0	16.8	Silty Sand, saturated	Tan/White/Dark Brown Streaks
	16.8	18.5	V.F.Silty Sand	Tan/White/Dark Brown Streaks
PZ-27	-	1.0	Sandy Silt	Brown
	1.0	4.0	Sandy Clay	Orange
	4.0	8.0	Moist Clayey Med. To Coarse Sand	Orange Brown
	8.0	8.5	Moist Sandy clay	Orange
	8.5	12.0	Moist Silty Med. To Coarse Sand	Orange
	12.0	15.0	Silty Sand and Gravel	Orange/Brown
	15.0	19.0	Wet Coarse Sand and Gravel	Orange/Brown

Attachment C (Concluded) Logs of Geoprobe® Borings

Site ID	Interval Top ft	Interval Bottom ft	Lithology	Color
PZ-29	-	1.0	Topsoil	Brown/Tan
	-	0.5	Silty Sand	Brown
	0.5	1.0	Clayey Sand	Yellow Orange
	1.0	2.5	Very Hard Sandy Silt	Yellow
	1.0	2.4	Clay	Orange
	2.4	4.0	Dry Med.-Coarse Silty Sand	Orange/White
	2.5	4.5	Clay	Mottled Yellow
	4.0	4.5	Sandy Clay	Orange
	4.5	5.5	Silty Sand/sandy Silt	White and Red
	4.5	8.0	Dry Med.-Coarse Silty Sand	Orange/White
	5.5	7.0	Hard Clay	Yellow
	7.0	8.0	Soft and Dry silt w/Angular Gravel Lense	Orange with White Gravel
	8.0	9.0	Dry Med.-Coarse Sand	Orange/White
	8.0	8.5	Clay	Orange
	8.5	9.0	Sandy Silt	Orange
	9.0	11.5	Silty Sand	Orange
	9.0	10.0	Clayey silt	Orange
	10.0	11.5	Hard Silty Clay	Tan
	11.5	13.0	Silt	Yellow
	11.5	12.0	Clay	Orange
	12.0	13.0	Medium Grained Sand	Orange White
	13.0	15.5	Silty Sand	Orange White
	13.0	14.0	Hard Moist Mottled Clay	Yellow w/Black Mottling
	14.0	15.0	Dry Clayey Silt	Yellow Tan
	15.5	16.0	Sandy Clay	OrangeTan
	16.0	19.0	Dry Medium Sand	Orange White
	19.0	20.0	Clayey Sand	Orange Brown
	20.0	20.6	Dry Medium Sand	Orange White
	20.6	22.6	Medium Sand	Orange Tan
	22.6	24.0	Clay, Last Two Feet Cave In	Tan Orange
PZ-30	-	0.3	Topsoil	Brown
	0.3	6.0	Moist Silty Sand	Med. Brown
	6.0	8.5	Dry Hard Sandy Clay	White w/Orange Mottling
	8.5	10.0	Dry Coarse Sand and Gravel	White/Orange
	10.0	10.5	Sandy Clay	Light Yellow
	10.5	11.5	Medium to Coarse Sand	Orange

Attachment D: Slug Test Analyses of Piezometers

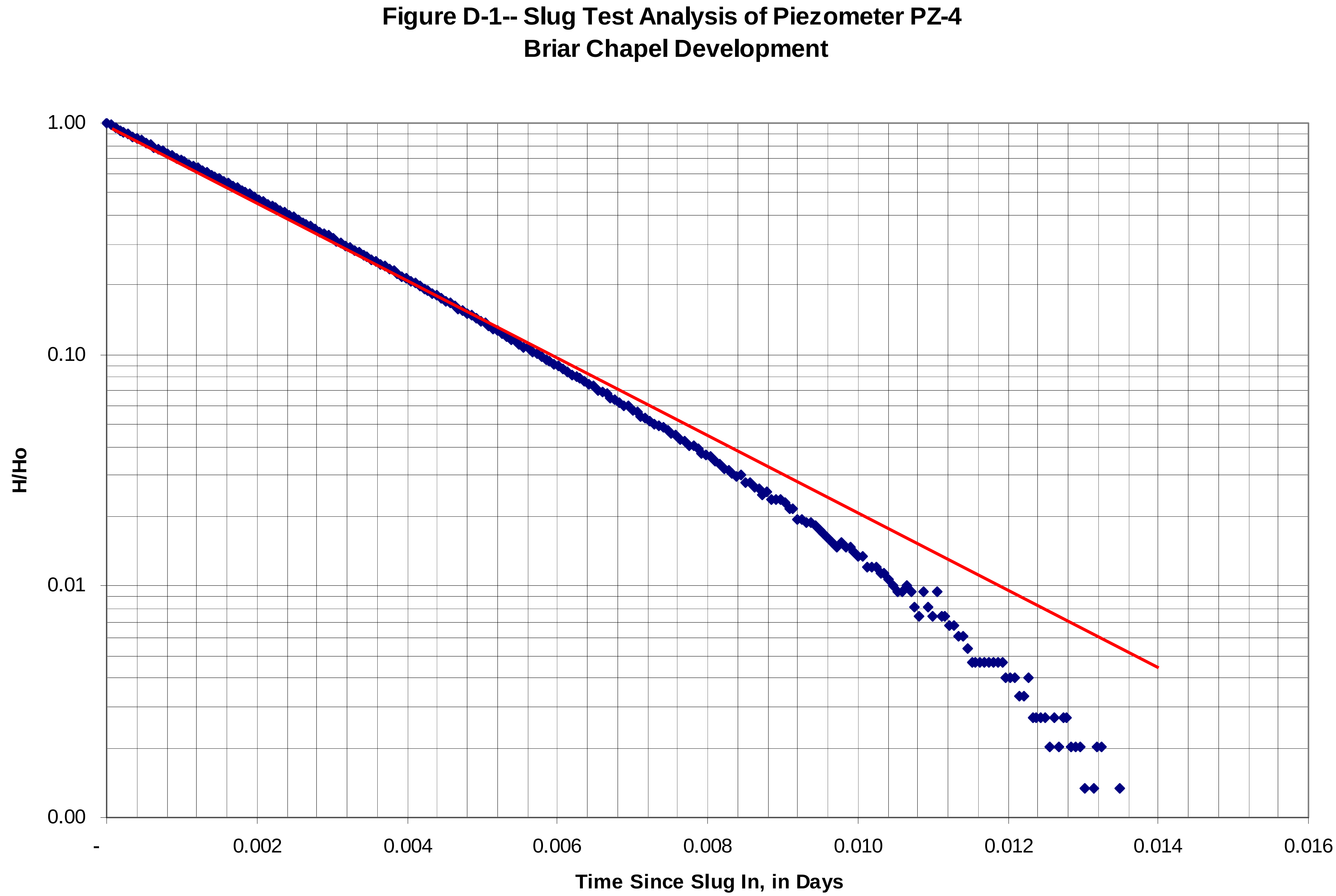


Figure D-1-- Slug Test Analysis of Piezometer PZ-4
Briar Chapel Development
1.00
0.10
0.01
0.00
H/Ho
-
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0.016
Time Since Slug In, in Days

