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Permit NO. 4302

SOLID WASTE SECTION

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Carmen Johnson

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COUNTY OF HARNETT
NORTH CAROLINA

DUNN-ERWIN LANDFILL
VERTICAL EXPANSION

Board of County Commissioners

H. L. Sorrell, Jr., Chairman
Beatrice Hill, Vice Chairman
Walt Titchener
Dan Andrews
Joe Bowden

County Manager

Dallas Pope

NORTH CAROLINA PROFESSIONAL SEAL 14110 ENGINEER EVERETTE HAWKS KNIGHT

December 1992

McKIM & CREED

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I. OVERVIEW OF HARNETT COUNTY SOLID WASTE FACILITIES

Introduction

The following report has been prepared in accordance with 10 NCAC 10G; North Carolina Solid Waste Management Rules, Department of Environment, Health and Natural Resources. This report together with the enclosed drawings is submitted for approval of a vertical expansion of the existing operational cell. In addition to the specific design requirements for a vertical expansion, also enclosed is a brief overview of the Harnett County facilities and an overall operation plan that includes a detailed discussion of how the Dunn-Erwin facility will operate (as requested by the N. C. DEHNR Regional Office).

General

Harnett County is a medium sized, predominantly rural county located in southeast North Carolina. The County's current population is approximately 70,000 and is expected to increase at a rate of approximately 5% over the next 20 years. There are 6 small municipalities which are geographically located in the eastern part of the County. These municipalities are Dunn, Erwin, Coats, Lillington, Buies Creek and Angier.

Based upon a brief review of past records, the 3 landfills within the County include Buies Creek, Anderson Creek, and Dunn-Erwin. The Buies Creek facility was closed out in 1986. The other two facilities are currently still in operation; however, future plans call for significant changes in operation. A brief overview of the two current landfill operations with anticipated future plans follows.

Anderson Creek Facility

The Anderson Creek facility is 30 acres in size and located southwest of Lillington near Highway 87. Due to the geographic location of the facility, it receives very little waste from any of the 6 municipalities. It appears that most of the waste is generated by sources outside Harnett County and current data indicates it receives approximately 30 tons per day of waste. Due to the source of waste and geographical location of the facility, the Anderson Creek facility will be converted to a transfer station. Customers utilizing the Anderson Creek facility will continue to bring their waste to the landfill site as always; however, the waste will be transferred to Dunn-Erwin and not landfilled at Anderson Creek.

Dunn-Erwin Facility

The Dunn Erwin landfill is approximately 225 acres in size and located in the southeastern part of the County between Dunn and Coats. The facility is relatively close to all 6 municipalities within the County and receives approximately 210 tons per day or 85% of the total waste stream generated by the County. With the addition of MSW from the Anderson Creek facility, the total waste at Dunn-Erwin will be 240 tons per day or approximately 60,000 tons per year. The Dunn-Erwin landfill is rapidly approaching its maximum permitted disposal capacity such that by October 1, 1993 we anticipate the Dunn-Erwin facility will be at capacity. A summary of the solid waste stream analysis is presented in Appendix E of this report.

Access into the Dunn-Erwin facility is from NCSR 1724 by way of a paved 2-lane road. A significant site characteristic is a small tributary that bisects the facility into two halves and flows predominantly from east to west. The referenced tributary is significant because it separates the municipal solid waste disposal area into separate "units", as defined by Subtitle D. As separate units, the County will be closing out the MSW facilities on the south side of the tributary in accordance to N. C Solid Waste Rules and not EPA Subtitle D Rules. Closure of the vertical expansion area will be in accordance to Subtitle D regulations as well as N. C. regulations. All of the MSW disposal after October 9, 1991 has occurred on the north side of the reference tributary.

The sources of borrow material for daily cover and landfill operation are also located on the north side of the tributary and adjacent to the MSW disposal area. As such, the need for off-site borrow material for operation of existing facilities has not been encountered to date. It also appears that there are sufficient materials available to operate the vertical expansion area for the next five (5) years. Consequently, the County will not need to search for available off-site materials unless or until the operation of the high tech facility occurs.

Located on the south side of the tributary are the yard waste processing area and several construction and demolition (C & D) landfill cells. The County will be closing out all the C & D landfills except the C & D landfill that was recently approved and currently receiving C & D debris. (Reference Appendix G for permit).

In general, the site is well maintained and operated such that there is little conflict between operational equipment and waste haulers. As previously stated the borrow sources are relatively close to the disposal area thus allowing for a very efficient operation. The County also segregates the borrow material during daily operation such that only the most impermeable material is utilized within the disposal area for daily cover and berms. The sandy deposits that are encountered are utilized for road maintenance.

