Golder Associates, Inc.
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

RECEIVED
JUN 28 1988
SOLID WASTE BRANCH

FINAL REPORT ON

Piedmont MSWLF 34-06

A PHASE II HYDROGEOLOGIC INVESTIGATION AT THE PROPOSED KERNERSVILLE, NC SANITARY LANDFILL SITE

VOLUME 1 OF 2

MAIN REPORT

Carmen Johnson
Fac/Perm/Co ID # 34-06 | Date ~~8/12/13~~ | Doc ID# DIN

Submitted to:

WASTE MANAGEMENT OF THE CAROLINAS, INC.
110 Berry Shoals Road
P.O. Box 338
Duncan, South Carolina 29334

SCANNED 3/14/14 (CP)

Carmen Johnson
Fac/Perm/Co ID # 34-06 | Date ~~8/12/13~~ | Doc ID# DIN

DISTRIBUTION:

4 Copies - Waste Management of The Carolinas, Inc., Duncan, SC
2 Copies - Golder Associates, Inc., Atlanta, Ga.

June 1988

863-3407

Golder Associates, Inc.
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

June 24, 1988 863-3407

Waste Management of The Carolinas, Inc.
110 Berry Shoals Road
P.O. Box 338
Duncan, South Carolina 29334

Attn: Mr. E. Gibson, P.E.

RE: FINAL REPORT ON A PHASE II HYDROGEOLOGIC INVESTIGATION OF THE PROPOSED KERNERSVILLE, NC SANITARY LANDFILL SITE

Gentlemen:

Please accept our final report for the above project. We conclude that while the site is presently covered with somewhat sandy materials overlying weathered bedrock, the water table is, for the most part, deep. Hence, a constructed liner placed at least four feet above the water table would allow this site to meet North Carolina requirements for a sanitary landfill.

Should you have any questions regarding this final report, please call.

Very truly yours,

GOLDER ASSOCIATES

Kenneth H. Rippere, P.G.
Principal

Ray Pearson, P. Eng.
Associate

KHR:RP:rcs

Enclosures

TABLE OF CONTENTS

Cover Letter

Table of Contents i

Volume 1 - Main Report

SECTION PAGE

1.0 INTRODUCTION 1

2.0 GEOGRAPHIC AND PHYSIOGRAPHIC SETTING 3
2.1 Location and Physiography 3
2.2 Transportation and Access 4

3.0 REGIONAL GEOLOGIC SETTING. 5
3.1 Regional Bedrock and Structural Geology . . 5
3.2 Regional Soil Conditions. 6

4.0 CLIMATE AND REGIONAL HYDROGEOLOGY. 8
4.1 Climatic Conditions 8
4.2 Regional Hydrogeology 8
4.2.1 Occurrence and Flow of Groundwater . 8
4.2.2 Well Inventory 11
4.3 Water Budget. 11

5.0 PHASE II INVESTIGATIONS. 13
5.1 Subsurface Drilling Investigations. 13
5.2 Piezometer Installations. 16
5.3 Piezometer Development. 17
5.4 Surveyings 18
5.5 In Situ Hydraulic Conductivity Tests. . . . 19

6.0 INVESTIGATION RESULTS. 21
6.1 Site Geology. 21
6.2 Site Surface Water Hydrology. 26
6.2.1 Site Topography and Drainage 26
6.2.2 Flood Prone Areas. 27
6.2.3 Wetlands 27
6.3 Site Groundwater Hydrology. 28
6.3.1 Uppermost Aquifer. 28
6.3.2 Groundwater Classification and Quality 29
6.3.3 Hydraulic Conductivity of Saturated Materials. 30
6.3.4 Groundwater Flow and Elevations . . 32

TABLE OF CONTENTS
(Cont'd)

6.3.5 Vertical Flow (Gradients). 34
6.3.6 Flow Boundaries/Migration Barriers . 34
6.3.7 Potential for Leachate Migration in Uppermost Aquifer. 36
6.4 Geotechnical Properties of Site Soils . . . 36

7.0 CONCLUSIONS AND RECOMMENDATIONS. 39

REFERENCES 43

TABLE 1 - Temperature and Precipitation Data
TABLE 2 - Storm Frequency
TABLE 3 - Well Inventory Summary
TABLE 4 - Piezometer Construction Summary
TABLE 5 - Piezometer Elevations and Coordinates
TABLE 6 - Summary of Hydraulic Conductivity Values
TABLE 7 - Hydraulic Conductivity Calculations using Hazen's Approximation
TABLE 8 - Field Mapping Station Descriptions
TABLE 9 - Borrow Pit Descriptions
TABLE 10 - Auger Probe Logs
TABLE 11 - Surface Water Information
TABLE 12 - Water Level Readings
TABLE 13 - Lateral Hydraulic Gradients
TABLE 14 - Vertical Hydraulic Gradients Between Multilevel Piezometers
TABLE 15 - Construction Slope Angle Estimates

In Order Following Page 44

FIGURE 1 - Site Location Plan
FIGURE 2 - Site Topographic Map
FIGURE 3 - Regional Geologic Map and Structural Cross-Section
FIGURE 4 - Explanation of Geologic Map Symbols
FIGURE 5 - Idealized Residual Soil Profile of the Southern Piedmont Region
FIGURE 6 - Groundwater Occurrence Block Diagram
FIGURE 7 - Location of Domestic Wells
FIGURE 8 - Piezometer Location and Generalized Potentiometric Map
FIGURE 9 - Geologic Field Mapping Stations
FIGURE 10 - Approximate Locations of Onsite Borrow Pits and Auger Probes
FIGURE 11 - Hydrogeologic Cross-Section and Seismic Line Location Plan
FIGURE 12 - Hydrogeologic Cross-Sections A-A', B-B'
FIGURE 13 - Hydrogeologic Cross-Sections C-C', D-D'

TABLE OF CONTENTS
(Cont'd)

FIGURE 14 - Engineering Implications Cross-Section
FIGURE 15 - Top of Bedrock Elevation Contour Map
FIGURE 16 - Surface Water Features
FIGURE 17 - Flood Prone Areas
FIGURE 18 - Groundwater Discharge Areas
FIGURE 19 - Proposed Groundwater Monitoring Locations
FIGURE 20 - Proposed Surface Water Monitoring Locations

Volume 2 - Appendices

APPENDIX A - Field Boring and Piezometer Installation Logs
APPENDIX B - Grain Size Distribution Analyses
APPENDIX C - Water Quality Analytical Results for Barrow's Well
APPENDIX D - In Situ Hydraulic Conductivity Data and Plots
APPENDIX E - Hazen's Approximations - Desciption and Calculations
APPENDIX F - Hydraulic Gradient Calculations
APPENDIX G - Legal Descriptions of Land Parcels
APPENDIX H - Seismic Survey Report

1.0 INTRODUCTION

Waste Management, Inc. (WMI) has obtained an option on the property of Beulah C. Barrow, et al, (hereafter called the Kernersville site) for the potential construction of a sanitary landfill. The site is located off Freeman Road in Forsyth County, North Carolina some 10 miles north of Kernersville, and is adjacent to the existing City of Kernersville Municipal landfill, as shown on Figure 1 and 2.

Golder Associates was retained by WMI to perform a hydrogeologic investigation of the Kernersville site. The investigation consisted of two phases:

- Phase I - A desk study, and
- Phase II - A field investigation.

The Phase I Study (Reference 1) included the acquisition and review of existing data and published literature regarding the climate, surface water, soils, wetlands, geological and hydrological conditions at the site.

The main objectives of the Phase II investigation included the following:

- determination of the occurrence of groundwater beneath the site, including assessment of groundwater flow directions and quality, estimated seasonal and maximum groundwater levels, and aquifer permeability;
- determination of the extent and permeability of strata (aquitards) which may restrict the infiltration of water into the aquifer;

- identification of sufficient quantities of borrow materials for daily operations; and
- determination of the top of bedrock at the site and intensity of fracturing within the upper parts of the bedrock.

The objectives, as stated above, were accomplished by performing the hydrogeologic investigation as five tasks. The five tasks are: a topographic survey; a geological investigation; laboratory testing of soils; a field drilling program; and in situ permeability testing.

Soil and rock core logs from the Phase II drilling investigations are included in Appendix A. All Phase II tasks were completed and are discussed in the following sections of this report. A report on a seismic refraction survey at the site is included in Appendix H.

2.0 GEOGRAPHIC AND PHYSIOGRAPHIC SETTING

2.1 Location and Physiography

The Kernersville site is located approximately 10 miles north of Kernersville, North Carolina, in the northeast corner of Forsyth County (Figure 1). The site is in the Piedmont physiographic province, a region with gently rolling to hilly terrain , with a dense surface water drainage network, moderately steep stream valleys, and broad ridge-crests. Although slopes are often steep, total relief is not great and elevations generally range from 800 to 1000 feet above mean sea level. The site topography is shown in Figure 2. The region is primarily wooded, with some pasture land and occasional fields of cultivated crops.

The Kernersville area is currently zoned R-6, suburban residential. The area is sparsely settled, with fifteen residences identified on and within 2000 feet of the site. Of these residences, six were located in the Hiram Hills subdivision, southeast of the site.

Belews Lake, operated by Duke Power, lies to the north of the site, with the lakeshore being about 3000 feet from the site. Conditions in the lake will not currently support sport fishing, and the recreational activities associated with the lake are correspondingly limited. Duke Power is working to re-establish sport fishing in the lake; when this is accomplished recreational use of the lake will certainly increase.

No state parks, scenic areas, recreational facilities or state nature or state historical preserves have been identified near the Kernersville site.

2.2 Transportation and Access

The Kernersville site is accessed by Goodwill Church-Freeman Road, an all weather gravel road. Travel distance to the nearest paved road is about 1/2 mile.

The city of Kernersville, about three miles to the south, is serviced by rail and by U.S. Interstate Highway I-40. Commercial air service is available at the Greensboro High Point Airport about 10 miles to the southeast; there is no turbo-jet airport within 10,000 feet of the site, or piston-type airport within 5,000 feet of the site.

3.0 REGIONAL GEOLOGIC SETTING

3.1 Regional Bedrock and Structural Geology

A geologic map and structural cross-section of the Kernersville region is presented in Figures 3 and 4. The Kernersville site is located on igneous and metamorphosed rocks of the Charlotte Belt. The oldest rocks in the area are mafic igneous rocks (dense, dark colored rocks high in magnesium and iron) which were later intruded by granite. At about the same geologic time, the rocks were metamorphosed; the mafic rocks became amphibolite (a rock composed primarily of the mineral horneblende) and the granite became gneiss (a granite-like rock with alternating bands of light and dark minerals). Blocks of amphibolite may be found within the gneiss, indicating that the amphibolite is older than the gneiss. Veins of pegmatite (a coarse grained, light colored rock consisting primarily of quartz and feldspar) were formed during the late stages of igneous intrusion and metamorphism, and crosscut both the gneiss and amphibolite, (Reference 2).

The Charlotte Belt was formed during late Paleozoic time, in the roots of an ancient mountain system formed by compression of the earth's crust. Later, in the Triassic time, the region was subjected to tension, forming diabase dikes and rift valleys.

Diabase dikes are thin, near vertical sheets of the fine grained, very hard, mafic rock diabase. They are typically a few feet or tens of feet wide, several miles long, and often oriented northwest-southeast. They may act as a barrier to or conduit for horizontal groundwater flow. Diabase dikes are common in the region, but have not been identified at the Kernersville site.

Rift valleys are major structural features of the North Carolina Piedmont. The rift valley nearest to the Kernersville site is the Dan River Basin, which extends from about 10 miles northwest of the site, northeast into Virginia.

The Dan River Basin originated when a fault formed on the northwest margin of the basin and the area within the basin moved downward, tilting to the northwest. Sand and gravel from the surrounding highlands were washed into the basin. Later, a lake formed in the center of the basin, and silt, clay, and some organics were deposited in this area, while deposition of sand and gravel continued on the edges of the basin. The lake deposits were later partially covered with a complex mixture of sediments. Strata within the Dan River basin dip to the northwest, indicating that movement along the fault continued during and after deposition of the sediments (Reference 3). There is no evidence of this fault extending closer than 10 miles to the site nor of other major faults in the immediate area.

The regional mountain system formed during the late Paleozoic was still active during the Triassic, and was eroded to near sea level during the Tertiary period. This flat surface was then uplifted and the resulting plateau was again eroded, producing the topography of dense drainage networks, steep valleys, and near equal ridge crest elevations which characterize the Piedmont today.

3.2 Regional Soil Conditions

When igneous and metamorphic rocks of the Piedmont are exposed at the earth's surface, they are weathered by chemical and mechanical means. Mechanical weathering breaks the rocks down into sand, gravel and boulders; chemical

weathering then reduces these particles to sand, silt and clay size. The resulting soil profile thus becomes coarser with depth. An idealized profile, typical of residual Piedmont soils, is presented in Figure 5.

In addition to residual soils, alluvial soils occur in flood plains and terrace deposits in the Piedmont. Terrace deposits generally consist of sand, gravel and cobbles and occur locally along the side of steep valleys.

4.0 CLIMATE AND HYDROLOGY

4.1 Climatic Conditions

The climate in the Kernersville area is warm and humid, with a mean annual temperature of 59.5 degrees F, and average annual rainfall of 44.2 inches. Rainfall is evenly distributed throughout the year. Mean monthly temperatures range from 41 degrees F in December and January, to 78 degrees F in July. Snow cover (average depth 2 inches) is present, on the average, nine days out of the year. Winds average 8 mph and are primarily out of the northeast during the fall months, and from the southwest during the remainder of the year. Average relative humidity is near 80 % at sunrise and 50 % at mid-afternoon (Reference 4). Temperature and precipitation data for the site are presented in Table 1. The intensity, duration and frequency of rainstorms is presented in Table 2.

4.2 Regional Hydrogeology

4.2.1 Occurrence and Flow of Groundwater

Groundwater in the Piedmont Plateau province is obtained from two sources, residual soil and the underlying crystalline or metamorphosed bedrock. The most favorable location for wells in the Piedmont Plateau province is the lower elevations of discharge areas (Figure 6). The most probable reasons for relatively large supplies of groundwater in the lowland areas, as listed by Herrick and Le Grand (Reference 5) and Thompson et. al., (Reference 6), are as follows:

a) less surface runoff and consequently more direct influent seepage occurs in the valleys;

b) influent seepage occurs from upland surface runoff;

c) influent seepage occurs from upland areas, resulting in a continuous source of recharge; and

d) the residual soil has a greater void space for storage of groundwater and is usually thickest in stream valleys.

The aquifers in the Piedmont are recharged from precipitation. The Kernersville area annually receives approximately 44 inches of precipitation (Table 1). Recharge occurs as water infiltrates through the residual material into the saturated soil zone. Groundwater may eventually flow into the crystalline rock via fractures, or by flowing directly into openings in exposed rock. Most infiltration can be expected to occur on level to gently sloping (0-2%) surfaces; less infiltration and increased runoff is expected on sloped terrain. Upon reaching the saturated zone, groundwater generally flows laterally and downgradient to discharge areas in topographic lows. Locally, anisotropic features may divert downgradient flow to discharge areas with higher permeability soil and bedrock. Diversions of this sort may be caused by features such as faults, fractures, and joints present in the bedrock.

In the past, groundwater was primarily withdrawn from the residual soil for domestic needs from large diameter (4 to 6 ft.) wells, about 15 to 40 feet deep. The wells were typically advanced by hand excavation into the saturated zone a few feet beyond the depth of the water table. The exposed soils were stabilized with open-jointed brick or rock masonry. These wells provide a large storage capacity but

frequently go dry during periods of drought. The groundwater yield of wells open in the residual soil depends on the thickness of the saturated zone, degree and depth of weathering, topographic setting, vegetation cover, and the permeability of the soil.

Groundwater in the crystalline rocks of the Piedmont Plateau province occurs in joints, fractures, fault zones, and other secondary porosity features in the bedrock. Wells drilled into this rock are typically advanced until a permeable zone with an adequate groundwater yield is encountered. The quality of groundwater that can be withdrawn by a well depends largely on the extent to which the rock openings are interconnected. Most wells drilled into the Piedmont bedrock are used for domestic water supply.

Groundwater levels in the crystalline aquifers are primarily affected by seasonal precipitation and less so by evapotranspiration. Groundwater levels are usually highest in the spring and lowest during the autumn months.

Water level fluctuation in the residual soil is primarily a function of precipitation and evapotranspiration. Water levels generally rise rapidly during wet periods and decline slowly during dry periods.

The water table in the site region is generally controlled by the trend of the surface topography. Thus, a majority of the recharge occurring at the Kernersville site is expected to flow downgradient, discharging into the two streams which border the north and south margins of the site.

4.2.2. Well Inventory

Fifteen existing well locations have been identified on and near the Kernersville site. Two of these locations (W-1 and W-10, on Figure 7) have wells that probably extend into relatively unweathered rock, while the remainder are large diameter (24 inch) shallow (measured or reported depth 30 -60 feet) wells which probably derive their water from the soil and partially weathered rock.

Well locations are shown in Figure 7; well information on domestic wells in the area is presented in Table 3. It should be noted that location W-10 on Figure 7 (the Hiram Hills sub-division) contains at least six wells, some of which may be outside the 2000 ft. perimeter. These existing domestic wells were used to provide additional hydrologic information, however, soil boring information was not available for these wells.

It is recommended that all on-site wells be grouted prior to commencement of landfill operations.

4.3 Water Budget

Water budgets are a method of evaluating the fate of water which falls in to a drainage basin as precipitation, and in particular of evaluating the amount of infiltration or groundwater recharge of an area. A water budget may be written in the form:

Precipitation - Runoff - Evapotranspiration + Storage = Infiltration

Precipitation in the region is 44.2 inches per year (Section 4.1). Mean annual flow into Belews Lake is 99 cfs; for a 76 square mile drainage basin this is equivalent to runoff of 17.7 inches per year (Reference 7). Potential evapotranspiration in the area is estimated at between 31 and 41 inches per year, based on a shallow lake evaporation of 41 inches (Reference 8).

Inserting these values into the above equation, it can be seen that potential evapotranspiration and runoff are sufficient to account for all the available precipitation. This does not mean that infiltration is not occurring; it simply means that all the water entering the groundwater as recharge is ultimately being evapotranspired or discharged to surface water within the basin.

In order to evaluate, by water budget, whether infiltration into a landfill will occur, preliminary design parameters, such as area, slope, cover material, etc., as well as climatic data, must be available. Water budget and infiltration may then be calculated by methods such as the Hydrologic Evaluation of Landfill Performance (HELP) program developed and approved by the U.S. EPA. The HELP program is particularly attractive, because it is widely accepted, and climatic data for the Kernersville region are available. We suggest this method, or other applicable methods, be used to evaluate infiltration of the site when landfill design is known.

5.0 PHASE II - FIELD INVESTIGATION

The field investigation was conducted to collect information on the engineering properties of the site materials and hydrogeologic characteristics across the site. The field investigations consisted of the completion of 12 soil borings and the subsequent installation of 18 piezometers. Rock core samples were obtained from 7 of the 12 borings to identify the bedrock hydrologic and engineering characteristics. Soil boring, rock core and piezometer installation logs for the Phase II field drilling program are presented in Appendix A.

5.1 Subsurface Drilling Investigations

A total of 12 test borings were completed at 9 locations during the Phase II investigation (see Figure 8). Three test borings were drilled at location number one (Figure 8), two of which were hand augered soil borings numbered HA1D and HA1S, where the suffix D and S stands for deep and shallow. At the remaining eight boring locations, one test boring was drilled at each location using a Mobile B - 61 drill rig. Test borings included both soil and rock core sampling for most boreholes. All soil and rock samples were logged on site by a qualified Golder Associates field engineer.

Drilling was performed by ATEC Associates, Inc. of Raleigh, NC, under the supervision of the Golder Associate field engineer. Prior to initiating the drilling program, the drilling rig, drilling equipment, and sampling equipment were steam cleaned on-site. The soil borings were completed using one or a combination of the following techniques, depending on conditions: hollow stem augers, roller bit (wash rotary), and rock core drilling.

Hollow stem augers (3-1/4 inch I.D.) were used whenever possible in order to determine the location of the water table and obtain soil samples. A roller bit (4-1/4 or 3-1/4 inch) or rotary wash method was used when the material was too hard to auger, and for uncorable material. The rock coring process was used for sampling competent or recoverable rock. Temporary metal casing (6 inch and 3-1/2 inch I.D.) was used when conditions were deemed necessary, to achieve fluid circulation during roller bit drilling or rock coring. For borehole number P1D, both casings were required to complete drilling operations. The temporary casing was also used in installing the piezometers.

Soil samples were collected with a standard split-barrel (split-spoon) on five-foot centers. Split-barrel samplers were driven two feet, removed from the borehole, and opened. Standard penetration blow counts were recorded and the soil samples classified on field boring logs (Appendix A). A portion from each sample interval was placed in a jar for further analysis, if needed. A total of 19 samples were delivered to Golder Associates laboratory for grain size analysis. Grain size distribution curves of various soils analyzed is included as Appendix B.

The total depths of the test borings depended on the material encountered and the location of the water table. Two of the main goals of this phase were to determine groundwater flow both laterally and vertically, and to define the top of bedrock and the degree of fracturing. The borings averaged from 30 to 35 feet in depth below the water table. The top of bedrock was defined in all borings, except borings P2D, P4D, P8D and HA1, where the bedrock was deeper than 70 to 80 feet below ground surface.

The procedures for completing a typical boring were based on soil/bedrock conditions and the depth to groundwater. Hollow stem augers were preferentially used to determine the depth to the water table in overburden soils. After locating the water table, the next step was to identify the different soil units and the top of bedrock. If the water table was not found above a depth of 50 feet or before auger refusal, then another drilling process had to be used. The second drilling process varied, depended upon the conditions of the soils; either the roller bit, in very dense soils or weathered rock, or the core barrel was used to find and sample competent bedrock. Neither of these processes allowed for recognition of the water table because they required the circulation of water during drilling. Therefore, in the case where water was induced by wash rotary or rock coring methods, the water level in the borehole was allowed to stabilize before the natural water table was identified and screen intervals were determined. An attempt was made to obtain soil or rock core samples in all designated screen intervals.

The rock coring process was used to obtain core samples of the bedrock. A 3-1/4 inch double core barrel with NQ rods was used to recover core samples. Rock core samples were logged in the field and placed in core boxes for future analysis. Drilling advance rates were recorded during rock coring. Rock coring logs are provided as Appendix A.

The water source for roller bit and rock core drilling came from two domestic wells on site. Water quality analyses were performed on the water sample taken from the well at the Barrow's residence. Results of these analyses are included as Appendix C.

When necessary, bentonite was added during drilling to maintain borehole integrity and to prevent the temporary casing from becoming stuck. The use of bentonite was restricted to the portion of the borehole which was five feet or more above the screened interval. The borehole was thoroughly flushed with potable well water prior to piezometer installation.

5.2 Piezometer Installation

Following completion of the individual boreholes, piezometer screen intervals were selected, based on the lithology penetrated and the depth to water. A total of eighteen piezometers were installed at nine different soil boring locations. The location of the piezometers are shown in Figure 8. The construction details of the individual piezometers are summarized in Table 4. The individual piezometer construction diagrams are included in Appendix A.

The piezometers were assembled and installed through the temporary casing. The temporary casing assisted in containing and transferring all piezometer materials to the desired installation depths. Most of the piezometers were constructed to yield water levels at specific lithologic units, however; selected piezometers were constructed in a manner which enabled the collection of a composite water level by effectively screening different units.

Multi-level piezometers were installed in boreholes to identify the vertical and horizontal hydraulic head distribution in both overburden and rock materials. One borehole had three piezometers installed (numbered P8D, M, and S), five boreholes had two piezometers installed in each borehole (numbered P2D and S, P3D and S, and P5D and S), and the

remaining five boreholes had one piezometer installed in each borehole (numbered P1DD, P1D, P1S, P4D and P6D (see Figure 8)). Since most of the boreholes penetrated more than one water producing zone it was possible to screen and hydraulically monitor these separate zones by installing piezometers in various saturated soil or rock strata.

The piezometers are constructed of 3/4 inch diameter schedule 40, flush threaded PVC pipe. Piezometer screens consisted of machine slotted (100 slot) PVC pipe. Each piezometer was equipped with an end cap and a vented top cap. The gravel pack consisted of coarse sand.

For the installation of single piezometers, a 2 to 3 foot bentonite pellet seal was placed in the borehole above the gravel pack, and the borehole was grouted to ground surface with a cement-bentonite grout. For multi-level piezometers, the screen and sand packs were placed at predetermined depths, and bentonite pellets and bentonite slurry was used to form an effective seal between each piezometer open interval.

All boreholes were flushed prior to piezometer installation. Protective surface casings were installed over all piezometers, except the hand augered piezometers HAID and S, to prevent vandalism.

5.3 Piezometer Development

Upon completion of piezometer installations, they were developed using an air-lift method to ensure the following:

- any fluids introduced into the piezometers during well installation are removed;

- a direct hydraulic connection is established between the well bore and the formation; and
- the formation surrounding the screen has been stabilized.

An oil-less compressor was utilized for air lifting to reduce the potential of injecting hydrocarbons into the groundwater. Piezometers were developed by inserting polyethylene tubing down the piezometer and displacing the water column in the piezometer with air. Development was performed in a surging fashion to facilitate the removal of sediment within the screened interval.