Figure D-2-- Slug Test Analysis of Piezometer PZ-5
Briar Chapel Development

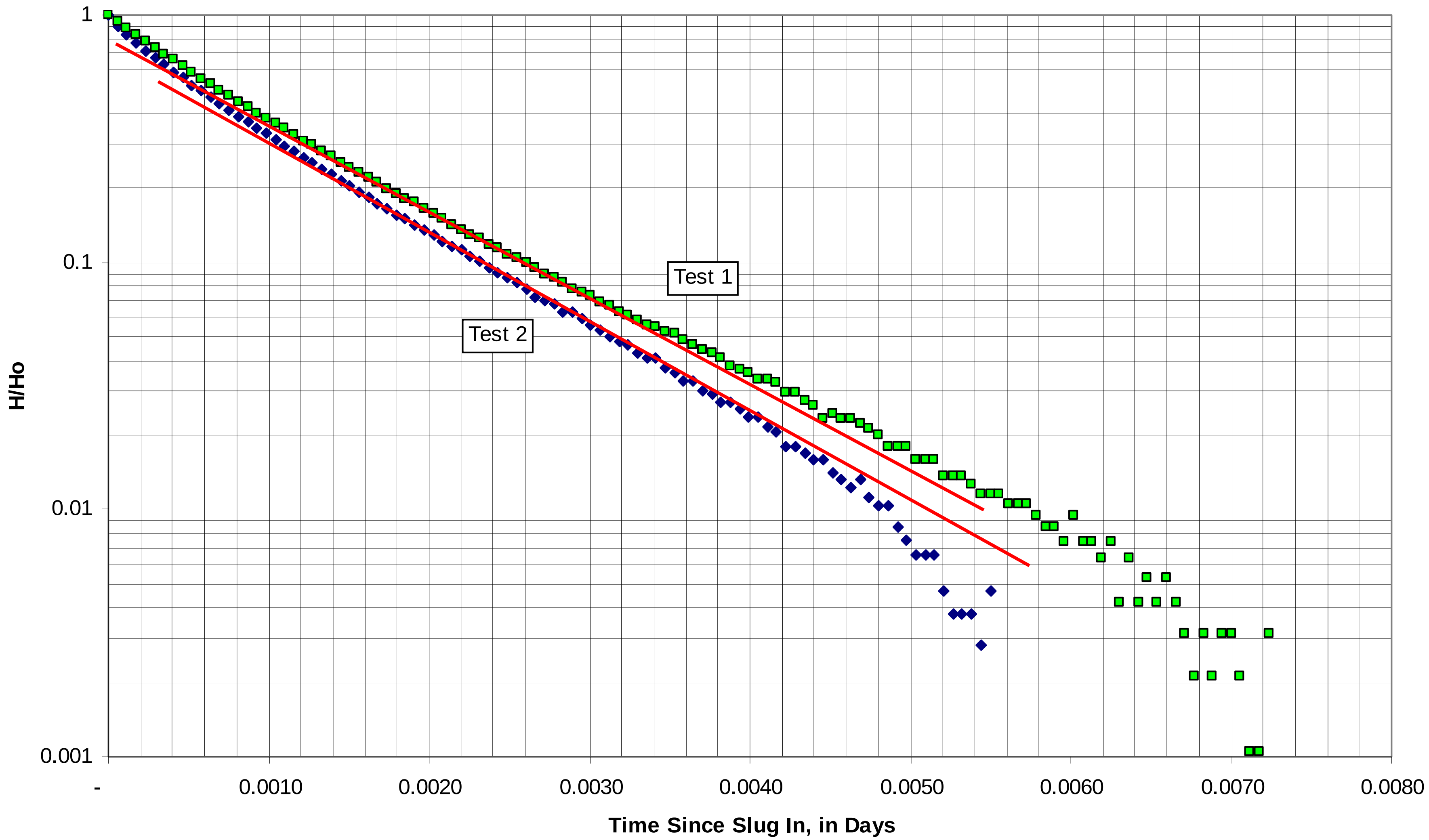


Figure D-3.-- Slug Test Analysis of Piezometer PZ-6
Briar Chapel Development

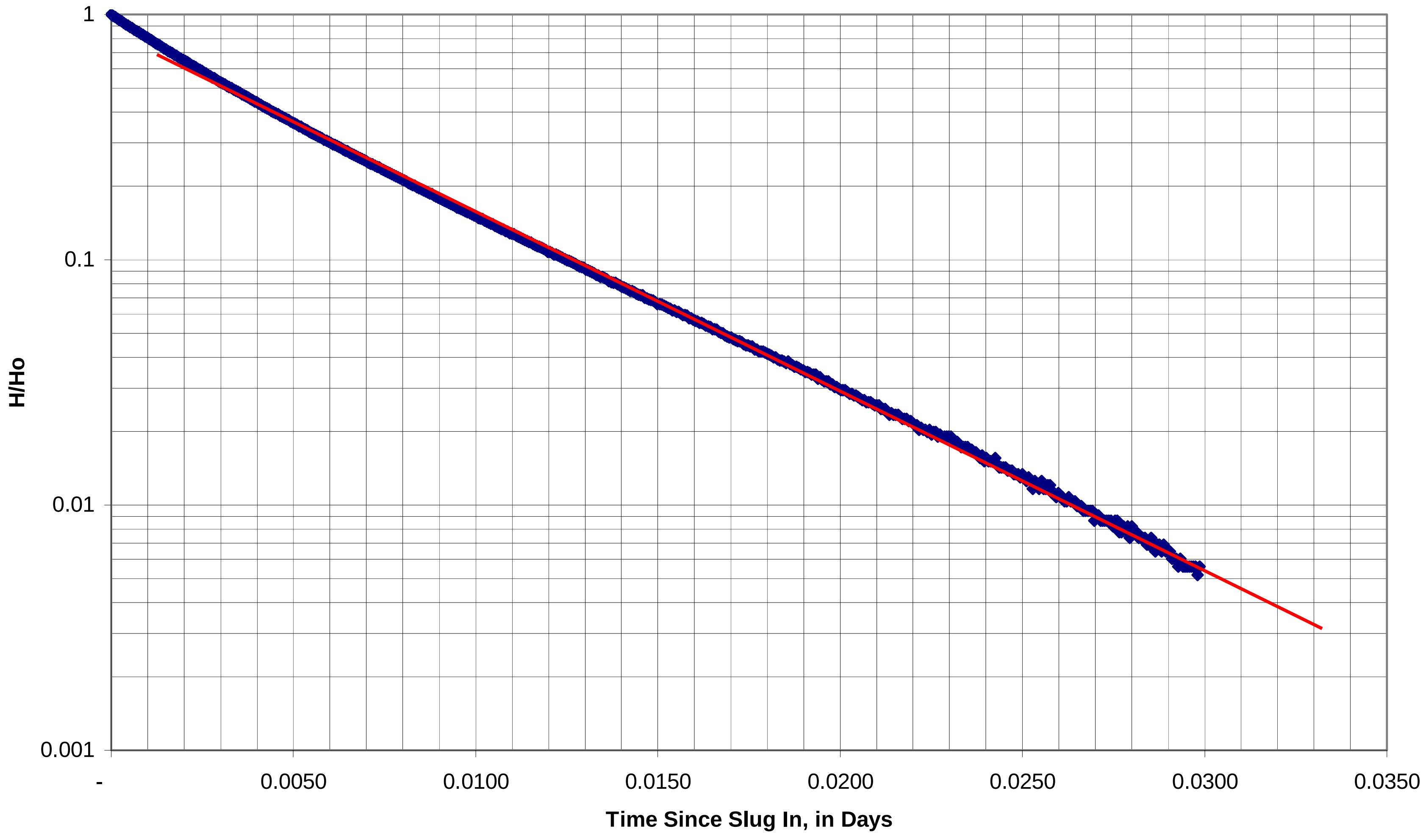


Figure D-4.-- Slug Test Analysis of Piezometer PZ-7
Briar Chapel Development

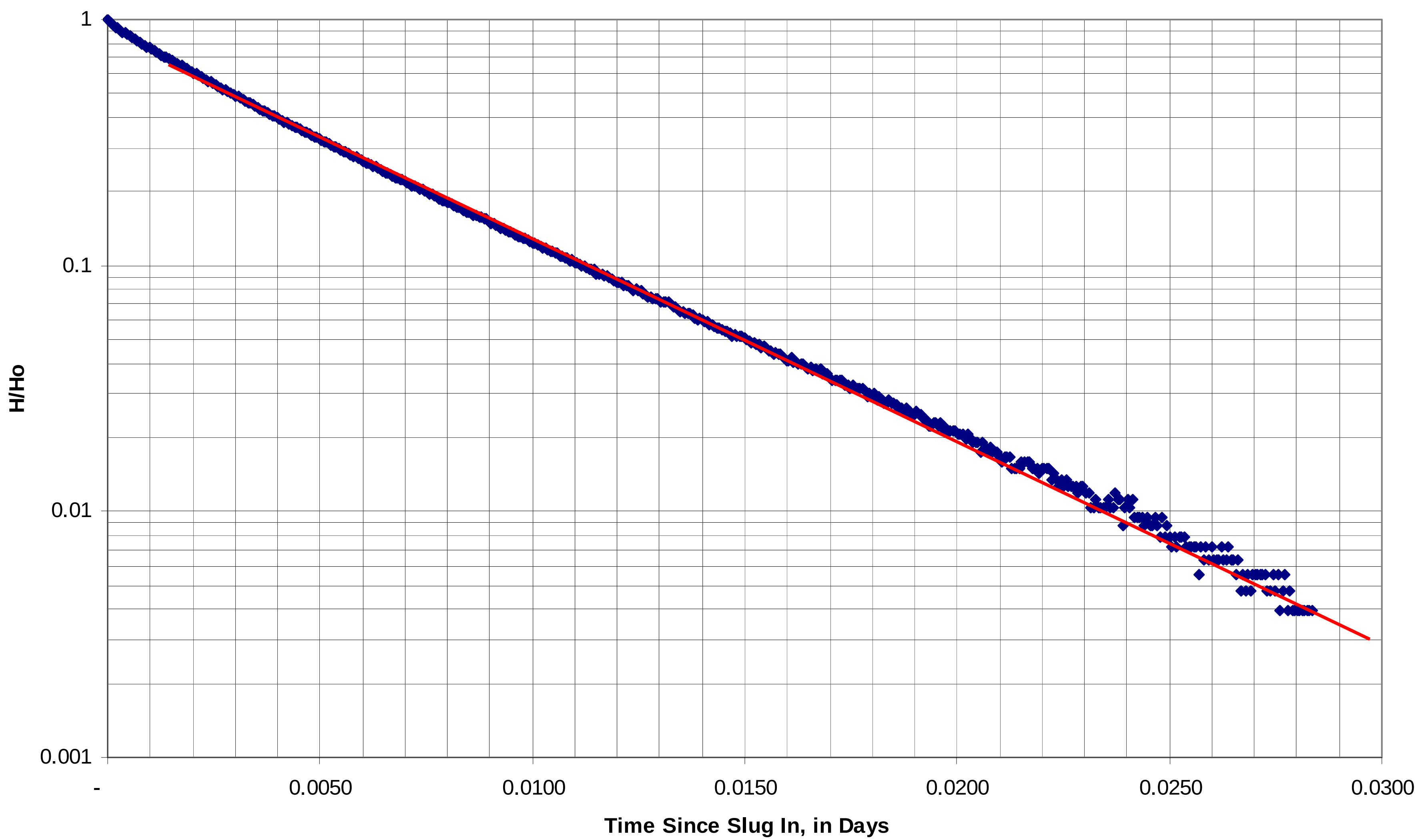


Figure D-5-- Slug Test Analysis of Piezometer PZ-14Aa
Briar Chapel Development

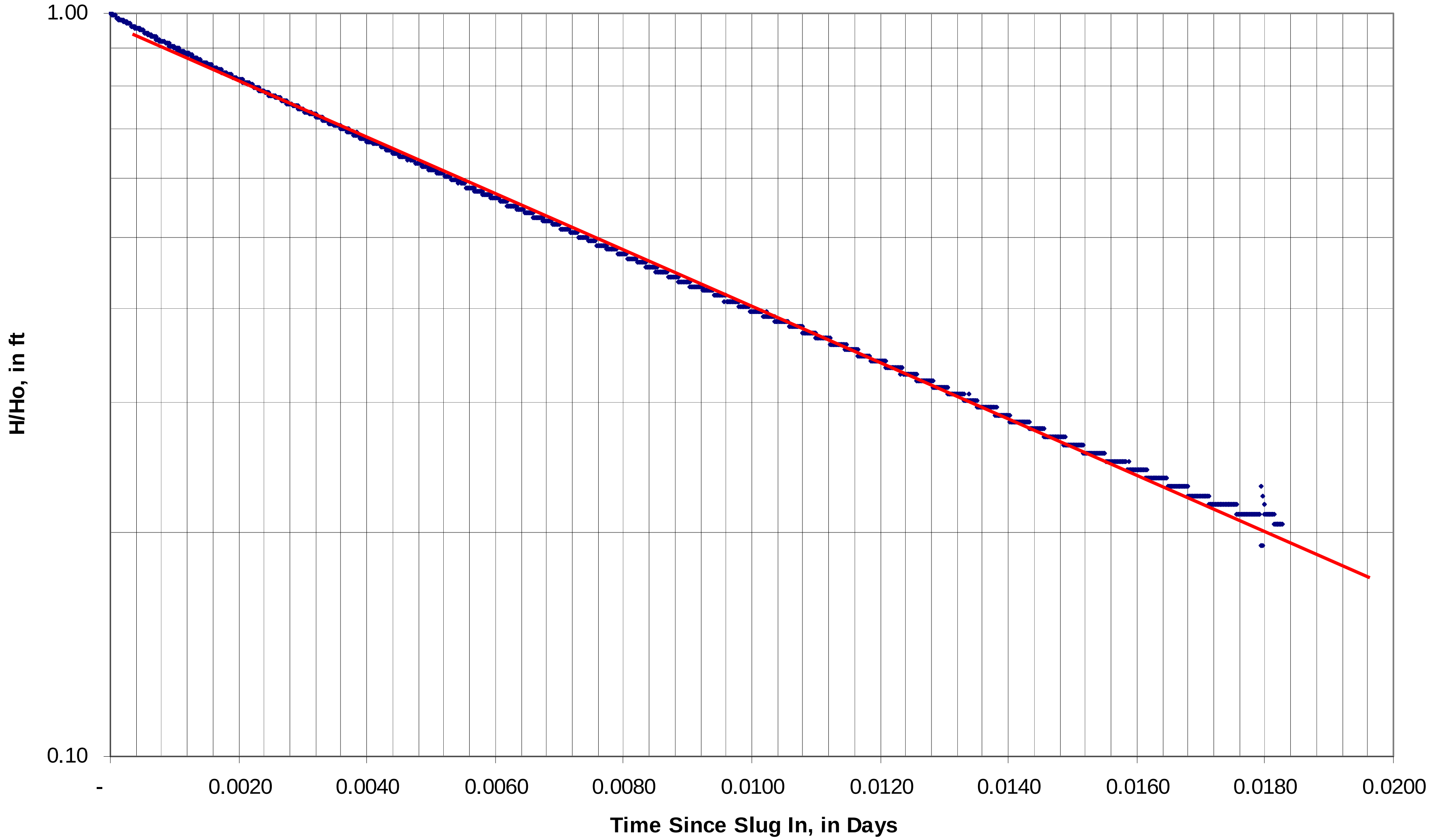
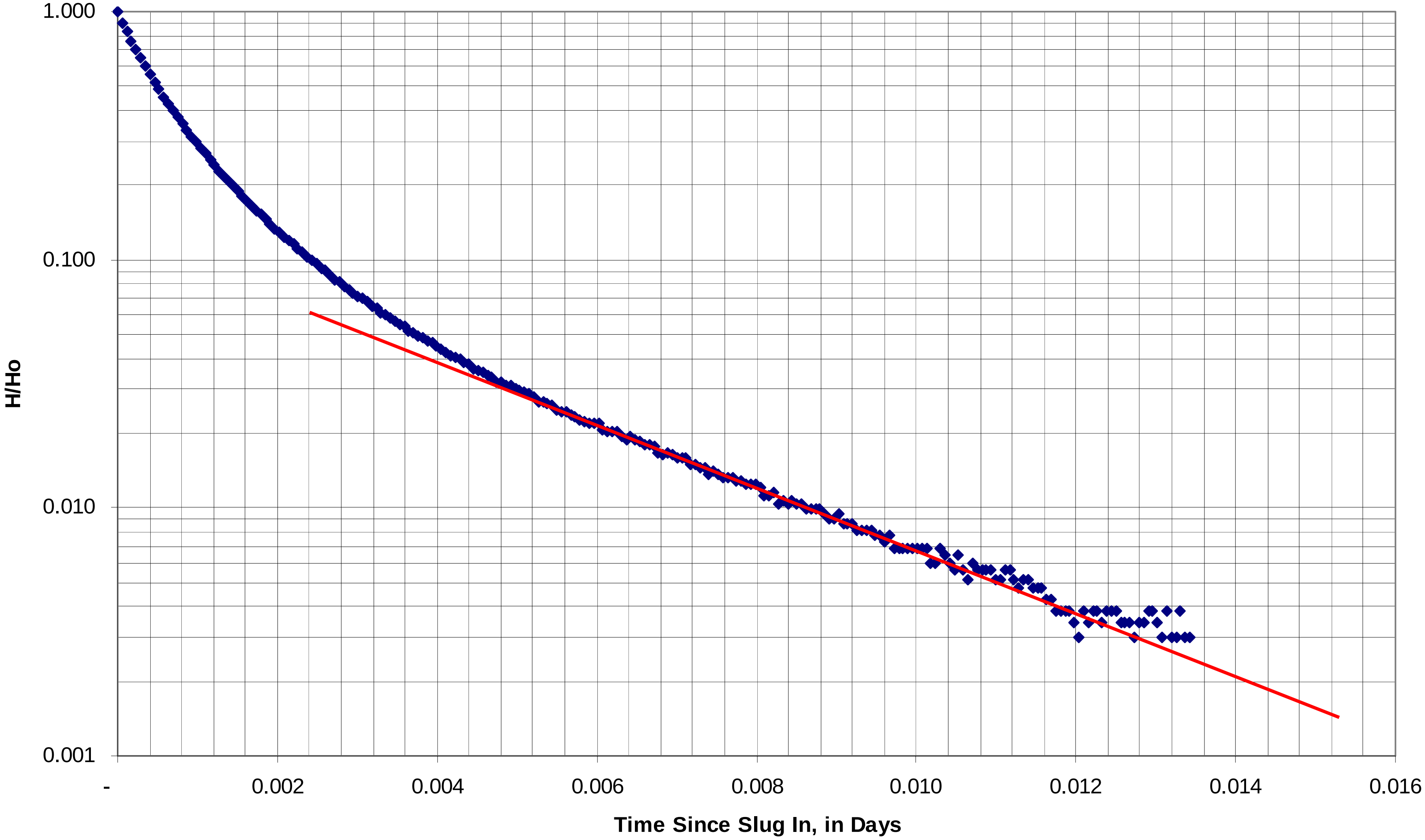