Currently on-site facilities at the Dunn-Erwin landfill consists of the following:

a) Weigh station

b) Maintenance building

c) Municipal solid waste disposal area

d) MSW cells that stopped receiving waste prior to October 9,1991

e) An approved construction and demolition landfill

f) Asbestos monofill

g) Borrow area

h) Yard waste processing area that includes means for disposal of yard trash, land clearing debris, inert debris, C & D debris as defined by Memorandum #16.

i) Tire disposal area

II. <u>DAILY OPERATION OF THE DUNN-ERWIN FACILITY</u>

The following summarizes daily operations of the Dunn-Erwin facility as requested by the Regional Office of NC DEHNR:

a) All solid waste will enter the facility by way of NCSR 1724 and are weighed. Only solid waste as defined by the N. C. Solid Waste Management Rule 15A NCAC 13(B) is accepted.

b) MSW is directed to the disposal area located on the east side of the access road immediately past the weigh scales.

c) All other material is directed to the yard waste receiving area. Operation of yard waste facility is outlined in Section III of this report.

d) Construction and demolition debris is directed to the approved existing demolition landfill located at the south end of the facility.

e) Currently, waste in the existing disposal area is end dumped by the haulers at the top of the fill slope and pushed into the cell by the equipment operator. This process generally keeps operating activity working in the dry.

f) <u>Proposed</u> operations will require the construction of berms and placement of the waste at the toe of the berms by the haulers. The operator(s) will then haul material in as needed for daily cover. Section IV of this document, along with the enclosed drawings, addresses the proposed operations, specifically the vertical expansion area. Please refer to this section for further details concerning facility operations.

III. DAILY OPERATION OF YARD WASTE FACILITY

The Management of waste as defined by Memorandum #16 from the Solid Waste Section of NC DEHNR is as follows:

a) Material enters the Dunn-Erwin landfill site and is measured by scales similar to any other waste entering the facility.

b) Construction, demolition and yard waste customers are directed to the yard waste facility, specifically the staging area.

c) Loads of construction debris will be directed to the construction and demolition landfill by the yard waste crew.

d) Tires will be accepted at an area adjacent to the staging area for stockpiling. Asbestos, if properly packaged in accordance to Subtitle D regulations will be directed to the asbestos monofill.

e) Unauthorized dumping of construction or demolition debris in the staging area will be managed by fines. Material dumped at the yard waste facility will be loose and outside of any containers. If delivered in bags, the customer must empty the bags. Empty plastic bags and other containers will not be accepted at the yard waste facility.

f) At the staging area, yard waste is unloaded and segregated into leaves and grass clippings; limbs and stumps less than 6" in diameter, and the remaining yard waste that does not fall into either of the first two categories. A detailed outline of the operation of the yard waste processing area follows:

i) Material received at the yard waste facility shall be limited to separated construction and demolition debris, organic wood, leaves and grass. Woody organic material will be stockpiled temporarily, processed and then placed in stockpile within 7 days. Grass clippings and leaves will be placed in windrows within 48 hours.

ii) A Norkot Slabgrinder or similar will be used to reduce waste material size to a uniform size. Screen sizes of 1" to 4" will be utilized. Woody waste will be stockpiled as shown on the plans and utilized as a mulch. Leaves and grass clippings will be placed in windrows for composting within 48 hours.

iii) Windrows consisting of the leaves and grass clippings will be located as shown on the plans. The windrows will be turned utilizing a clam shell front end loader to maintain proper aeration and temperature control.

iv) The windrows will be carefully managed with detailed attention to temperature, oxygen, moisture and C/N ratio. Temperatures will be maintained between 70 degrees and 32 degrees Fahrenheit. Carbon to nitrogen ratios (C/N) between 20:1 to 30:1 will be maintained. Oxygen will be such that the windrow will be squishy and comparatively light. Moisture will be maintained such that water can be squeezed out.

v) Windrow will be constructed with a bottom width of 16 feet, and approximately 8′ in height. A temperature probe will be utilized to insure proper temperature control. All other parameters will be controlled based upon visual inspection and experience. Turning frequency will be as necessary to maintain conditions described in item V above.

vi) Compost will receive final aeration upon completion of stabilization cycle to ensure stability before distribution.

vii) Nitrogen bearing waste (grass clippings) will be incorporated into piles within 48 hours of on-site arrival.

viii) Monitoring and reporting requirements will be submitted to the Division which includes the following information:

(a) Sources, type, quality (by weight or volume) of waste received at the facility.

(b) Turning frequencies, timing and amount of water addition (if applicable).

(c) Sampling of temperature, duration, and changes during composting.

(d) The quantity, by weight or volume, of compost or mulch produced.

(e) The quantity, by weight or volume, of compost and mulch removed from the facility.

(f) A description of the end product and distribution or method of disposal.

A copy of the Yard Waste Report is presented in Appendix H.

IV. VERTICAL EXPANSION

This section together with the enclosed drawings is submitted for approval in accordance with 10 NCAC 10G; North Carolina Solid Waste Management Rules, Department of Environment, Health, and Natural Resources, Solid Waste Division, Solid Waste Section and specifically addresses the design requirements as required by the Solid Waste Section.

1. Disposal Area and Borrow Site

(a) Drawing 2 presents both the disposal area and the borrow site. No existing buildings are located within the borrow site or the expansion area. The existing waste boundary, buffer areas, temporary bench marks (TBM), and property lines are all defined on drawing 2.

(b) The grading plan for the borrow site requires the installation of 3 sediment basins around the perimeter. The grading plan for the disposal area requires the construction of a perimeter storm drainage collection facility followed by the construction of berms prior to the placement of any waste or mounding in the disposal area. Drawings 6 & 7 present a typical cross section for the mounding operation. It should be noted that surface drainage at the top will be diverted away from the working face. Similarly, surface drainage at the bottom will always be draining away from the work area.

As the vertical expansion progresses, storm drainage will be diverted to slope drains where it is collected and directed to one of two sediment basins. The slope drains are tied together or extended in a manner such that the system remains a closed storm drainage system for the entire drainage reach to the bottom of the waste disposal area. This concept eliminates discharge of stormwater on fill slopes thus minimizing long term maintenance requirements. Details regarding location of slope drains on each layer and type of slope drain are presented on drawing 4.