The development process continued until relatively clean formation water was discharged from piezometers. In addition, field pH measurements were made periodically during the development process to assist in the determination of when the piezometers were developed sufficiently. These measurements are included on piezometer installation logs (Appendix A).

5.4 Surveying

Following completion of the piezometers, the top of piezometer casing elevations and the X and Y coordinates were surveyed by a registered professional surveyor (Survey and Mapping Services of West Columbia, S.C.).

Piezometer elevations and coordinates were surveyed to the nearest one hundreth (0.01) of a foot and are summarized in Table 5.

In addition, property boundaries were surveyed during the field investigation. Legal descriptions of land parcels encompassing the site are included in Appendix G.

5.5 Hydraulic Conductivity Tests

Subsequent to piezometer development and stabilization of water levels, either a rising or falling head test was performed in each piezometer in order to estimate the hydraulic conductivity of the screened interval. The variable head (rising and falling) tests were initiated by inducing a head differential (driving head) by adding distilled water or rapidly removing water from the piezometer and measuring and recording the rate of recovery (ie. water level rise or fall versus time). Water levels were measured with a SINCO water level indicator and a calibrated engineers rule.

Piezometers P2S and P7D required falling head tests (adding water) because the water column was too short for airlifting. It should be noted these tests are somewhat less reliable than rising head tests.

Variable head tests were analyzed by different methods described by Hvorslev (Reference 9). Details of these tests and their analyses are summarized in Table 6 and are discussed later in this document. All variable head data along with analytical graphs are included in Appendix D.

In addition to in situ hydraulic conductivity tests, hydraulic conductivities were estimated from the grain size distribution analyses of soils. The Hazen's hydraulic conductivity approximation method was applied to the results of the grain size distribution analyses. Details of Hazen's method, as well as the analyses, are provided as Appendix E.

The results of these analyses are summarized in Table 6. It should be noted that the Hazen's approximation method is most applicable to materials in which the uniformity coefficient is less than ten. Calculations for hydraulic conductivity estimates using the Hazen's method are included in Table 7.

6.0 INVESTIGATION RESULTS

General

The completion of the desk study (Reference 1), the seismic report, and the Phase II field investigation have facilitated the overall hydrogeologic evaluation of the proposed Kernersville site. This project specifically evaluated the regional and site specific hydrogeology and its interactions with other elements of the hydrologic cycle and the environment. Additionally, information and data which is crucial to the engineering design and the location of monitoring wells was collected for the proposed solid waste landfill.

As part of the hydrogeologic evaluation, the field data was compiled into a comprehensive data base to define the geology and hydrology of the site. The data base included the lithologic logs of the soil and rock core borings, water level measurements (reduced to elevations) obtained from the piezometers, results of the geotechnical analysis of soil samples, refraction seismic data, and field and laboratory hydraulic conductivity tests. Specifically, the data analyses addressed the site geology, the site hydrogeology and the geotechnical properties of the overburden materials at the site. The methodologies applied and the specific analysis of the WMI hydrogeological data base are discussed in the following sections.

6.1 Site Geology

The site specific shallow subsurface geology is interpreted from Phase II soil test borings (Figure 8), rock core drilling, hand auger probe holes, and geologic field mapping. Soil boring and rock core logs are included in Appendix A.

Field mapping stations are shown in Figure 9, with descriptions of these stations included in Table 8. Exposure of rock outcrops in borrow pits at the Kernersville site is summarized in Table 9. The locations of these pits, along with Phase I hand auger probe investigations are shown on Figure 10 and described in Table 10. The conditions discussed in the following paragraphs, and those presented on the boring logs (Appendix A) and geologic cross-sections (Figures 12, 13 and 14), represent the subsurface conditions at the site. Such conditions incorporate geotechnical engineering considerations (ie. rock ripability; Figure 14), which are based on test borings and on a previous refraction seismic survey (Reference 1). The location of refraction seismic lines is shown on Figure 11.

The soil borings drilled at this site encountered residuum, saprolite, highly to partially weathered rock, and bedrock. Although individual borings are representative of the subsurface conditions at the precise boring locations, they are not necessarily indicative of the subsurface conditions at other site areas.

Eight soil units or types were differentiated beneath the topsoil during the soil test boring program. These units were given a number designation to assist in geologic interpretation. The units included residuum materials including silts, sands, sump clays and alluvium deposits (units 1, 2, 5 and 6), saprolite (unit 3) and highly weathered rock (unit 4), alternating layers of rock and partially weathered rock (unit 7), and competent bedrock materials (unit 8). The following is a description of the various units encountered during the drilling investigation:

TOPSOIL

Topsoil thickness ranges from 0 to 2.5 ft. In general, topsoils were thicker in pastures or farm fields. The fields have thicker topsoil than woods or hillsides. The topsoil was primarily composed of a dark brown silty clay to a red clayey silt.

UNIT 1
AND UNIT 2

Units 1 and 2 were observed immediately beneath the surficial topsoil. These units were more predominant in the low lying areas. The thickness of these units ranged from approximately one to fifteen feet. Unit 1 was more predominant across the site, whereas unit 2 was mostly located in the tobacco fields. Unit 1 is a dry to moist, firm to stiff, tan clayey silt, with some micaceous fine to coarse sand, whereas Unit 2 is a firm, moist red silty clay, with traces of fine sand.

UNIT 3

Unit 3 was only observed in soil boring P4D. Unit 3, considered a saprolite, was found where a large thickness of overburden to 35 feet depth was present and commences at 7 feet below ground. Unit 3 is composed of firm, moist white, brown and red silt, with little fine to medium sand. From the soil borings, it appears that unit 3 was a localized unit and is not continuous across the site.

UNIT 4

Unit 4 appears continuous across the site. The thickness ranges from 10 feet below ground surface to top of rock. It is a multi-colored, brown, micaceous, fine to coarse sand, with some silt, and is dense to very dense, and dry to moist. It also includes quartz lenses and intensely weathered rock. The upper water producing aquifer is partly contained in Unit 4.

UNIT 5

Unit 5 is not continuous across the site and, where encountered, occurred between Unit 4 and Unit 8 (bedrock) only. It exhibited a lower permeability than other overburden units, and was found to be as much as 47 feet thick Unit 5 is an orange silt with some fine sand, that is very dense, and generally dry.

UNIT 6

Unit 6 was found only in the low lying areas on the northern boundary of the site in soil boring HA1D,S. It is considered to be localized alluvial deposits that are found near streams and might be considered part of the wetlands. The soils were probably derived from stream and flood plain deposits. The soil consisted of gray and blue clay layers and layers of gray and white coarse sand.

UNIT 7 & 8 Units 7 and 8 appear continuous across the site. Unit 7 is comprised of alternating layers of rock and partially weathered rock. Unit 8 is competent bedrock and was mostly made up of granitic gneiss and schist. These materials were intact enough to be sampled using rock coring techniques.

The rock coring logs (appendix A) were used to interpret the lower subsurface geology and the bedrock. The bedrock was composed mostly of granitic gneiss and schist, with some amphibolite gneiss and mica schist. Above the competent bedrock, alternating layers of rock and partially weathered rock were encountered. These layers consisted of slightly weathered rock to extensively weathered rock. The alternating layers of rock and partially weathered rock made up a zone of high permeability and in most cases provided the primary aquifer. The competent bedrock encountered across the site varied from an elevation of 760 to at least 660 feet msl. The competent rock encountered in five of the borings had few fractures; however, the remaining borings did not encounter competent bedrock. Thus, correlation of fracture sets was not possible.

As identified by field mapping (Figure 9; Table 8), bedrock occasionally crops out within stream beds near the southern border of the site and in borrow pits at the site; However, the depth to rock is generally greater than 30 to 40 feet, as illustrated by test borings (Appendix A).

Five geologic cross-sections depict the site geology as shown in Figures 12 and 13. These figures are keyed to the location plan, Figure 11. Cross-sections are presented in a one-to-one scale with no vertical exaggeration and a 5X vertical exaggeration so that both the geology and hydrology of the site could be inferred.

A contour map has been prepared using the rock core logs and the seismic data to depict the elevation of the top of competent rock, as shown in Figure 15. The map illustrates the bedrock highs associated with hills, although these hills may have a considerable thickness of overburden (60 to 65 feet). Depth to rock, as determined from test boring data, ranged at least from 8 to 65 feet.

Based on the field mapping and drilling program, the site does not contain significant fracture sets at shallow depths. The major streams, described below, adjacent to the site may represent linears composed of more highly fractured rock.

6.2 Site Surface Water Hydrology

6.2.1 Site Topography and Drainage

The site area is rolling to hilly, with a dense drainage network, moderately steep stream valleys, and broad ridge-crests. There are two high ridges on site with slightly steep slopes. The rest of the site has gentle rolling slopes. The elevations range from 840 to 740 feet above mean sea level. The site topography is shown on Figure 2.

840
- 740
100 ft.

The site is divided into two separate watersheds, with the dividing line running from the northwest corner to the southeast corner as shown on Figure 16. The northern watershed is about 1/3 of the site area and drains north, northeast, and southeast. The southern watershed drains southwest and south.

The site is drained by two unnamed tributaries of East Belews Creek, which drain into Belews Lake and ultimately into the Dan River. One of the tributaries crosses the southwest corner of the site, while the other is immediately north of the site. Information on the pH, specific conductivity and estimated flow in these tributaries at the time of the site reconnaissance visit (Reference 1) is represented in Table 11, together with data from a previous study of the watershed.

6.2.2 Flood Prone Areas

Flood prone areas (areas lying within the 100 year flood plain) for the Kernersville Region have been identified on maps prepared by the United States Geologic Survey (USGS), and are presented in Figure 17. Flood prone areas are found in the flood plains of both unnamed creeks. Areas on the site which are classified as flood prone areas include a small (less than five acres) area on the northeastern property line and an area estimated at about 15 acres, in the southwestern corner of the property.

6.2.3 Wetlands

The flood plain of the creek in the southwestern corner of the property was visited during a site reconnaisance and found to be flat and boggy, supporting bottom land hardwoods such as sycamores and sweetgums. There had been rain the previous day and ponded water was found in much of the area.

Areas such as this may, from a hydrological perspective, reasonably be described as wetlands. Such areas occur along flood plains of creeks, within the areas mapped by the USGS as flood prone areas. Elsewhere, slopes are moderate to steep, soils are well drained, and cannot be considered wetlands. The map of flood prone areas (Figure 17) may thus be considered to indicate areas where there is potential for wetlands to occur. Golder Associates recommends the U.S. Corps of Engineers be requested to clarify this situation.

6.3 Site Groundwater Hydrology

The regional hydrogeologic framework developed earlier can now be further defined to include site specific conditions. Such conditions are interpreted from Phase II subsurface investigations and related hydrogeologic data. Data assembled for hydrogeologic interpretations includes the following: soil and rock core logs; hydrogeologic cross-sections; bedrock elevation contours; aquifer hydraulic conductivities; groundwater elevations; and laboratory soil sample analyses. Interpretations of the site groundwater hydrology are presented in the following sections: (6.3.1) Uppermost aquifer, (6.3.2) Groundwater Classification and Quality, (6.3.3) Hydraulic Conductivity of Saturated Materials, (6.3.4) Groundwater Flow and Elevations, (6.3.5) Vertical Flow (Gradients), (6.3.6) Flow Boundaries/Migration Barriers, and (6.3.7) Potential for Leachate Migration in Uppermost Aquifer.

6.3.1 Uppermost Aquifer

The Phase II subsurface investigations and hydrologic data suggest that the zone of saturation predominantly occurs within residual soils, although the saturated zone may occasionally be found in bedrock highs that accompany hilltops. Residual materials that comprise the uppermost

aquifer at the site predominantly consist of micaceous sands, although saturated silty soils are also present. These residual materials may range in nature from a well developed soil to partially weathered rock.

In review of soil logs and hydrogeologic information, the uppermost aquifer on site is considered unconfined. Semiconfined conditions may exist in areas where significant thicknesses of lower permeability silt-rich soils are present.

Hydrogeologic cross-sections (Figures 12 and 13) illustrate the distribution of the zone of saturation with respect to various geologic units. These figures show that the zone of saturation is primarily associated with the unit designated number 4, which consists of micaceous sands derived from highly to partially weathered rock. The cross-sections also depict where the water table intersects competent rock near the hilltops at piezometer locations P-1 and P-6. Review of the general potentiometric surface map (Figure 8) and the top of rock elevation contour map (Figure 15), shows areas where the bedrock is considered the uppermost aquifer are constrained to the two hillcrests located near piezometer locations P-1 and P-6.

6.3.2 Groundwater Classification and Quality

The electrical conductivity data available from field measurements indicates that the chloride content of the groundwater is less than 250 ppm.

Groundwater from the well of Mr. Barrow was used for both the decontamination of drilling equipment and well installation purposes. A sample (BW-1) of groundwater from this well was analyzed for various priority pollutants, which included dissolved metals, volatile organics and pesticides.

Results of the analyses showed that groundwater from Barrow's well showed no indication of any contamination. Of the parameters analyzed (126 parameters total) only two parameters, chromium and selenium, were above detection limits, with concentrations well below drinking water standards and near detection limits.

The pH of 4.5 ± 0.5 measured in Barrow's well, Well 1 (Figure 7) is somewhat outside the USEPA secondary drinking water standard for pH. This is probably due to natural causes (i.e. granitic or acidic terrain). Groundwater pH values in the Piedmont and Blue Ridge Provinces are quoted as rarely below values of 5.5 (Reference 11), although the low values are more often found in water beneath light-colored soils, such as those found at this site. Thus the groundwater in Well 1 can be considered somewhat abnormal, but is not entirely unexpected in this terrain. The water does not in itself present a threat to health but may cause increased corrosion of some parts of the water supply system. Groundwater analytical data of Barrow's well water is presented in Appendix C for reference.

6.3.3 Hydraulic Conductivity of Saturated Materials

The spatial and vertical variation of hydraulic conductivity, or the ability of the soils to transmit water, has been evaluated using analyses of the rising and falling head test data, results of laboratory analyses of soil samples, and results of applying Hazen's approximation to the soil particles size distribution curves. Cumulatively, these methods provide an indication of the hydraulic characteristics of most of the geologic units observed during the field investigation.

The rising and falling head test data has been analyzed using the Hvorslev method as illustrated in Appendix D. Some problems were encountered during calculations due to the size of the piezometer and the fact that the water table was drawn down below or was already below the top of the sand pack in two of the piezometers (P7D and P7S, respectively). Because of these problems, some of the hydraulic conductivity values may be too low. The results of field and numerical analyses are summarized in Table 6. Calculations of Hazen's approximations are included in Table 7.

In situ hydraulic conductivities derived from piezometers screened in overburden materials ranged from 5 x 10^{-6} cm/s in piezometer P2S, to 1 x 10^{-4} cm/s in piezometers P2D and P5S. These values corresponded with Hazen's approximation values of 4 x 10^{-4} cm/s to 2 x 10^{-4} cm/s, respectively. Generally, Hazen's approximations were in good agreement and within an order of magnitude of field in situ tests. An exception to this was the Hazen's approximation for P2S (4 x 10^{-4} cm/s) which was two orders of magnitude greater than the field in situ value.

In situ hydraulic conductivities derived from piezometer P3D and P7D screened in rock were approximately 9 x 10^{-6} cm/s and 4 x 10^{-6} cm/s, respectively. Values could not be calculated for tests attempted in piezometers P5D and P6D due to a recovery rate that was too fast for hand measurements. The fast response of these piezometers implies a high hydraulic conductivity that may approach or be greater than 1 x 10^{-3} cm/s. It is important to note that piezometer P6D is screened in material that ranges from partially weathered to competent rock. The fast response of the piezometer may represent a permeable weathered zone near the top of rock.

6.3.4 Groundwater Flow and Elevations

The selective installation of multilevel piezometers, such as those installed at the Kernersville site, allows identification of both the horizontal and vertical components of groundwater flow. Water levels in the individual piezometers (Table 12) should approximate the water level of the geologic formation(s) adjacent to the sand pack or open interval. Water levels have been measured at various time in all piezometers on site and have been converted to elevations (Table 12).

The direction of groundwater flow has been evaluated using the available water level measurements (Table 12). The set of water level measurements on June 1, 1987 were plotted in plan view, based on groundwater potentials measured in the uppermost portion of the aquifer, and are presented as Figure 8. The groundwater levels measured during the investigation may have been approaching their seasonal low. A dug well at Mocksville, Rowan County N.C., some 32 ft. deep, showed seasonal variations of about 7 ft. (Reference 12). Thus, the water table at the proposed landfill site may rise by about this value in winter months. *

The water table contour map indicates a shallow water table along the southeast portion of the property with a maximum elevation of about 785 feet MSL and a minimum elevation of about 740 feet MSL. The flow of groundwater is mostly from the northeast to the southwest, although a groundwater divide traverses the property near the north and east portion of the site, diverting flow to north and south.

From the cross-sections (Figures 12 and 13) it appears the water table follows the top of rock in the high areas, and ponds in the lower areas. Lateral hydraulic gradients from water level measurements taken June 1, 1987 show that

from the southeast corner and outwards, the hydraulic gradient averages .02, and from the northwest corner of the site hydraulic gradient averages .005. Lateral hydraulic gradient calculations are presented in Table 13.

An estimate of the groundwater flow velocity in soil unit 4 (sand and silt) can be made by using the hydraulic conductivities derived from in-situ variable head tests and hydraulic gradients derived from groundwater elevations measurements. Using Darcy's Law,

$$V = \frac{Ki}{ne}$$

where V = Velocity (distance/time),
K = hydraulic conductivity (distance/time)
i = hydraulic gradient, and
ne = effective porosity (dimensionless)

The approximate flow velocity in the most permeable soil unit 4, has been calculated using Darcy's equation and the following data:

1. The highest and most likely representative horizontal hydraulic conductivity of 1.2×10^{-4} cm/sec from Unit 4.

2. A hydraulic gradient .027 cm/cm (ft./ft.) measured between piezometer P2 and P5 on June 1, 1987; and

3. An estimated effective porosity (ne) of 0.35, which is typical of sand materials (Reference 10) The calculated velocity is 9.26×10^{-6} cm/sec or 10 ft/year.

Because this calculated velocity is based on a maximum observed hydraulic gradient measured between P2 and P5, the flow velocity presented should be considered conservatively high, for general site conditions.

6.3.5 Vertical Flow (Gradients)

The vertical head distribution measured in site piezometers has confirmed conceptual recharge-discharge areas. A summary of vertical head differentials and gradients measured in site piezometers is included in Table 14. The potential differences observed in site piezometers are also illustrated in the hydrogeologic cross-sections (Figures 12 and 13).

The data shows that most of the piezometers have a vertical downward hydraulic component, however, three piezometer locations (P-2, P-3, and P-5) indicated a vertical upward gradient or component which implies groundwater discharge. From the water level measurements taken on June 1, 1987 (Table 12), the downward hydraulic gradient averaged .01 and the upward hydraulic gradient averaged .04, as shown in Table 14. Groundwater discharge areas on site are shown on Figure 18. The seasonal variation of the groundwater table should not significantly affect the vertical head distribution or location of recharge/discharge areas; however, it may increase the magnitude of the hydraulic gradient and groundwater flow velocity.

6.3.6 Flow Boundaries/Migration Barriers

The subsurface hydrogeology at the proposed Kernersville site, to the depth investigated, is controlled by temporal precipitation events, surface topography, subsurface variations in material properties, and top of bedrock. Thus, the water table elevation is anticipated to be highest in the late winter and early spring months, in response to the increase in rainfall and reduced evapotranspiration, and the

lowest during the mid summer months in response to the reduced rainfall and increased evapotranspiration. The ridge crest and higher areas have a slightly elevated water table compared to the water level in the lower areas. The water table is found in the bedrock and alternating layers of rock and partially weathered rock in the higher areas. In the lower areas the water table is found in the soils above the bedrock (Unit 4 and 7).

The lowermost flow boundary at the site is the bedrock and the uppermost boundary is the phreatic surface, which appears to be controlled by topography. The lateral hydraulic gradients have been included in Table 13, based on site specific information from the field investigation. Gradient calculations are included in Appendix E. The lateral boundaries appear to be the unnamed streams on the north and south boundaries, which appear to be local discharge areas, and the apparent groundwater divide running through the site from the northwest to southeast. With changes in site topography, it is anticipated that lateral flow boundaries will change.

Vertical hydraulic gradients have been calculated and are presented in Table 14, with calculations included in Appendix E. For most of the site the vertical hydraulic gradients are downward. There are at least three locations where the vertical hydraulic gradient is upward. The upward vertical hydraulic gradients should decrease during operations due to the overall reduction in recharge. Discharge areas which exhibit upward vertical gradients are shown in Figure 18.

6.3.7 Potential For Leachate Migration in Uppermost Aquifer

It is clear that a successful landfill design must prevent migration of leachate into the aquifer. The residuum soils naturally occurring at the Kernersville site present a barrier to such migration; where several feet of residuum exist between the landfill cell and the water table , no other barrier may be required. However, available data indicate that in many areas such as on the ridge crests, the landfill cell may potentially extend below the bottom of the residuum soils and into weathered and fractured rock. In these areas, a constructed low permeability migration barrier below the waste may be required.

6.4 Geotechnical Properties of Site Soils

The geotechnical properties of the site soils have been assessed by the following techniques: standard penetration resistance, particle size analysis, soil classification, geologic considerations including drilling and logging, and a seismic survey. The objectives of the geotechnical work have been to determine:

1. the excavatibility of the materials;
2. the volumes of material potentially available for daily cover;
3. the likely presence of good quality clay materials for potential constructed liners; and
4. the likely safe slope angles in various site materials, for landfill design purposes.

Based on the soil boring logs and the seismic report, the first 30 feet should not require any special equipment for removing the residuum. The cross-sections, Figures 12 thru 14, can be used for defining boundaries between the

different soil units. The rippability of soil units 1, 2 and 3 should pose no problems as these soils could be moved with a scraper. Soil unit 4 is rippable, however, a dozer will be required because this unit is greater than 100 blow-count material. Unit 7 and some of unit 4 (partially weathered rock and boulders) will be marginal and might require some blasting. Unit 8 consists of competent bedrock that will be non-rippable. Figure 14 was drawn from the above engineering implication, showing a typical cross-section and its rippability.

The soil units 1,2,3 and possibly some of unit 4 can be used as soil cover for the proposed landfill. The approximate volume of cover is 700,000 cubic feet, for an average of 17 feet over the entire site.

Materials suitable for construction of migration barriers include compacted residuum, compacted offsite borrow, and synthetic liners. Residuum is available on site, however excessive amounts of roots or stones may be present in some of the residuum. Offsite borrow material near the site probably resembles onsite residuum in consistency with the Piedmont Province. Clay-rich material may be available in the Dan River Basin, although haul distances may prohibit use.

Recompacted saprolite or sandy materials are probably too permeable for use as a migration barrier, therefore, other types of liner may be more effective at this site.

Water budget analyses such as the HELP program may be used to evaluate the need for liners and covers, and assist in determining the appropriate materials for testing and cost analyses, regarding barrier materials.

The safe slope grades for construction purposes are indicated in Table 15. The grades were estimated based on material properties, as determined by geologic logging, STP testing, laboratory grain size analysis, and on information available in Reference 1. The safe slope angles are based on a factor of safety of 1.0 and range from 1:1 in unit 5 to 2:1 in unit 2.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The Phase I Desk Study, and Phase II Field Investigations were used to draw conclusions and recommendations for WMI's proposed Kernersville Sanitary Landfill site.

The conclusions of the Phase I Desk Study are:

- The area surrounding the site is primarily domestic forest and agricultural land.
- The site is not located within 10,000 feet of an airport runway used by turbojet aircraft, or within 5,000 feet of an airport runway used by piston-type aircraft.
- Approximately 15 residences lie within 2000 feet of the site, including six in the Hiram Hills subdivision, southeast of the site. The four residences on the site are to be vacated.
- The existing city of Kernersville Municipal Landfill borders the proposed site at the southeast corner, and may be a potential source of groundwater or surface water pollution. The potential for groundwater contamination from the existing landfill site is considered extremely low since the groundwater gradients are moving water off the proposed site. The potential for surface water contamination is considered higher since the stream on the southern boundary flows from the existing landfill through the proposed landfill. Sampling points in this stream are discussed later.
- The site has less than 20 acres lying within the 100 year flood plain. These same acres can be considered to indicate areas where there is potential for wetlands to occur.
- The site is located on igneous and metamorphosed igneous rocks of the Charlotte Belt within the Piedmont Physiographic Province.
- Fifteen water wells are known to exist within 2000 feet of the site boundary. Six of these occur in the Hiram Hills subdivision, and five occur on the site. All wells on-site should be sealed and abandoned.

- Surface water bodies near the site include 2 ponds on site, 2 unnamed tributaries of East Belews Creek, and Belews Lake 3000 feet north of site.

- No state parks, scenic areas, recreational facilities, or state nature or state historical preserves have been identified near the site.

- The average wind velocity is 8 mph, primarily from the northeast.

- Groundwater quality data from a domestic well on site is good with no indications of groundwater contamination, although the pH was somewhat lower than normal for the region.

The desk study found no evidence which would indicate that the site is unsuitable for further study as a solid waste landfill.

The conclusions of the Phase II field investigation and the seismic investigation, based on twelve soil borings fitted with single or multiple piezometers, and eight seismic refraction lines are:

- The topsoil thickness is zero to 2.5 feet across site.