Figure D-6.-- Slug Test Analysis of PZ-16
Briar Chapel Development



Figgure D-7.-- Slug Test Analysis of PZ-19
Briar Chapel Development

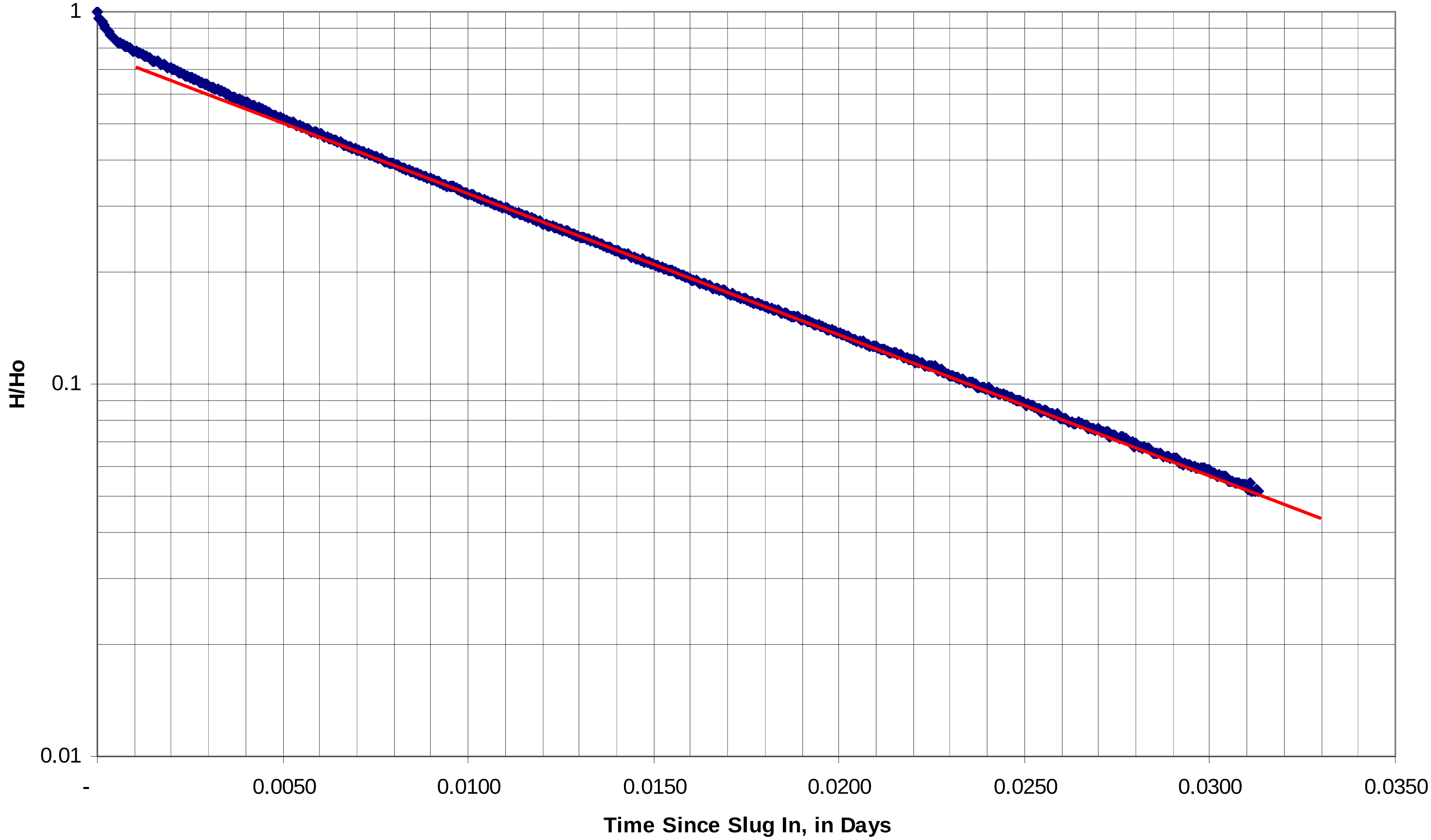


Figure D-8.--Slug Test analysis of Piezometer PZ-21
Briar Chapel Development

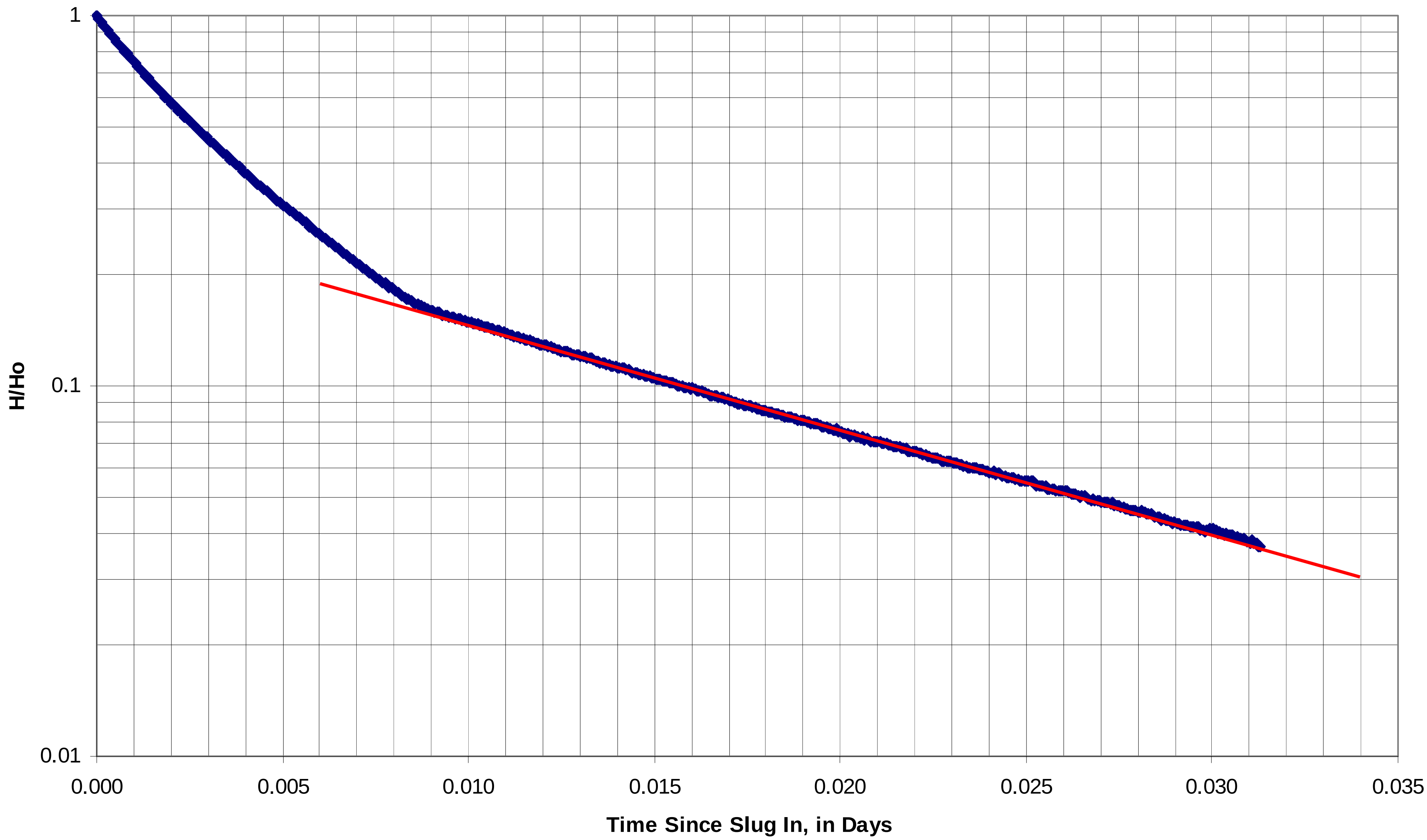


Figure D-9.-- Slug Test Analysis of Piezometer PZ-23
Briar Chapel Development

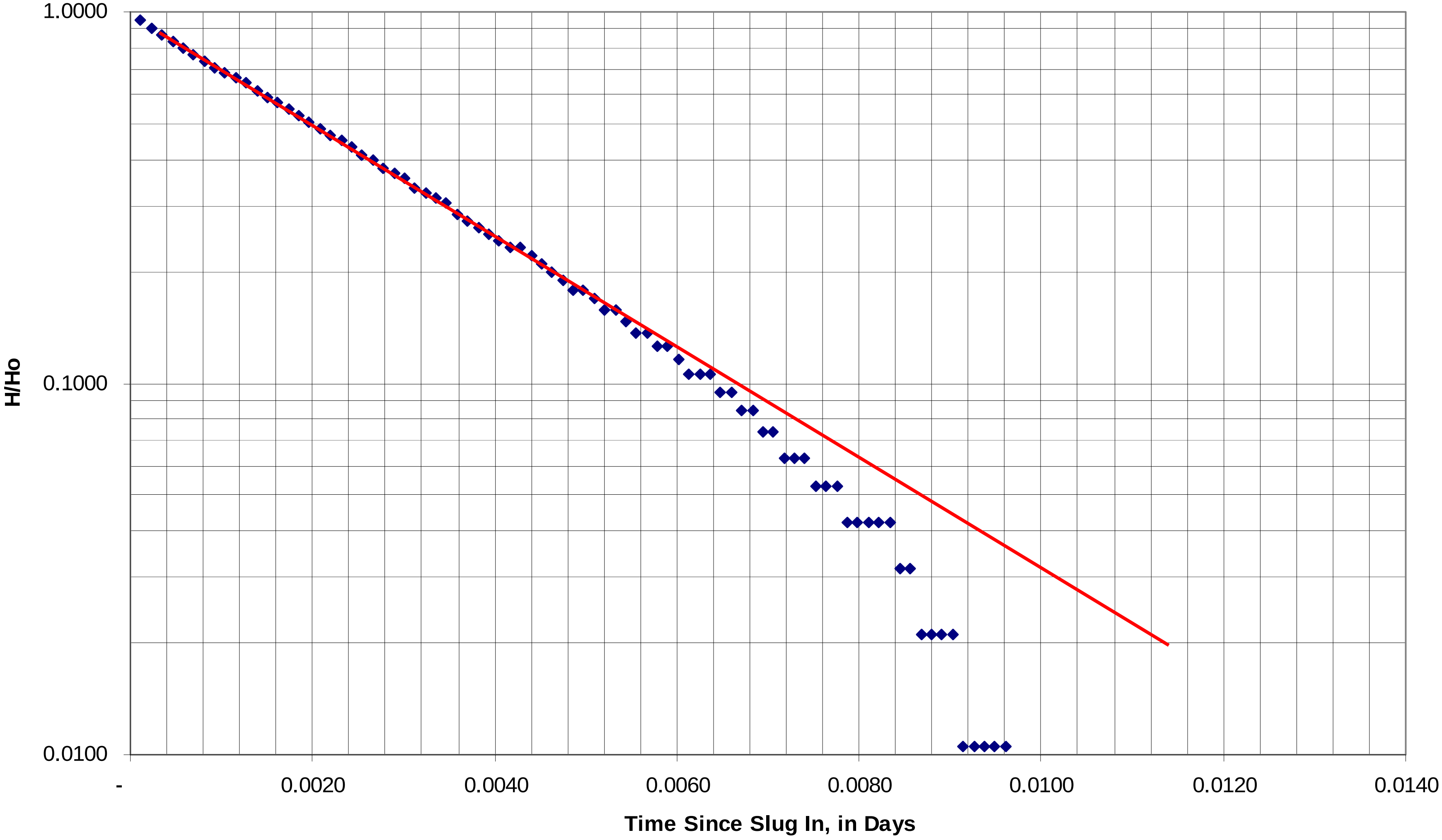


Figure D-10.-- Slug Test Analysis in Peizometer PZ-24a
Briar Chapel Development

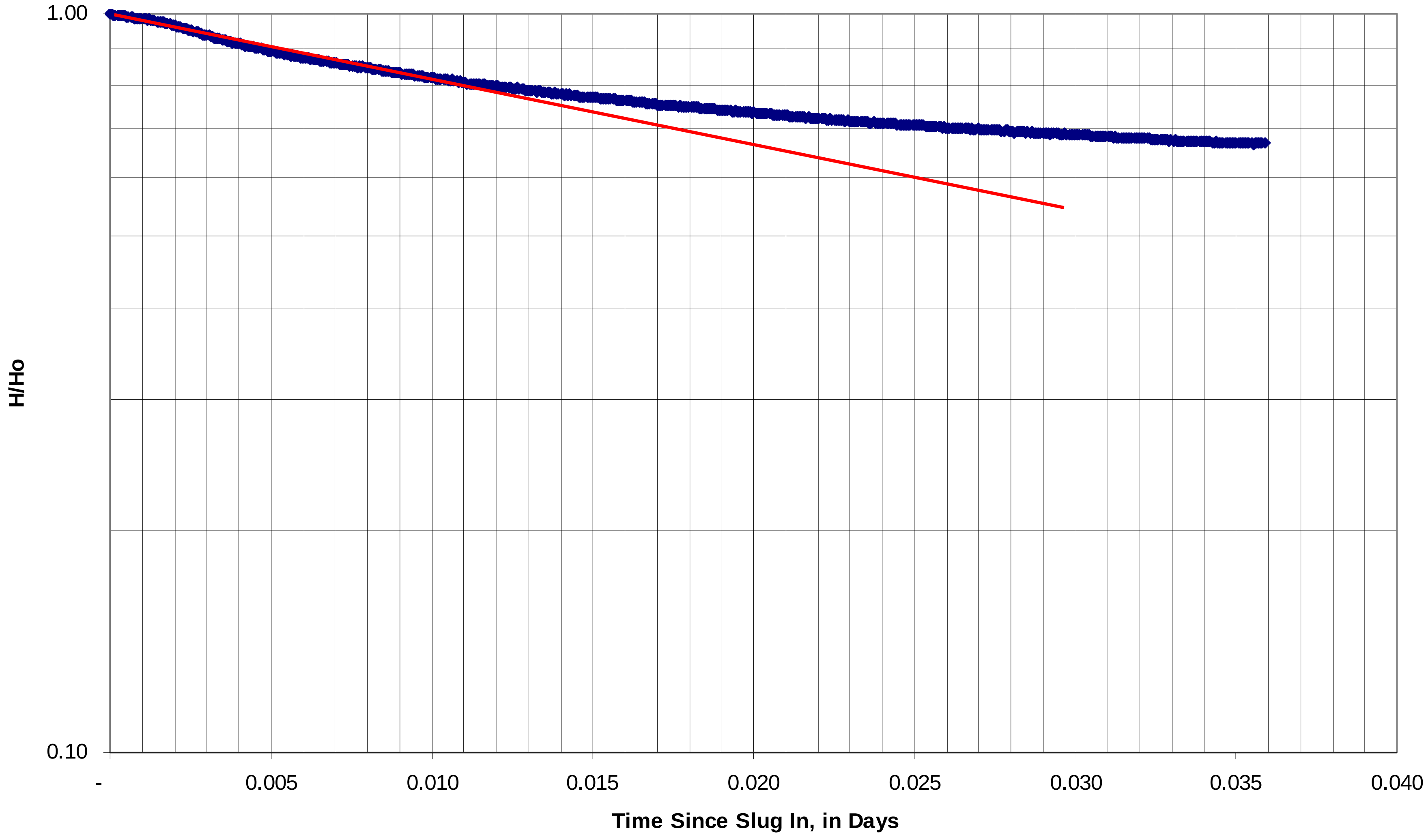


Figure D-11.-- Slug Test Analysis of Piezometer PZ-26
Briar Chapel Development

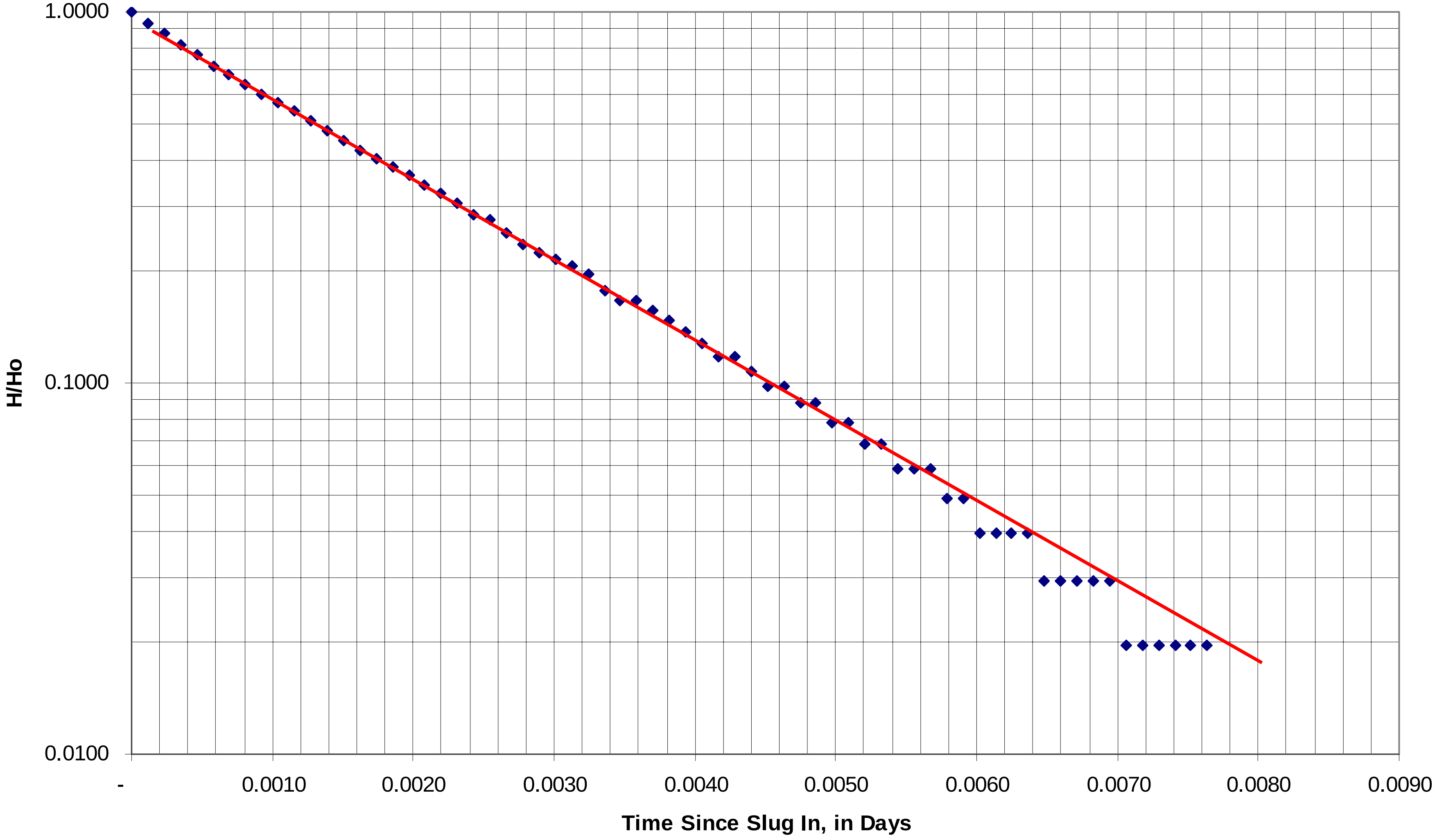


Figure D.12.-- Slug Test Ana.ysis of Piezometer PZ-27
Briar Chapel Develpment

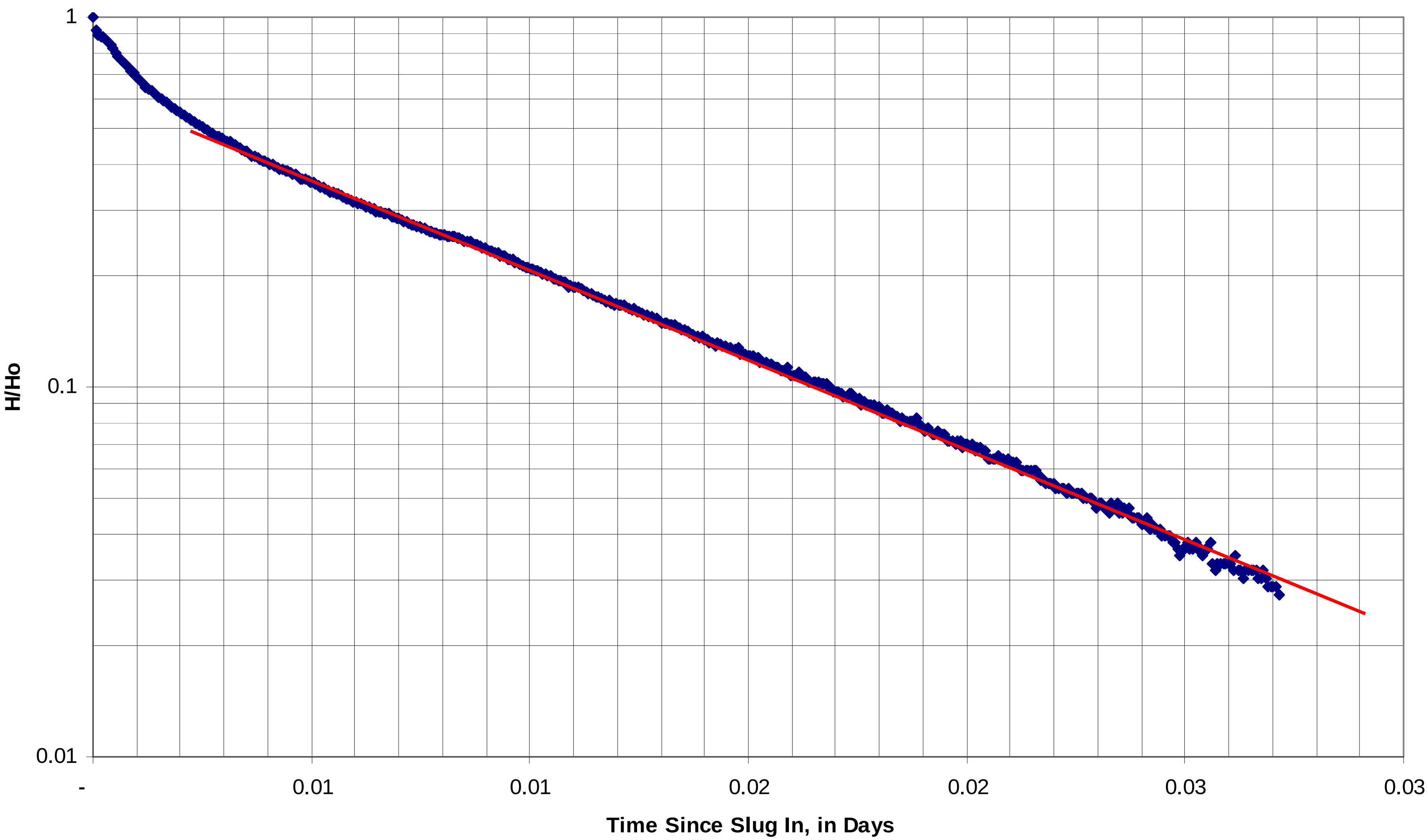
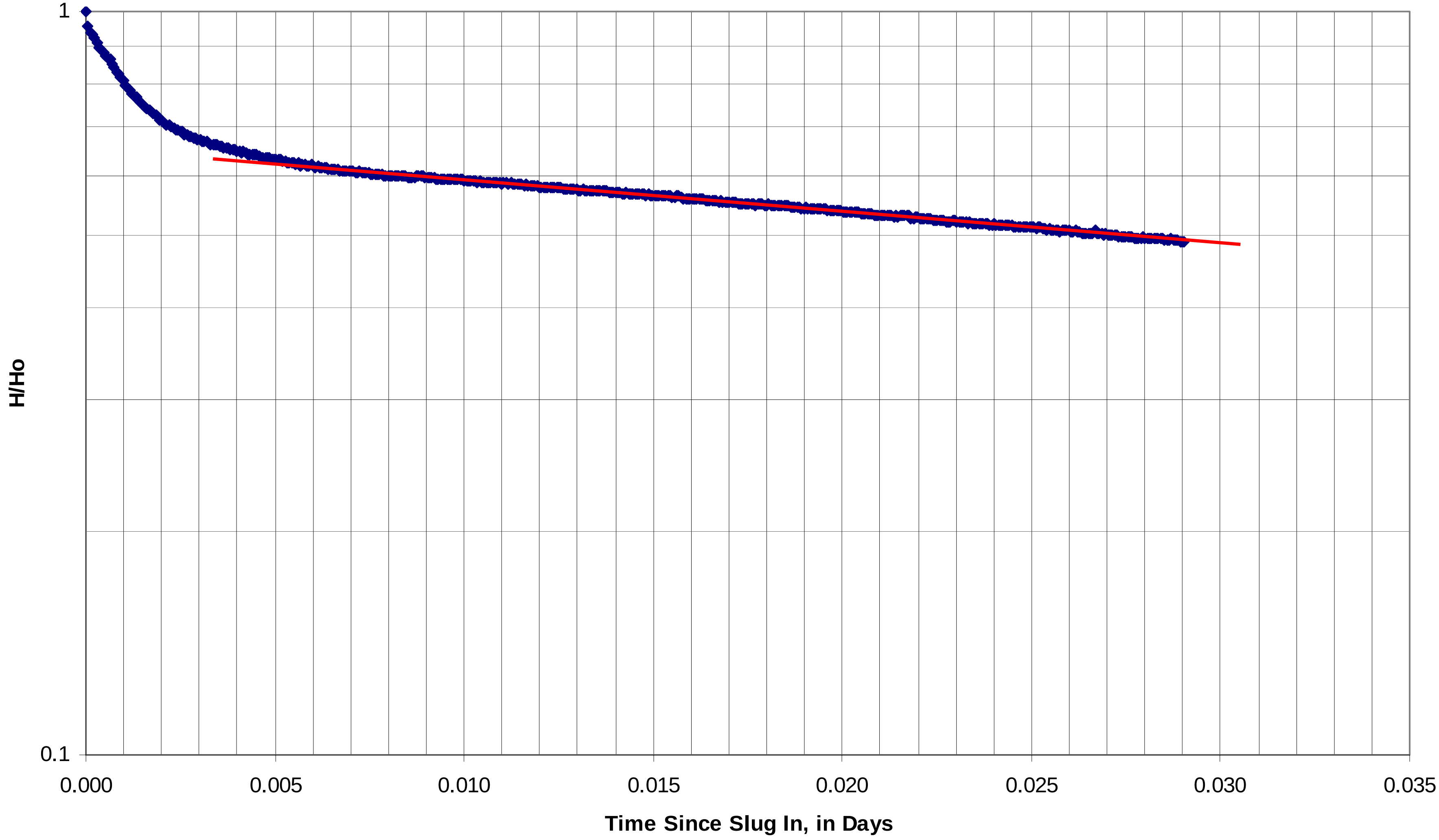


Figure D-13.-- Slug Test Analysis of Piezometer PZ-30
Briar Chapel Development



Attachment E: S&ME Preliminary Subsurface Exploration Report

PRELIMINARY
SUBSURFACE EXPLORATION REPORT
1200 Acre Assemblage
Chatham County, North Carolina
S&ME Project No. 1051-00-273

December 22, 2000

Newland Communities
c/o Newland Carolina
15 Hunter's Pond Drive
Columbia, South Carolina 29229

Attention: Mr. Stephen B. Corboy

Reference: **Preliminary Subsurface Exploration Report**
1200 Acre Assemblage
Chatham County, North Carolina
S&ME Project No. 1051-00-273

Dear Mr. Corboy:

S&ME, Inc. is pleased to submit this preliminary subsurface exploration report for the referenced project. The exploration was performed to provide general information regarding subsurface conditions at the site as they relate to the proposed development. This report presents a brief discussion of our understanding of the project, results of field testing, and our preliminary geotechnical conclusions and recommendations regarding site development.