The grading plan for the borrow site is presented on drawing 5. The slope of the access road to the borrow site should not exceed 10%. The bottom elevation of the borrow site should be located a minimum of 4 feet above the permanent acquifer. During grading operations, it is anticipated that perched water conditions will be encountered. Past investigations in this area have raised questions from the NC DEHNR regarding location of the groundwater table. As such excavations in the borrow area will prove the location of the permanent acquifer.

(c) A construction plan showing proposed final contours, existing contours, location of slope drains and drop structures, and the removal of stormwater run-off from the disposal area is presented on drawing 4. The construction plan for the borrow site showing proposed final contours, existing contours, temporary and permanent erosion control measures is presented on drawing 5.

(d) An erosion control plan that identifies the location of temporary and permanent erosion control measures for the disposal area is shown on drawing 4. The existing disposal site currently drains to a single sediment basin located on the south side of the facility that is adequately sized for the entire site. Prior to construction, the existing sediment basin will be cleaned out to insure it has the maximum capacity available. The proposed vertical expansion calls for the installation of a sediment basin on the northeast side of the facility. Proposed grades are such that approximately 25% of the facility drains to the basin on the northeast side. Both basins will be periodically maintained and cleaned every three (3) months or as needed. Diversion ditches, energy dissipators, ditch stabilizations, and pipe drains are included in the drawings. Stormwater/Erosion Control Calculations are presented in Appendix B and Seeding Specifications are presented in Appendix A.

(e) Detailed diagrams of dikes, trenches, sediment basins and other pertinent details for the disposal area may be found on drawings 6 & 7.

2. <u>Disposal Area Information</u>

(a) Cross-sections of the disposal area showing original and proposed elevations is presented on drawings 6 & 7. Existing conditions represent the current cell as of October 1, 1993. At that time, current filling operations will be ceased and the proposed vertical expansion will begin. It should also be noted that the upper 1 foot of existing soil cover may be utilized as daily cover during the vertical expansion. Care should be taken to avoid removing more than 1 foot of soil since this may unearth solid waste already landfilled.

(b) The site shall be developed to promote drainage away from the working area. Approximately 25% of the proposed site drains towards the northwest side of the facility. The remaining drainage is to be directed to the existing sediment basin located on the south side of the facility.

(c) The area method of filling, as shown in Appendix F, will be utilized such that 5 - 10 foot thick cell layers are constructed daily with operations extending over the entire fill area before proceeding to the next vertical lift. As shown on drawing 6, the dikes should be approximately ten (10) feet in height with a 1:1 (H to V) interior slope and a 3:1 (H to V) exterior slope. We anticipate that each daily cell will be approximately 5 to 10 feet in height, 50 feet wide and 100 feet long.

Initiation of construction will consist of installation of the perimeter storm drainage channels. Mounding should begin in the northeast corner of the facility by constructing a dike along the entire north face of the facility and a portion of the east side. The dikes will serve as a structure to place the MSW against and also minimize the amount of wind blown material. Operations are to begin with area 16 and continue southwest to area 154. (Reference drawing 3. The fill areas are grided on 100′ X 100′ squares and numbered for reference.) This process should be repeated for each lift. Daily operations should progress until the high point of a layer is located near the center of the facility. As such, the facility will always have positive surface drainage <u>away</u> from the working face. Upon reaching the final elevations, the working areas shall be seeded as soon as possible to minimize the potential for erosion.

By filling the northeast corner first and progressing southward with operations, most of the drainage will be diverted away from the working face and toward the existing sediment basin or new sediment basin as previously discussed. It is also important to note that by layer filling in the manner described, the site may be easily closed out at any a time during the facility life with minimal effort needed to control stormwater runoff.

It is understood that access to the disposal area may be limited during extremely wet conditions. As such, the landfill operator should reserve areas as close as possible to the access road on the disposal area for deposition of waste during inclimate weather.

3. Site Operation

(a) Day-to-day operation and maintenance of the site is to be managed by Mr. Robert Burnette, landfill supervisor. Mr. Jerry Blanchard is responsible for overall operation and maintenance of the facility.

(b) The facility has been designed to maximize the potential volume for waste within the available area. It is understood that the life of the facility will not extend beyond 5 years or 1998. Anticipated volumes were developed from data for a single month after the waste stream for the Anderson Creek and Dunn-Erwin landfills were combined. (Reference Appendix E) Field surveys of the existing cell at Dunn-Erwin confirmed the above quantities received at the Dunn-Erwin facility within 15%. Due to the potential for variations in the solid waste stream we elected to design the facility to the maximum feasible volume possible. It is important to note that the proposed facility is designed such that it may be closed at anytime prior to 1998. Furthermore, should the waste stream be such that the landfill is not built to completion by 1998, as presented on the design drawings, the storm drainage and erosion control measures will be in place for the project closeout.

The facility life based upon the current waste stream is approximately 93 months. At the end of 5 years, we anticipate that all of Layer 1 and 20 vertical feet of Layer 2 will be completed. The above calculation is based upon a daily cell approximately 25 feet in width, 100 feet in length, and 10 feet deep. Thus, layer 1 would have a total capacity of 805 daily cells and an anticipated life of 39 months. Similarly, layer 2 has a capacity of 637 daily cells and an anticipated life of 30 months. The 3rd and final layer has a capacity of 490 cells and an anticipated life of 24 months.