- Saprolite was found only in one borehole.

- The bedrock is mostly of Granitic Gneiss and Schist, with some Amphibolite gneiss and micaceous schist and occurs at depths varying from 8 feet to 65 feet below ground surface.

- A groundwater and corresponding surface water divide appears to be present on-site.

- Groundwater flows under water table conditions north and south of the groundwater divide.

- Groundwater discharge areas on site include about 15.7 acres in the southwest corner, about 1.4 acres on the north boundary, and about 2.8 acres near the east boundary. Groundwater discharge areas are defined here as areas where the water table in June was within 10 feet of surface and may reasonably be expected to rise to within 4 feet of surface during intense, wet periods.

As a result of the desk study, seismic report and the field investigation, the Kernersville site appears to be suitable for the construction of the proposed solid waste sanitary landfill, since the water table is deep and is not likely to rise much more than a few feet. However, the site piezometers should be monitored in winter months to confirm this.

Upon selection of the Kernersville site a monitoring well network is necessary for compliance with the regulatory requirements, with respect to protection of groundwater. Golder Associates suggest one monitoring well be installed to collect groundwater samples which are representative of the groundwater quality upgradient, prior to passing beneath the landfill. It should be noted that since a ground water divide is located in the area of the proposed landfill, a traditional upgradient monitoring well cannot be installed to collect background groundwater quality samples, since all locations are downgradient. Thus, a monitoring well should be installed which can collect a sample which is representative of the groundwater prior to passing beneath the site. This well should be located as far removed from the landfill as possible while still screened in the same geologic formation as prevailing on site.

The location of the downgradient monitoring wells cannot be determined until the location, depth and various other construction details have been finalized. It is anticipated that the landfill may alter the shallow groundwater flow

system. For example, this may occur as a result of reducing the infiltration in the area of the groundwater divide, thus eliminating the divide, resulting in a localized change in the direction of groundwater flow. An additional well may be required near the existing sanitary landfill and the proposed site to assure background groundwater quality. Proposed preliminary locations of groundwater monitoring wells are shown on Figure 19. These locations are based on current site conditions and should be adjusted once construction details are made.

Prior to construction of the landfill, the piezometers should be properly plugged and abandoned with a cement bentonite grout. However, additional sets of water level data should be collected on a regular basis prior to grouting.

In addition to a groundwater monitoring system, surface monitoring will be required to detect any impacts on the surrounding surface water quality. The surface water monitoring program must ensure that the site does not discharge pollutants into surface waters that is in violation with the National Pollutant Discharge Elimination System (NPDES), under Section 402 of the Clean Water Act.

In review of site hydrogeology, all surface or groundwater from the site area must discharge into two tributary streams; one stream borders the northern margin of the site, and the other traverses the southern portion of the site. It is proposed that surface water monitoring stations be established both up and downgradient of both tributary

streams in order to properly monitor the impacts that landfill operations would have on surface water quality. Proposed surface water monitoring locations are presented on Figure 20.

GOLDER ASSOCIATES, INC.

R. Pearson for

Greg Richardson
Geotechnical Engineer

Kenneth H. Rippere, P.Geol.
Principal

Ray Pearson, P.Eng.
Associate

GR:KHR:RP:rcs

REFERENCE

1. Golder Associates, Phase I Hydrogeologic Desk Study, Porposed Kernersville Sanitary Landfill, North Carolina. Waste Management of North America, Inc., January 1987.

2. Rankin, D.W., G.H. Espenshade, and K.W. Shaw: "Stratigraphy and Structure of the Metamorphic Belt in Northwestern North Carolina and Southwestern Virginia," Am. Jour. Sci., Vol. 273A, pp 1-40.

3. Thayer, P.A.: "Stratigraphy and Geology of Dan River Triassic Basin, North Carolina," Southeastern Geology, Vol. 12, pp. 1.24.

4. United States Department of Agriculture Soil Conservation Survey: Soil Survey of Forsyth County North Carolina 1976.

5. Herrick, S.M. and Le Grand, H.E., 1949. Geology and Ground-Water Resources of the Atlanta Area, Georgia, Georgia State Division of Conservation, Dept. of Mines, Mining, and Geology, USGS Bull. No. 55.

6. Thompson, M.T. Herrick, S.M., Brown, E., The Availability and use of Water in Georgia, Bulletin No. 65, Georgia Department of Mines, Mining and Geology, December, 1956.

7. Weiss, Charles M. and T.P. Anderson: Belews Lake - Report of a Seven Year Study, University of North Carolina at Chapel Hill School of Public Health, Environmental Science and Engineering Publication No. 475.

8. Linsley, R.W., M.A. Kohler and J.L.H. Paulhus: Hydrology for Engineers, 2nd Ed. McGraw Hill Book Co., NY, 1975. 482 pp.

9. Cedergren, H.R., Seepage, Drainage and Flow Nets, 2nd ed., John Wiley and Sons, New York, 1977.

10. Freeze, R.A. and J.A. Cherry, Groundwater, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1979.

11. LeGrand, H.E., Ground Water of the Piedmont and Blue Ridge Province in the Southeastern States, Geological Survey Circular 538, Washington, 1967.

12. LeGrand, H.E., Ground-Water Resources in North Carolina, North Carolina Department of Conservation and Development, Division of Mineral Resources, Bulletin Number G9, 1956.

TABLES

TABLE 1

TEMPERATURE AND PRECIPITATION DATA

Month	Average Daily Maximum Temperature	Average Daily Minimum Temperature	Average Total Precipitation
	° F.	° F.	inches
January.....	50	32	3.7
February.....	52	32	3.5
March.....	59	37	4.0
April.....	70	47	3.6
May.....	79	56	4.0
June.....	87	65	3.6
July.....	88	68	4.6
August.....	87	67	4.3
September.....	81	62	3.6
October.....	72	49	3.1
November.....	60	38	2.8
December.....	50	32	3.4
YEAR.....	70	49	44.2

Source: Soil Survey of Forsyth County, North Carolina. Point of Record is Winston-Salem; period of record is not reported.

TABLE 2

STORM FREQUENCY

Return Period	Duration		
	1 Hour	6 Hours	24 Hours
1 Year	1.3"	2.2"	3.0"
5 Years	2.0"	3.2"	4.5"
10 Years	2.3"	3.7"	5.2"
25 Years	2.7"	4.5"	6.0"
50 Years	3.05"	4.7"	6.4"
100 Years	3.2"	5.2"	7.5"

Data are interpolated from regional maps presented in U.S. Department of Commerce Technical Paper No. 40 and are approximate.

TABLE 3

WELL INVENTORY

#	Owner	Type	Depth	W.L.	Approx Casing Elev.	Approx W.L. Elev.	pH	Cond	Yield (gpm/H)	Comments
1.	Julian Stephenson	6" drilled	147'	---	800	---	5.4	146	133	depth and yield information taken from plate on well head
2.	Clyde Lowe	24" caisson	---	24.8'	780	760	---	---	---	
3.	----------	24" caisson	---	16'	760	750	---	---	---	abandoned
4.	Barrow	24" caisson	60'	44.5'	800	760	---	---	---	water sample slightly turbid
5.	Barrow	24" caisson	---	---	800	---	---	---	---	
6.	Aldene Hardy	24" caisson	40'	27.8'	760	730	---	---	---	
7.	Foltz	24" caisson	30'	14'	780	760	---	---	---	abandoned; all information taken from plate on well head
8.	Tom Beeson	24" caisson	42'	38.5'	820	780	---	---	---	
9.	---	---	---	---	---	---	---	---	---	The residence at this location could not be visited; it is assumed that the residence is served by a water well.
10.	Hiram Hills Subdivision	1;6" drilled	---	---	---	---	---	---	---	
		5;24" caisson		---	---	---	---	---	---	At least six wells have been observed in this area; the owners could not be contacted during the site visit.

Note: Refer to Figure 7 for locations of above wells.

TABLE 4
CONSTRUCTION SUMMARY TABLE FOR PIEZOMETERS
WMI / PROPOSED LANDFILL / KERNERSVILLE, NC.
863 - 3407

Piezometer	DATE/TIME BORING AND INSTALLATION STARTED	FINISHED	GROUND ELEV. FT.MSL	T.O.C. ELEV. FT.MSL.	Total Depth FT.BLS.	Augered LENGTH FT.BLS	ROLLER CONE LENGTH FT.BLS.	ROCK CORED LENGTH FT.BLS.	Piezometer Bottom FT. BLS.	TOP OF Sand Pack FT.BLS.	TOP OF SEAL FT.BLS.	Screen Length FT.	Casing Length FT.	Stickup FT.	Remarks
P1D	4/21/87 3:40	4/28/87 4:30	841.47	843.87	62.0	22.0	14.0	26.0	61.8	56.0	52.5	5.1	59.5	2.4	
P1S	4/28/87 5:00	4/29/87 3:00	841.37	843.87	46.5	0.0	38.0	8.5	46.5	35.5	32.5	5.1	43.9	2.5	
P1DD	5/28/87 1:00	5/31/87 3:30	841.55	843.55	87.0	0.0	75.0	12.0	87.2	75.0	72.0	10.0	79.2	2.0	
P2D	4/30/87 8:30	5/1/87 5:00	821.35	823.35	70.0	43.5	26.5	0.0	69.8	63.0	45.5	5.1	66.7	2.0	
P2S			821.46	823.66					45.0	38.5	36.0	5.1	42.1	2.2	
P3D	5/2/87 1:50	5/6/87 2:00	759.26	761.26	58.0	43.0	5.0	10.0	57.6	51.0	49.0	5.1	54.5	2.0	
P3S			759.29	761.59					24.5	18.0	16.0	5.1	19.8	2.3	
P4D	5/6/87 3:10	5/12/87 3:00	782.48	785.78	59.0	48.0	11.0	0.0	58.3	52.0	50.0	5.1	56.5	3.3	
P5D	5/12/87 4:00	5/12/87 7:40	755.95	757.75	36.0	15.0	6.0	15.0	34.6	29.0	17.5	5.1	31.3	1.8	
P5S			755.97	757.97					17.1	11.0	9.0	5.1	14.0	2.0	
P6D	5/13/87 4:00	5/15/87 12:00	807.71	811.71	71.0	48.0	19.0	4.0	70.2	59.0	57.0	10.0	62.1	4.0	
P7D	5/15/87 1:00	5/16/87 10:55	767.80	769.50	41.0	25.0	1.5	14.5	39.3	32.0	25.5	5.1	35.9	1.7	
P7S			767.77	769.77					25.0	18.0	16.5	5.1	21.9	2.0	
P8D	5/16/87 1:00	5/31/87 4:00	747.77	749.57	79.0	50.0	29.0	0.0	78.5	71.0	43.5	5.1	75.2	1.8	
P8M			747.85	750.35					41.5	35.0	25.5	5.1	38.9	2.5	
P8S			747.86	750.86					24.5	18.0	16.0	5.1	22.4	3.0	
HA1D				743.68					17.4	13.5	0.0	2.0	20.0	4.6	
HA1S				742.28					12.0	3.0	0.0	5.1	10.0	3.2	

TABLE 5
PIEZOMETERS ELEVATION AND COORDINATES
KERNERSVILLE, NORTH CAROLINA
863 - 3407

PIEZOMETER	T.O.C. ELEV. FT. MSL.	GROUND ELEV. FT. MSL.	COORDINATES	
P1 S	844.20	841.7	N 891,796.25	E 1,693,558.88
P1 D	843.87	841.47	N 891,781.40	E 1,693,557.46
P1 DD	841.55	843.55	N 891,766.47	E 1,693,550.31
P2 S	823.66	821.46	N 891,074.47	E 1,693,852.033
P2 D	823.35	821.35	N 891,074.47	E 1,693,852.033
P3 S	761.59	759.29	N 891,009.59	E 1,692,504.39
P3 D	761.26	759.26	N 891,009.59	E 1,692,504.39
P4 D	785.78	782.48	N 891,991.54	E 1,692,396.84
P5 S	757.97	755.97	N 892,319.24	E 1,693,921.32
P5 D	757.75	755.95	N 892,319.24	E 1,693,921.32
P6 D	811.71	807.71	N 892,464.00	E 1,691,863.23
P7 S	769.77	767.77	N 892,309.51	E 1,690,994.30
P7 D	769.50	767.80	N 892,309.51	E 1,690,994.30
P8 S	750.86	747.86	N 891,435.52	E 1,691,569.64
P8 M	750.35	747.85	N 891,435.52	E 1,691,569.64
P8 D	749.57	747.77	N 891,435.52	E 1,691,569.64
HA 1D	743.68	739.00	N 892,925.92	E 1,692,155.62
HA 1S	742.28	739.00	N 892,931.76	E 1,692,158.85
EX 1	766.73		N 891,652.76	E 1,691,597.12
EX 2	800.59		N 891,199.60	E 1,691,678.00

TABLE 6
HYDRAULIC CONDUCTIVITY SUMMARY TABLE
KERNERSVILLE, N.C.
863-3407

PIEZOMETER (SCREENED)	INSITU-HVORSLEV: VARIABLE COMPUTER (1) (CM/SEC)	MANUAL (2) (CM/SEC)	BASIC TIME LAG (3) (CM/SEC)	HAZEN APPROXIMATION HAZEN'S (4) (CM/SEC)	COMMENTS
P1S					DRY HOLE
P1D					DRY HOLE
P1DD					UNABLE TO DEVELOP, TRIED FALLING TEST, HOWEVER, WAS UNABLE TO RAISE WATER LEVEL IN PIEZOMETER
P2S	5.48E-06	5.5680E-06	8.6398E-06	4.0E-04	(UNIT 4) UNCONFINED
P2D	1.19E-04	9.198E-05	1.445E-04	N/A	(UNIT 4) UNCONFINED
P3S	5.73E-05	5.3465E-05	1.1130E-04	N/A	(UNIT 4) UNCONFINED
P3D	8.10E-06	9.5812E-06	1.9930E-05	N/A	CONFINED
P4D	2.31E-05	1.9214E-05	2.2854E-05	4.0E-04	(UNIT 4) UNCONFINED
P5S	1.15E-04	1.148E-04	7.085E-05	1.6E-03	(UNIT 4) UNCONFINED
P5D					RECOVERED TOO QUICKLY FOR RISING HEAD TEST CONFINED
P6D					SAME AS P1DD, (UNITS 7 AND 8) CONFINED
P7S	1.45E-05	1.3787E-05	1.3499E-05	(1) 1.6E-05 (2) 4.0E-04	(UNIT 4) UNCONFINED
P7D	3.58E-06	4.2E-06	5.2E-06	N/A	(UNIT 4) CONFINED
P8S	2.22E-05	2.149E-05	4.4995E-05	4.0E-04	(UNIT 4) UNCONFINED
P8M	2.61E-05	2.608E-05	3.8295E-05	2.5E-05	(UNIT 5) UNCONFINED
P8D	2.38E-05	2.382E-05	5.861E-05	4.9E-05	(UNIT 6 AND 7) UNCONFINED

NOTE:

(1) IN SITU PERMEABILITY TEST CALCULATED BY HVORSLEV'S VARIABLE HEAD FORMULA FOR BOTH CONFINED AND UNCONFINED CONDITIONS AS STATED IN CONDITIONS.

(2) HVORSLEV'S CALCULATIONS CHECKED BY HAND.

(3) HVORSLEV'S BASIC TIME LAG FORMULA IS USED BECAUSE THE INITIAL HYDROSTATIC PRESSURE RECORDED BY THE PIEZOMETER SELDOM EQUALS THE TRUE SURROUNDING PORE-WATER PRESSURE (CEDERGREN, 1977). WATER MUST FLOW TO OR FROM THE HOLE OR DEVICE UNTIL THE HEAD IN THE DEVICE EQUALS THAT IN THE SURROUNDING SOIL. THE MAGNITUDE OF THE TIME LAG IS INVERSELY PROPORTIONAL TO THE PERMEABILITY OF THE SOIL AND VARIES WITH THE SIZE AND TYPE OF PRESSURE MEASURING DEVICE (CEDERGREN, 1977).

(4) HAZEN'S APPROXIMATION IS BASED ON THE FACT THAT THE HYDRAULIC CONDUCTIVITY OF SANDS DEPENDS UPON THE EFFECTIVE PARTICLE SIZE AND GRAIN SIZE DISTRIBUTION OF THE SAND.

TABLE 7
SUMMARY OF HAZEN'S APPROXIMATIONS
KERNERSVILLE, NORTH CAROLINA
863 - 3407

PIEZOMETER	DRILLING METHOD	SAMPLE INTERVAL (FT.)	D 10	D 60	UNIFORMITY COEFFICIENT (D / D)	HYDRAULIC CONDUCTIVITY * CM/SEC.	SOIL CLASSIFICATION AND REMARKS
P2 - 1B	AUGER	1.2 - 2	*1				RED SILTY CLAY, SOME COARSE (C) TO FINE (F) SAND. (UNIT2)
P2 - 6A	AUGER	23.5 - 25.5	0.01	0.25	25.00	1.00E-04	WHITE,TAN MICAEOUS C TO F SAND, AND SILT. (UNIT 3)
P2 - 11A	AUGER	48.5 - 50.5	0.02	0.31	15.50	4.00E-04	WHITE,TAN MICAEOUS C TO F SAND, AND SILT. (UNIT 4) *2
P4 - 2A	AUGER	3.5 - 5.5	*1				RED,WHITE CLAYEY SILT, TRACE FINE SAND. (UNIT 2)
P4 - 3A	AUGER	8.5 - 10.5	*1				WHITE,TAN CLAYEY SILT,TRACE FINE SAND. (UNIT3)
P4 - 9A	AUGER	38.5 - 40.5	*1				BROWN SILT, TRACE FINE SAND. (UNIT 4)
P4 - 11A	ROLLER CONE	48.5 - 50.5	0.0009	0.026	28.89	8.10E-07	BROWN SILT, SOME MICAEOUS (MIC.) M TO F SAND. (UNIT 4)
P4 - 13A	ROLLER CONE	59 - 61	0.02	0.15	7.50	4.00E-04	WHITE TAN C TO F SAND AND SILT. (UNIT 4) *2
P5 - 1A	AUGER	0 - 2	0.004	0.25	62.50	1.60E-05	LT. BROWN MICAEOUS C TO F SAND AND SILTY CLAY. (UNIT 1)
P5 - 4A	AUGER	13.5 - 15.5	0.04	0.6	15.00	1.60E-03	GRAY,TAN MIC. C TO F SAND,AND SILT, TRACE F GRAVEL (UNIT 4) *2
P5 - 5A	ROLLER CONE	18.5 - 20.5	0.04	0.7	17.50	1.60E-03	GRAY,TAN ,MIC. C TO F SAND, SOME SILT,LITTLE F GRAVEL (UNIT4)
P7 - 2A	AUGER	3.5 - 5.5	0.045	0.3	6.67	2.02E-03	LT. BROWN MIC. C TO F SAND, SOME SILT,TRACE F GRAVEL (UNIT1)
P7 - 5A	AUGER	18.5 - 20.5	0.004	0.2	50.00	1.60E-05	BLACK,GRAY,WHITE MIC.M TO F SOME AND SILT. (UNIT 4) *2
P7 - 6A	AUGER	23.5 - 25.5	0.02	0.85	42.50	4.00E-04	TAN,BROWN MIC. C TO F SAND,SOME SILT,LITTLE F GRAVEL (UNIT 4) *2
P8 - 2A	AUGER	3.5 - 5.5	0.0035	0.3	85.71	1.23E-05	BROWN,C TO F SAND, AND SILTY CLAY (UNIT 1)
P8 - 4A	AUGER	13.5 - 15.5	0.02	0.65	32.50	4.00E-04	BROWN,TAN MIC. C TO F SAND AND SILT (UNIT 4) *2
P8 - 10A	AUGER	43.5 - 45	0.005	0.3	60.00	2.50E-05	TAN BROWN MIC. C TO F SAND, AND SILT. (UNIT 4) *2
P8 - 14A	ROLLER CONE	65 - 67	0.001	0.018	18.00	1.00E-06	BROWN SILT,SOME FINE SAND. (UNIT 5)
P8 - 15A	ROLLER CONE	74 - 76	0.007	0.18	25.71	4.90E-05	REDDISH BROWN,MIC.C TO F SAND AND SILTY CLAY. (UNIT4) *2

NOTE :

* FOR SOILS HAVING A UNIFORMITY COEFFICIENT GREATER THAN 5 OR LESS THAN 2, HYDRAULIC CONDUCTIVITY VALUES SHOULD BE CONSIDERED ONLY APPROXIMATIONS

*1 UNABLE TO CALCULATE HYDRAULIC CONDUCTIVITY DUE TO INABLITIY TO ESTIMATE D 10

*2 PIEZOMETER WAS SCREENED IN SAMPLE MATERIAL.

TABLE 8

FIELD MAPPING STATION DESCRIPTIONS

Station 1: Borrow pit - near P-1

Exposure of granite schist striking N60E, the dip is nearly vertical, Residual Foliation.

Other rock exposed in the borrow pit includes granite gneiss, hornblende gneiss, and a quartz-feldspar pegmatite. The pegmatite is in vein form which appears to have cut other rock types.

Station 2: Spring-flowing to north at approximately 5-10 gpm. Marshy in this area.

Station 3: Deep gully-near where it forks approximately 10-15 feet deep. Residual soil exposed granitic schist residuum.

Station 4: Deep drainage cut (15-20 ft.) with exposed residuum from granitic gneiss parent rock. Soil is reddish brown, slightly silty, f-c SAND. Residuum has quartz cobbles from one large quartz vein underneath.

Station 5: Stream bed exposure of Residuum intermediate to moderately weathered. Composed of granitic gneiss and schist with feldspar (white) rich veins (approximately 1"-2" thick) cutting at various angles. Some dark gray, more intensely weathered amphibole rich layers. Covered by approximately 8'-9' of alluvium/residuum).

The residuum is int.-med. weathered granitic gneiss and schist showing residual structure (i.e. foliation).

No consistent strike and dip.

Station 6: Apparently man-made straight ditch, 2-2.5' wide and 0.5-1.0' deep bordering a steep hill 18' high on the east side. Flowing west. Very linear!

Station 7: (Sample 1) Outcrop in stream bed of amphibole, rich biotite/muscovite gneiss and schist. Approximately equivalent to diorite in composition. Mod. to non-weathered.

Strike - N70E (070)
Dip - 85W (varies greatly) foliation present

Station 8: Outcrop of competent (hard, non weathered) rock in stream bed. Similar composition to station 7 though foliation is less prominent.

Station 9: Abundant float-boulders of fine grained aphanitic amphibolile? Weathered to a sandstone granular type texture that readily exfoliates to round boulders. Very hard-bedrock is probably shallow in this area.

Station 10: Man made, North trending, bermed drainage ditch. Berm is about 2.5 ft. high. The water is a few inches deep.

Station 11: Borrow pit with rock exposure of granite gneiss with occasional layers of amphibolite schist. Many crosscutting quartz veins (thin 0.5"-2") along with discordantly cutting feldspathic veins (very thin, up to 0.5" thick) ranges from non-weathered to intensely weathered. The finer grained granite and amphibolite rich rocks are generally less weathered.

Foliations - #1 Strike N73E (073°)
#2 Strike N68E (068°), Dip-54E

Joint Strike 171° N9W N171E

Note: Station 11 is a good example of differential weathering with different rock types.

Station 12: 1 3/4" PVC well behind shed just above leach beds. Station is to the southeast outside of map area.

Station 13: Borrow area of existing landfill (off map area). Outcrop of granite gneiss strike of foliation N70E (070) Strike N45E - 100 ft. East of above measurement, attitude changes. Granitic gneiss is occasionally porphyritic. Occasional folding of foliation.

Station 14: Lowland and standing water just south of stream. Somewhat marshy. Extension of the flood plain.

Station 15: Float: low - moderately weathered. Chlorite/-muscovite schist, fine grained approximately 10 boulder sized pieces of float. Bedrock may be at shallow depth.

Note: A rockquarry located about 2.0 miles north-northeast of site. The quarry is about 150 yrds. by 150 yds (circular). Granitic gneiss exposed at quarry surface. The quarry ranges from about 20 to 40 feet in depth. Quarry is apparently on state owned land. Massive granitic/dioritic gneiss with hornblende and biotite.

A flowing stream drains the quarry at its northeast corner. Only a few puddles of standing water in bottom of quarry.

Note: There is an outcrop of granitic gneiss (almost a schist) on the hillside roadcut off Van Hoy Road approximately 1.5 miles north of the site.

TABLE 9

BORROW PIT DESCRIPTIONS

B1 North of Freeman Road near West property line

Depth	Soil/Rock Description
0'-12"	Saprolite- light to dark grey micaceous, fine to coarse SAND, little silt.
12'	Rock- light grey biotite GNEISS with large (0.5'-1" feldspar crystals, and horneblende. Feldspar AMPHIBOLITE, as blocks 5'-10' across surrounded by gneiss.

B2 North of Freeman Road, near East property line

Depth	Soil/Rock Description
0'-8'	Saprolite- medium grey micaceous fine to coarse SAND, little silt.
8'	Rock- horneblende- feldspar GNEISS, cut by 0.5' vein of quartz-feldspar PEGMATITE. Depth at weathering over pegmatite is about 5 feet.

B3 Active Borrow area for City of Kernersville landfill, about 1000' South of Southeast corner of property.