PROJECT AND SITE INFORMATION

The 1200 acre assemblage is located in northern Chatham County. The site is located within an area bounded by Parker Herndon Road, Andrews Store Road, U.S. 15-501 and Mann's Chapel Road. A Duke Power overhead transmission line extends roughly in an east-west direction through the center of the site. Numerous drainage swales and creeks collect surface water runoff. These swales flow into two major creeks, Pokeberry and Wilkinson Creek. Pokeberry Creek is located along the eastern property boundary while Wilkinson Creek is located along the western boundary.

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Because of its more central location, Pokeberry Creek will significantly impact proposed site development. Wilkinson Creek will have fewer site development consequences. The site is currently moderately to heavily wooded with several dirt roads and paths providing access to limited areas. Recently these roads have been maintained by hunters. Topographically, the site ranges in elevation from 550 feet to 410 feet along Pokeberry Creek. During site visits, numerous boulders were observed on the ground surface across portions of the site. These boulders range in size from basketball to car size.

The proposed construction will likely consist of residential homes, a golf course and clubhouse and some commercial development with access provided off of Mann's Chapel Road and U.S. 15-501. Based on previous experience with similar developments, maximum cuts and fills of 25 to 30 feet would be expected.

EXPLORATION PROGRAM

The preliminary subsurface exploration program for this project consisted of a visual site reconnaissance by a geotechnical engineer and performance of twelve widely spaced soil test borings. Boring locations were performed along existing trails and paths by estimating locations from provided topographic maps. Because borings were located over very long distances, locations shown on the site plan should be considered very approximate. In addition to the performed borings, eight trackhoe excavated test pits were performed. Similarly, the test pit locations on the attached site plan should be considered approximate. A Komatsu PC300LC with a four foot bucket and rock teeth was used to excavate to depths of 11 to 20 feet below the existing ground surface.

Borings B-1 through B-12 were drilled to depths of 1 to 29 feet. Borings were advanced using a Mobile B-57 drill mounted on an all terrain vehicle. Borings were advanced using hollow stem augers. Within each boring, samples were taken at 2.5 foot intervals within the top 10 feet and at 5 foot intervals below 10 feet using a split-spoon sampler. Standard penetration tests were conducted in conjunction with split-spoon sampling in general accordance with ASTM D-1586.

At completion of drilling operations, representative portions of split-spoon samples were returned to our laboratory for visual classification. Soils were classified according to Unified Soil Classification System guidelines.

Test Boring Records, a subsurface profile drawing showing subsurface information from the borings, and Test Pit Records are included in the Appendix. Representative photographs of the site and test pit locations are also included. Strata shown on Test Boring Records are intended to represent approximate depths of changes in soil types. Naturally, transitional changes in soil types are often gradual and cannot be defined at a particular depth.

Geologic Conditions

The proposed site is in the Piedmont Physiographic Province. Based on the North Carolina Geologic Map, the parent rock materials consist of metamorphosed granitic rock. These granitic rocks consist primarily of quartz, feldspar and biotite and weather (chemically and physically) erratically in the form of boulders. The depth to partially weathered rock, mass rock and boulders can vary significantly over relatively short distances. Boulders in this geologic region can range from basketball to car size. Typically the feldspar and biotite will weather to fine grained silts and clays. The quartz will weather to coarse grained silty sands. Visual observation of the site reveals areas of steep topographic relief with significant boulders located on the existing ground surface. This is a visual indication that an area of highly resistant materials exist. In these areas, shallow depths to boulders should be anticipated. Areas which have no visible signs of surface boulders is an indication relatively deep weathering has occurred. The depth to boulders and mass rock will likely be greater in these areas.

Subsurface Conditions

Borings and excavated test pits encountered topsoil to depths of about 8 to 10 inches. Beneath the topsoil, undisturbed residual soils common to the Chatham County area were encountered. In general, these soils consist of upper layers of sandy clay and silty clay having low to high plasticity.

The upper approximate 2 to 3 feet was found to be moist to wet at most boring locations. With depth, soils typically transition to sandy silts and silty sands. Results of standard penetration testing varied from 17 to 70 blows per foot, with typical values of 20 to 40 blows per foot. These values indicate a stiff to very hard consistency for the silts and clays and a medium dense to dense relative density for sands.

Based on the performed test pits, boulders were encountered in five of eight excavated test pits. The boulders were typically found surrounded by soil. At shallow depths less than 10 to 15 feet, the backhoe could remove these materials with relative ease. However, the test pit sides were observed to cave as the boulders were removed. As depths increased boulders which were partially confined by the surrounding soils refused backhoe excavation. The boulders which could be removed ranged in size from 1 to 8 feet in diameter.

Material classified as partially weathered rock was encountered in all borings at depths varying from approximately 1 to 19 feet beneath existing ground surface. Partially weathered rock is an engineering term given to materials which exhibit standard penetration test results of greater than 100 blows per foot but can be penetrated with difficulty with augers. In some borings, lenses and layers of partially weathered rock were encountered with soil below.

Massive rock and/or boulders, which refused auger advancement, were encountered in borings B-2 through B-6 and B-12 at depths varying from 1 to 26 feet beneath existing ground surface. At boring B-2, auger refusal was encountered at approximately 1 foot and when twice offset about 30 feet laterally. Based on past experience, the surface of both partially weathered and mass rock will vary significantly over relatively short horizontal distances.

Groundwater was measured at depths of approximately 16 and 20 feet in borings B-6 and B-11, respectively. Groundwater levels will fluctuate, being dependent upon precipitation, seasonal conditions, and other factors. During wet periods of the year, perched groundwater will often occur above low permeability weathered and mass rock.

The above description of subsurface conditions is relatively brief and general. More detailed information may be obtained from review of individual Test Boring and Test Pit Records.

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

The preliminary exploration indicates that the site is adaptable for proposed development. Geotechnical considerations include excavation of boulders, partially weathered rock and mass rock during general site grading and utility and footing construction. The large site acreage should enable the roadway, building locations and finish grade elevations to be adjusted so that effects of any near-surface rock conditions are reduced. On-site silts and clays will become unstable and difficult to compact when wet. Accordingly, grading during wet weather will require specialized measures including undercutting, stabilization, and drying of soils. Light to moderate building loads may be supported on shallow, spread footings provided estimated settlements are within acceptable limits. These issues are discussed in detail in the following sections of the report.

Once development plans are further advanced, a final subsurface exploration should be performed in specific building and pavement areas. This exploration should include additional borings, laboratory testing of on-site soils, and engineering analysis incorporating specific project information.

Site Grading

Site preparation should be initiated with clearing and stripping operations within the proposed building and parking/roadway areas. Preliminary borings indicated a topsoil thickness of about 8 to 10 inches. Deeper stripping depths are usually required to remove rootmat associated with trees. Also, logging operations often disturb the upper soils, mixing topsoil with undisturbed soils below. As a result, stripping depths are typically greater than topsoil depths indicated on the borings.

At the time borings were performed, near surface soils were generally wet. Because of the fine-grained nature of near-surface soils at the site, indiscriminant use of heavy, rubber-tired equipment during stripping, clearing, and fill placement operations could significantly impact grading costs if site work is performed during a wet period of the year. The silts and clays encountered at boring locations will rapidly deteriorate under heavy wheel loads when existing at a moisture condition above optimum, evidenced by severe rutting of the subgrade and mixing of topsoil with underlying soils. Damage to the subgrade soils could be reduced with the use of relatively light, wide-tracked equipment, and by initiating site preparation during the typically drier summer and fall months.

Upon completion of clearing and stripping operations, building and parking/roadway areas which will receive fill should be proofrolled with a loaded tandem axle dump truck under the observation of a geotechnical engineer to identify any areas requiring subgrade repair. If the exposed subgrade soils within building pad or paved areas are unstable in the opinion of the geotechnical engineer, the soils should be undercut to stable material and backfilled in thin lifts as discussed in the Fill Placement section of this report.

Visual classification of soils indicates that some moderately to highly plastic soils exist at the site. Typically, soils with a high plasticity do not perform well directly beneath pavements or floor slabs. This is due to the fact that highly plastic soils have a high potential for loss of strength when saturated and have a high potential for volume change when their moisture content is allowed to vary over time. Plastic soils can be used as fill, but must be placed in specified areas and compacted at a suitable moisture content.

Suitability of On-Site Soils for Reuse as Fill

In general, soils encountered in the borings should be suitable for reuse as fill provided proper moisture controls are implemented. As stated above, highly plastic soils must be placed and compacted in specified areas. At the time the exploration was performed, near surface soils were wet of the optimum moisture content. Drying of soils can normally be accomplished by aerating during favorable weather conditions. Rock pieces and boulders will likely be generated during excavation. Boulders on the order of 1 to 3 feet can be sometimes be used within deep fill areas of parking and drives, but will not be suitable for use beneath buildings.

Fill Placement and Compaction

After proper site preparation, building and paved areas may be raised to their design subgrade levels with soils free of deleterious materials and compacted in relatively thin lifts. Depending upon building foundation and floor slab loads, soils should be compacted to 95 to 100 percent of the soil's standard Proctor maximum dry density. Soil moisture should be maintained within 3 percent of optimum moisture.

Fill placement should be monitored by a qualified soil technician working under the direction of the geotechnical engineer. In addition to visual evaluation, the technician should perform a sufficient amount of in-place density tests.

Excavation

Excavations will extend through moderate to high consistency soils, partially weathered rock, mass rock and boulders. We expect that conventional earth moving equipment (self-loading scrapers, moderately sized backhoes and bulldozers) should be suitable for completing excavations within the near surface soils. Excavation of boulders will likely require removal through use of a large track hoe or front end loader top loading a dump truck or scraper. As an alternative a bulldozer could be used to push the boulders out of the way. Boulders which are too large to pick up or push will have to be blasted or broken down through use of a "headache ball" or ram hoe.

Local excavation of the higher consistency soils can normally be accomplished with a large track mounted backhoe. However, the rate of excavation in the higher consistency soils is typically slow. Partially weathered rock will be difficult to excavate particularly within confined excavations such as utility trenches. Utility trenches which extend through areas of concentrated boulders will tend to cave during excavation. In addition to increasing the required excavation, boulders will not be suitable for reuse as structural fill within confined trenches unless a ram hoe is used to decrease particle size.

It has been our experience that during open site grading, weathered rock materials in which standard penetration test values do not exceed 50 blows for 2 inches (50 blows per 3 inches to 50 blows per 6 inches) can be loosened using large bulldozers (CAT D8 or equivalent) with a single-tooth ripper and new ripper tooth. The ripping process can be slow within the less weathered materials. Blasting will likely be required during open site grading operations for removal of weathered rock where standard penetration test values equal or exceed 50 blows for 2 inches (50 blows per 2 inches to 50 blows per 0 inches). Within confined excavations such as utility trenches, the use of pneumatic hammers or blasting will likely be required for removal of all weathered rock having SPT values greater than or equal to 50 blows per 4 inches.

It is important to realize that the speed and difficulty of excavation of rock-like materials will depend on the equipment, experience of the operators, location and orientation of joints, foliation or other planes of weakness within the rock materials and the diligence with which the contractor pursues excavation. As such, it is impossible to accurately predict quantities of rippable and blast quality rock.

Permanent excavations should have side slopes of 2(H):1(V) or flatter for long term stability and erosion control. Cut slopes should be vegetated as soon as possible after exposure to reduce surface erosion. If mowing of slopes is to be conducted, slopes of 3(H):1(V) or flatter will be required. Localized zones of groundwater may be present within the near surface soils following periods of rainfall. We expect that groundwater infiltration in temporary excavations can likely be controlled by ditching and/or pumping from sumps within excavations. If seepage is observed along permanent cut slopes, flattening of the slope angle, installation of a toe drain or other measures may be required to improve long term stability.

Foundation and Floor Slab Support

Light to moderate column loads can be supported on shallow spread footings bearing in properly compacted structural fill or approved existing soils. Based on past experience, column loads on the order of 100 to 300 kips can be supported on a shallow foundation system provided settlements on the order of 1 inch can be tolerated. Design bearing pressures will be on the order of 2,000 to 4,000 pounds per square foot. Detailed information will be necessary to predict actual total and differential settlements. Should column loads be greater than those which can be supported on spread footings, deep foundations such as driven piles or drilled shafts (caissons) can be constructed to provide support.

Floor slabs can be soil supported provided the site is properly prepared and graded. Depending of slab loads and traffic (e.g. forklifts), placement of crushed stone between the slab and subgrade may be necessary. Subgrade support parameters for floor slab design can be provided during the final exploration.

QUALIFICATIONS OF REPORT

This report has been prepared in accordance with generally accepted engineering practice for specific application to this project. Any wetland, environmental, or contaminant assessment efforts are beyond the scope of this geotechnical exploration; and therefore, those issues are not addressed in this geotechnical exploration report. The preliminary recommendations contained in this report are based on the applicable standards of our profession at the time this report was prepared. No other warranty, express or implied, is made.

Preliminary recommendations submitted in this report are based, in part, upon the data obtained from the geotechnical exploration. The nature and extent of variations between and outside of the borings made may not become evident until the final exploration is performed. In the event that the nature or design of the proposed development is different from that described herein, the preliminary recommendations contained in this report should be reviewed and modified or verified in writing.

CLOSURE

S&ME, Inc. appreciates the opportunity to provide our services to Newland Communities on this project. If you have any questions concerning information presented herein, please do not hesitate to contact us.

Sincerely,
S&ME, INC.