The County has the necessary equipment to perform all operations described herein. A summary of the County landfill equipment follows:

i) 1 350 Rex Compactor 1978

ii) 1 355 Rex Compactor 1986

iii) 1 T D 15C International Dozer

iv) 1 850B John Deere Dozer

v) 1 D-G-H- Cat Dozer

vi) 1 613 Cat Pan 1984

vii) 1 613 Cat Pan 1989

viii) 1 615 Cat Pan 1990

ix) 1 412 International Pan 1986

x) 1 250 International Loader 1978

xi) 1 Gallion Motor-Grader

xii) JCB Back-Hoe

xiii) White Road Tractor 1970

xiv) Roger Low-Boy Trailer

4. Expanded Groundwater and Surface Water Monitoring

Harnett County currently has a groundwater monitoring program in place. Drawing 2 presents the location of the 5 monitoring wells located across the site. Two wells are located down gradient of the proposed vertical expansion area. The other three wells are located at selected locations across the site. In addition to the groundwater testing, at least one surface water tests has been performed both upstream and downstream of the landfill expansion area. The County will be testing 2 times per year effective January 1, 1993 as required by the Solid Waste Regulations.

Recent groundwater and surface water sampling and testing have not indicated any problems at the Dunn-Erwin landfill. As such, we recommend the existing monitoring plan be continued.

5. Cover Soil

(a) Geotechnical data from the Dunn-Erwin facility may be found in Appendix C. It should be noted that test pits have not been dug within the proposed borrow area. Actual test pit locations are located within the previously approved adjacent borrow site. Based upon a review of the soil boring data, subsurface conditions appear to be similar between the two borrow sites. As such, the laboratory tests performed on remolded samples taken from the test pits on the adjacent borrow site should be considered representative of the proposed borrow site for the vertical expansion.

We have also noted boring locations as discussed in the referenced geotechnical report on Drawing 2. The boring locations for the proposed area are approximate and presented for reference while reviewing the S&ME Report in Appendix C.

(b) The least permeable soil shall be stockpiled to be utilized for final cover.

(c) Earthwork calculations may be found in Appendix D for the disposal area and for the borrow site. Approximately 580,000 c.y. is available from the proposed borrow site.

6. Other information:

(a) A copy of the legal description for the Dunn-Erwin facility is presented in Appendix I.

(b) A copy of the permit for the C & D landfill is presented in Appendix G.

(c) A copy of the zoning letter is presented in Appendix J.

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APPENDIX A

SEEDING SPECIFICATIONS

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PART 1 - GENERAL

1.1 Description and General Requirements:

1.1.1 This section covers the furnishing of materials, labor, and equipment necessary to minimize erosion, siltation, and pollution on the project or projects covered by these specifications.

1.1.2 The Contractor shall take whatever measures are necessary to minimize soil erosion and siltation, water pollution, and air pollution. The Contractor shall also comply with the applicable regulations of all legally constituted authorities relating to pollution prevention and control. The Contractor shall keep himself fully informed of all such regulations which in any way affect the conduct of the work. In the event of conflict between such regulations and the requirements of these specifications, the more restrictive requirements shall apply.

1.1.3 Failure on the part of the Contractor to perform the necessary measures to control erosion, siltation, and pollution will result in the Engineer notifying the Contractor to take such measures. In the event that the Contractor fails to perform such measures within 24 hours after receipt of such notice, the Engineer may suspend the work with no extension of contract time, or may proceed to have such measures performed by others at the Contractor's expense, or both.

1.1.4 Related Work in Other Sections:

Clearing, Grading, and Excavation:	Section 02200
Seeding:	Section 02480

1.2 Quality Assurance:

1.2.1 Erosion and sedimentation control shall conform to the requirements of the North Carolina Sedimentation Pollution Control Act of 1973.

PART 2 - PRODUCTS

2.1 Seeding and seeding materials shall conform to the requirements of Section 02480.

2.2 Silt fences shall conform to the details shown on plans.

PART 3 - EXECUTION

3.1 The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent the eroding of soil and the siltation of rivers, streams, lakes, reservoirs, ditches, ground surfaces, or other property. Should any erosion or siltation occur, the Contractor shall take immediate action to correct the situation. The Contractor shall remove and properly dispose of any material washed into rivers, streams, lakes, reservoirs, ditches, storm sewers, or other property. The Contractor shall be liable for any damage to private or public property resulting from insufficient erosion and siltation control measures.

3.2 Construction operations in rivers, streams, ditches, and water impoundments shall be restricted to those areas which must be entered for the performance of work shown on the plans. Excavated materials shall not be deposited in rivers, streams, ditches, or impoundments except that temporary earth dikes may be used when approved by the Engineer, but such dikes shall be completely removed in such manner as to prevent siltation. Frequent fording of flowing streams with equipment will not be permitted. Temporary bridges or other structures shall be used wherever frequent stream crossings are necessary.

3.3 Temporary and permanent erosion control measures shall be provided as shown on the plans or as directed by the Engineer. Temporary sediment control devices must be installed to the extent possible prior to initiation of grading and excavation. The devices must be maintained at a minimum of 50% of the original sediment storage capacity and may not be removed until the areas they serve have been stabilized. Temporary erosion control measures shall include, but not be limited to, the use of temporary berms, dikes, drainage ditches, silt basins, silt ditches, slope drains, structures, stone check dams, vegetation, mulches, mats, netting, gravel, or other necessary methods. Temporary erosion control may include work outside the construction limits.