Depth	Soil/Rock Description
0'-6'	Residuum- red brown clayey SILT, little fine sand, trace cobbles and boulders.
6'-20'	Saprolite- light grey fine to coarse SAND, little silt, trace gravel. Where cut to an approximate 2.5:1 slope, erosion fills up to 4 feet deep have formed.
20'	Rock- biotite Gneiss with large (1/2' to 1") feldspar crystals.

Note: For detailed locations, see Figure 8.

TABLE 10

AUGER PROBE LOGS

AH 1

0-	Red brown micaceous clayey SILT, little fine sand
	Boring terminated at 2.6'. Water level at 2.3' at time of boring

AH 2

0 - 0.25	Topsoil
0.25' -	Yellow brown micaceous fine SAND, some silt
	Boring terminated at 1.7'. No water in hole at time of boring

AH 4

0-	Red brown clayey SILT, little fine sand
	Boring terminated at 4.0'. No water in hole at time of boring.

AH 3

0 - 0.5'	Topsoil
0.5' -	Reddish brown micaceous fine to medium SAND, some clayey silt
	Boring terminated at 3.0'. No water in hole at time of boring.

AH 5

0 - 2.5'	Topsoil
2.5' -	Yellow brown clayey SILT, some fine to coarse sand
	Boring terminated at 4.0'. Water level at 3.2' at time of boring.

TABLE 10
(Continued)

AH 6

0 - 2'	Red brown clayey SILT, some find sand
2' -	Red brown SILT, some fine sand.

Boring terminated at 3.2'. No water in hole at time of boring.

Note: For detailed locations, see Figure 8.

TABLE 11

SURFACE WATER INFORMATION

Location	Date/ Time	pH	Conductivity	Estimated Flow
SW 1	11-20-86/ 09:00	5.6	110	800 gpm
SW 2	11-20-86/ 09:48	6.4	90	450 gpm

Notes:
1. For sample location see Figure 3.
2. Light rain began falling about 4 a.m. on 11-20-86, continuing through the sampling period.
3. SW1 is downstream of the existing City of Kernersville Landfill.

WATER QUALITY PARAMETERS IN EAST BELEWS CREEK

Conductivity	Alkalinity	Chlorides	Sulfate
(umhos/cm)	(mg/l $CaCo_3$	(mg/l)	(mg/l)
72.0	28.0	3.0	3.7

Average for the Period 1970-1977. Ref: Weiss

Sample location is approximately 3000' downstream of the Kernersville site.

TABLE 12
WATER LEVEL READINGS
KERNERSVILLE N.C.
863-3407

PIEZOMETER NUMBER	T.O.C. ELEV. (MSL)	01-JUN-87 ELEV	01-JUN-87 DEPTH	20-JUN-87 ELEV	20-JUN-87 DEPTH	COMMENTS
P1S	844.20	ERR	*1	ERR	*1	
P1D	843.87	ERR	*1	ERR	*1	
P1DD	843.55	770.98	72.57	770.13	73.42	
P2S	823.66	786.51	37.15	786.33	37.33	PH = 5 AFTER DEVELOPMENT
P2D	823.35	786.60	36.75	786.47	36.88	PH = 5 AFTER DEVELOPMENT
P3S	761.59	750.32	11.27	749.58	12.01	
P3D	761.26	750.89	10.37	750.09	11.17	
P4D	785.78	753.16	32.62	752.33	33.45	PH = 5.5 AFTER DEVELOPMENT
P5S	757.97	752.07	5.90	751.05	6.92	PH = 5 AFTER DEVELOPMENT
P5D	757.75	753.15	4.60	752.25	5.50	PH = 5 AFTER DEVELOPMENT
P6D	811.71	750.49	61.22	750.24	61.47	
P7S	769.77	749.27	20.50	748.38	21.39	PH = 5 AFTER DEVELOPMENT
P7D	769.50	748.05	21.45	747.03	22.47	PH = 5.5 AFTER DEVELOPMENT
P8S	750.86	743.96	6.90	743.64	7.22	PH = 5-6 AFTER DEVELOPMENT
P8M	750.35	744.09	6.26	742.53	7.82	PH = 5-6 AFTER DEVELOPMENT
P8D	749.57	743.37	6.20	742.26	7.31	PH = 5-6 AFTER DEVELOPMENT
HA1S	742.28	736.90	5.38	735.57	6.71	SOIL BORING MADE WITH HAND AUGER
HA1D	743.68	737.30	6.38	736.68	7.00	SOIL BORING MADE WITH HAND AUGER
EXW1	766.73	745.73	21.00	744.73	22.00	EXISTING WELL
EXW2	800.59					

NOTES: *1 WATER LEVEL BELOW SCREEN INTERVAL.

2 SEE PIEZOMETER INSTALLATION LOGS (APPENDIX A) FOR WATER LEVELS RECORDED DURING DRILLING AND PIEZOMETER INSTALLATION

TABLE 13
LATERAL GRADIENTS SUMMARY
BETWEEN MULTIPLE PIEZOMETERS
KERNERSVILLE, NORTH CAROLINA
863 - 3407

JUNE 1, 1987

PIEZOMETER	LATERIAL GRADIENT DIRECTION	MAGNITUDE	COMMENTS
P2 - P1	NORTH	0.020	
P2 - P3	WEST	0.026	
P2 - P5	NORTH	0.027	
P2 - P7	NORHTWEST	0.012	
P2 - P8	WEST	0.019	
P2 - HA1	NORTHWEST	0.020	
P1 - P4	WEST	0.016	
P1 - P5	NORTHEAST	0.027	
P1 - HA1	NORTHWEST	0.019	
P3 - P8	WEST	0.007	
P4 - HA1	NORTH	0.017	
P4 - P6	WEST	0.003	
P6 - HA1	NORTHEAST	0.025	
P6 - P7	WEST	0.003	
P6 - P8	SOUTH	0.007	

TABLE 14
VERTICAL GRADIENTS SUMMARY
BETWEEN MULTIPLE PIEZOMETERS
KERNERSVILLE, NORTH CAROLINA
863 - 3407

PIEZOMETER	JUNE 1, 1987 VERTICAL GRADIENT DIRECTION	JUNE 1, 1987 VERTICAL GRADIENT MAGNITUDE	JUNE 20, 1987 VERTICAL GRADIENT DIRECTION	JUNE 20, 1987 VERTICAL GRADIENT MAGNITUDE	COMMENTS
P2D - P2S	UPWARD	*1	UPWARD	*1	
P3D - P3S	UPWARD	0.02	UPWARD	0.015	
P5D - P5S	UPWARD	0.06	UPWARD	0.065	
P7S - P7D	DOWNWARD	0.08	DOWNWARD	0.09	
P8M - P8S		*1	DOWNWARD	0.105	
P8S - P8D	DOWNWARD	0.01	DOWNWARD	0.026	
P8M - P8D	DOWNWARD	0.02	DOWNWARD	0.007	

NOTE:

*1 THE DIFFERENCE IN WATER LEVELS IS INSIGNIFICANT, THEREFORE NO HYDRAULIC GRADIENT WAS CALCULATED.

015

TABLE 15

ESTIMATED FRICTION ANGLE AND MAXIMUM SLOPE
FOR KERNERSVILLE, N.C.
863-3407

SOIL UNIT #	FIELD DESCRIPTION	PARTICLE SIZE ANALYSIS RESULTS	AVERAGE S.P.T.	DESCRIPTIVE DENSITY	FRICTION (1) ANGLE	MAX. (2) SLOPE
1	TAN, CLAYEY SILT, SOME TO AND MIC. F.TO TO C. SAND, FIRM TO STIFF, DRY TO MOIST	54% FINES 46% F. TO C. SAND	19.4	MEDIUM	33	2 : 1
2	RED SILTY CLAY, TRACE F. SAND, FIRM, MOIST	99% FINES < 1% SAND	18	MEDIUM	32	2 : 1
3	WHITE, BROWN, RED SILT, LITTLE F. TO M. SAND, FIRM, MOIST.	98% FINES 2% F. TO C. SAND	26	MEDIUM	34	1.5 : 1
4	MULTI-COLORED, BROWN MICACEOUS F. TO C. SAND, SOME SILT, DENSE TO V. DENSE, DRY MOIST	27% FINES 70% F. TO C. SAND 3% F. COBBLES	75	V.DENSE	>44	1 : 1
5	ORANGE SILT, SOME FINE SAND, DENSE, DRY.	90% FINES 10% F. TO C. SANDS	39	DENSE	38	1.5 : 1
6	ALLUVIAL DEPOSITS (STREAM DEPOSITS)	N/A	N/A	N/A	N/A	N/A
7	ALTERNATING LAYERS OF ROCK AND PARTIALLY WEATHERED ROCK.	N/A	>50	V.DENSE	42	1.5 : 1
8	COMPETENT ROCK (GRANITIC GNEISS AND SCHIST)	17% FINES 81% F. TO C. SAND 2% F. COBBLES	>100	V.DENSE	>44	VERTICAL

NOTE:

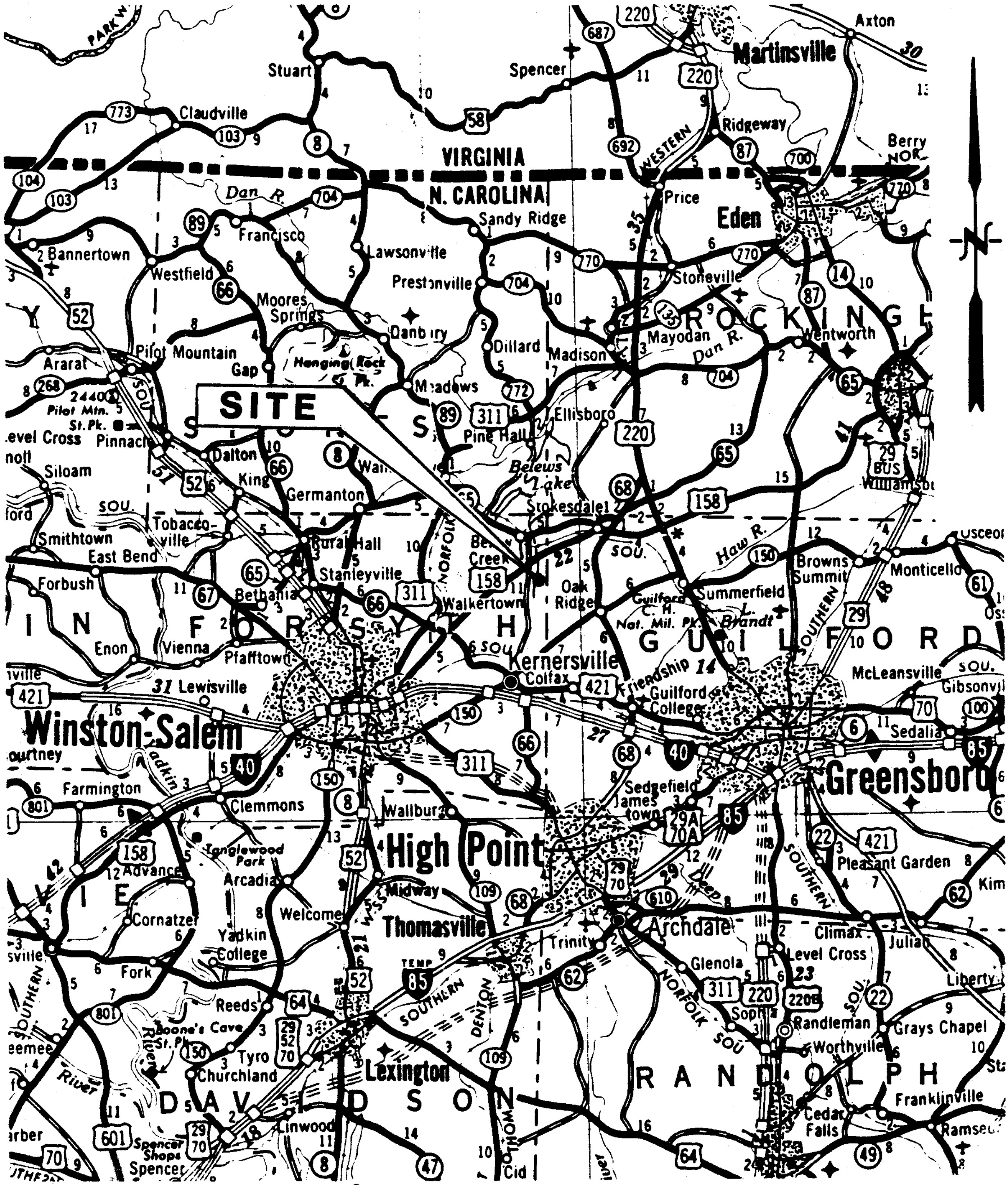
1. FRICTION ANGLE ESTIMATED FROM LAMBE AND WHITMAN, 1969.

2. MAX. SLOPE ESTIMATED ASSUMING A F.O.S. OF 1.0.

N/A = NOT APPLICABLE

FIGURES

A = 20440A-B



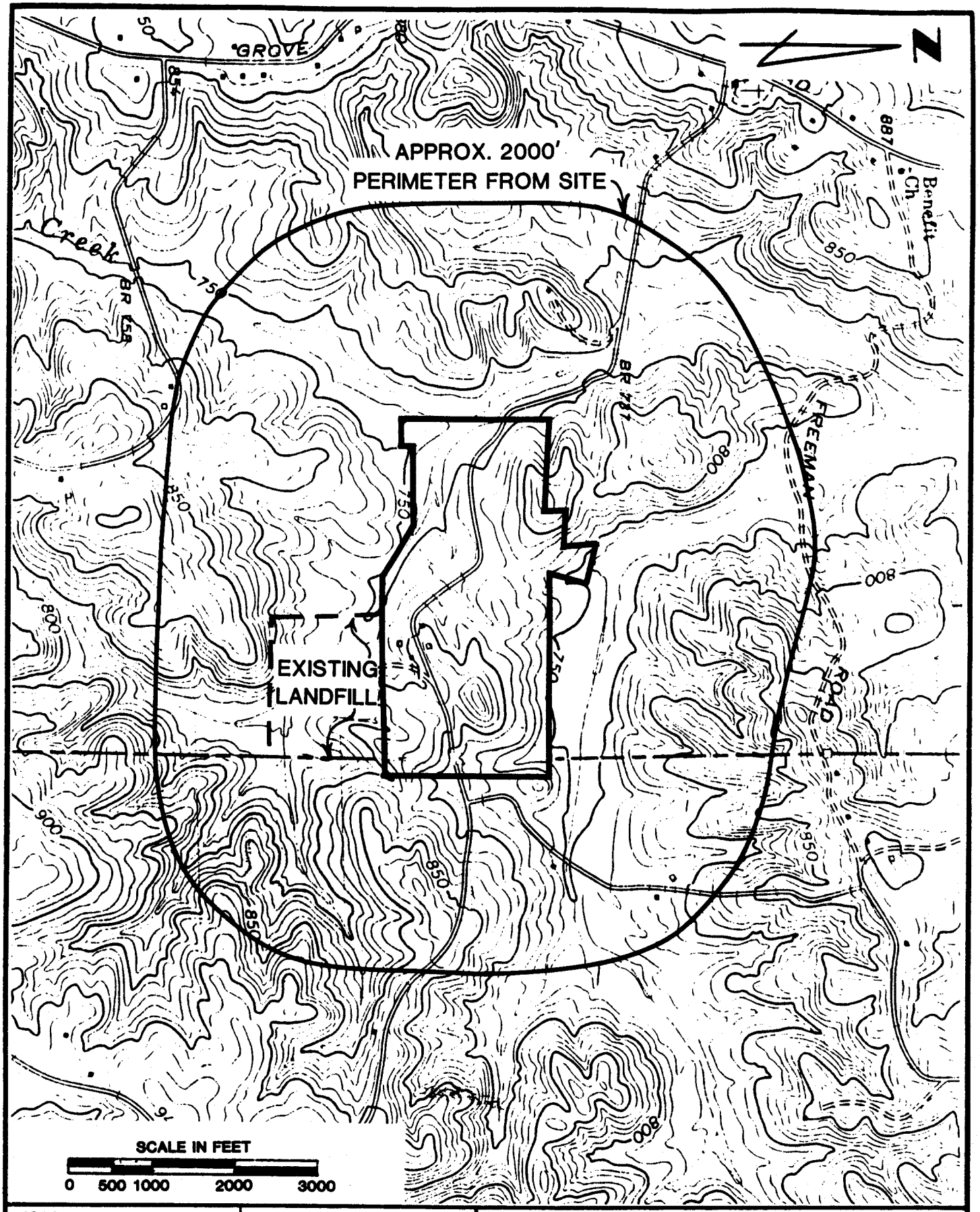
0 4 8

SCALE IN MILES

JOB NO.	863-3407	SCALE	N.T.S.	SITE LOCATION PLAN
DRAWN	SKB	DATE	10/31/86	
CHECKED	-	DWG. NO.	1	
Golder Associates			WASTE MANAGEMENT, INC.	FIGURE 1

FILE NO. 873-3407

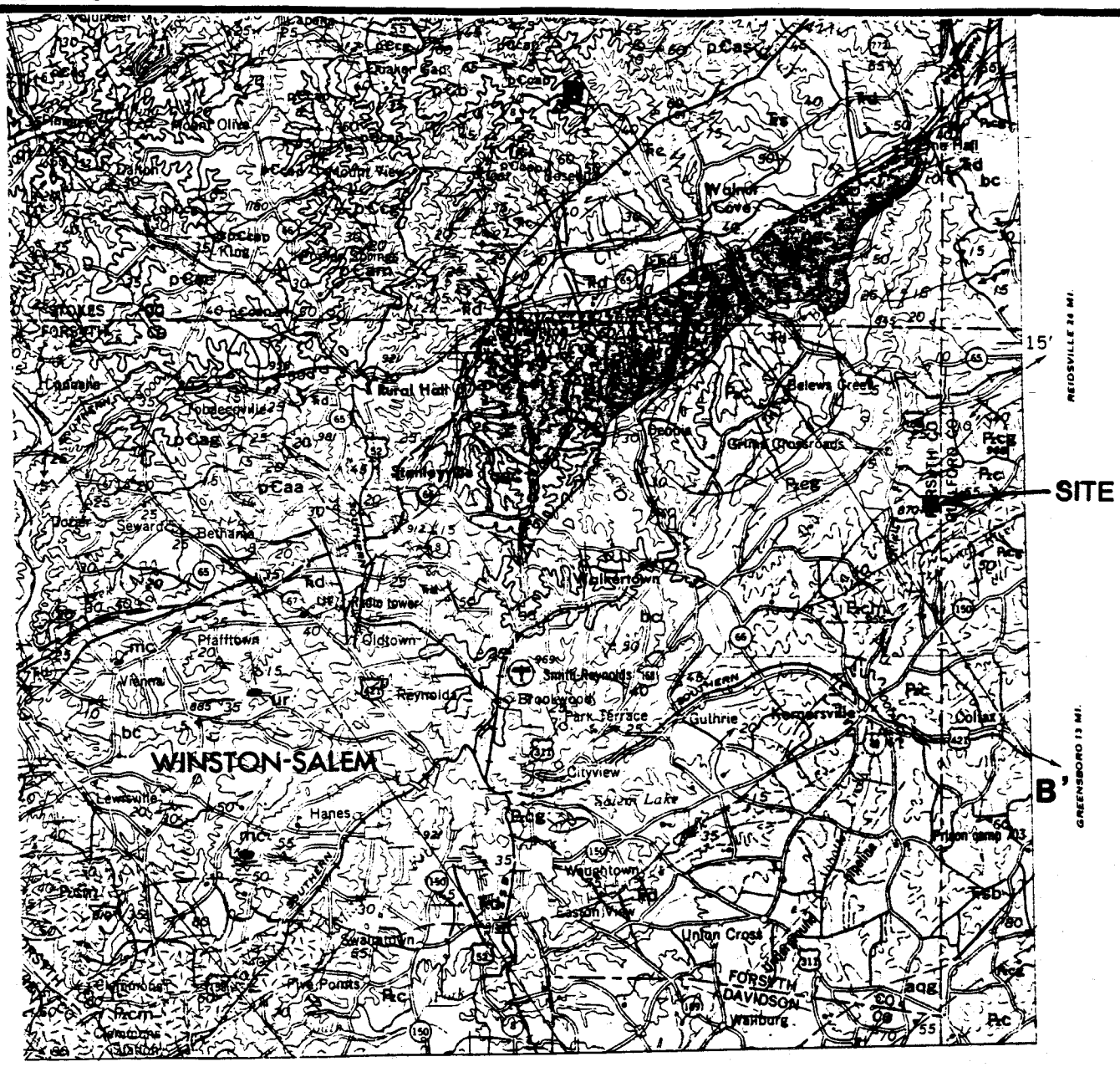
AF 20440A-B

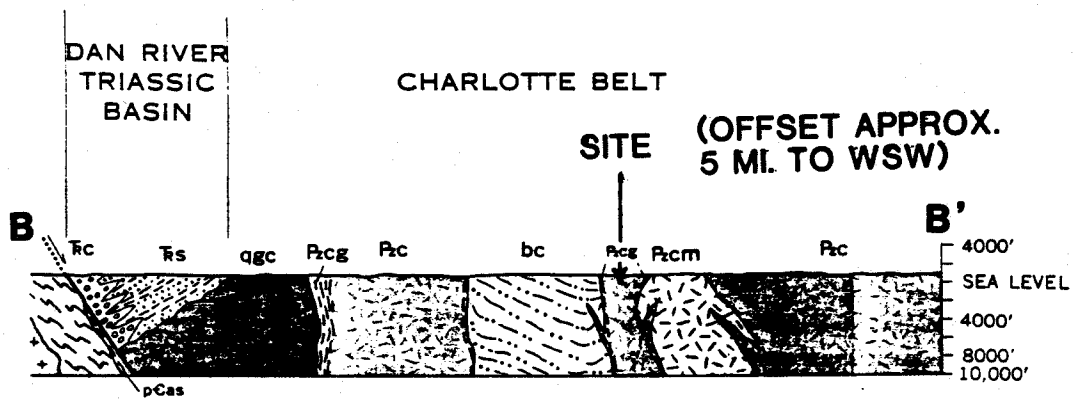


JOB NO. 863-3407	SCALE AS SHOWN	SITE TOPOGRAPHIC MAP	
DRAWN LJW	DATE 12/22/86		
CHECKED	DWG. NO. 48		
Golder Associates		WASTE MANAGEMENT OF CAROLINAS, INC.	FIGURE 2

FILE NO. 873-3407

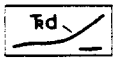
A# 20440A-B





JOB NO. 863-3407	SCALE ≈ 1"=250,000'	REGIONAL GEOLOGIC MAP AND STRUCTURE SECTION	
DRAWN LJW	DATE 12/22/86		
CHECKED AES	DWG. NO.		
Golder Associates		WASTE MANAGEMENT, INC.	FIGURE 3

FILE NO. 873-3407



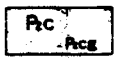
Diabase

Dark-gray, fine- to medium-grained diabase forming dikes a few inches to several hundred feet thick

Clastic sedimentary rocks

Tan, gray, to maroon shale, siltstone, sandstone, and arkose of nonmarine origin; thin coal beds locally

Tc, *conglomerate, clasts pebble to boulder size*



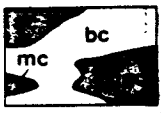
Granitic rock of the Charlotte belt

Quartz monzonite and granodiorite that commonly contain large microcline phenocrysts; generally have biotite and muscovite, epidote, and locally much hornblende. In a few places contain thin layers of mafic rock Usually nonfoliated

P₂cg, *gneissic quartz monzonite and granodiorite mostly along pluton borders*

Mafic rock of the Charlotte belt

Mainly gneissic metagabbro and metadiorite; small scattered bodies of coarse hornblendite, serpentinized peridotite, and anthophyllite-talc-chlorite schist. Scattered bodies of unmetamorphosed gabbroic rocks near Farmington contain olivine, orthopyroxene, and clinopyroxene. Locally intruded by many dikes of gneissic granite (P₂cg) *and pegmatite*



Gneiss and schist of the Charlotte belt

Fine-grained biotite-quartz-feldspar gneiss and some interlayered augen gneiss. Amphibolite layers occur locally. Intruded by many dikes of pegmatite and granite