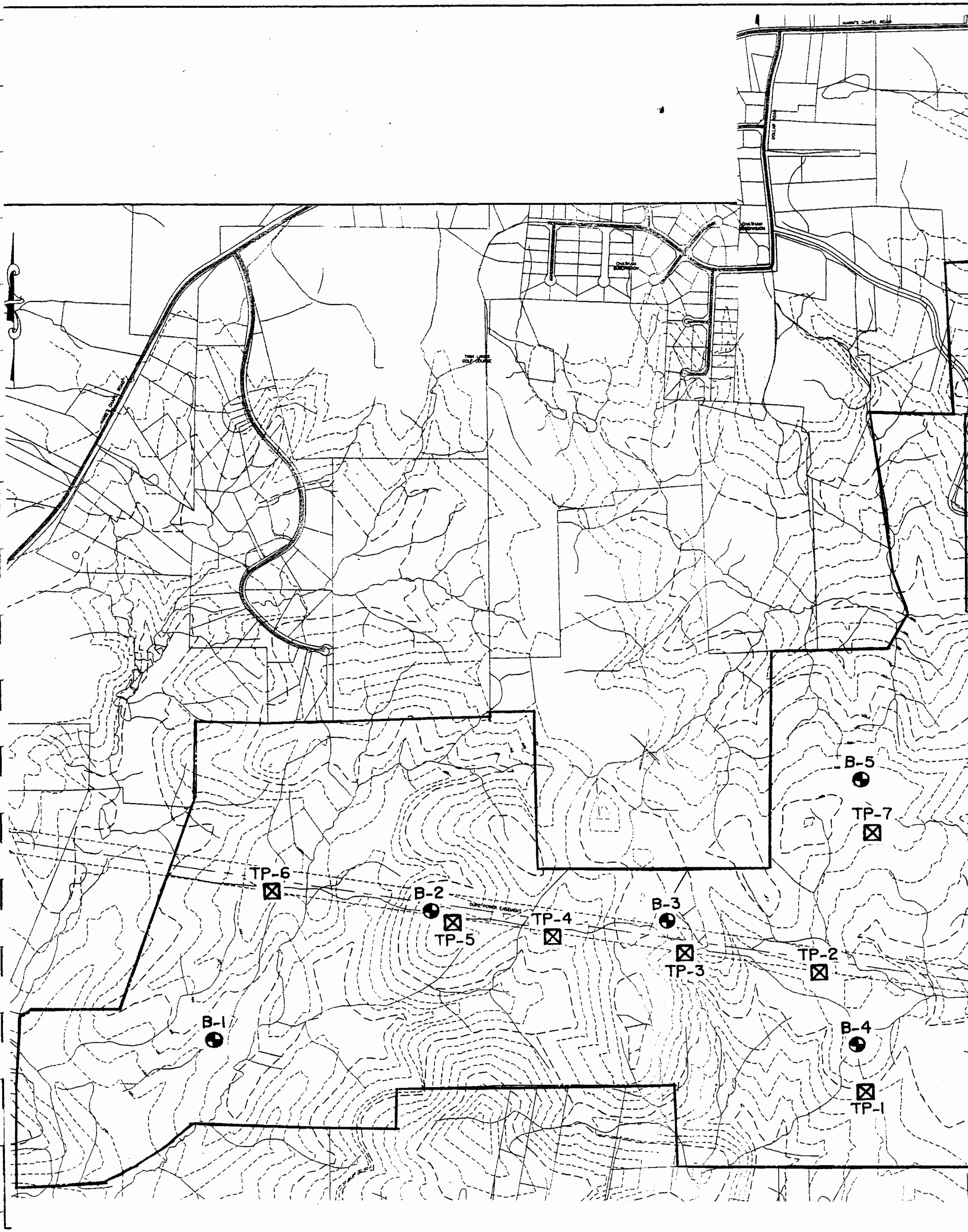
12-22-00

Keith C. Brown, P.E.
Engineering Department Manager
N.C. Registration No. 22540

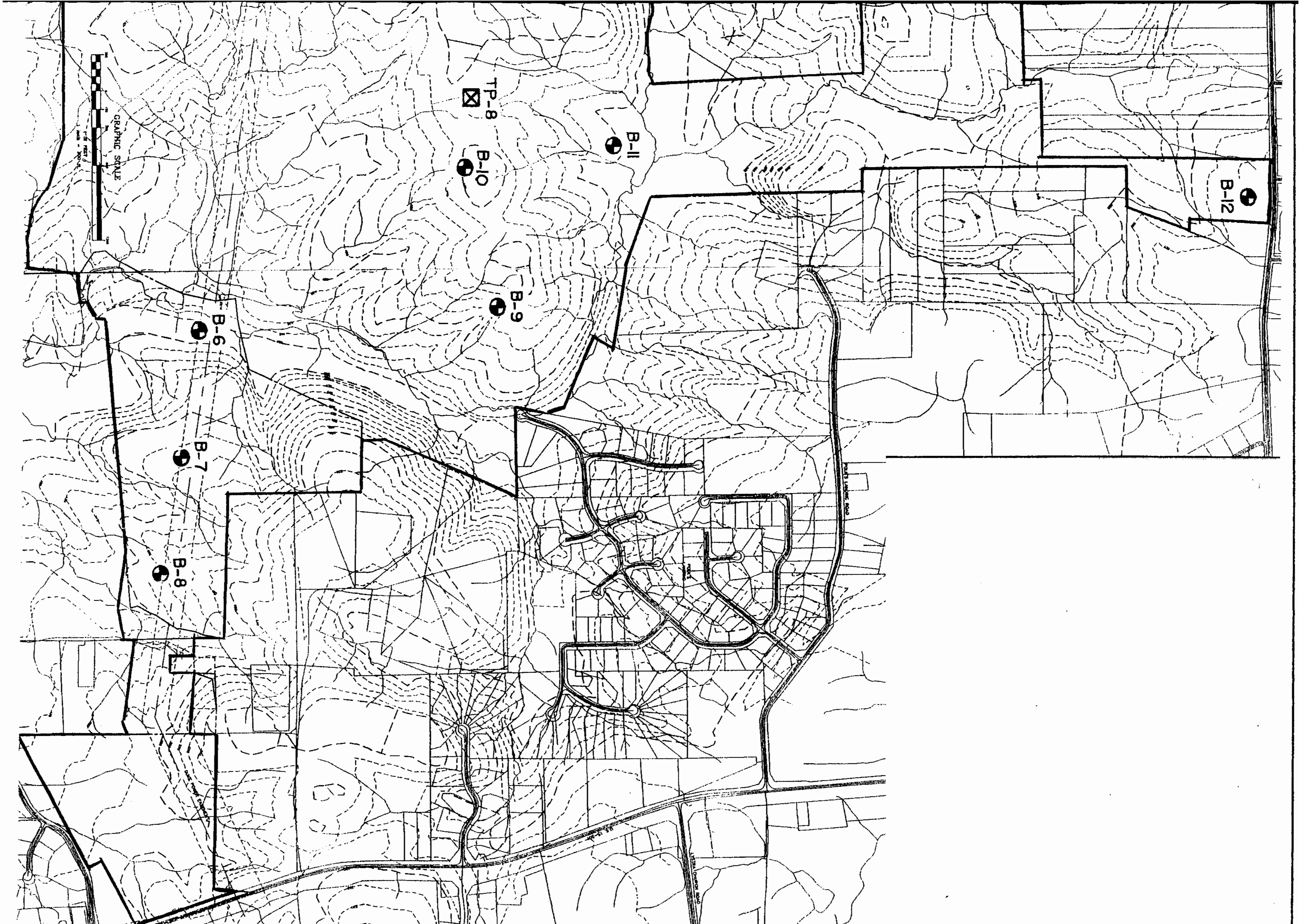
Wes Lowder, P.E.
Geotechnical/Materials Manager/VP
N.C. Registration No. 18819

KCB/WL/tag

Attachments

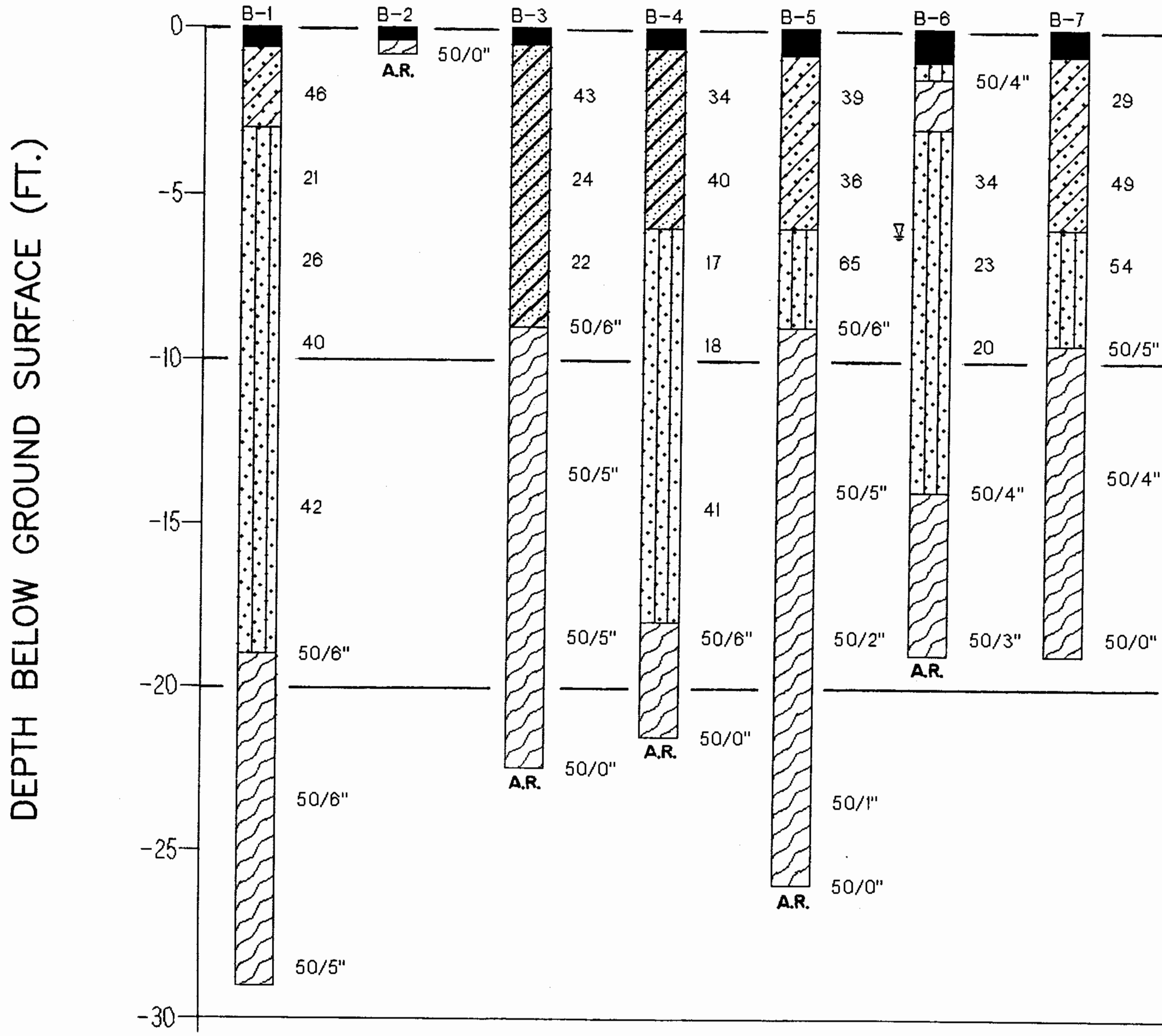


MANN'S CHAPEL ROAD
DOLLAR ROAD
CHATHAM SUBDIVISION
DUKE POWER EASEMENT
B-5
TP-7
TP-6
B-2
TP-5
TP-4
B-3
TP-3
TP-2
B-1
B-4
TP-1



1,200-ACRE ASSEMBLAGE U.S. HIGHWAY 15-501 & MANNING CHAPEL ROAD CHATHAM CO., NORTH CAROLINA	S&ME ENVIRONMENTAL SERVICES ENGINEERING · TESTING	SCALE: 1" = 1,000'	APPROVED BY: AFR
		DATE: DECEMBER 2000	DRAWN BY: TRP
		JOB NO. 1051-00-273	FIGURE 1

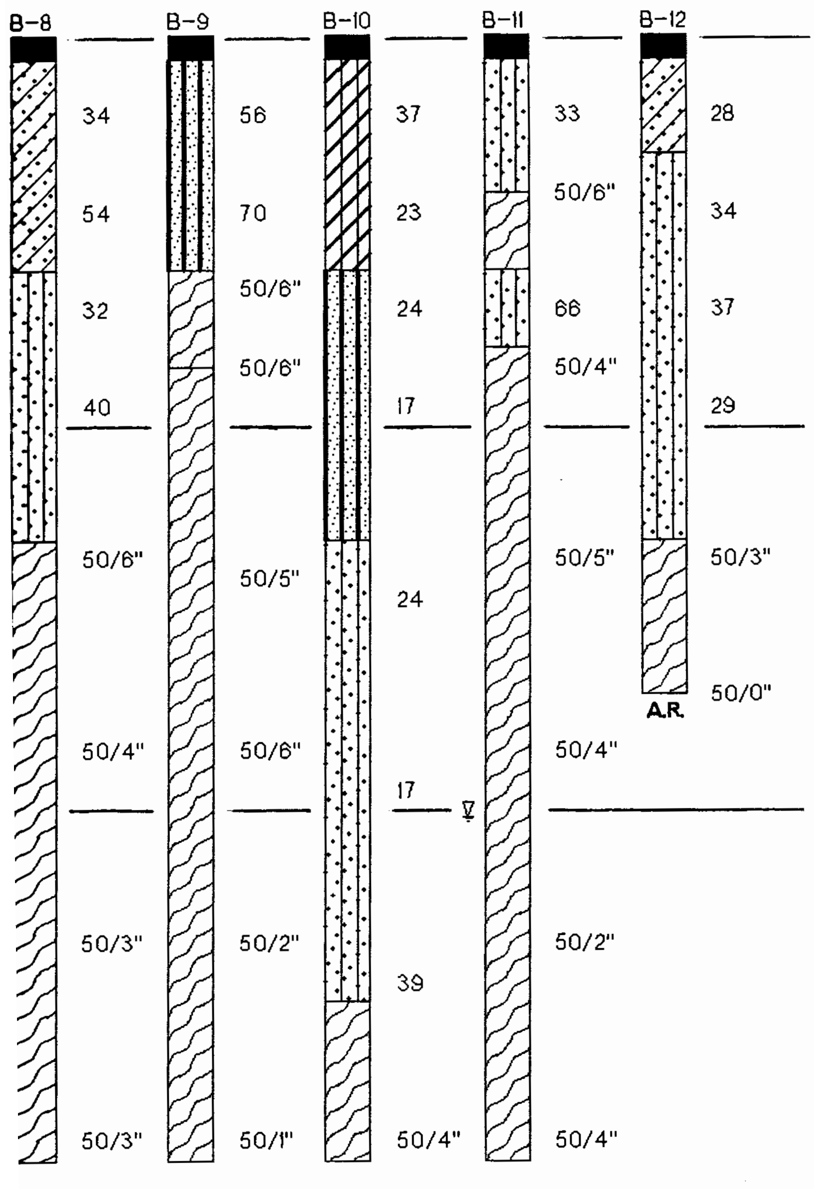
GENERALIZED SUBSU



LEGEN

SEE ATTACHED

ŔFACE CONDITIONS



LEGEND

GENERALIZED SUBSURFACE CONDITIONS

CHATHAM COUNTY ASSEMBLAGE

CHATHAM CO., NORTH CAROLINA

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ENVIRONMENTAL SERVICES

SCALE:	(V) 1" = 5'	APPROVED BY:	KCB
DATE:	DECEMBER 2000	DRAWN BY:	TRP
JOB NO.	1051-00-273	FIGURE	2

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES
(Shown in Graphic Log)

- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Sandy
- Silty
- Clayey
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS
(Shown in Water Level Column)

▽ = Water Level At Termination Of Boring
▼ = Water Level Taken After 24 Hours
◀ = Loss Of Drilling Water
HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	8 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES
(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration – The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586

REC – Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD – Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks exluded) Divided by the Total Length of the Core Run Times 100%.

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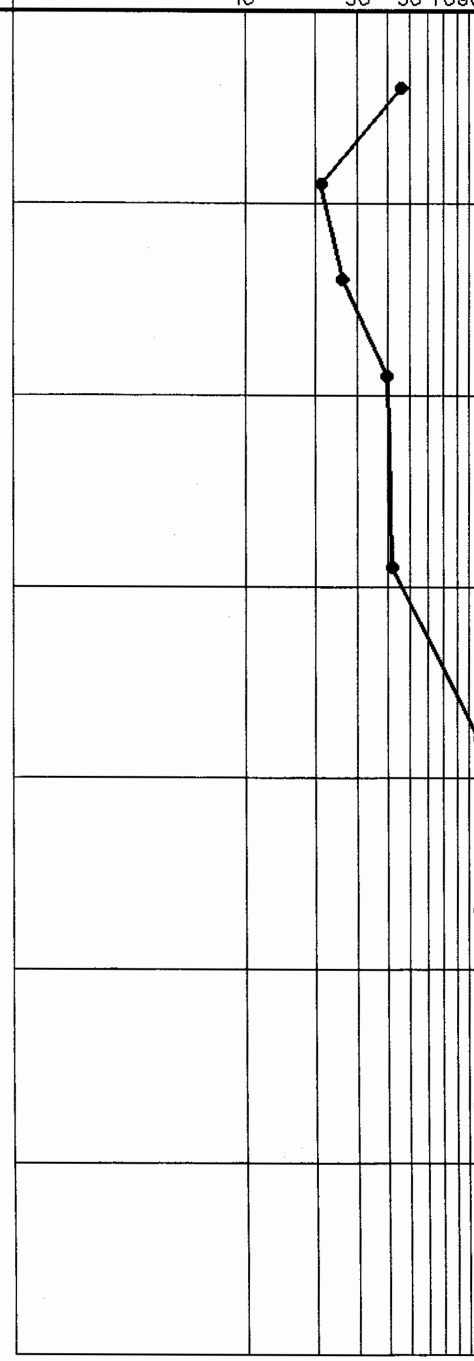
PROJECT:	Chatham County Assemblage Chatham County, N.C.	TEST BORING RECORD	B-1

PROJECT NO.:	*1051-00-273*	**ELEVATION:**	*GROUND SURFACE*
LOGGED BY:	*KCB*	**BORING DEPTH:**	*29.0 FEET*
DATE DRILLED:	*12/5/00*	**WATER LEVEL:**	*DRY*
DRILLING METHOD:	*3-1/4" I.D. H.S.A.*	**DRILL RIG:**	*MOBILE B-57*

NOTES:
Boring location is approximate.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.
0	Topsoil				
	Dense Orange and White Clayey Fine to Medium **SAND** (SC), Moist				
	Medium Dense to Dense Yellow, Brown and White Silty Fine to Coarse **SAND** (SM), Moist				
19	Partially Weathered Rock Sampled as Orange, Brown and Yellow Silty Fine to Medium **SAND** (SM)				
29	*Boring terminated at 29.0'. No water was observed below the existing ground surface after Termination of Boring (TOB).*				

Standard Penetration Test Data (Blows/ft)



BPF
46
21
26
40
42
50/6"
50/6"
50/5"

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PROJECT:	Chatham County Assemblage Chatham County, N.C.	TEST BORING RECORD	B-2

PROJECT NO.: 1051-00-273	ELEVATION: GROUND SURFACE	NOTES:
LOGGED BY: KCB	BORING DEPTH: 0.8 FEET	Boring location is approximate. Boring offset twenty feet 2 times.
DATE DRILLED: 12/6/00	WATER LEVEL: DRY	
DRILLING METHOD: 3-1/4" I.D. H.S.A.	DRILL RIG: MOBILE B-57	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 7090	BPF
		Topsoil						50/0"
		Partially Weathered Rock (No Recovery)						
		Auger refusal occurred at 0.8'. No water was observed below the existing ground surface after TOB.						
5								
10								
15								
20								
25								
30								
35								

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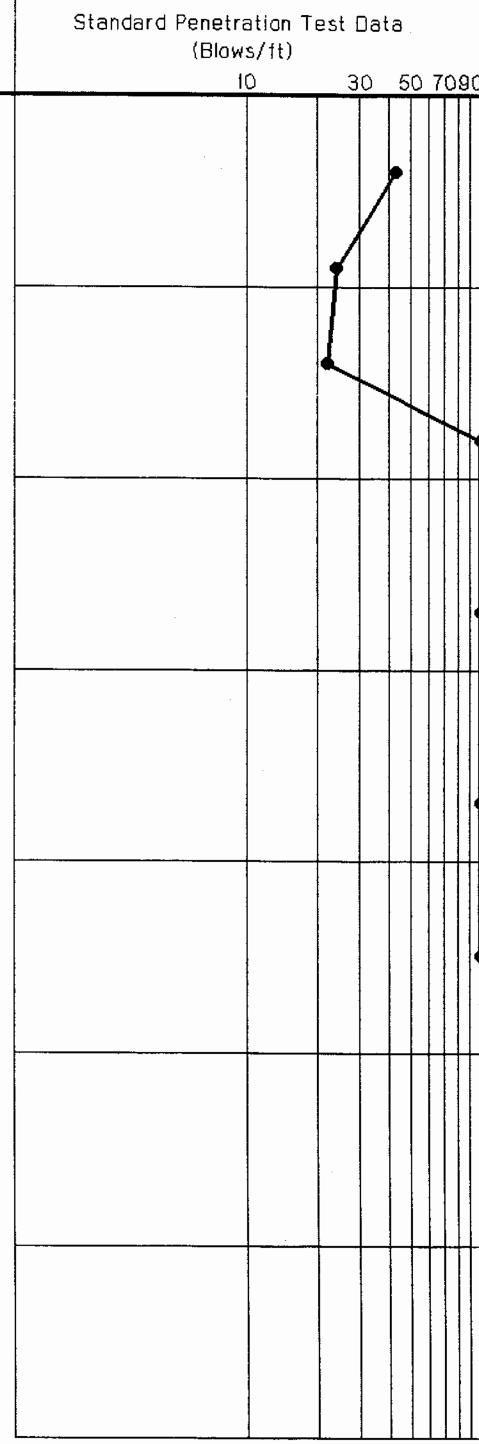
PROJECT: **Chatham County Assemblage**
Chatham County, N.C.