3.4 The Engineer may limit the area over which excavation, embankment, and grading operations are performed whenever the Contractor's operations are not effectively minimizing erosion and/or siltation.

3.5 All disturbed, non-paved areas shall be seeded and fertilized, mulched, and tacked as soon as practical after cleanup in accordance with the detailed technical specifications therefore. In no case shall a total area of one acre or more be left ungrassed for a period of thirty (30) days when construction has been completed in the area.

3.6 The Contractor shall take every precaution throughout the life of the project to prevent the pollution of rivers, streams, and water impoundments. Pollutants such as chemicals, fuels, lubricants, bitumens, sewage, and other harmful waste shall not be discharged into or alongside rivers, streams, or impoundments, or into natural or manmade channels leading thereto. The Contractor shall also comply with all Federal, State, and local water and air pollution laws.

3.7 Contractor shall maintain all erosion control measures until such time as the appropriate State authority approves and releases the site at which time the Contractor shall remove all erosion control measures as directed by the Engineer.

END OF SECTION

PART 1 - GENERAL

1.1 The work of seeding and mulching shall be performed immediately upon completion of grading. The Contractor shall adapt his operations to variations in weather or soil conditions as necessary for the establishment and growth of the grasses or legumes. In all operations, care shall be taken to preserve the required line, grade, and cross-section of the area.

PART 2 - PRODUCTS

2.1 Seed shall be certified by and comply with the rules and regulations of the NC Department of Agriculture. Only high quality seed shall be used. Wet, moldy, or otherwise damaged seed or seed containing an excess of noxious weeds will not be acceptable. Each variety of seed shall be furnished and delivered in separate bags. If seed is to be mixed before sowing, it shall be mixed by methods which will mix the seed thoroughly and uniformly without causing damage to the seed. During handling and storage, seed shall be protected from damage from any cause.

2.2 Fertilizer shall comply with the rules and regulations of the NC Department of Agriculture. It shall be manufactured from cured stock and have an analysis of 5-10-10. During handling and storage, the fertilizer shall be protected against hardening, caking, or loss of plant food values. Any hardened or caked fertilizer shall be pulverized to its original condition before being used.

2.3 Lime shall comply with the rules and regulations of the NC Department of Agriculture. It shall be agricultural grade ground dolomitic limestone containing not less than 85 percent of combined calcium and magnesium carbonates. It shall be so graded that 100 percent will pass a No. 10 sieve and 40 percent will pass a No. 100 sieve. During handling and storage, lime shall be protected against hardening and caking. Any hardened or caked lime shall be pulverized to its original condition before being used.

2.4 Mulch shall consist of clean grain straw reasonably free from mature seedbearing stalks, roots, or bulblets of Johnson Grass, Nutgrass, Sanbur, Wild Garlic, Wild Onion, Bermuda Grass, Crotalaria, Witchweed, and restricted noxious weeds as defined by the NC Department of Agriculture at the time of use. Mulch that is matted or lumpy shall be loosened and separated before being used.

PART 3 - EXECUTION

3.1 The Seed bed shall be properly prepared and true to line and grade with lime and fertilizer worked into the soil four to six inches deep. All weeds and other unacceptable growth shall be cut and disposed of properly. Uneven and rough areas shall be smoothed to provide a uniform surface. The soil shall be loosened to a minimum depth of five inches and all clods shall be broken up. The top two or three inches of soil shall be worked into an acceptable seedbed by the use of approved methods. On cut slopes greater the 2:1, the Engineer may permit the depth of preparation to be reduced, but in all cases the slope surface shall be scarified, grooved, trenched, or punctured so as to provide places in which the seeding materials can lodge.

3.2 Lime and fertilizer shall be distributed uniformly over the prepared seedbed at the specified rates and then harrowed, raked, or otherwise thoroughly worked or mixed into seedbed. Seed shall be distributed uniformly over the prepared seedbed at the specified rate and immediately harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil. Immediately after seed has been properly covered, the seedbed shall be compacted by means approved by the Engineer.

3.3 Within 24 hours after the completion of seeding, all areas shall be mulched. Mulch shall be spread uniformly by hand or by approved mechanical spreaders which will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.

3.4 Mulch shall be held in place by applying a sufficient amount of asphalt emulsion or other approved binding material. The rate and method of application shall meet the approval of the Engineer. When the binding material is not applied directly with the mulch, it shall be applied immediately following the mulch application. During the application of the binding material, adequate precautions shall be taken to prevent damage to traffic, structures, traffic control devices, and other appurtenances. When any damage does occur, the Contractor shall repair it, including any necessary cleaning. The Contractor shall take precautions to prevent mulch from entering drainage structures and shall promptly remove any blockages which may occur.