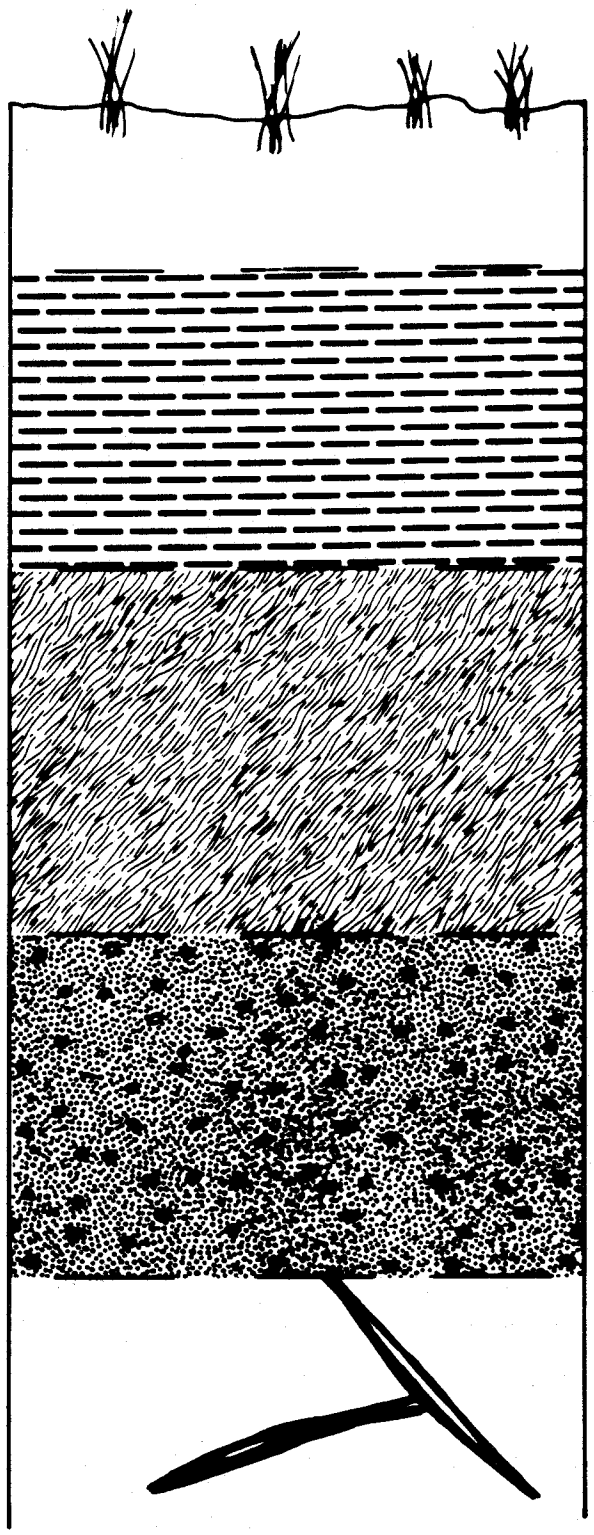
qgc, *fine- to medium-grained laminated quartz-feldspar gneiss (metaarkose?), micaceous quartzite, and quartz-muscovite schist*

ac, *fine-grained laminated amphibolite*

mc, *white to gray impure marble, containing calc-silicates*

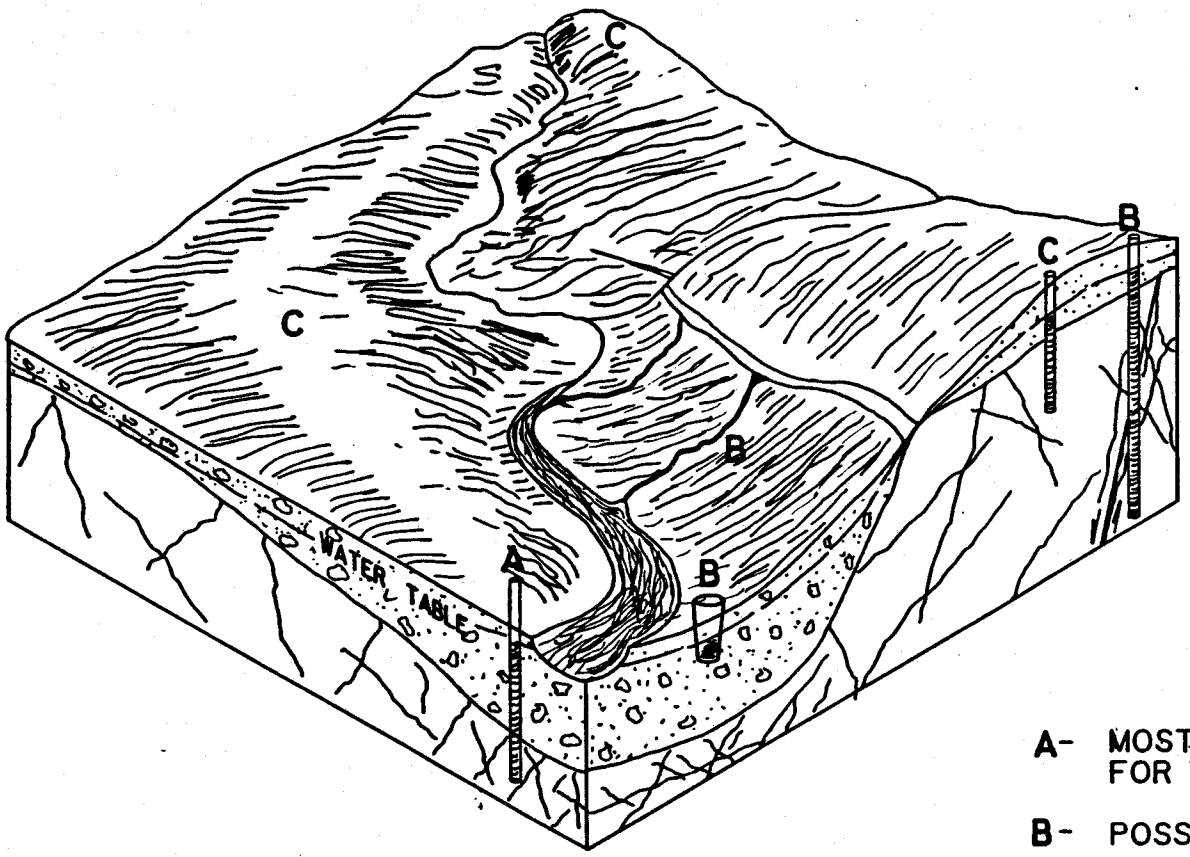
JOB NO. 863-3407	SCALE NTS	EXPLANATION OF GEOLOGIC MAP SYMBOLS
DRAWN LJW	DATE 12/22/86	
CHECKED AES	DWG. NO.	
Golder Associates	WASTE MANAGEMENT, INC.	FIGURE 4

FILE NO. 873-3407

STRATUM		NOTES
TOPSOIL LOAM, SANDY LOAM OR SILT LOAM 0.5 - 2.0 FT.		
RESIDUUM CLAYEY TO SANDY SILT, TYPICALLY YELLOW BROWN TO RED BROWN, WITHOUT STRUCTURE 4.0 - 10.0 FT.		ROOTS OFTEN OCCUR THROUGHOUT MOST OF THE RESIDUUM
SAPROLITE SILTY SAND TO SAND AND GRAVEL, TYPICALLY YELLOW BROWN TO GRAY, PRESERVING THE TEXTURE AND STRUCTURE (JOINTS, FOLIATION, ETC.) OF THE PARENT ROCK 5.0 - 40.0 FT.		
PARTIALLY WEATHERED ROCK SAND GRAVEL AND BOULDERS RESULTING FROM MECHANICAL BREAKDOWN OF THE ROCK 1.0 - 40.0 FT.		GROUNDWATER OFTEN OCCURS UNDER UNCONFINED CONDITIONS IN PARTIALLY WEATHERED ROCK. THIS IS OFTEN THE MOST PERMEABLE STRATUM IN THE PROFILE.
ROCK WITH WEATHERED FRACTURES IN UPPER PORTION, WITH UNWEATHERED FRACTURES AT DEPTH		GROUNDWATER OCCURS IN FRACTURES IN ROCK.

JOB NO. 863-3407	SCALE NTS	IDEALIZED RESIDUAL SOIL PROFILE, SOUTHERN PIEDMONT REGION
DRAWN LJW	DATE 12/22/86	
CHECKED AES	DWG. NO.	
Golder Associates	WASTE MANAGEMENT, INC.	FIGURE 5

FILE NO. 873-3407



A- MOST FAVORABLE LOCATION FOR WELL

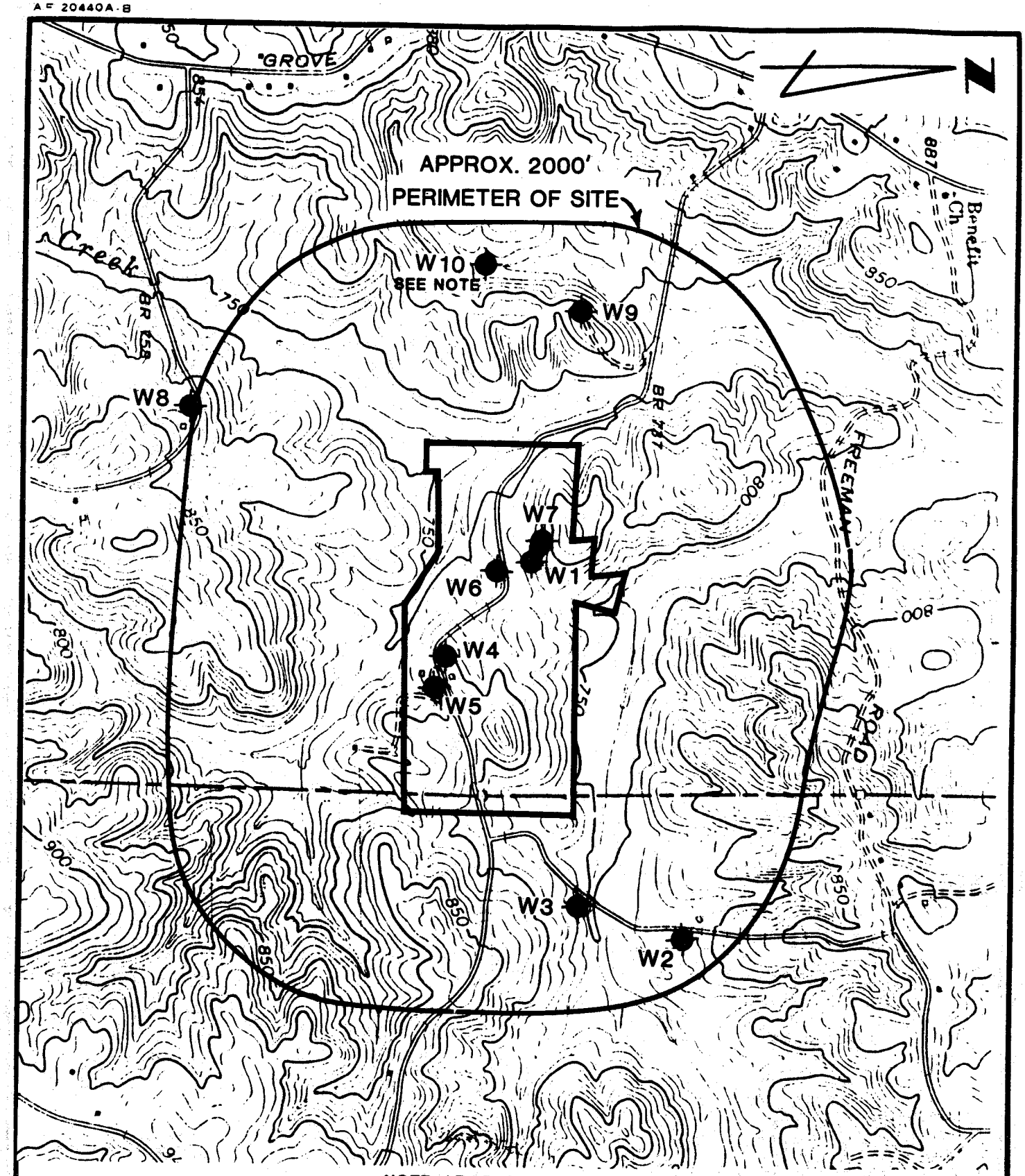
B- POSSIBLE LOCATIONS FOR WELL

C- LEAST FAVORABLE LOCATIONS FOR WELL

(AFTER: REFERENCE 21)

JOB NO. 863-3407	SCALE NONE	GROUNDWATER OCCURRENCE BLOCK DIAGRAM		
DRAWN T.s.R.	DATE 1/21/87			
CHECKED RDD	DWG. NO 10			
Golder Associates		WASTE MANAGEMENT, INC.	FIGURE 6	

AF 20440A-B



SCALE IN FEET

0 500 1000 2000 3000

NOTE: AT LEAST 6 WELLS HAVE BEEN OBSERVED IN THIS LOCATION, THE HIRAM HILLS SUBDIVISION (TABLE 3). SOME MAY BE OUTSIDE THE 2000 FT. PERIMETER.

JOB NO. 863-3407	SCALE AS SHOWN	LOCATIONS OF DOMESTIC WELLS	
DRAWN LJW	DATE 12/22/86		
CHECKED	DWG. NO.		
Golder Associates		WASTE MANAGEMENT OF CAROLINAS, INC.	FIGURE 7

FILE NO. 863-3407

"Drawings at End of File"

TABLE 8

FIELD MAPPING STATION DESCRIPTIONS

Station 1: Borrow pit - near P-1

Exposure of granite schist striking N60E, the dip is nearly vertical, Residual Foliation.

Other rock exposed in the borrow pit includes granite gneiss, hornblende gneiss, and a quartz-feldspar pegmatite. The pegmatite is in vein form which appears to have cut other rock types.

Station 2: Spring-flowing to north at approximately 5-10 gpm. Marshy in this area.

Station 3: Deep gully-near where it forks approximately 10-15 feet deep. Residual soil exposed granitic schist residuum.

Station 4: Deep drainage cut (15-20 ft.) with exposed residuum from granitic gneiss parent rock. Soil is reddish brown, slightly silty, f-c SAND. Residuum has quartz cobbles from one large quartz vein underneath.

Station 5: Stream bed exposure of Residuum intermediate to moderately weathered. Composed of granitic gneiss and schist with feldspar (white) rich veins (approximately 1"-2" thick) cutting at various angles. Some dark gray, more intensely weathered amphibole rich layers. Covered by approximately 8'-9' of alluvium/residuum).

The residuum is int.-med. weathered granitic gneiss and schist showing residual structure (i.e. foliation).

No consistent strike and dip.

Station 6: Apparently man-made straight ditch, 2-2.5' wide and 0.5-1.0' deep bordering a steep hill 18' high on the east side. Flowing west. Very linear!

Station 7: (Sample 1) Outcrop in stream bed of amphibole, rich biotite/muscovite gneiss and schist. Approximately equivalent to diorite in composition. Mod. to non-weathered.

Strike - N70E (070)
Dip - 85W (varies greatly) foliation present

Station 8: Outcrop of competent (hard, non weathered) rock in stream bed. Similar composition to station 7 though foliation is less prominent.

Station 9: Abundant float-boulders of fine grained aphanitic amphibolile? Weathered to a sandstone granular type texture that readily exfoliates to round boulders. Very hard-bedrock is probably shallow in this area.

Station 10: Man made, North trending, bermed drainage ditch. Berm is about 2.5 ft. high. The water is a few inches deep.

Station 11: Borrow pit with rock exposure of granite gneiss with occasional layers of amphibolite schist. Many crosscutting quartz veins (thin 0.5"-2") along with discordantly cutting feldspathic veins (very thin, up to 0.5" thick) ranges from non-weathered to intensely weathered. The finer grained granite and amphibolite rich rocks are generally less weathered.

Foliations - #1 Strike N73E (073°)
#2 Strike N68E (068°), Dip-54E

Joint Strike 171° N9W N171E

Note: Station 11 is a good example of differential weathering with different rock types.

Station 12: 1 3/4" PVC well behind shed just above leach beds. Station is to the southeast outside of map area.

Station 13: Borrow area of existing landfill (off map area). Outcrop of granite gneiss strike of foliation N70E (070) Strike N45E - 100 ft. East of above measurement, attitude changes. Granitic gneiss is occasionally porphyritic. Occasional folding of foliation.

Station 14: Lowland and standing water just south of stream. Somewhat marshy. Extension of the flood plain.

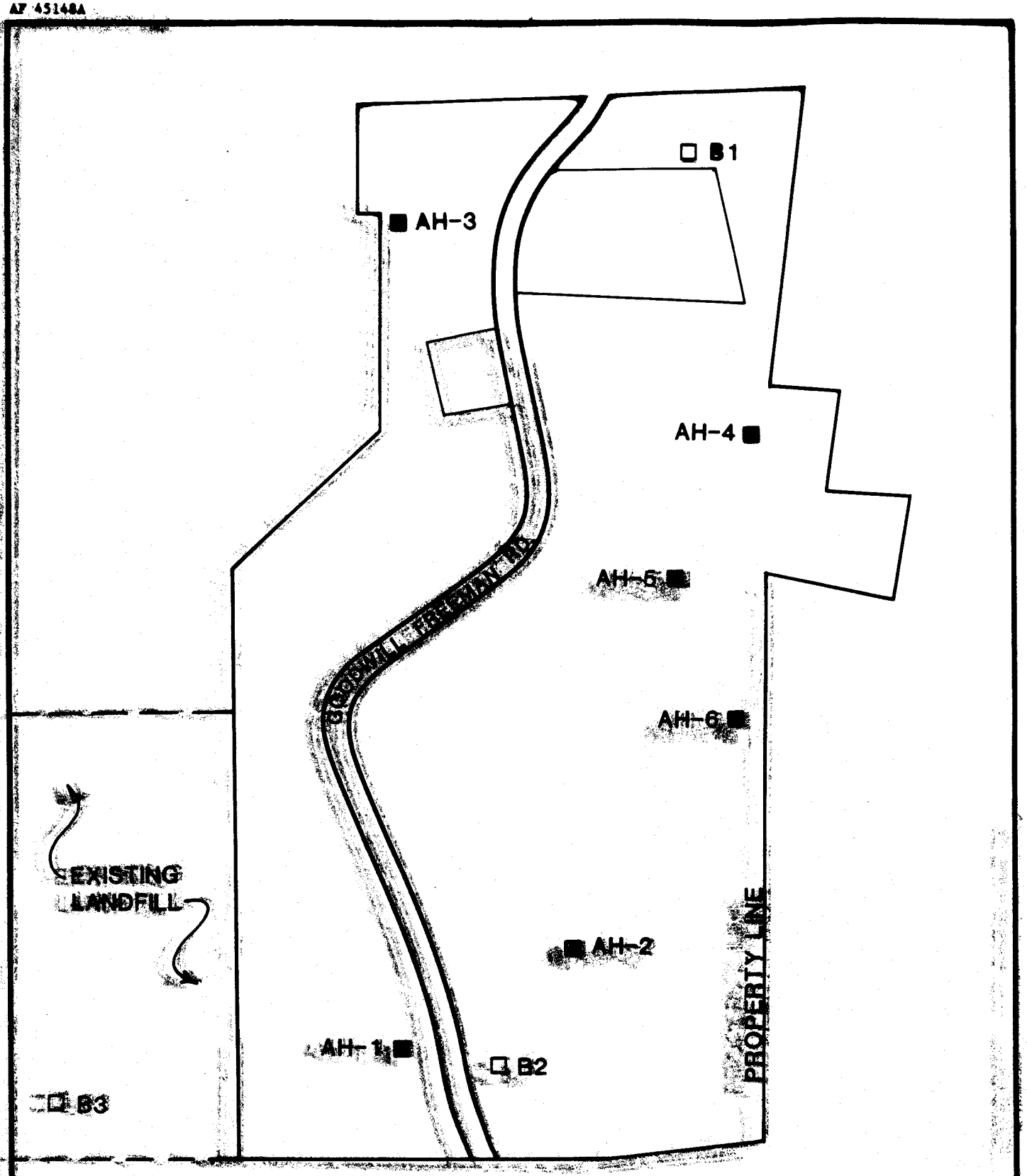
Station 15: Float: low - moderately weathered. Chlorite/-muscovite schist, fine grained approximately 10 boulder sized pieces of float. Bedrock may be at shallow depth.

Note: A rockquarry located about 2.0 miles north-northeast of site. The quarry is about 150 yrds. by 150 yds (circular). Granitic gneiss exposed at quarry surface. The quarry ranges from about 20 to 40 feet in depth. Quarry is apparently on state owned land. Massive granitic/dioritic gneiss with hornblende and biotite.

A flowing stream drains the quarry at its northeast corner. Only a few puddles of standing water in bottom of quarry.

Note: There is an outcrop of granitic gneiss (almost a schist) on the hillside roadcut off Van Hoy Road approximately 1.5 miles north of the site.

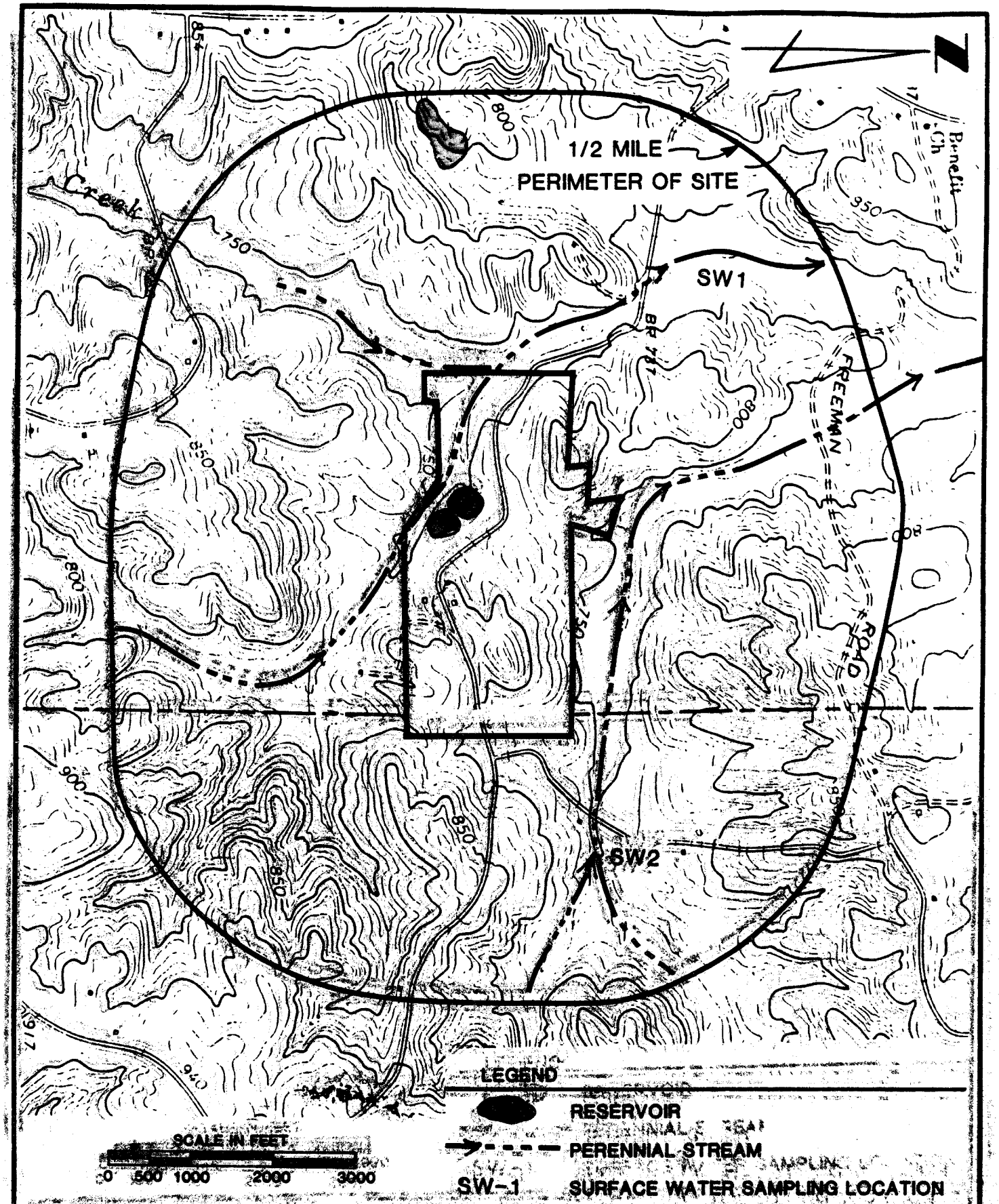
AF 45148A



JOB NO. 863-3407	SCALE 1" 400'	APPROXIMATE LOCATION OF ONSITE AUGER PROBES AND BORROW PITS
DRAWN LJW	DATE 12/22/86	
CHECKED HES	DWG. NO.	
Golder Associates	WASTE MANAGEMENT, INC.	FIGURE 10