TEST BORING RECORD B-3

PROJECT NO.:	*1051-00-273*	**ELEVATION:**	*GROUND SURFACE*
LOGGED BY:	*KCB*	**BORING DEPTH:**	*22.5 FEET*
DATE DRILLED:	*12/6/00*	**WATER LEVEL:**	*DRY*
DRILLING METHOD:	*3-1/4" I.D. H.S.A.*	**DRILL RIG:**	*MOBILE B-57*

NOTES:
Boring location is approximate.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
0	Topsoil					
	Hard to Very Stiff Orange, Red, Brown and Light Gray Fine to Medium Sandy **CLAY** (CL), Moist to Wet					43
5						24
						22
	Partially Weathered Rock Sampled as Yellow-Brown and White Silty Fine to Medium **SAND** (SM), Moist					50/6"
10						
						50/5"
15						
						50/5"
20						
						50/0"
25	*Auger refusal occurred at 22.5'. No water was observed below the existing ground surface after TOB.*					
30						
35						

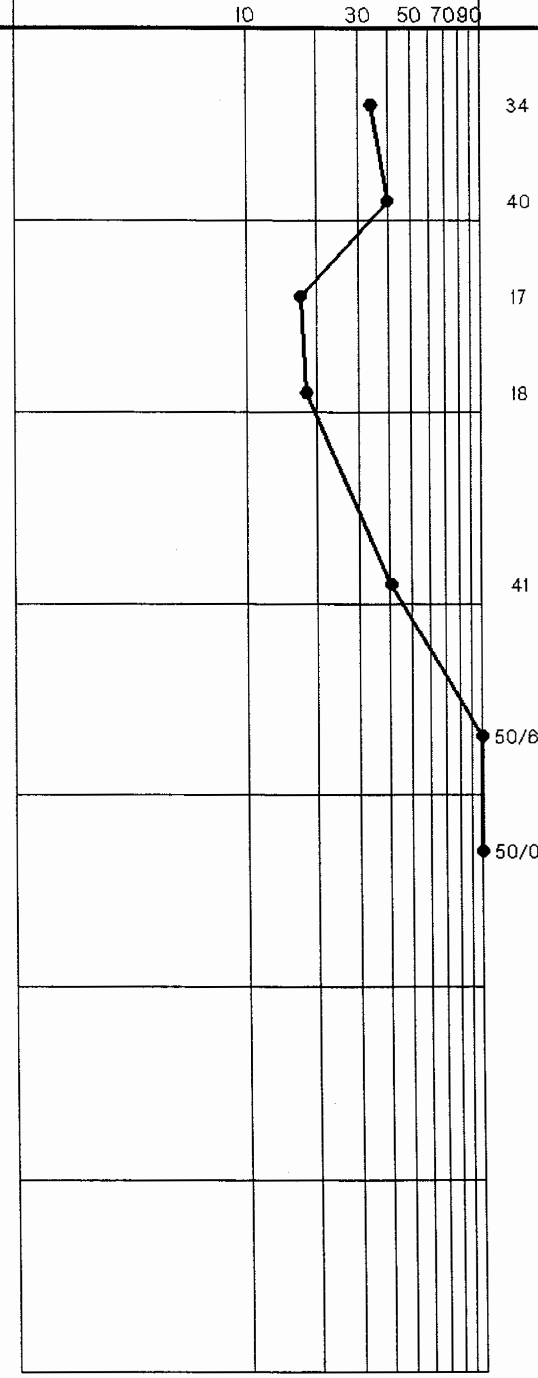


PROJECT:	Chatham County Assemblage Chatham County, N.C.	TEST BORING RECORD	B-4

PROJECT NO.:	1051-00-273	ELEVATION:	GROUND SURFACE
LOGGED BY:	KCB	BORING DEPTH:	21.5 FEET
DATE DRILLED:	12/6/00	WATER LEVEL:	DRY
DRILLING METHOD:	3-1/4" I.D. H.S.A.	DRILL RIG:	MOBILE B-57

NOTES:
Boring location is approximate.

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft)	BPF
		Topsoil						
5		Hard Orange and Yellow Sandy **CLAY** (CL)						34 40
10 15		Medium Dense to Dense Yellow-Brown and White Silty Fine to Coarse **SAND** (SM), Moist						17 18 41
20		Partially Weathered Rock Sampled as Gray and Brown Silty Fine to Medium **SAND** (SM)						50/6" 50/0"
25 30 35		*Auger refusal occurred at 21.5'. No water was observed below the existing ground surface after TOB.*						



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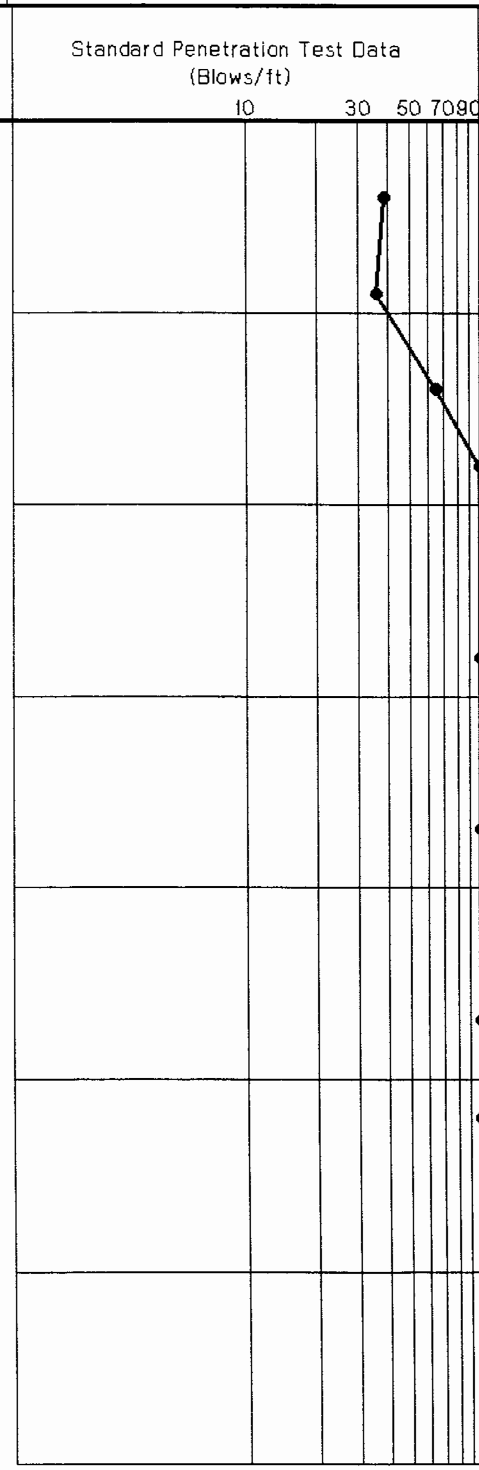
PROJECT:	Chatham County Assemblage Chatham County, N.C.	TEST BORING RECORD	B-5

PROJECT NO.:	*1051-00-273*	**ELEVATION:**	*GROUND SURFACE*
LOGGED BY:	*KCB*	**BORING DEPTH:**	*26.0 FEET*
DATE DRILLED:	*12/7/00*	**WATER LEVEL:**	*DRY*
DRILLING METHOD:	*3-1/4" I.D. H.S.A.*	**DRILL RIG:**	*MOBILE B-57*

NOTES:
Boring location is approximate.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
	Topsoil					
	Dense Orange and Yellow Clayey Fine to Coarse **SAND** (SC), Moist					39
5						36
	Very Dense Yellow, Orange and Brown Silty Fine to Coarse **SAND** (SM)					65
	Partially Weathered Rock Sampled as Orange, Yellow and Brown Silty Fine to Medium **SAND** (SM)					50/6"
10						
						50/5"
15						
						50/2"
20						
						50/1"
25						50/0"
	Auger refusal occurred at 26.0'. No water was observed below the existing ground surface after TOB.					
30						
35						



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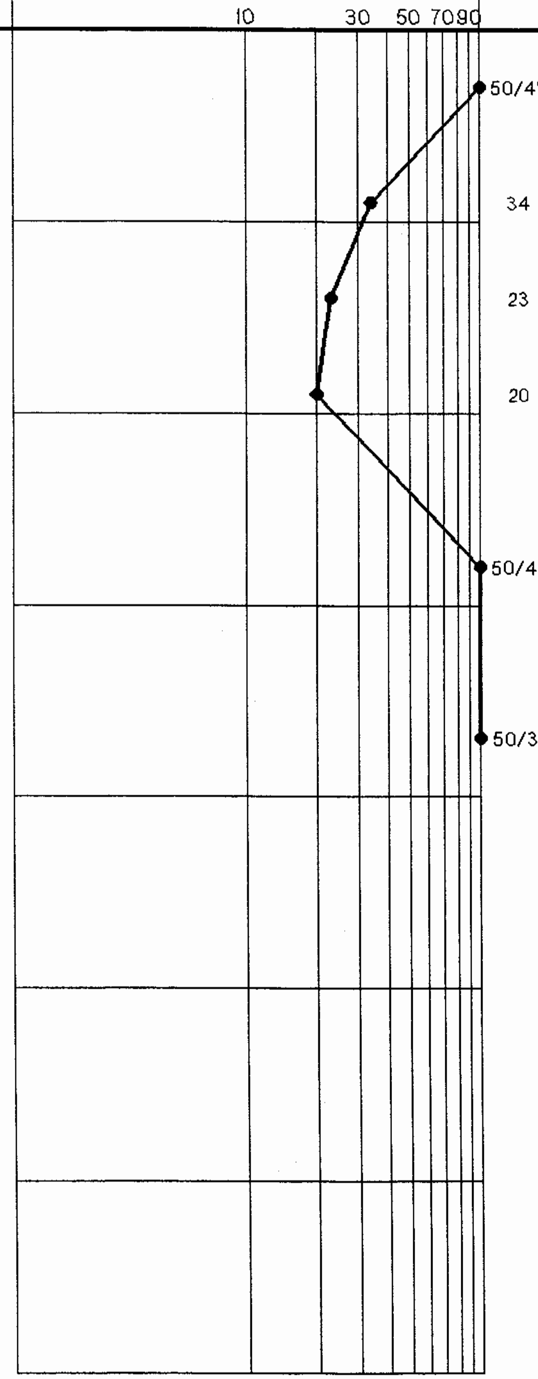
PROJECT:	Chatham County Assemblage Chatham County, N.C.	TEST BORING RECORD	B-6

PROJECT NO.:	*1051-00-273*	**ELEVATION:**	*GROUND SURFACE*
LOGGED BY:	*KCB*	**BORING DEPTH:**	*19.0 FEET*
DATE DRILLED:	*12/5/00*	**WATER LEVEL:**	*16.0 FEET @ TOB*
DRILLING METHOD:	*3-1/4" I.D. H.S.A.*	**DRILL RIG:**	*MOBILE B-57*

NOTES: Boring location is approximate.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
0	Topsoil					
	Medium Dense Brown Silty Fine **SAND** (SM)					50/4"
5	Partially Weathered Rock Sampled as Yellow-Brown Slightly Clayey Silty Fine **SAND** (SM), Boulder					34
	Dense to Medium Dense Orange and Red Silty Fine to Coarse **SAND** (SM)					23
10						20
	Partially Weathered Rock Sampled as Orange and Brown Silty Fine to Coarse **SAND** (SM)					50/4"
15			▽ (16.0)			
						50/3"
20	*Auger refusal occurred at 19.0'. Water was observed at 16.0' below the existing ground surface after TOB.*					
25						
30						
35						

Standard Penetration Test Data (Blows/ft)



PROJECT:	Chatham County Assemblage Chatham County, N.C.	TEST BORING RECORD	B-7

PROJECT NO.:	1051-00-273	ELEVATION:	GROUND SURFACE
LOGGED BY:	KCB	BORING DEPTH:	19.0 FEET
DATE DRILLED:	12/5/00	WATER LEVEL:	DRY
DRILLING METHOD:	3-1/4" I.D. H.S.A.	DRILL RIG:	MOBILE B-57

NOTES:
Boring location is approximate.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft)	BPF
0	Topsoil						
	Medium Dense to Dense Yellow and Orange Clayey Fine to Medium **SAND** (SC)						29
5							49
	Very Dense Orange and Brown Silty Fine to Medium **SAND** (SM)						54
10	Partially Weathered Rock Sampled as Orange, Yellow and Brown Silty Fine to Medium **SAND** (SM)						50/5"
							50/4"
15							
							50/0"
20	*Boring terminated at 19.0'. No water was observed below the existing ground surface after TOB.*						
25							
30							
35							

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PROJECT:	Chatham County Assemblage Chatham County, N.C.	TEST BORING RECORD	B-8

				NOTES:
PROJECT NO. :	*1051-00-273*	ELEVATION:	*GROUND SURFACE*	Boring location is approximate.
LOGGED BY:	*KCB*	BORING DEPTH:	*29.0 FEET*	
DATE DRILLED:	*12/5/00*	WATER LEVEL:	*DRY*	
DRILLING METHOD:	*3-1/4" I.D. H.S.A.*	DRILL RIG:	*MOBILE B-57*	

DEPTH (ft)	GRAPHIC LOG	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	Standard Penetration Test Data (Blows/ft) 10 30 50 70 90	BPF
0–0.5		Topsoil						
0.5–6		Dense to Very Dense Orange and Red Clayey Fine to Medium **SAND** (SC), Moist						34 54
6–13		Dense Orange, Brown and Yellow Silty Fine to Coarse **SAND** (SM), Moist						32 40
13–29		Partially Weathered Rock Sampled as Orange, Brown and Yellow Silty Fine to Medium **SAND** (SM)						50/6" 50/4" 50/3" 50/3"
29		*Boring terminated at 29.0'. No water was observed below the existing ground surface after TOB.*						

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

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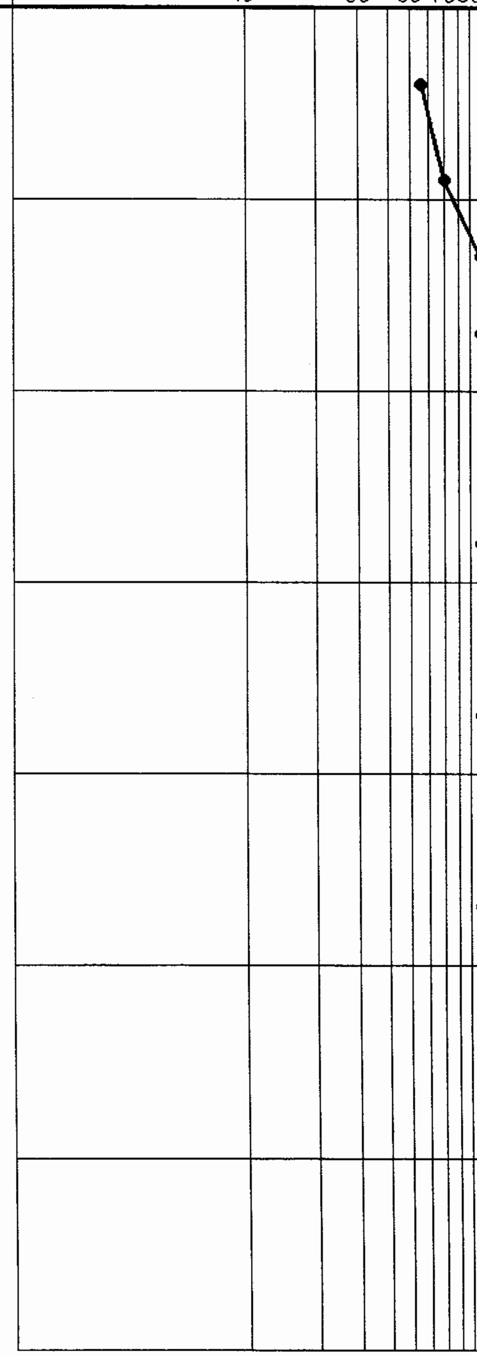
PROJECT: Chatham County Assemblage, Chatham County, N.C.	TEST BORING RECORD B-9