3.5 Unless specified otherwise on the Plans, the type of seed and the rates for seed, fertilizer, lime and mulch shall be as listed below:

Shoulders, Side Ditches, Slopes (Max. 3:1)

DATE:	TYPE:	PLANTING RATES:
Aug 15 - Nov 1	Tall Fescue	300 lbs./acre
Nov 1 - Mar 1	Tall Fescue & Abruzzi Rye	300 lbs./acre 25 lbs./acre
Mar 1 - Apr 15	Tall Fescue	300 lbs./acre
Apr 15 - Jun 30	Hulled Common Bermudagrass	25 lbs./acre
Jul 1 - Aug 15	Tall Fescue and ***Browntop Millet ***or Sorghum - Sudan Hybrids	120 lbs./acre 35 lbs./acre 30 lbs./acre
	SLOPES (3:1 to 2:1)	
Mar 1 - Jun 1	Sericea Lespedeza (scarified) &	50 lbs./acre
(Mar 1 - Apr 15)	Add Tall Fescue	120 lbs./acre
(Mar 1 - Jun 30)	Or Add Weeping Lovegrass	10 lbs./acre
(Mar 1 - Jun 30)	Or Add Hulled Common Bermudagrass	25 lbs./acre
Jun 1 - Sep 1	***Tall Fescua and ***Browntop Millet *** or Sorghum - Sudan Hybrids	120 lbs./acre 35 lbs./acre 30 lbs./acre
Sep 1 - Mar 1	Sericea Lespedza (unhulled - unscarified) and Tall Fescue	70 lbs./acre 120 lbs./acre
(Nov 1 - Mar 1)	Add Abruzzi Rye	25 lbs./acre

PART 4 - SEEDBED PREPARATION

4.1 Chisel compacted areas and spread topsoil 3 inches deep over adverse soil conditions, if available.

4.2 Rip the entire area to 6 inches depth.

4.3 Remove all loose rock, roots, and other obstructions leaving surface reasonably smooth and uniform.

4.4 Apply agricultural lime, fertilizer, and superphosphate uniformly and mix with soil (see below*).

4.5 Continue tillage unit a well-pulverized, firm, reasonably uniform seedbed is prepared 4 to 6 inches deep.

4.6 Seed on a freshly prepared seedbed and cover seed lightly with seeding equipment or cultipack after seeding.

4.7 Mulch immediately after seeding and anchor mulch.

4.8 Inspect all seeded areas and make necessary repairs or reseeding within the planting season, if possible. If stand should be over 60% damaged reestablish following original lime, fertilizer and seeding rates.

4.9 Consult Conservation Inspector on maintenance treatment and fertilization after permanent cover is established.

* Apply: Agricultural Limestone - 2 tons/acre or 3 tons/acre in clay soils.
Fertilizer - 1000 lbs/acre (10-10-10)
Superphosphate - 500 lbs/acre (20%)
Mulch - 2 tons/acre (small grain straw)
Anchor - asphalt emulsion at 450 gal./acre

Consultation Conservation Engineer or Soil Conservation Service for additional information concerning other alternative for vegetation of denuded areas. The above vegetation rates are those which do well under local conditions, other seeding rate combinations are possible.

***Temporary - Reseed according to optimum season for desired permanent vegetation, Do not allow temporary cover to grow over 12" in height before mowing, otherwise fescue may be shaded out.

4.10 The Contractor shall maintain seeded areas in a satisfactory condition until final acceptance of the project. Areas of damage or failure due to any cause shall be corrected by being repaired or by being completely redone as may be directed by the Engineer. Damage or failure resulting from poor seed, the Contractor's operation, or his failure to provide erosion control shall be repaired or replaced at the Contractor's expense.

4.11 The Contractor shall maintain adequate drainage on the project at all times. In the event water pockets are formed, they shall be drained by the Contractor and all wet and unstable material shall be removed and disposed of and the area backfilled and compacted with suitable material. Such remedial work caused by the failure of the Contractor to keep the area adequately drained shall be performed at his expense.

END OF SECTION

APPENDIX B

EROSION CONTROL CALCULATIONS

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EROSION & SEDIMENT CONTROL

CALCULATIONS

FOR:

HARNETT COUNTY

DUNN-ERWIN LANDFILL

VERTICAL EXPANSION

McKIM & CREED
PROJECT NO.

0006-L009.9E

December 1992

**EROSION & SEDIMENT CONTROL
CALCULATIONS
FOR:**

**HARNETT COUNTY
DUNN-ERWIN LANDFILL
VERTICAL EXPANSION**

INDEX

<u>**References:**</u>

1. North Carolina Sedimentation Control Commission, Erosion and Sediment Control Planning and Design Manual, September 1988.

2. Virginia Soil and Water Conservation Commission, Virginia Erosion and Sediment Control Handbook, 1980.

3. Goldman, Jackson, Bursztynsky, Erosion and Sediment Control Handbook, 1986.

4. Michael R. Lindburg, P.E., Civil Engineering Manual, Fourth Edition, 1986.

5. H. Rooney Malcom, P.E., Elements of Urban Stormwater Design.

6. United States Department of Agriculture, Soil Conservation Service, Guide for Sediment Control on Construction Sites in North Carolina, Revised August 1979.