FILE NO. 863-3407

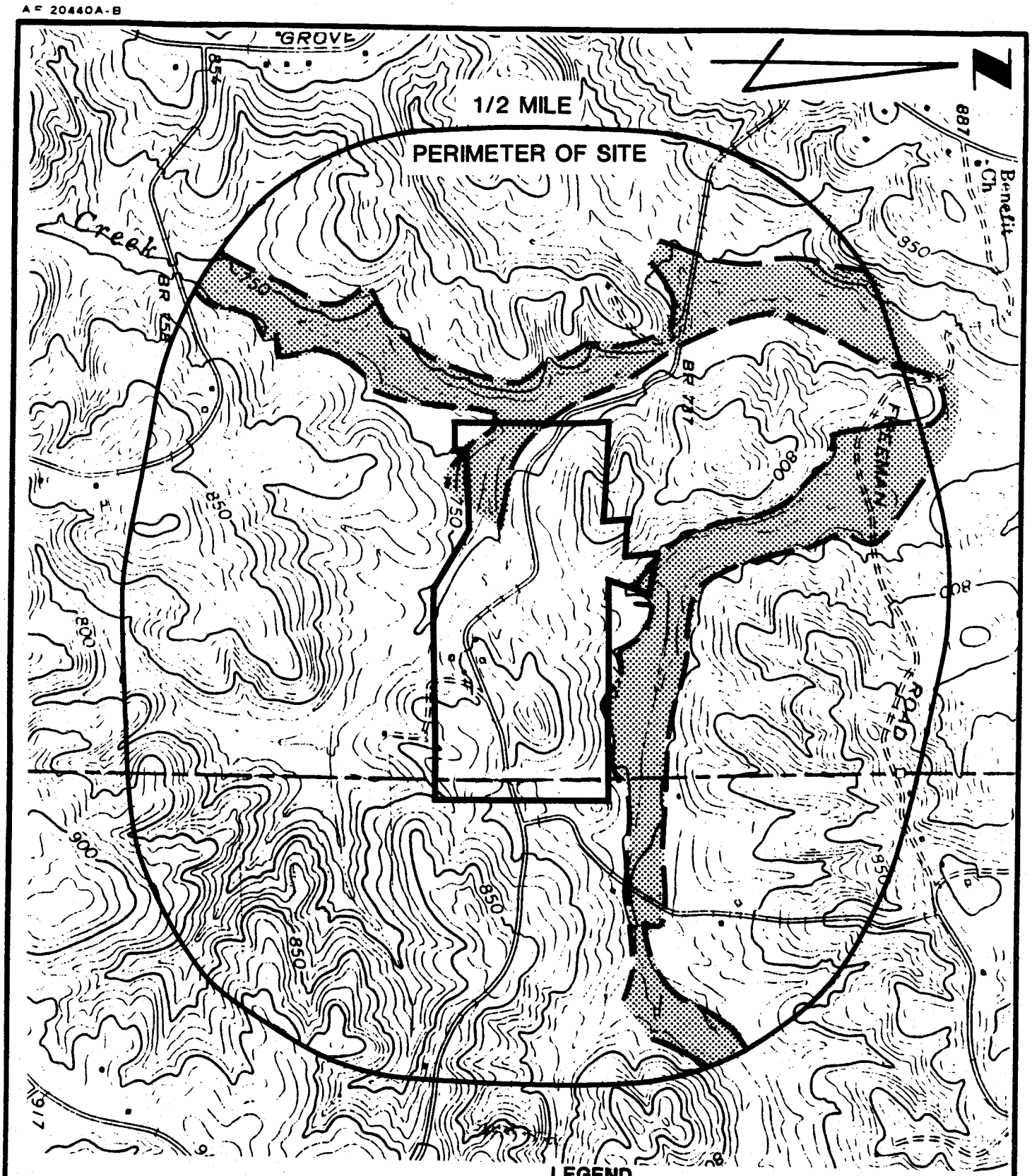
AF 20440A-B



JOB NO. 863-3407	SCALE AS SHOWN	SURFACE WATER FEATURES
DRAWN LJW	DATE 12/22/86	
CHECKED	DWG. NO.	
Golder Associates	WASTE MANAGEMENT, INC.	FIGURE 16

FILE NO. 863-3407

AF 20440A-B



SCALE IN FEET

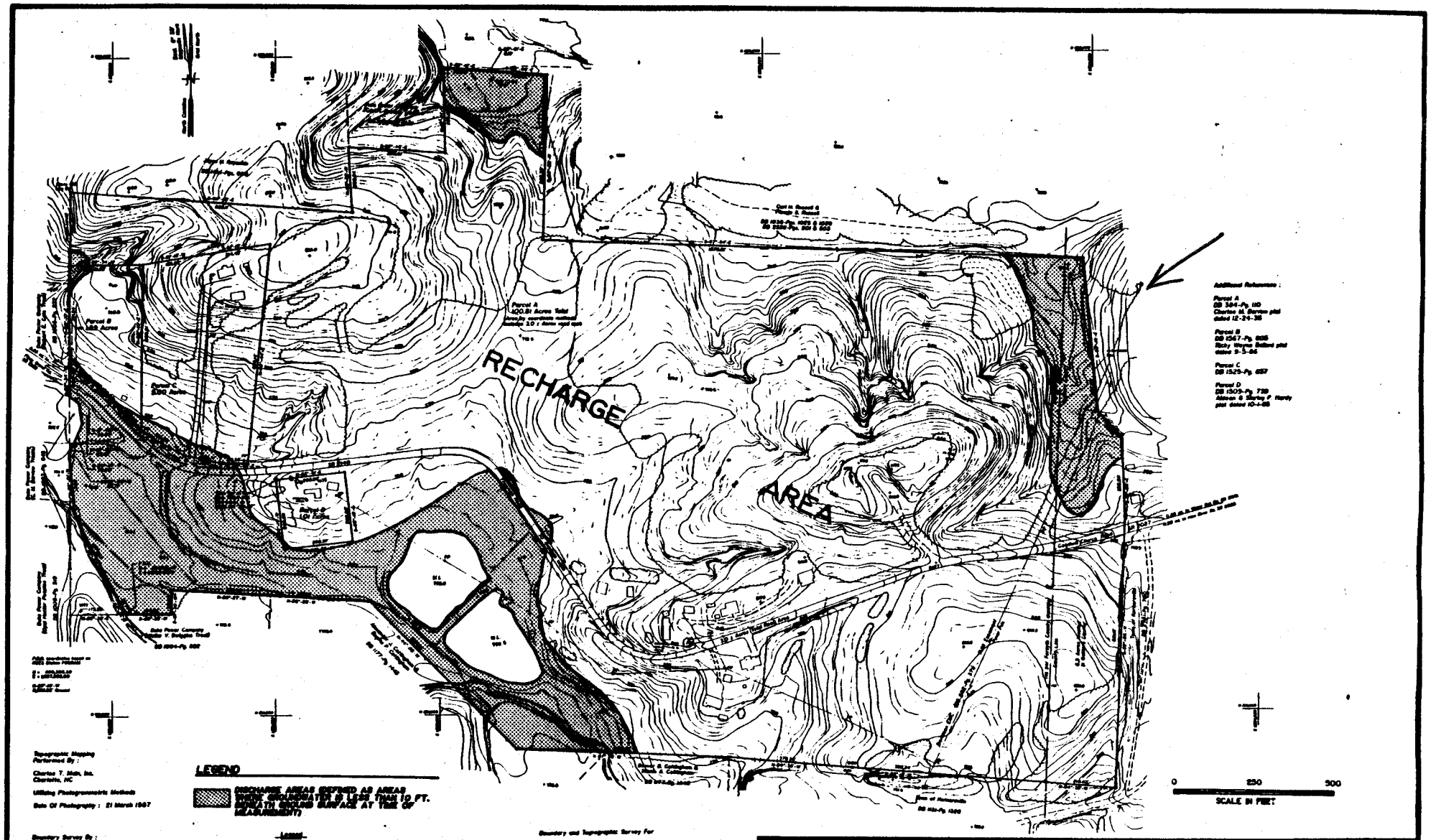
0 500 1000 2000 3000

LEGEND

BOUNDARY OF AREA WITHIN THE 100 YEAR FLOOD PLAIN AS MAPPED BY USGS.

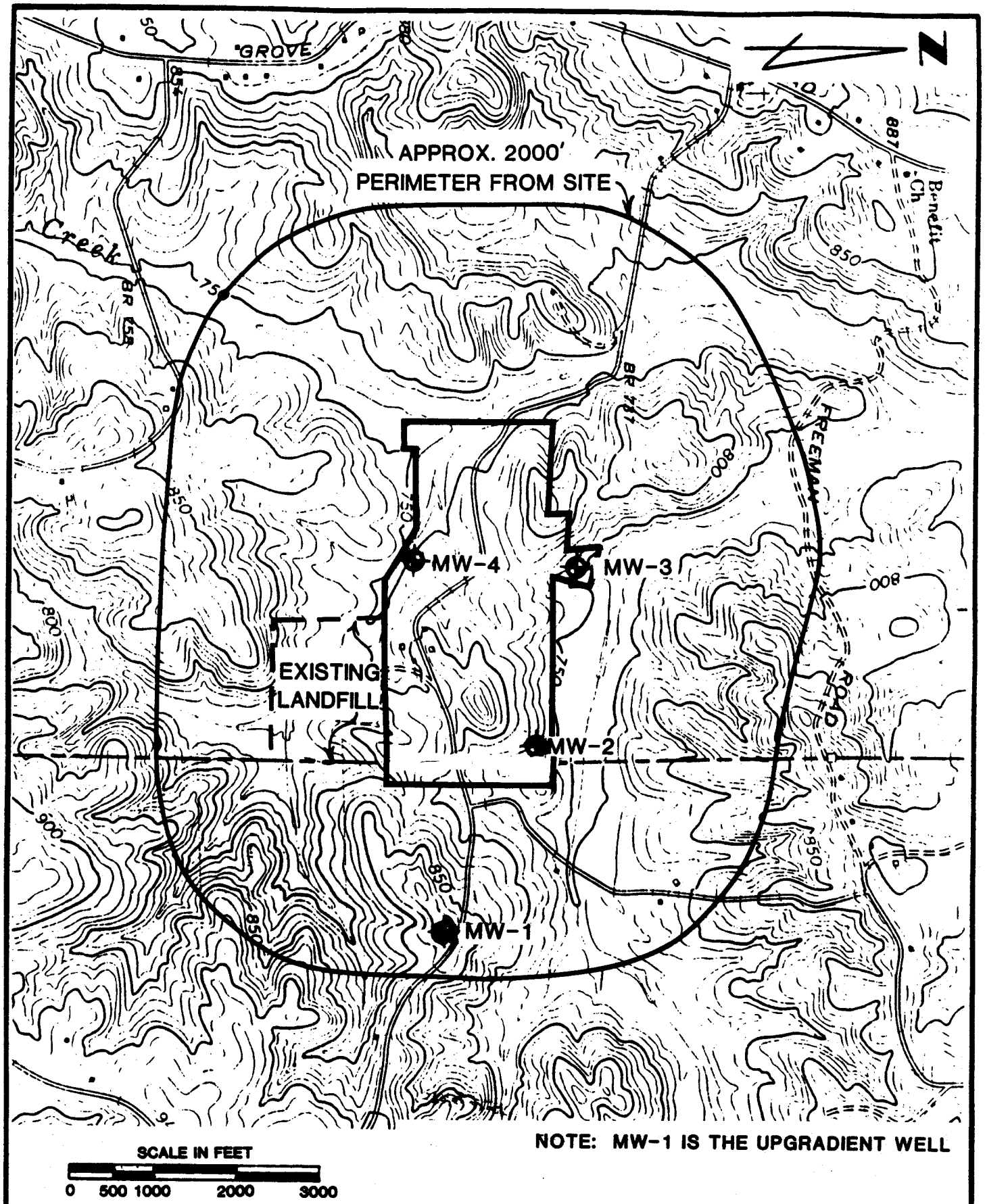
JOB NO. 863-3407	SCALE AS SHOWN	FLOOD PRONE AREAS	
DRAWN LJW	DATE 12/22/86		
CHECKED	DWG. NO. 53		
Golder Associates		WASTE MANAGEMENT, INC.	FIGURE 17

FILE NO. 863-3407



FILE NO. 863-3407

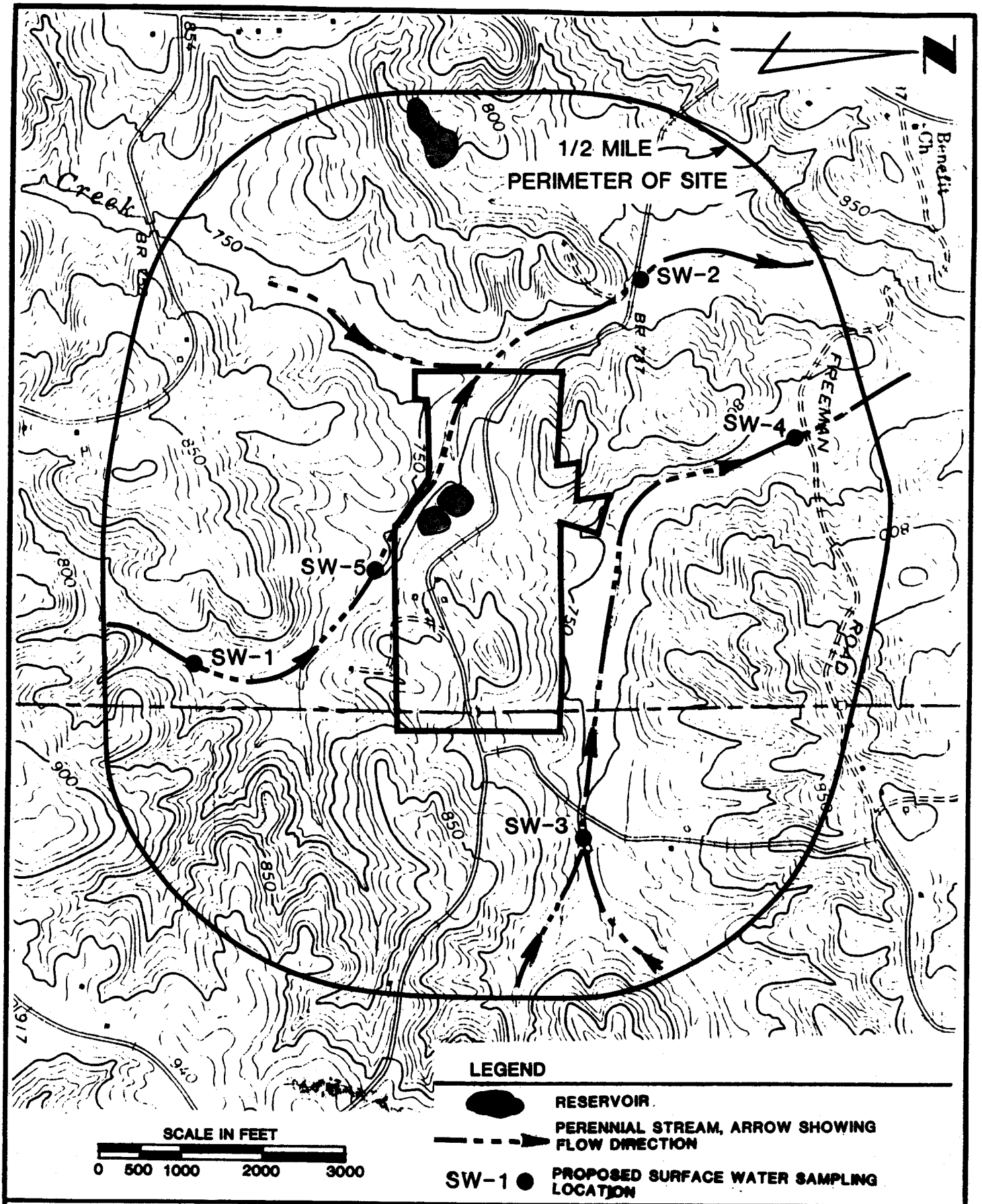
AF 20440A-B



JOB NO. 863-3407	SCALE AS SHOWN	PROPOSED MONITORING WELL LOCATIONS	
DRAWN SKB	DATE 7/1/87		
CHECKED	DWG NO. 54		
Golder Associates		WASTE MANAGEMENT OF CAROLINAS, INC.	FIGURE 19

FILE NO. 863-3407

AF 20440A-B

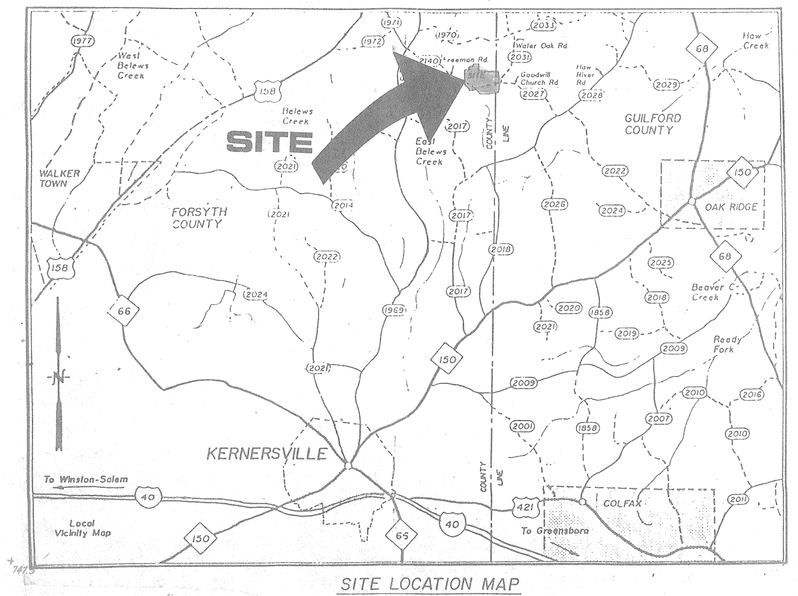


JOB NO. 863-3407	SCALE AS SHOWN	PROPOSED SURFACE WATER MONITORING STATIONS	
DRAWN LJW	DATE 12/22/86		
CHECKED	DWG. NO. 52		
Golder Associates		WASTE MANAGEMENT, INC.	FIGURE 20

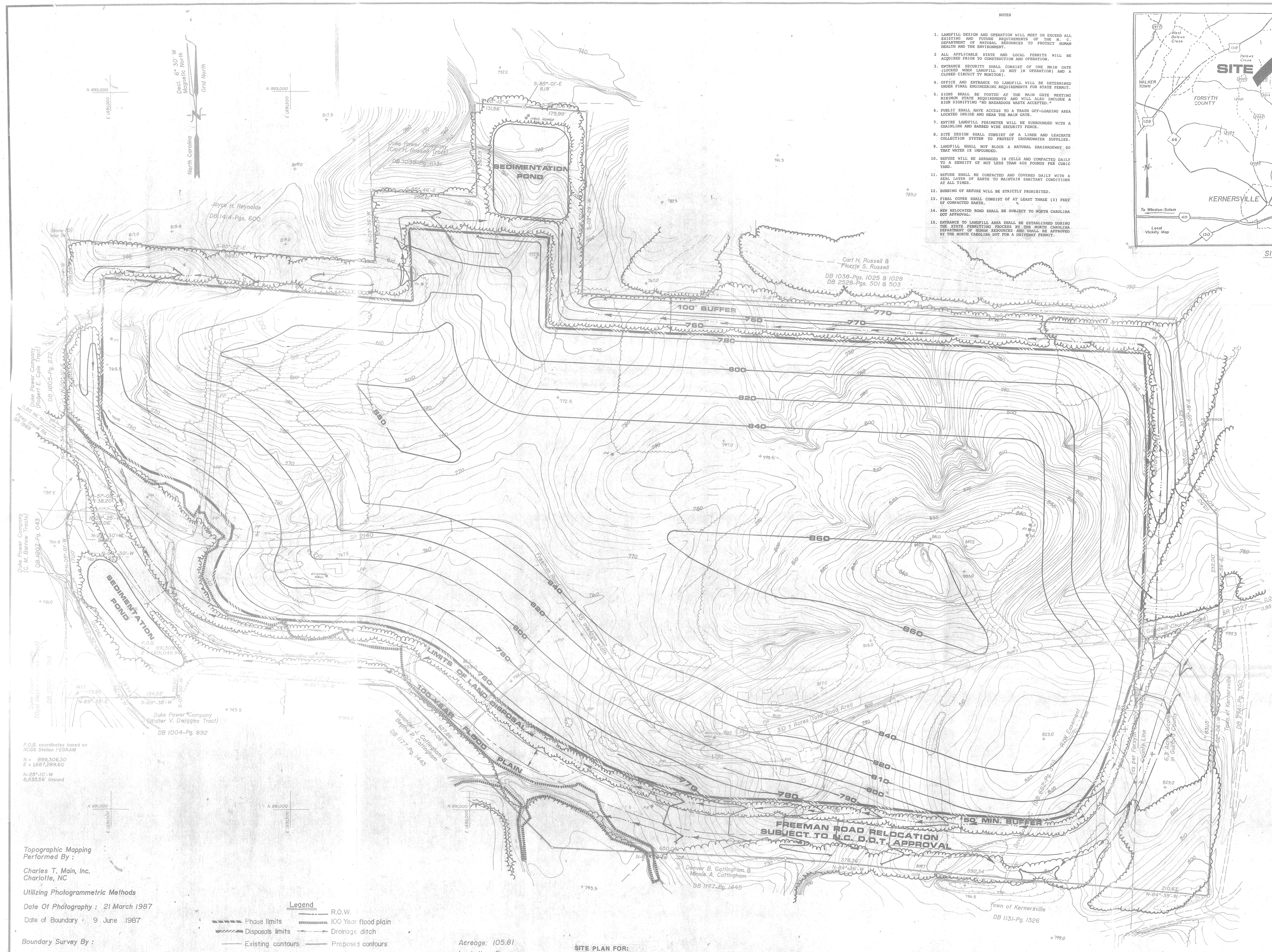
FILE NO. 863-3407

NOTES

1. LANDFILL DESIGN AND OPERATION WILL MEET OR EXCEED ALL EXISTING AND FUTURE REQUIREMENTS OF THE N. C. DEPARTMENT OF NATURAL RESOURCES TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT.
2. ALL APPLICABLE STATE AND LOCAL PERMITS WILL BE ACQUIRED PRIOR TO CONSTRUCTION AND OPERATION.
3. ENTRANCE SECURITY SHALL CONSIST OF ONE MAIN GATE (LOCKED WHEN LANDFILL IS NOT IN OPERATION) AND A CLOSED CIRCUIT TV MONITOR).
4. OFFICE AND ENTRANCE TO LANDFILL WILL BE DETERMINED UNDER FINAL ENGINEERING REQUIREMENTS FOR STATE PERMIT.
5. SIGNS SHALL BE POSTED AT THE MAIN GATE MEETING MINIMUM STATE REQUIREMENTS AND WILL ALSO INCLUDE A SIGN SIGNIFYING "NO HAZARDOUS WASTE ACCEPTED."
6. PUBLIC SHALL HAVE ACCESS TO A TRASH OFF-LOADING AREA LOCATED INSIDE AND NEAR THE MAIN GATE.
7. ENTIRE LANDFILL PERIMETER WILL BE SURROUNDED WITH A CHAINLINK AND BARBED WIRE SECURITY FENCE.
8. SITE DESIGN SHALL CONSIST OF A LINER AND LEACHATE COLLECTION SYSTEM TO PROTECT GROUNDWATER SUPPLIES.
9. LANDFILL SHALL NOT BLOCK A NATURAL DRAINAGEWAY SO THAT WATER IS IMPOUNDED.
10. REFUSE WILL BE ARRANGED IN CELLS AND COMPACTED DAILY TO A DENSITY OF NOT LESS THAN 600 POUNDS PER CUBIC YARD.
11. REFUSE SHALL BE COMPACTED AND COVERED DAILY WITH A SEAL LAYER OF EARTH TO MAINTAIN SANITARY CONDITIONS AT ALL TIMES.
12. BURNING OF REFUSE WILL BE STRICTLY PROHIBITED.
13. FINAL COVER SHALL CONSIST OF AT LEAST THREE (3) FEET OF COMPACTED EARTH.
14. NEW RELOCATED ROAD SHALL BE SUBJECT TO NORTH CAROLINA DOT APPROVAL.
15. ENTRANCE TO LANDFILL AREA SHALL BE ESTABLISHED DURING THE STATE PERMITTING PROCESS BY THE NORTH CAROLINA DEPARTMENT OF HUMAN RESOURCES AND SHALL BE APPROVED BY THE NORTH CAROLINA DOT FOR A DRIVEWAY PERMIT.



SITE LOCATION MAP
Scale: 1" = 6,200'



Topographic Mapping Performed By :

Charles T. Main, Inc.
Charlotte, NC

Utilizing Photogrammetric Methods

Date Of Photography : 21 March 1987

Date of Boundary : 9 June 1987

Boundary Survey By :

Survey & Mapping Services
of South Carolina, Inc.