PROJECT NO.:	*1051-00-273*	**ELEVATION:**	*GROUND SURFACE*
LOGGED BY:	*KCB*	**BORING DEPTH:**	*29.0 FEET*
DATE DRILLED:	*12/7/00*	**WATER LEVEL:**	*DRY*
DRILLING METHOD:	*3-1/4" I.D. H.S.A.*	**DRILL RIG:**	*MOBILE B-57*

NOTES: Boring location is approximate.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
0	Topsoil					
	Very Hard Orange-Yellow Slightly Clayey Fine Sandy **SILT** (ML)					56
						70
6	Partially Weathered Rock Sampled as Yellow-Brown Fine Sandy **SILT** (ML)					50/6"
8	Partially Weathered Rock Sampled as Gray, Black and Brown Silty Fine **SAND** (SM)					50/6"
						50/5"
						50/6"
						50/2"
						50/1"
29	*Boring terminated at 29.0'. No water was observed below the existing ground surface after TOB.*					

Standard Penetration Test Data (Blows/ft): 10, 30, 50, 70, 90



S&ME Environmental Services Engineering * Testing

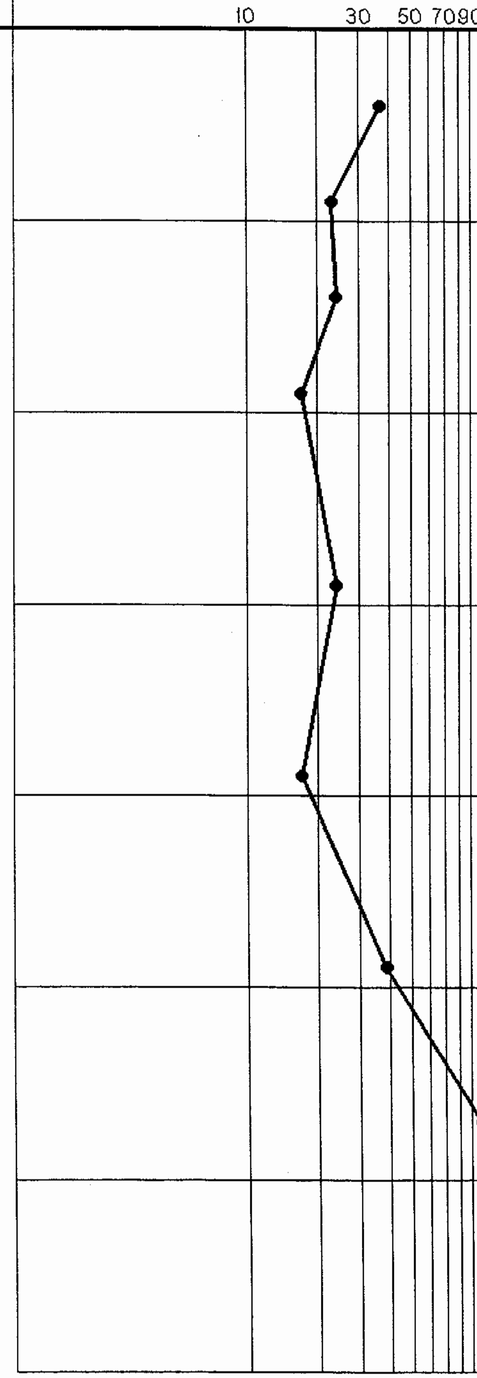
PROJECT:	**Chatham County Assemblage** Chatham County, N.C.	**TEST BORING RECORD**	**B-10**

PROJECT NO.:	*1051-00-273*	**ELEVATION:**	*GROUND SURFACE*
LOGGED BY:	*KCB*	**BORING DEPTH:**	*29.0 FEET*
DATE DRILLED:	*12/6/00*	**WATER LEVEL:**	*DRY*
DRILLING METHOD:	*3-1/4" I.D. H.S.A.*	**DRILL RIG:**	*MOBILE B-57*

NOTES:
Boring location is approximate.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
0	Topsoil					
0–6	Hard to Very Stiff Orange, Red and Gray Fine Sandy Silty **CLAY** (CL), Moist					37, 23
6–13	Very Stiff White, Light Gray and Orange Slightly Clayey Fine Sandy **SILT** (ML), Moist to Wet					24, 17
13–25	Medium Dense to Dense Yellow, Orange and Brown Silty Fine to Coarse **SAND** (SM)					24, 17, 39
25–29	Partially Weathered Rock Sampled as Yellow and Brown Silty Fine to Medium **SAND** (SM)					50/4"
29	*Boring terminated at 29.0'. No water was observed below the existing ground surface after TOB.*					

Standard Penetration Test Data (Blows/ft)



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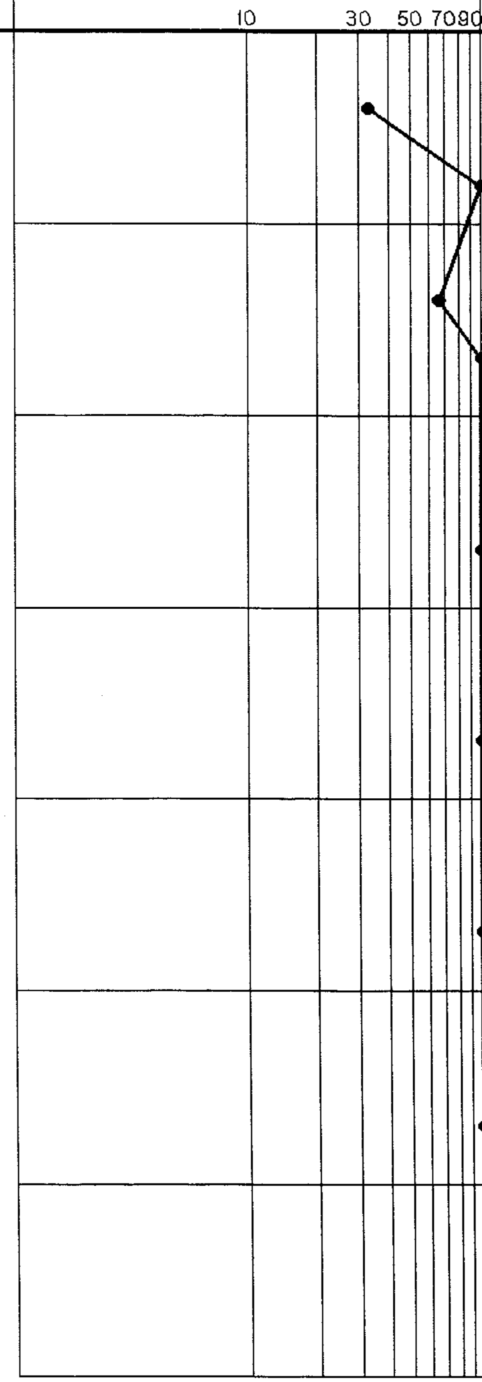
PROJECT:	Chatham County Assemblage Chatham County, N.C.	TEST BORING RECORD	B-11

PROJECT NO.: *1051-00-273*	**ELEVATION:** *GROUND SURFACE*	**NOTES:** Boring location is approximate.
LOGGED BY: *KCB*	**BORING DEPTH:** *29.0 FEET*	
DATE DRILLED: *12/6/00*	**WATER LEVEL:** *20.0 FEET @ TOB*	
DRILLING METHOD: *3-1/4" I.D. H.S.A.*	**DRILL RIG:** *MOBILE B-57*	

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
0	Topsoil					
	Medium Dense Orange, Brown and Black Slightly Clayey Silty Fine to Coarse **SAND** (SM)					33
5	Partially Weathered Rock Sampled as Orange, Brown and White Silty Fine to Coarse **SAND** (SM)					50/6"
	Very Dense Yellow and Brown Silty Fine to Coarse **SAND** (SM)					66
10	Partially Weathered Rock Sampled as Yellow and Brown Silty Fine to Coarse **SAND** (SM), Moist to Wet					50/4"
15						50/5"
20			▽			50/4"
25						50/2"
	- Wet Below 28 Feet					50/4"
30	*Boring terminated at 29.0'. Water was observed at 20.0' below the existing ground surface after TOB.*					
35						

Standard Penetration Test Data (Blows/ft)



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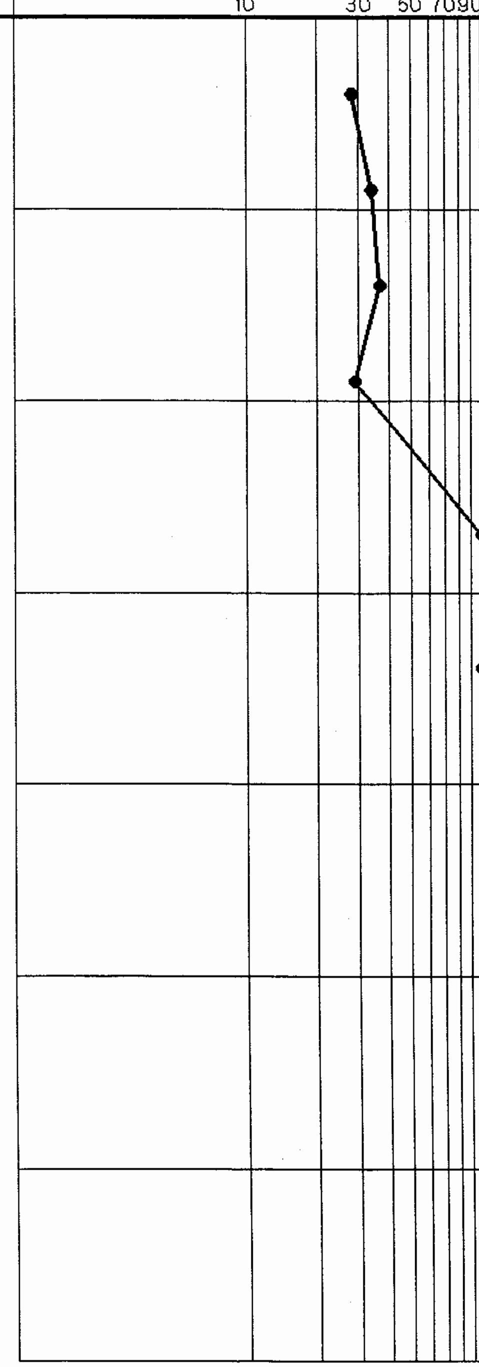
PROJECT:	**Chatham County Assemblage** Chatham County, N.C.	TEST BORING RECORD	B-12

PROJECT NO.:	*1051-00-273*	**ELEVATION:**	*GROUND SURFACE*
LOGGED BY:	*KCB*	**BORING DEPTH:**	*17.0 FEET*
DATE DRILLED:	*12/6/00*	**WATER LEVEL:**	*DRY*
DRILLING METHOD:	*3-1/4" I.D. H.S.A.*	**DRILL RIG:**	*MOBILE B-57*

NOTES:
Boring location is approximate.

DEPTH (ft)	Soil Description	OVM (ppm)	WATER LEVEL	SAMPLE	ELEV.	BPF
0	Topsoil					
	Medium Dense Orange and Yellow Clayey Fine to Medium **SAND** (SC), Moist					28
5	Dense to Medium Dense Yellow, Black and White Silty Fine to Coarse **SAND** (SM), Moist					34
						37
10						29
	Partially Weathered Rock Sampled as Brown and Yellow Silty Fine to Medium **SAND** (SM), Wet					50/3"
15						50/0"
	Auger refusal occurred at 17.0'. No water was observed below the existing ground surface after TOB.					

Standard Penetration Test Data (Blows/ft)



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TEST PIT SUMMARY
Chatham County Assemblage
Chatham County, North Carolina
S&ME Project No. 1051-00-273

Date	Test Pit	Depth (feet)	Description
	TP-1	0.0 - 0.8	Topsoil
		0.8 - 5.0	Orange and Yellow Sandy CLAY (CL), Moist to Wet
		5.0 - 15.0	Orange and Yellow Slightly Clayey Silty SAND (SM)
		15.0 - 17.0	Partially Weathered Rock Sampled as Yellow and Brown Silty Fine to Coarse SAND (SM), Moist
			Test pit terminated at 17.0 feet. No boulders visible on immediate ground surface.
	TP-2	0 - 1.0	Topsoil
		1.0 - 4.0	Orange and Yellow Sandy CLAY (CL), Moist
		4.0 - 13.0	Orange and Yellow Slightly Clayey Silty Fine to Medium SAND (SM)
			Trackhoe refusal at 13.0 feet. Boulders encountered ranged form 3 feet to 5 feet in diameter
	TP-3	0.0 - 1.0	Topsoil
		1.0 - 5.0	Orange Sandy Silty CLAY (CL), Moist to Wet
		5.0 - 15.0	Yellow and Brown Silty Fine to Coarse SAND (SM)
		15.0 - 17.0	Partially Weathered Rock Sampled as Yellow and Brown Silty Fine to Coarse SAND (SM), Moist
			Boulders encountered from ground surface. Test pit terminated at 17.0 feet.

TEST PIT SUMMARY
Chatham County Assemblage
Chatham County, North Carolina
S&ME Project No. 1051-00-273

Date	Test Pit	Depth (feet)	Description
	TP-4	0.0 - 1.0	Topsoil
		1.0 - 4.0	Orange and Yellow Sandy CLAY (CL), Moist to Wet
		4.0 - 11.0	Yellow and Tan Silty Fine to Medium SAND (SM)
			Trackhoe refusal at 11.0 feet. Boulders encountered to termination.
	TP-5	0.0 - 1.0	Topsoil
		1.0 - 5.0	Orange and White Fine Sandy Silty CLAY (CL)
		5.0 - 11.0	Tan and Orange Silty Fine to Medium SAND (SM)
		11.0 - 14.0	Partially Weathered Rock Sampled as Yellow and Brown Silty Fine to Coarse SAND (SM), Moist
			Trackhoe refusal at 14.0 feet. Boulders encountered from ground surface.
	TP-6	0.0 - 1.0	Topsoil
		1.0 - 5.0	Orange Fine Sandy Silty CLAY (CL)
		5.0 - 8.0	White and Tan Slightly Clayey Silty Fine to Medium SAND (SM)
		8.0 - 18.0	White and Tan Slightly Clayey Silty Fine to Medium SAND (SM)
		18.0 - 20.0	Partially Weathered Rock Sampled as White and Tan Silty Fine to Medium SAND (SM)
			Test pit terminated at 20.0 feet. No visible boulders were observed at the ground surface.