7. Concrete Pipe Design Manual, American Concrete Pipe Association.

CALCULATION

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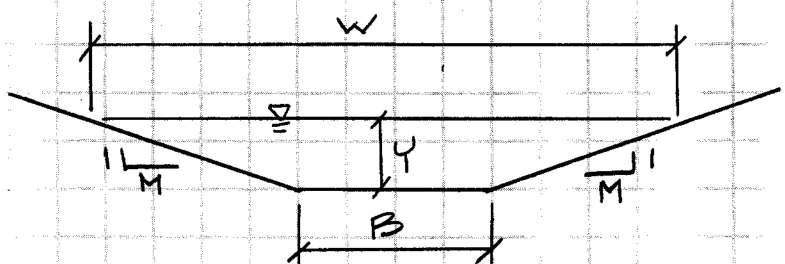
REMARKS

DESIGN CRITERIA & ASSUMPTIONS

CHANNEL CALCULATIONS:



$W = B + 2MY$ — W = TOP WIDTH (FT)

$A = BY + MY^2$ — A = CROSS SECTIONAL AREA (SF)

$W_P = B + 2Y\sqrt{1+M^2}$ — W_P = WETTED PERIMETER (FT)

$R = A / W_P$ — R = HYDRAULIC RADIUS

$Q = 1.486/n \; A R^{0.67} S^{0.5}$ — Q = FLOW (CFS)

$V = 1.486/n \; R^{0.67} S^{0.5}$ — V = VELOCITY (FPS)

n = ROUGHNESS COEFFICIENT

OPEN CHANNEL FLOW CRITERIA

VELOCITY	STABILIZATION CONDITION
0 - 2.5 FPS	NORMAL SEEDING
2.5 - 4.5 FPS	ADD JUTE NET WITH STRAW
4.5+ FPS	ARMORIZE
4.5 FPS	MAX. VELOCITY FOR GRASS LINED CHANNELS

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REMARKS

MAXIMUM ALLOWABLE SHEAR STRESS
(SEE TABLE 8.05g ON PAGE 82)

LINER	SHEAR STRESS
NET W/STRAW	1.45
FS-2 FILTER STONE	0.80
CLASS "A" RIP-RAP	2.50
CLASS "B" RIP-RAP	3.80

MANNINGS ROUGHNESS COEFFICIENT
(SEE TABLES 8.05e & 8.05f ON PAGE 82)

LINER	"n" (DEPTH RANGE) 0-0.5 FT	0.5-1.0 FT	1.0-2.0 FT
NET W/STRAW	0.065	0.033	0.033
FS-2	0.045	0.034	0.034
CLASS "A"	0.106	0.054	0.044
CLASS "B"	0.215	0.068	0.062

GRASS LINED CHANNEL HAVE A RETARDANCE CLASS "C". THE ROUGHNESS COEFFICIENT IS IN RELATION TO THE PRODUCT OF THE VELOCITY & HYDRAULIC RADIUS, SEE FIG 8.05c ON PAGE 81)

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REMARKS

SLOPE DRAIN SYSTEM DESIGN

INLET CAPACITIES

INLET NO.	DRAINAGE AREA (Ac)	C	ΔH (FT)	L (FT)	T_c (MIN)	i_{10} (IN/HR)	Q_{10} (CFS)
A1	1.0	0.35	13	500	5	7.5	2.6
A2	2.9		20	800	6	7.3	7.4
A3	6.0		20	1100	8	6.8	14.3
A4	8.5		20	1200	9	6.5	19.3
A5	0.7		5	300	5	7.5	1.8
B1	2.4	0.35	15	600	5	7.5	6.3
B2	4.9		15	1000	8	6.8	11.7
B3	9.6		20	1300	10	6.2	20.8
B4	2.2		10	700	6	7.3	5.6
C1	1.0	0.35	20	500	5	7.5	2.6
C2	2.0		10	600	5	7.5	5.3

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SLOPE DRAIN SYSTEM:
PIPE FLOWS

PIPE SECTION	TRIBUTARY AREAS	AREA (AC)	ΣCA	T_c (MIN)	i_{10} (IN/HR)	Q_{10} (CFS)
A1 - OUT	A1	1.0	0.35	5	7.5	2.6
A2 - OUT	A2	2.9	1.02	6	7.3	7.4
A3 - A4	A3	6.0	2.10	8	6.8	14.3
A4 - A5	A3+A4	14.5	5.08	9	6.5	33.0
A5 - OUT	A3+A4+A5	15.2	5.32	9	6.5	34.6
B1 - OUT	B1	2.4	0.84	5	7.5	6.3
B2 - B3	B2	4.9	1.72	8	6.8	11.7
B3 - B4	B2+B3	14.5	5.08	10	6.2	31.5
B4 - OUT	B2+B3+B4	16.7	5.85	10	6.2	36.2
C1 - C2	C1	1.0	0.35	5	7.5	2.6
C2 - OUT	C1+C2	3.0	1.05	5	7.5	7.9

REMARKS

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REMARKS

SLOPE DRAIN SYSTEM
HEADWATER ANALYSIS : (INLET CONTROL)
— MAX. PIPE DIA. = 18"
— MAX. HW = 2 FT FOR PIPES ON FILL SECTION
— MAX. HW = DIA. + 1 FT FOR PIPES NOT IN FILL
(SEE FIGURE 33 ON PAGE 83)

NOTE: 12" DIA. MAX. HW/D = 2 FT MAX. Q = 5.2 CFS
15" DIA MAX. HW/D = 1.6 FT MAX. Q = 7.5 CFS
18" DIA. MAX HW/D = 1.3 FT MAX. Q = 9.5 CFS