P. O. Box 3263
2028 Platt Springs Road
West Columbia, SC 29171
(803) 796 - 8214

Legend

- Phase limits
- Disposals limits
- Existing contours
- Computed point
- Iron pipe, Old
- Iron pipe, New
- Monument Old
- Stone Old
- R.O.W.
- 100 Year flood plain
- Drainage ditch
- Proposed contours
- Boundary / Property Line
- Adjoining Property Line
- Fence
- Wells
- Reinforced Concrete Pipe

Acreage: 105.81 (excluding Freeman Road area)

SITE PLAN FOR:

PROPOSED SOLID WASTE DISPOSAL FACILITY

Belews Creek Township, Forsyth County, North Carolina

Oak Ridge Township, Guilford County, North Carolina

Date : 12 July 1987 Revised August 5, 1987

100 0 100 200 300

Scale : 1" = 100'

2 Foot Contour Interval.

Boundary Survey
Ratio of precision is 1 : 8,500

NORTH CAROLINA PROFESSIONAL SEAL 11744 ENGINEER EDWARD GIBSON III

PETITIONER

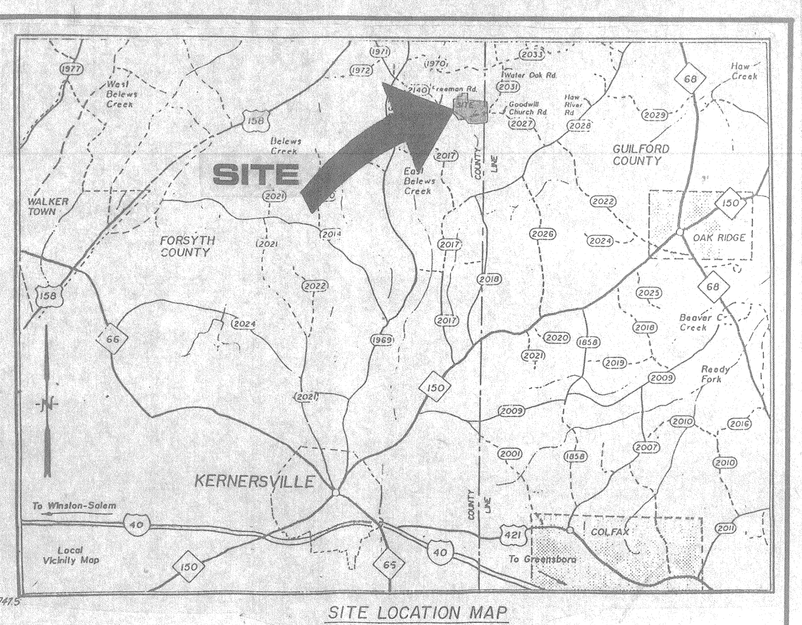
Waste Management of Carolinas, Inc.
155 Glenn Road
Spartanburg SC 29304

PLAN PREPARED BY:

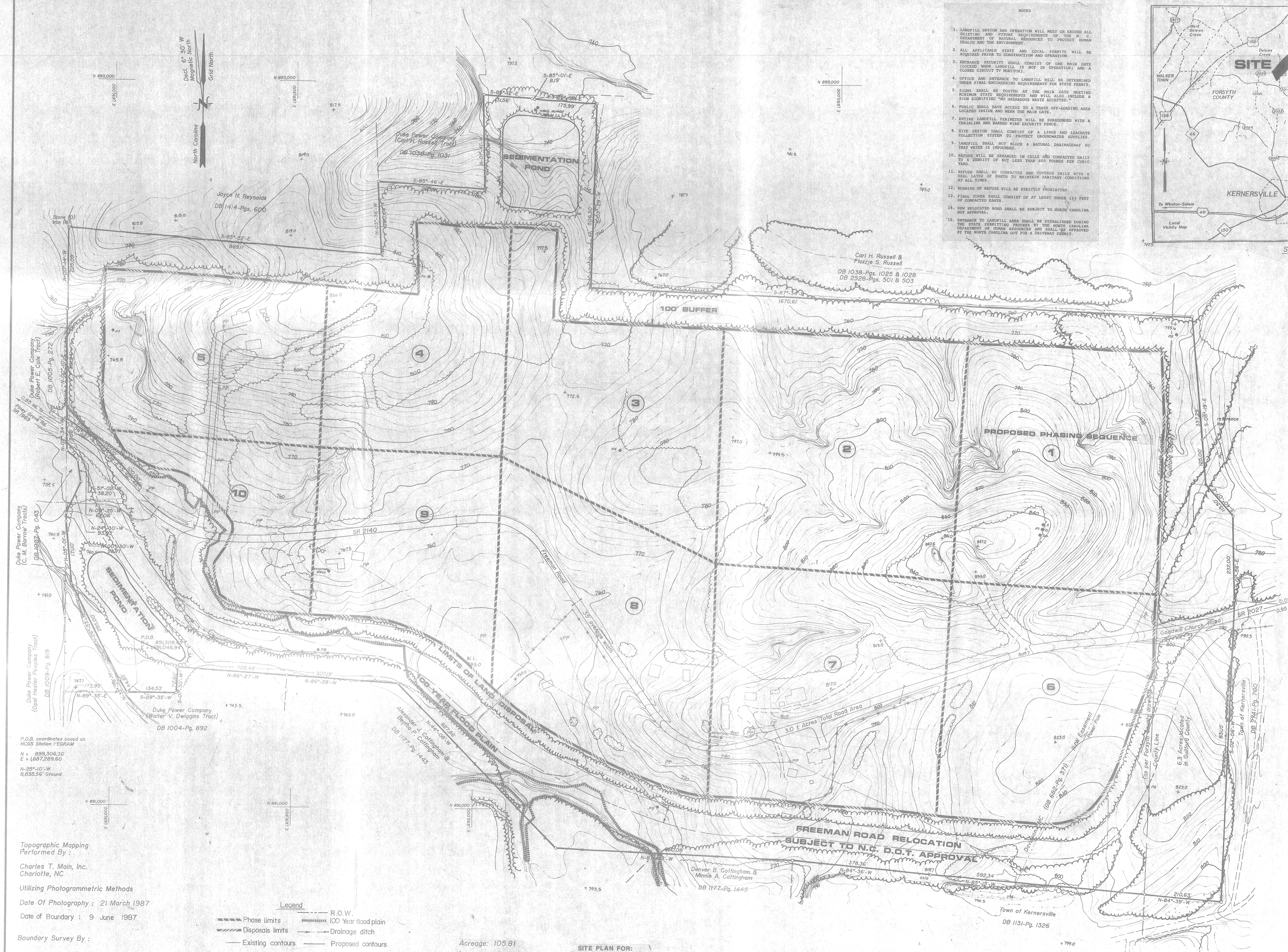
Edward L. Gibson, P.E.
Reg. No. 11744
Waste Management of North America, Inc.
2600 Delk Road
Marietta, GA 30067

NOTES

1. LANDFILL DESIGN AND OPERATION WILL MEET OR EXCEED ALL EXISTING AND FUTURE REQUIREMENTS OF THE N. C. DEPARTMENT OF NATURAL RESOURCES TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT.
2. ALL APPLICABLE STATE AND LOCAL PERMITS WILL BE ACQUIRED PRIOR TO CONSTRUCTION AND OPERATION.
3. ENTRANCE SECURITY SHALL CONSIST OF ONE MAIN GATE (LOCKED WHEN LANDFILL IS NOT IN OPERATION) AND A CLOSED CIRCUIT TV MONITOR).
4. OFFICE AND ENTRANCE TO LANDFILL WILL BE DETERMINED UNDER FINAL ENGINEERING REQUIREMENTS FOR STATE PERMIT.
5. SIGNS SHALL BE POSTED AT THE MAIN GATE MEETING MINIMUM STATE REQUIREMENTS AND WILL ALSO INCLUDE A SIGN SIGNIFYING "NO HAZARDOUS WASTE ACCEPTED."
6. PUBLIC SHALL HAVE ACCESS TO A TRASH OFF-LOADING AREA LOCATED INSIDE AND NEAR THE MAIN GATE.
7. ENTIRE LANDFILL PERIMETER WILL BE SURROUNDED WITH A CHAINLINK AND BARBED WIRE SECURITY FENCE.
8. SITE DESIGN SHALL CONSIST OF A LINER AND LEACHATE COLLECTION SYSTEM TO PROTECT GROUNDWATER SUPPLIES.
9. LANDFILL SHALL NOT BLOCK A NATURAL DRAINAGEWAY SO THAT WATER IS IMPOUNDED.
10. REFUSE WILL BE ARRANGED IN CELLS AND COMPACTED DAILY TO A DENSITY OF NOT LESS THAN 500 POUNDS PER CUBIC YARD.
11. REFUSE SHALL BE COMPACTED AND COVERED DAILY WITH A SEAL LAYER OF EARTH TO MAINTAIN SANITARY CONDITIONS AT ALL TIMES.
12. BURNING OF REFUSE WILL BE STRICTLY PROHIBITED.
13. FINAL COVER SHALL CONSIST OF AT LEAST THREE (3) FEET OF COMPACTED EARTH.
14. NEW RELOCATED ROAD SHALL BE SUBJECT TO NORTH CAROLINA DOT APPROVAL.
15. ENTRANCE TO LANDFILL AREA SHALL BE ESTABLISHED DURING THE STATE PERMITTING PROCESS BY THE NORTH CAROLINA DEPARTMENT OF HUMAN RESOURCES AND SHALL BE APPROVED BY THE NORTH CAROLINA DOT FOR A DRIVEWAY PERMIT.



SITE LOCATION MAP
Scale: 1" = 6,200'



Topographic Mapping Performed By :

Charles T. Main, Inc.
Charlotte, NC

Utilizing Photogrammetric Methods

Date Of Photography : 21 March 1987

Date of Boundary : 9 June 1987

Boundary Survey By :

Survey & Mapping Services
of South Carolina, Inc.

P. O. Box 3263
2028 Platt Springs Road
West Columbia, SC 29171
(803) 796 - 8214

Legend

- Phase limits
- Disposals limits
- Existing contours
- Computed point
- Iron pipe, Old
- Iron pipe, New
- Monument Old
- Stone Old
- R.O.W.
- 100 Year flood plain
- Drainage ditch
- Proposed contours
- Boundary / Property Line
- Adjoining Property Line
- Fence
- Wells
- Reinforced Concrete Pipe

Acreage: 105.81
(excluding Freeman Road area)

SITE PLAN FOR:

PROPOSED SOLID WASTE DISPOSAL FACILITY

Belews Creek Township, Forsyth County, North Carolina

Oak Ridge Township, Guilford County, North Carolina

Date :12 July 1987 Revised August 5, 1987

100 0 100 200 300

Scale : 1" = 100'

2 Foot Contour Interval.

Boundary Survey
Ratio of precision is 1 : 8,500

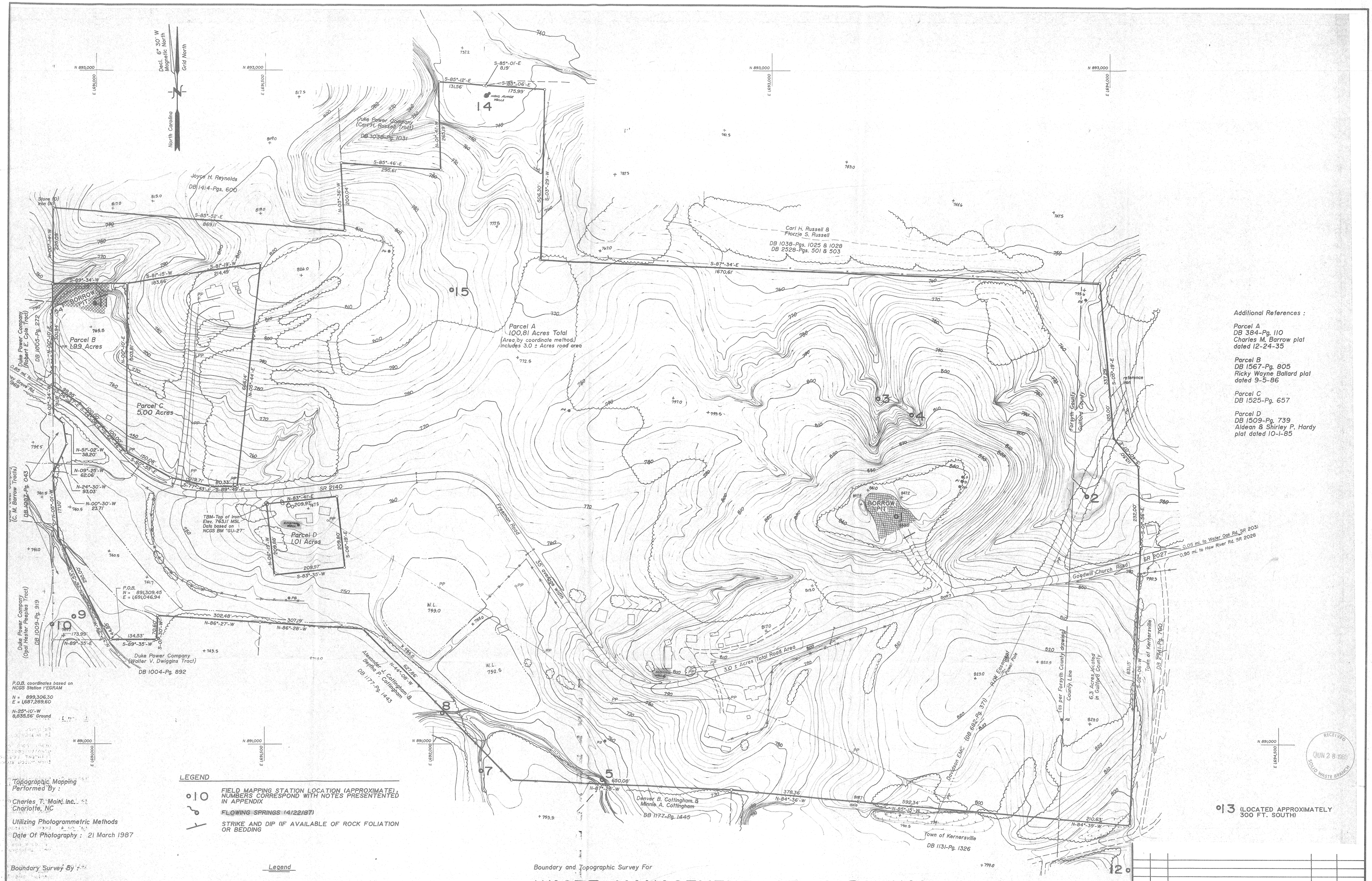
NORTH CAROLINA PROFESSIONAL SEAL 11744 ENGINEER EDWARD GIBSON III

PETITIONER

Waste Management of Carolinas, Inc.
155 Glenn Road
Spartanburg SC 29304

PLAN PREPARED BY:

Edward L. Gibson, P.E.
Reg. No. 11744
Waste Management of North America, Inc.
2600 Delk Road
Marietta, GA 30067



Additional References :

Parcel A
DB 384-Pg. 110
Charles M. Barrow plat
dated 12-24-35

Parcel B
DB 1567-Pg. 805
Ricky Wayne Ballard plat
dated 9-5-86

Parcel C
DB 1525-Pg. 657

Parcel D
DB 1509-Pg. 739
Aldean & Shirley P. Hardy
plat dated 10-1-85

°13 (LOCATED APPROXIMATELY 300 FT. SOUTH)

RECEIVED
JUN 28 1988
SOLID WASTE BRANCH

Topographic Mapping
Performed By :

Charles T. Main, Inc.
Charlotte, NC

Utilizing Photogrammetric Methods

Date Of Photography : 21 March 1987

Boundary Survey By :

Survey & Mapping Services
of South Carolina, Inc.

P. O. Box 3263
28 Platt Springs Road
Columbia, SC 29171
796 - 8214

LEGEND

°10 FIELD MAPPING STATION LOCATION (APPROXIMATE), NUMBERS CORRESPOND WITH NOTES PRESENTENTED IN APPENDIX

FLOWING SPRINGS (4/22/87)

STRIKE AND DIP (IF AVAILABLE OF ROCK FOLIATION OR BEDDING

Legend

- Computed point
- Iron pipe, Old
- Iron pipe, New
- Monument Old
- Stone Old
- Boundary / Property Line
- Adjoining Property Line
- Fence
- Wells
- Reinforced Concrete Pipe

Boundary and Topographic Survey For

WASTE MANAGEMENT OF CAROLINAS, INC.

Belews Creek Township, Forsyth County, North Carolina

Oak Ridge Township, Guilford County, North Carolina

Date : 9 June 1987

100 0 100 200 300

Scale : 1" = 100'

Golder Associates
Atlanta, Georgia

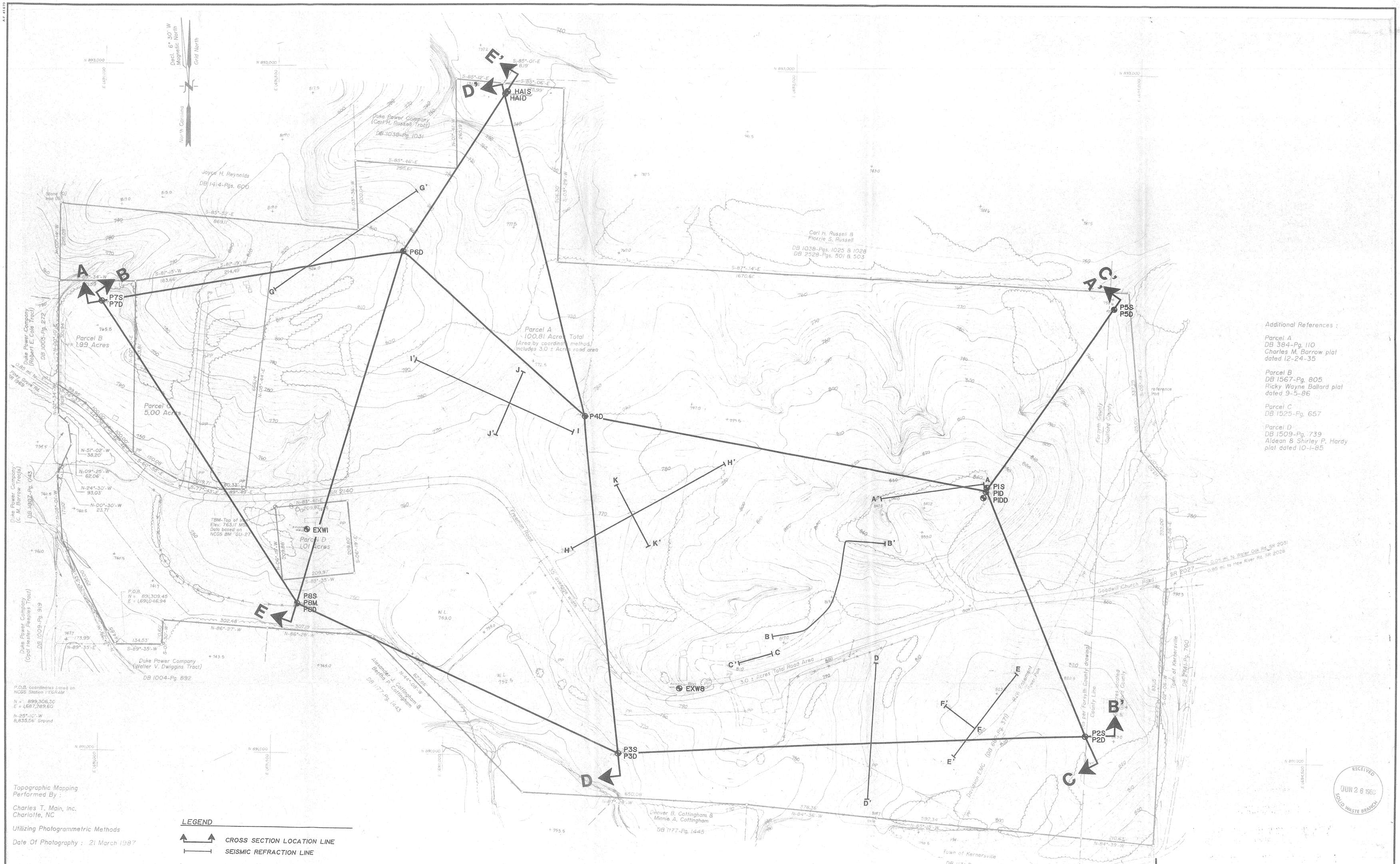
REV.	DATE	DESCRIPTION	DR BY	APP BY

SCALE: AS SHOWN		PROJECT NO. 863-3407
863-3407		PROJECT: KERNERSVILLE, NORTH CAROLINA
DES BY	G.G.C.	6/30/87
DR BY	SKB	7/1/87
CHK BY	[illegible]	6/26/87
APP BY	[illegible]	6/26/87
		SHEET TITLE: GEOLOGICAL FIELD MAPPING STATIONS

Waste Management of Carolinas, Inc
Duncan, South Carolina, 29334

SHEET ____ OF ____
DRAWING NO. 54

FIGURE 9



Additional References :

Parcel A
DB 384-Pg. 110
Charles M. Barrow plat
dated 12-24-35

Parcel B
DB 1567-Pg. 805
Ricky Wayne Ballard plat
dated 9-5-86

Parcel C
DB 1525-Pg. 657

Parcel D
DB 1509-Pg. 739
Aldean & Shirley P. Hardy
plat dated 10-1-85

Topographic Mapping
Performed By :

Charles T. Main, Inc.
Charlotte, NC

Utilizing Photogrammetric Methods

Date Of Photography : 21 March 1987

LEGEND

CROSS SECTION LOCATION LINE

SEISMIC REFRACTION LINE

Boundary Survey By :

Survey & Mapping Services
of South Carolina, Inc.

P. O. Box 3263
2028 Platt Springs Road
West Columbia, SC 29171
(803) 796 - 8214

Legend

- Computed point
- Iron pipe, Old
- Iron pipe, New
- Monument Old
- Stone Old
- Boundary / Property Line
- Adjoining Property Line
- Fence
- Wells
- Reinforced Concrete Pipe

Boundary and Topographic Survey For

WASTE MANAGEMENT OF CAROLINAS, INC.

Belews Creek Township, Forsyth County, North Carolina

Oak Ridge Township, Guilford County, North Carolina

Date : 9 June 1987

100 0 100 200 300

Scale : 1" = 100'

Golder Associates
Atlanta, Georgia

REV.	DATE	DESCRIPTION	DR BY	APP BY

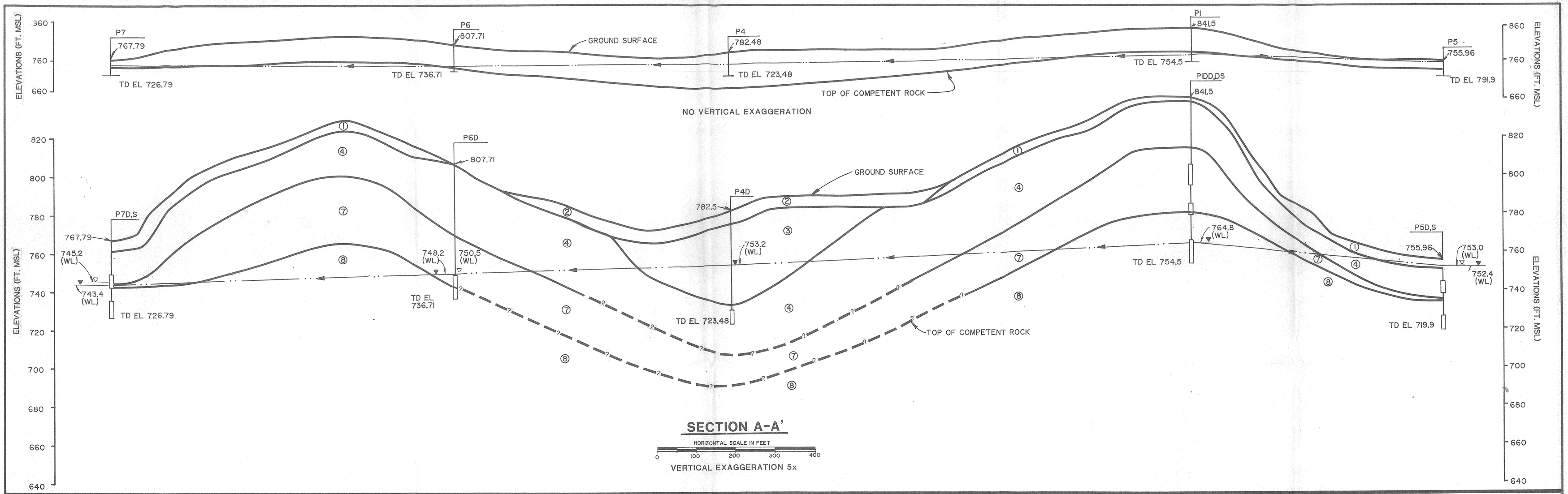
SCALE: AS SHOWN			PROJECT NO. 863-3407
FILE No. 863-3407			PROJECT: KERNERSVILLE, NORTH CAROLINA
DES BY	GGK	6/23/87	SHEET TITLE: HYDROGEOLOGIC CROSS SECTION AND SEISMIC LINE LOCATION MAP
DR BY	SKB	6/29/87	
CHK BY	[illegible]	6/26/88	
APP BY	[illegible]	6/26/88	

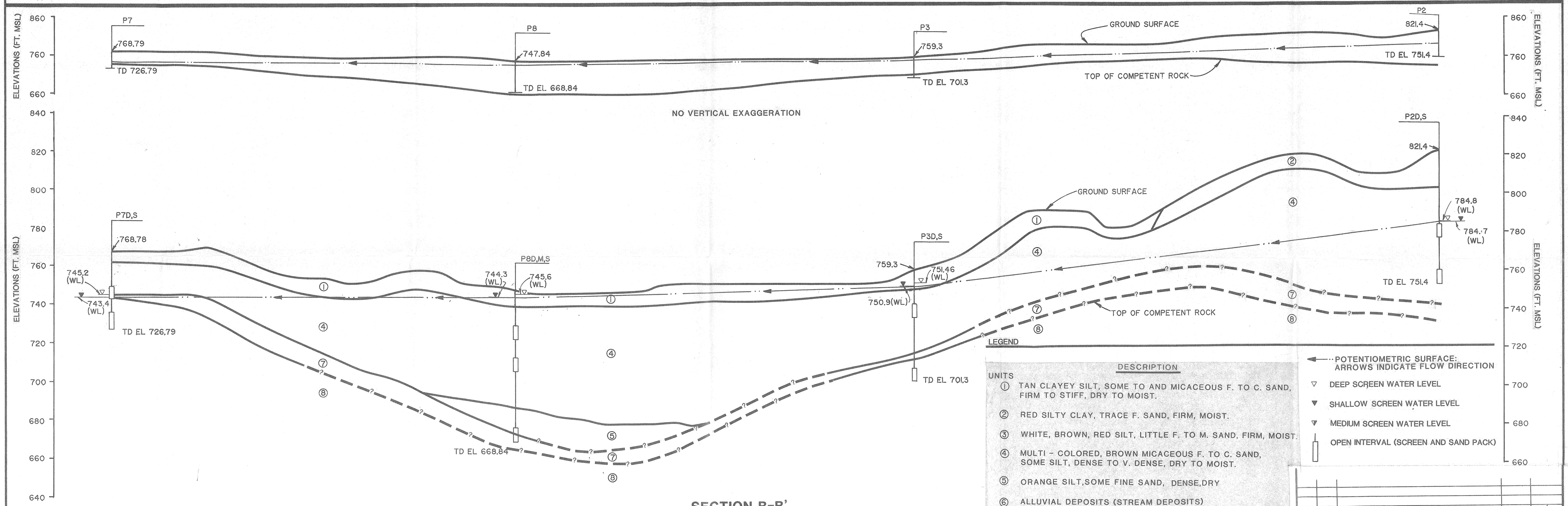
Waste Management of Carolinas, Inc.
Duncan, South Carolina, 29334