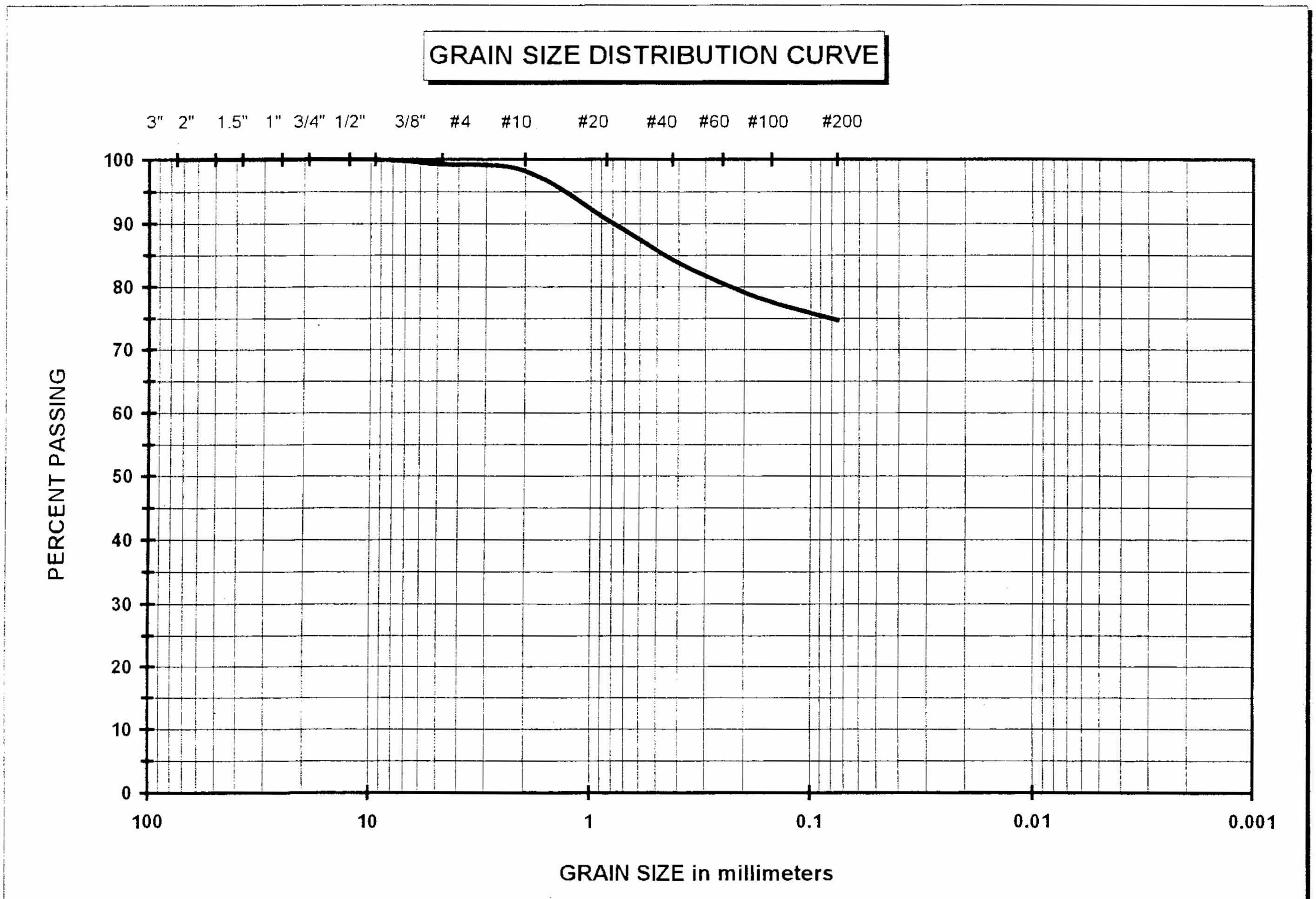
TEST PIT SUMMARY
Chatham County Assemblage
Chatham County, North Carolina
S&ME Project No. 1051-00-273

Date	Test Pit	Depth (feet)	Description
	TP-7	0.0 - 0.8	Topsoil
		0.8 - 2.0	Gray and Yellow Slightly Clayey Silty Fine to Medium SAND (SM)
		2.0 - 4.5	Orange, Red and Gray Sandy CLAY (CL)
		4.5 - 17.0	White, Red and Orange Very Fine to Medium SAND (SM), Moist
			Test pit terminated at 17.0 feet.
	TP-8	0.0 - 1.1	Topsoil
		1.1 - 2.0	Light Orange Fine Sandy Silty CLAY (CL), Wet
		2.0 - 5.0	Orange Fine Sandy Silty CLAY (CL), Moist
		5.0 - 17.0	Yellow-Orange and White Silty Fine to Medium SAND (SM)
			Test pit terminatedat 17.0 feet. 4 to 6 foot diamter boulders were encountered in upper 10 feet. Boulders increased with depth.

GRAIN SIZE DATA SHEET

Project Description: Chatham County Assemblage

Project Number: 1051-00-273



Gravel	< 75 mm and > 4.75 mm		Fine Sand	< 0.425 mm and > 0.075 mm
Coarse Sand	< 4.75 mm and >2.00 mm		Silt	< 0.075 and > 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm		Clay	> 0.005 mm

Boring No.: **B - 4** Sample No.: **1** Elevation (ft): **1.0**

Soil Description: **Brown Sandy SILT**

ATTERBERG LIMIT (-#40 MATERIAL)	
LIQUID LIMIT	--
PLASTIC LIMIT	--
PLASTICITY INDEX	--
NATURAL MOISTURE (%)	--

GRAIN SIZE DATA	
SAND (%)	**25.3**
SILT & CLAY (%)	**74.7**

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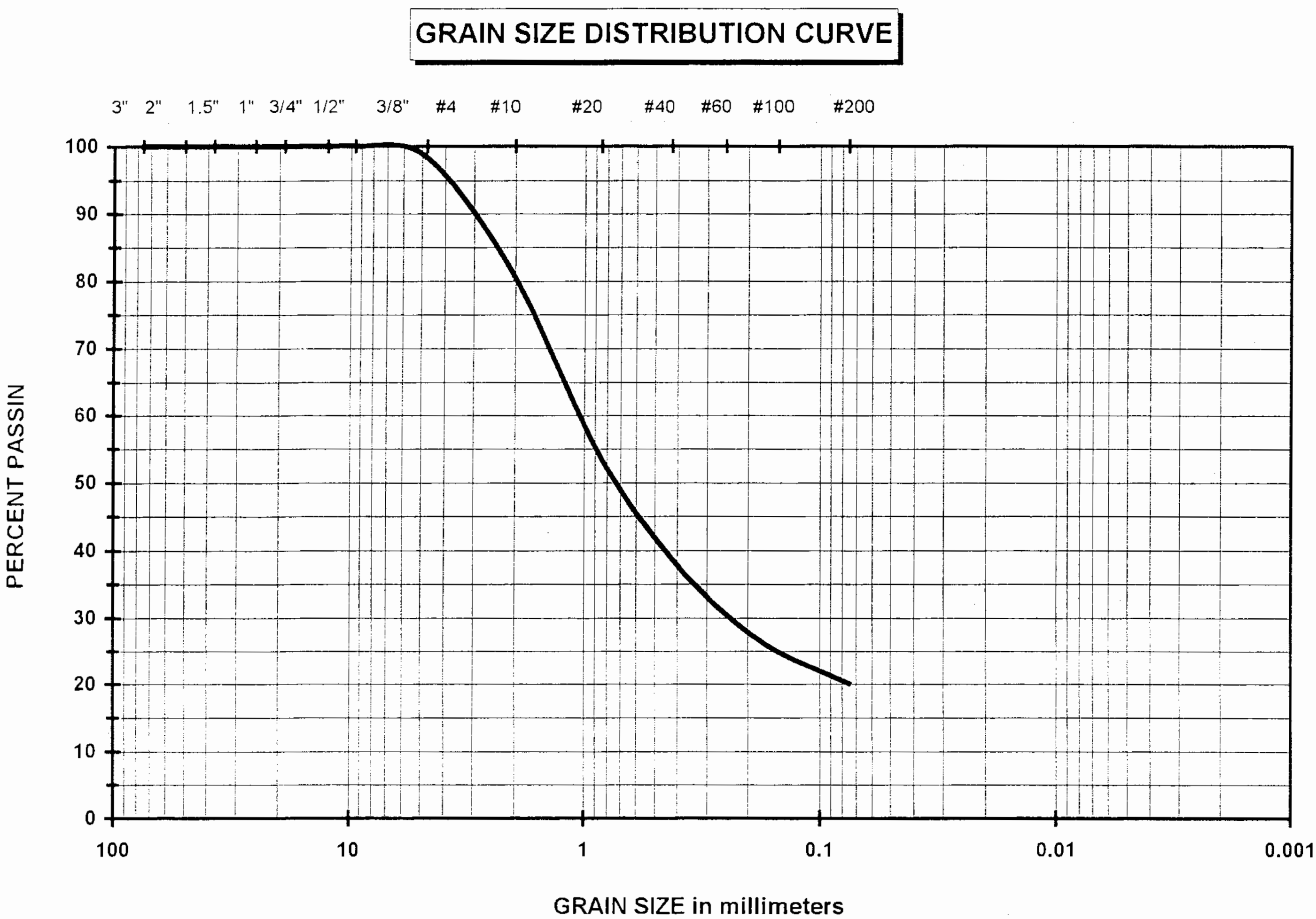
GRAIN SIZE DATA SHEET

Project Description: Chatham County Assemblage

Project Number: 1051-00-273



Gravel	< 75 mm and > 4.75 mm
Coarse Sand	< 4.75 mm and >2.00 mm
Medium Sand	< 2.00 mm and > 0.425 mm

Fine Sand	< 0.425 mm and > 0.075 mm
Silt	< 0.075 and > 0.005 mm
Clay	> 0.005 mm

Boring No.: B - 7 Sample No.: 3 Elevation (ft): 6.0

Soil Description: **Tan - Brown Silty SAND**

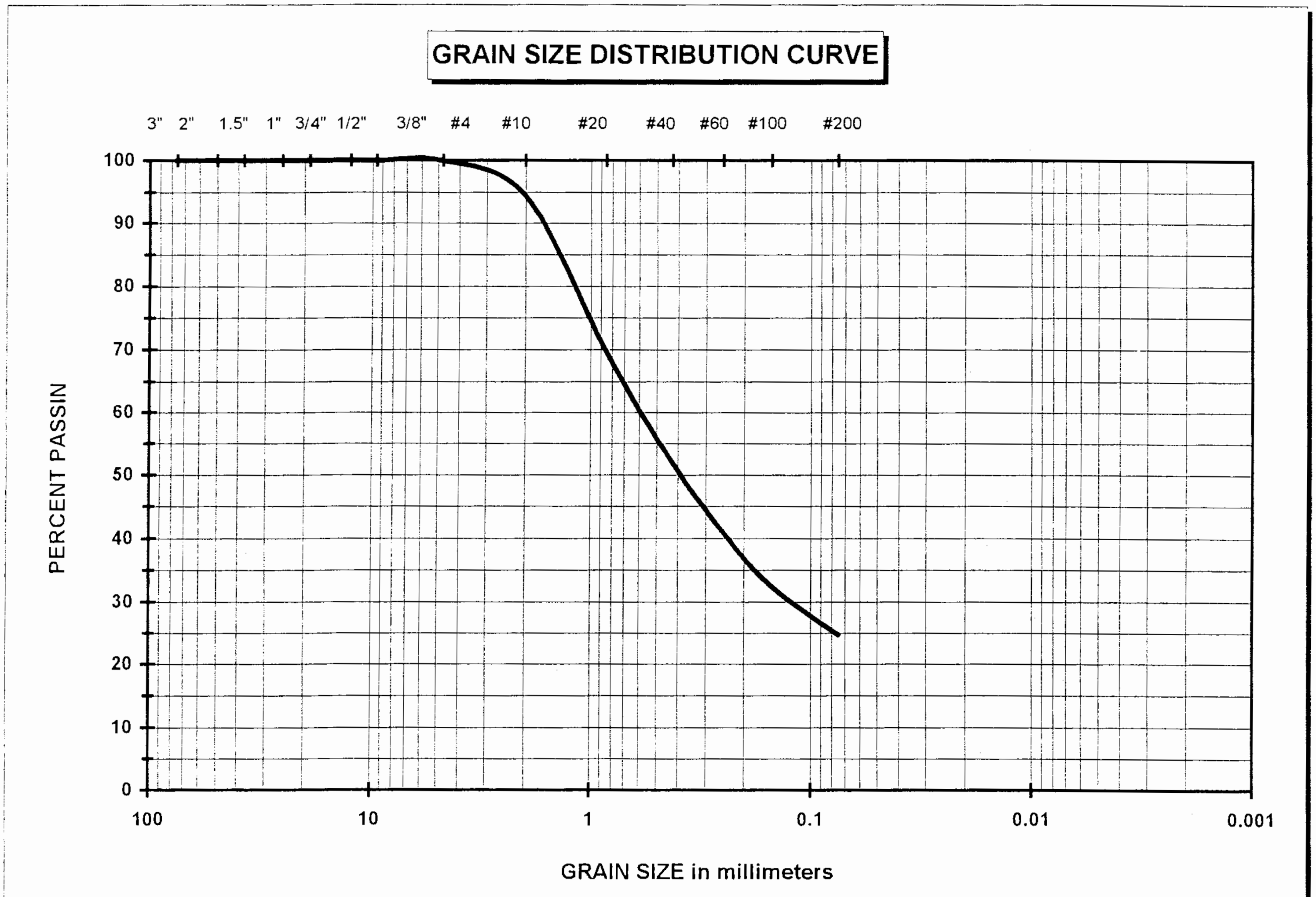
ATTERBERG LIMIT (-#40 MATERIAL)	
LIQUID LIMIT	--
PLASTIC LIMIT	--
PLASTICITY INDEX	--
NATURAL MOISTURE (%)	--

GRAIN SIZE DATA	
SAND (%)	79.9
SILT & CLAY (%)	20.1

GRAIN SIZE DATA SHEET

Project Description: Chatham County Assemblage

Project Number: 1051-00-273



Gravel	< 75 mm and > 4.75 mm
Coarse Sand	< 4.75 mm and >2.00 mm
Medium Sand	< 2.00 mm and > 0.425 mm

Fine Sand	< 0.425 mm and > 0.075 mm
Silt	< 0.075 and > 0.005 mm
Clay	> 0.005 mm

Boring No.: B - 8 Sample No.: 4 Elevation (ft): 8.5

Soil Description: **Brown Silty SAND**

ATTERBERG LIMIT (-#40 MATERIAL)	
LIQUID LIMIT	--
PLASTIC LIMIT	--
PLASTICITY INDEX	--
NATURAL MOISTURE (%)	--

GRAIN SIZE DATA	
SAND (%)	75.3
SILT & CLAY (%)	24.7

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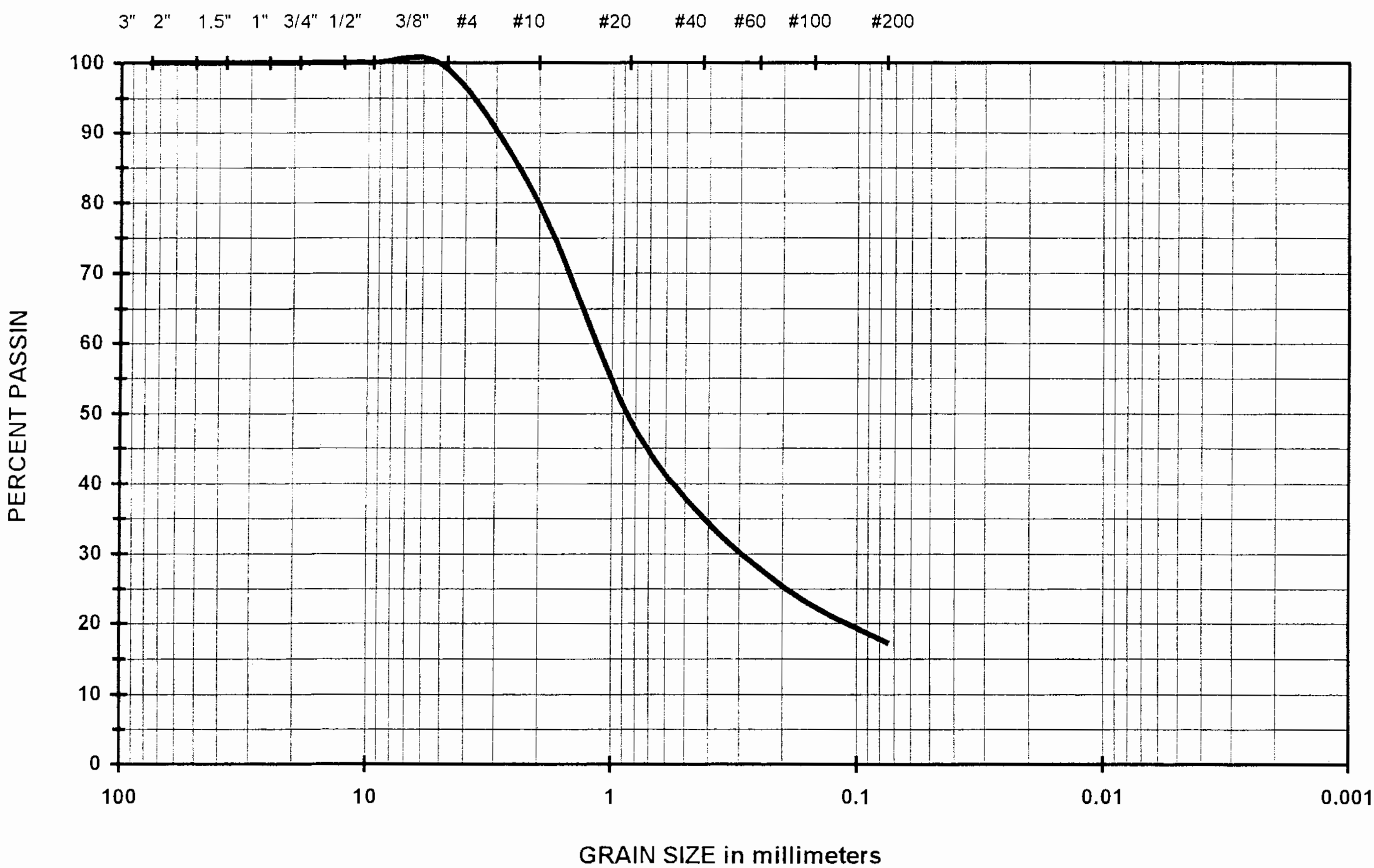
GRAIN SIZE DATA SHEET

Project Description: Chatham County Assemblage

Project Number: 1051-00-273

GRAIN SIZE DISTRIBUTION CURVE



Gravel	< 75 mm and > 4.75 mm
Coarse Sand	< 4.75 mm and >2.00 mm
Medium Sand	< 2.00 mm and > 0.425 mm

Fine Sand	< 0.425 mm and > 0.075 mm
Silt	< 0.075 and > 0.005 mm
Clay	> 0.005 mm

Boring No.: B - 11 Sample No.: 3 Elevation (ft): 6.0

Soil Description: **Tan - Brown Silty SAND**

ATTERBERG LIMIT (-#40 MATERIAL)	
LIQUID LIMIT	--
PLASTIC LIMIT	--
PLASTICITY INDEX	--
NATURAL MOISTURE (%)	--

GRAIN SIZE DATA	
SAND (%)	82.7
SILT & CLAY (%)	17.3