SHEET ____ OF ____

DRAWING NO. 50

FIGURE 11





LEGEND

UNITS	DESCRIPTION
①	TAN CLAYEY SILT, SOME TO AND MICACEOUS F. TO C. SAND, FIRM TO STIFF, DRY TO MOIST.
②	RED SILTY CLAY, TRACE F. SAND, FIRM, MOIST.
③	WHITE, BROWN, RED SILT, LITTLE F. TO M. SAND, FIRM, MOIST.
④	MULTI - COLORED, BROWN MICACEOUS F. TO C. SAND, SOME SILT, DENSE TO V. DENSE, DRY TO MOIST.
⑤	ORANGE SILT, SOME FINE SAND, DENSE, DRY
⑥	ALLUVIAL DEPOSITS (STREAM DEPOSITS)
⑦	ALTERNATING LAYERS OF ROCK AND PARTIALLY WEATHERED ROCK.
⑧	COMPETENT ROCK (GRANITIC GNEISS AND SCHIST)

POTENTIOMETRIC SURFACE: ARROWS INDICATE FLOW DIRECTION

▽ DEEP SCREEN WATER LEVEL

▼ SHALLOW SCREEN WATER LEVEL

▽ MEDIUM SCREEN WATER LEVEL

OPEN INTERVAL (SCREEN AND SAND PACK)

REV.	DATE	DESCRIPTION	DR BY	APP BY
1	2/17/88	FOR FILE ONLY - REVISED GROUNDWATER LEVELS	EAH	

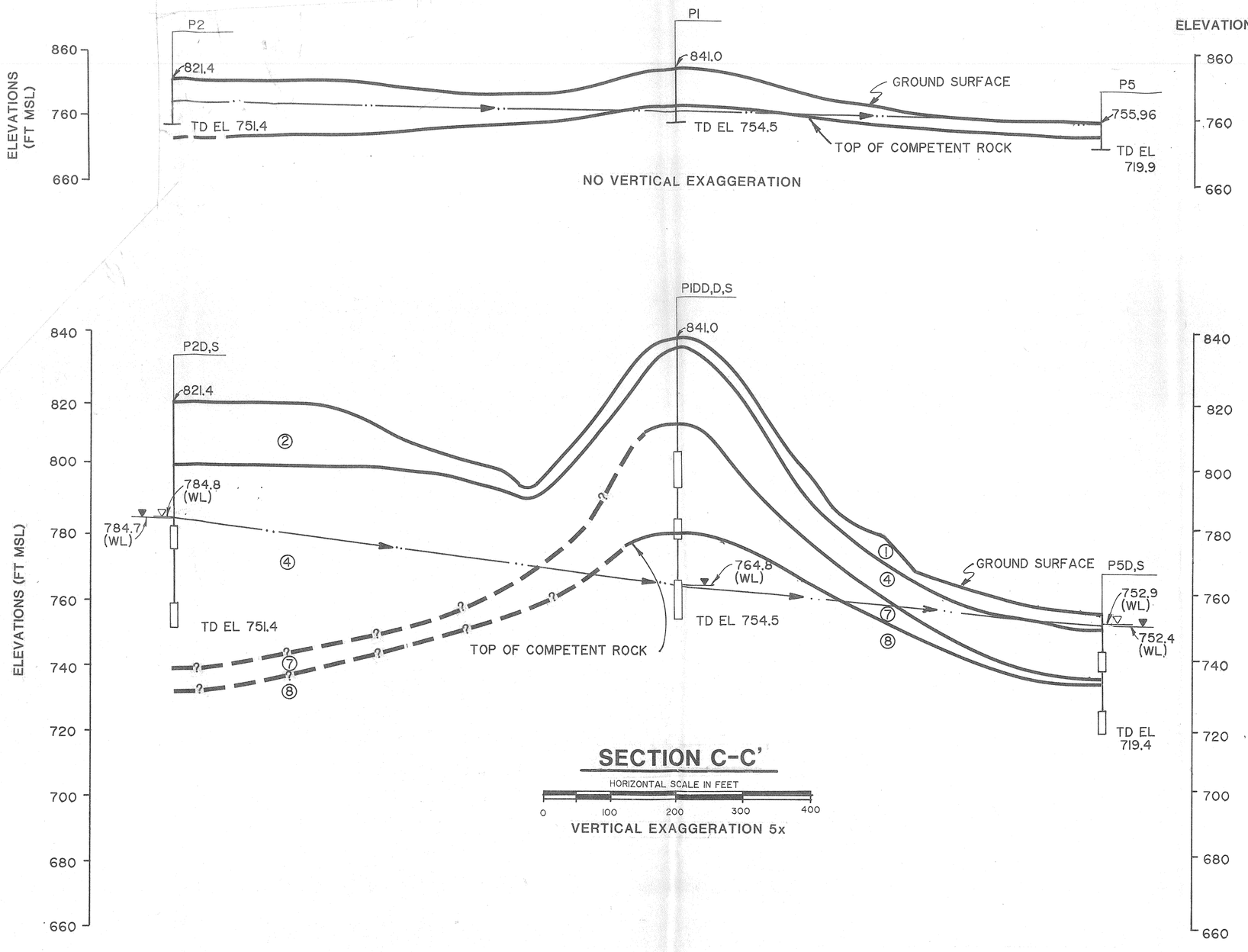
SCALE: AS SHOWN	PROJECT NO. 863 - 3407
DES BY GGR 6/22/87	PROJECT: KERNERSVILLE NORTH CAROLINA
DR BY EAH 6/22/87	SHEET TITLE: HYDROGEOLOGIC CROSS SECTION A-A' AND B-B'
CHK BY	
APP BY	

Golder Associates
Atlanta, Georgia

Waste Management of Carolinas, Inc.
Duncan, South Carolina, 29334

SHEET ____ OF ____
DRAWING NO. 44
FIGURE 12

RECEIVED
JUN 28 1989
SOLID WASTE BRANCH

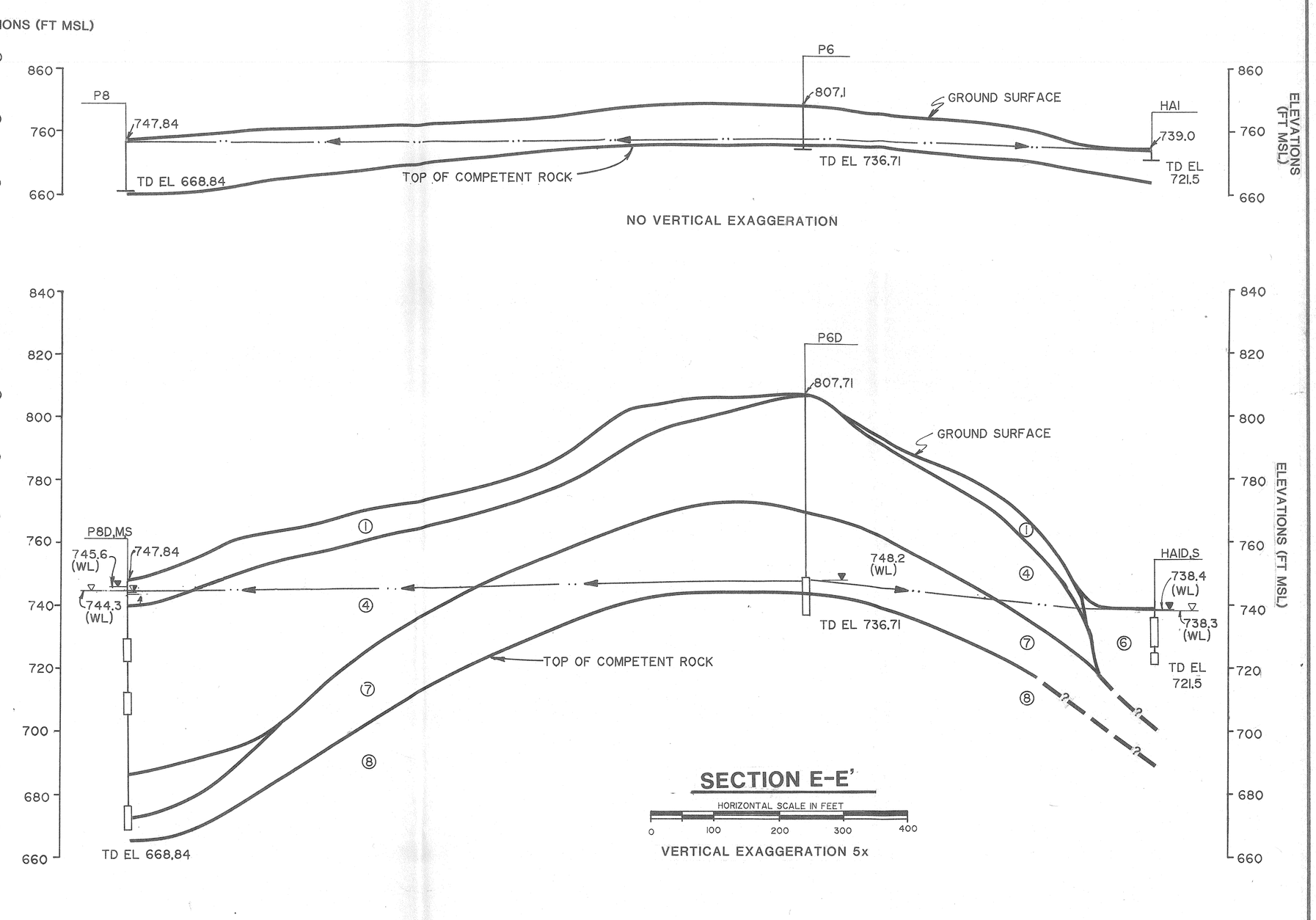


SECTION C-C'

HORIZONTAL SCALE IN FEET

0 100 200 300 400

VERTICAL EXAGGERATION 5x

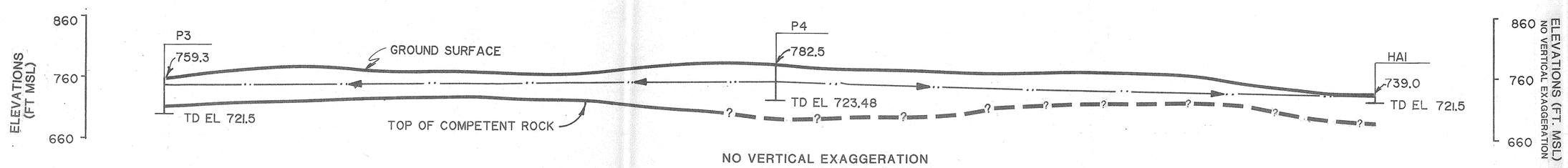


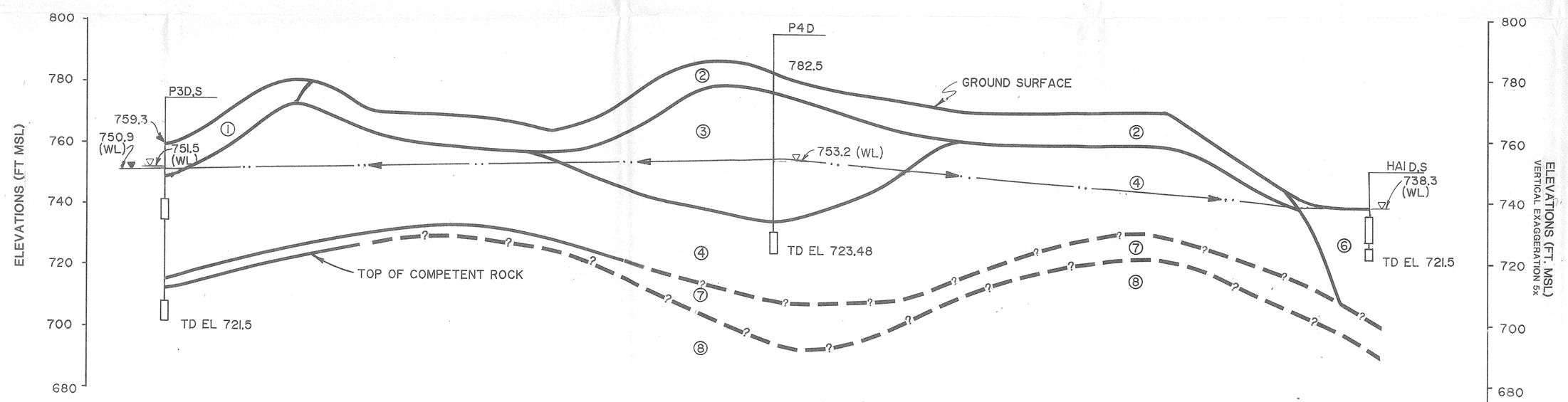
SECTION E-E'

HORIZONTAL SCALE IN FEET

0 100 200 300 400

VERTICAL EXAGGERATION 5x





SECTION D-D'

HORIZONTAL SCALE IN FEET

0 100 200 300 400

VERTICAL EXAGGERATION 5x

LEGEND

- POTENTIONMETRIC SURFACE: ARROW INDICATE FLOW DIRECTION
- DEEP SCREEN WATER LEVEL
- SHALLOW SCREEN WATER LEVEL
- MEDIUM SCREEN WATER LEVEL
- OPEN INTERVAL (SCREEN AND SAND PACK)

DESCRIPTION

UNITS

1. TAN CLAYEY SILT, SOME TO AND MICACEOUS F. TO C. SAND, FIRM TO STIFF, DRY TO MOIST.
2. RED SILTY CLAY, TRACE F. SAND, FIRM, MOIST.
3. WHITE, BROWN, RED SILT, LITTLE F. TO M. SAND, FIRM, MOIST.
4. MULTI - COLORED, BROWN MICACEOUS F. TO C. SAND, SOME SILT, DENSE TO V. DENSE, DRY TO MOIST.
5. ORANGE SILT, SOME FINE SAND, DENSE, DRY
6. ALLUVIAL DEPOSITS (STREAM DEPOSITS)
7. ALTERNATING LAYERS OF ROCK AND PARTIALLY WEATHERED ROCK.
8. COMPETENT ROCK (GRANITIC GNEISS AND SCHIST)

REV.	DATE	DESCRIPTION	DR BY	APP BY
1	2/17/88	FOR FILE ONLY - REVISED GOUNDWATER LEVELS	EAH	6/26/88

SCALE: AS SHOWN

863 - 3407

DES BY	GGR	6/22/87
DR BY	EAH	6/22/87
CHK BY	RP	6/26/88
APP BY	RP	6/26/88

PROJECT NO.

PROJECT: KERNERSVILLE NORTH CAROLINA

SHEET TITLE: HYDROGEOLOGIC CROSS SECTIONS C-C', D-D', & E-E'

Golder Associates
Atlanta, Georgia

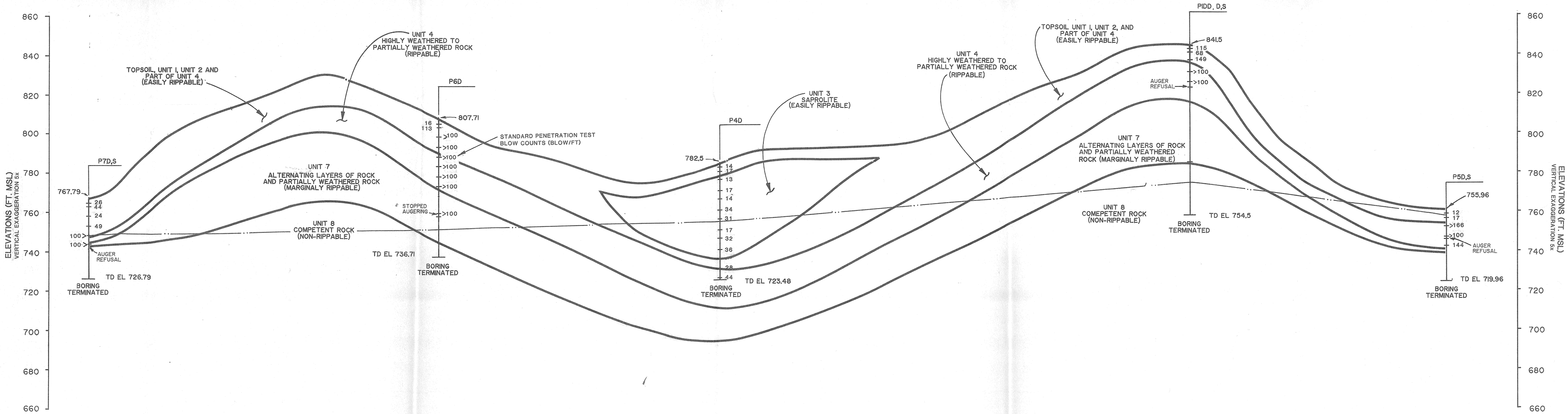
Waste Management of Carolinas, Inc
Duncan, South Carolina, 29334

SHEET ____ OF ____

DRAWING NO. 45

FIGURE 13

RECEIVED JUN 28 1988 SOLID WASTE BRANCH



GENERALIZED SITE ENGINEERING CHARACTERISTICS

HORIZONTAL SCALE IN FEET

0 100 200 300 400

LEGEND

P6D ← TEST BORING NUMBER

16
113 ← STANDARD PENETRATION (BLOW COUNTS)
>100
>100
>100
>100

DESCRIPTION

UNITS

1. TAN CLAYEY SILT, SOME TO AND MICACEOUS F. TO C. SAND, FIRM TO STIFF, DRY TO MOIST.
2. RED SILTY CLAY, TRACE F. SAND, FIRM, MOIST.
3. WHITE, BROWN, RED SILT, LITTLE F. TO M. SAND, FIRM, MOIST.
4. MULTI - COLORED, BROWN MICACEOUS F. TO C. SAND, SOME SILT, DENSE TO V. DENSE, DRY TO MOIST.
5. ORANGE SILT,SOME FINE SAND, DENSE,DRY
6. ALLUVIAL DEPOSITS (STREAM DEPOSITS)
7. ALTERNATING LAYERS OF ROCK AND PARTIALLY WEATHERED ROCK.
8. COMPETENT ROCK (GRANITIC GNEISS AND SCHIST)

RECEIVED JUN 28 1988 SOLID WASTE BRANCH

REV.	DATE	DESCRIPTION	DR BY	APP BY

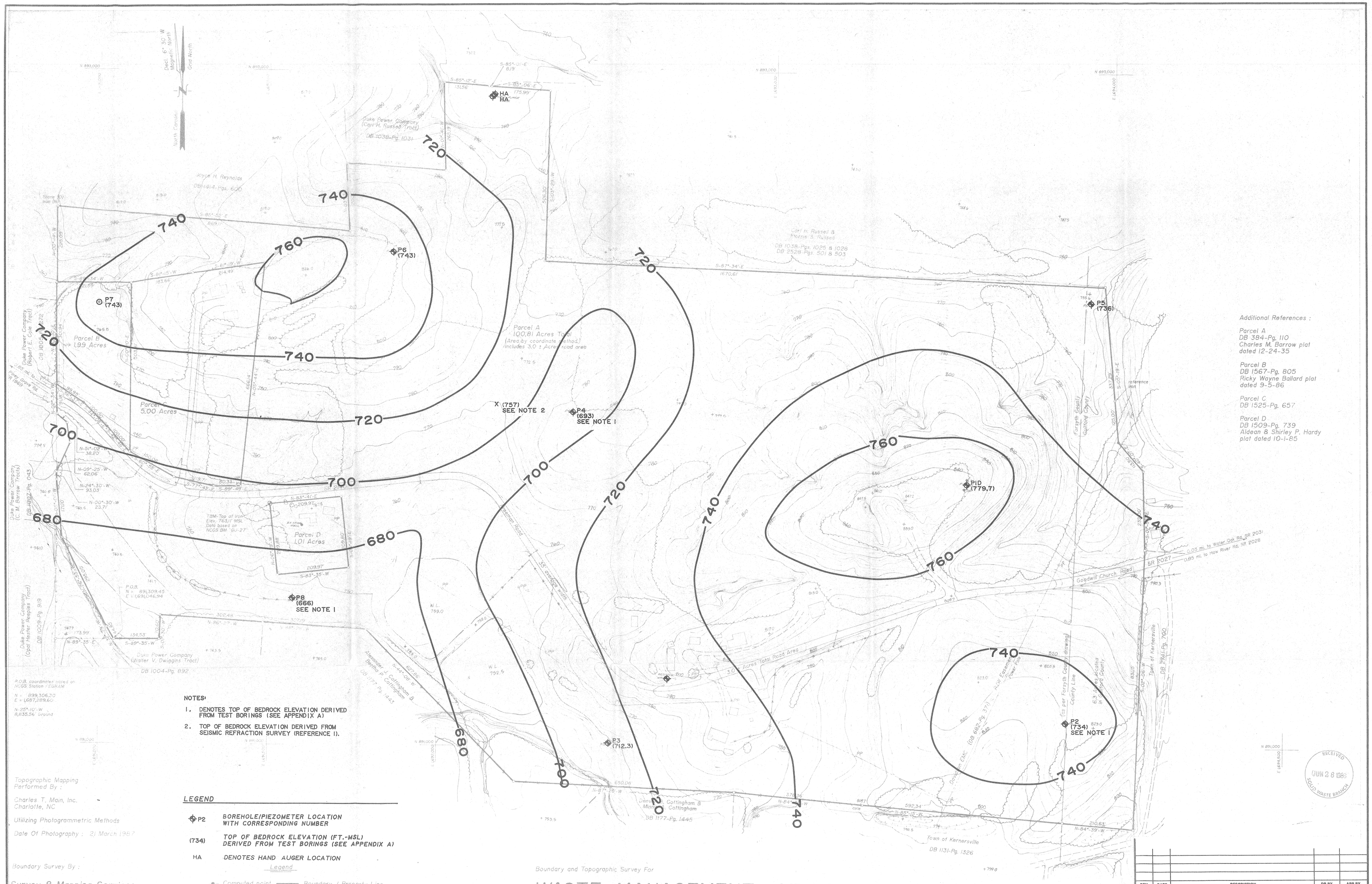
SCALE: AS SHOWN		PROJECT NO.
863 - 3407		PROJECT: KERNERSVILLE NORTH CAROLINA
DES BY	GGR	6/23/87
DR BY	EAH	6/23/87
CHK BY	[illegible]	6/26/88
APP BY	[illegible]	6/26/88

SHEET TITLE: ENGINEERING IMPLICATIONS CROSS SECTION

Golder Associates
Atlanta, Georgia

Waste Management of Carolinas, Inc
Duncan, South Carolina, 29334

SHEET ____ OF ____
DRAWING NO. 46
FIGURE 14



NOTES:

1. DENOTES TOP OF BEDROCK ELEVATION DERIVED FROM TEST BORINGS (SEE APPENDIX A)
2. TOP OF BEDROCK ELEVATION DERIVED FROM SEISMIC REFRACTION SURVEY (REFERENCE 1).

Topographic Mapping
Performed By :

Charles T. Main, Inc.
Charlotte, NC

Utilizing Photogrammetric Methods

Date Of Photography : 21 March 1987

Boundary Survey By :

Survey & Mapping Services
of South Carolina, Inc.

P. O. Box 3263
2028 Platt Springs Road
West Columbia, SC 29171
(803) 796 - 8214

LEGEND

P2	BOREHOLE/PIEZOMETER LOCATION WITH CORRESPONDING NUMBER
(734)	TOP OF BEDROCK ELEVATION (FT.-MSL) DERIVED FROM TEST BORINGS (SEE APPENDIX A)
HA	DENOTES HAND AUGER LOCATION

Legend

- Computed point
- Iron pipe, Old
- Iron pipe, New
- Monument Old
- Stone Old
- Boundary / Property Line
- Adjoining Property Line
- Fence
- Wells
- Reinforced Concrete Pipe

Boundary and Topographic Survey For

WASTE MANAGEMENT OF CAROLINAS, INC.

Belews Creek Township, Forsyth County, North Carolina

Oak Ridge Township, Guilford County, North Carolina

Date : 9 June 1987

100 0 100 200 300

Scale : 1" = 100'

Golder Associates
Atlanta, Georgia

REV.	DATE	DESCRIPTION	DR BY	APP BY

SCALE: AS SHOWN		PROJECT NO. 863-3407
FILE No. 863-3407		PROJECT: KERNERSVILLE, NORTH CAROLINA
DES BY	GGC	6/23/87
DR BY	SKB	6/29/87
CHK BY	[illegible]	6/26/87
APP BY	[illegible]	6/26/87

SHEET TITLE: GENERALIZED TOP OF BEDROCK ELEVATION CONTOUR MAP

Waste Management of Carolinas, Inc.
Duncan, South Carolina, 29334

SHEET ____ OF ____

DRAWING NO. 51

FIGURE 15