PIPE SECTION	Q TOTAL (CFS)	DIA. (IN)	# PIPES REQ'D	FLOWS EACH (CFS)	HW/D	HW (FT)	
A1-OUT	2.6	12	1	2.6	1.02	1.02	<2.0
A2-OUT	7.4	15	1	7.4	1.5	1.9	<2.0
A3-A4	14.3	15	2	7.2	1.48	1.9	<2.0
A4-A5	33	30	1	33	1.21	3.0	<3.5
A5-OUT	34.6	30	1	34.6	1.29	3.2	<3.5
B1-OUT	6.3	15	1	6.3	1.33	1.7	<2.0
B2-B3	11.7	15	2	5.85	1.21	1.5	<2.0
B3-B4	31.5	30	1	31.5	1.2	3.0	<3.5
B4-OUT	36.2	36	1	36.2	0.9	2.7	<4.0
C1-C2	2.6	12	1	2.6	1.02	1.02	<2.0
C2-OUT	7.9	18	1	7.9	1.07	1.6	<2.0

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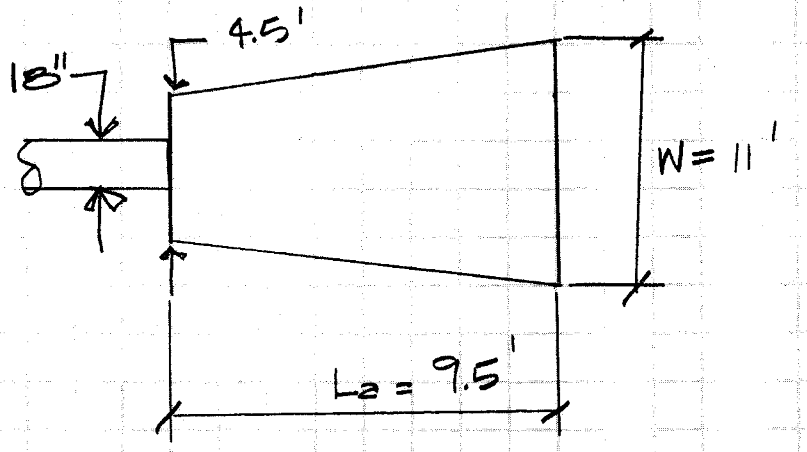
REMARKS

OUTLET PROTECTION DESIGN:

PIPE C2 - OUT
(SEE FIG. 8.06 ON PAGE <u>86</u>)

$D_o = 1.5$ FT
$Q = 8$ CFS



$d_{50} = 0.3$ FT $= 3.6$ USE CLASS "A" RIP-RAP

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REMARKS

CULVERT CROSSING DESIGN:

(SEE FIGURE 33 ON PAGE 84)

– $Q_{REQUIRED} = Q_{DC-B} + Q_{DC-E} + Q_{DC-D} + Q_{PIPE\ C2-OUT}$

$= 1.6 + 2.6 + 7.4 + 7.9 = 19.5$ CFS

– CORRUGATED PLASTIC PIPE

– MAX. HW = 3 FT

– USE 24" DIA. CORRUGATED PLASTIC PIPE

D = 2 FT

Q = 19.5 CFS

HW/D = 1.3 ⟿ HW = 2.6 < 3.0 FT (ok)

– OUTLET PROTECTION DESIGN

(SEE FIG. 8.06 ON PAGE 86)

D_o = 24"

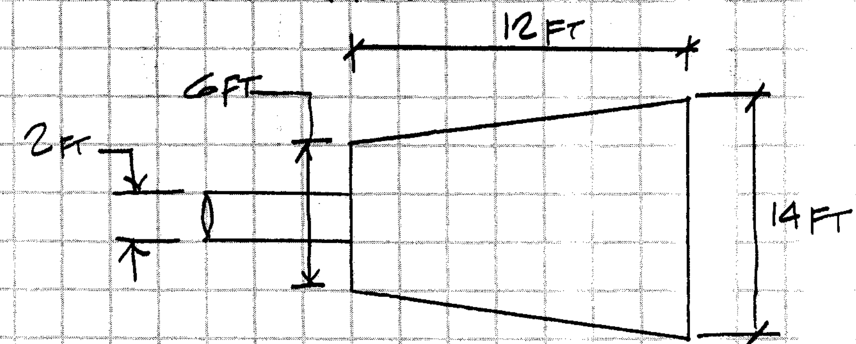
Q = 19.5 CFS

L_a = 12 FT

W = 2 + 12 = 14 FT

d_{50} = 0.4 FT = 4.8"

USE CLASS "A" RIP-RAP



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REMARKS

STILLING BASIN DESIGN
(SEE APPENDIX C & FIGURE 1 ON PAGES 85 & 86)
(COMBINE PIPES A1-OUT, A2-OUT, A5-OUT, B1-OUT, B4-OUT)

A1-OUT $D = 12'' = 1\text{ FT}$

$Q = 2.6\text{ CFS}$

$Q_{FULL} = (1.49/0.018)((1)^2(0.7854))(0.25)^{0.67}(0.0260)^{0.5}$

$= (82.78)(0.7854)(0.40)(0.51)$

$= 13.2\text{ CFS}$

$V_{FULL} = 16.9\text{ FPS}$

$Q/Q_{FULL} = 2.6/13.2 = 0.20$

$d/d_{FULL} = 0.35 \rightsquigarrow \text{DEPTH} = 0.35(1) = 0.35\text{ FT}$

$= 4.2''$

$V/V_{FULL} = 0.66 \rightsquigarrow V = (0.66)(16.9) = 11.2\text{ FPS}$

A2-OUT $D = 15'' = 1.25\text{ FT}$

$Q = 7.4\text{ CFS}$

$Q_{FULL} = (1.49/0.018)((1.25)^2(0.7854))(1.25(0.25))^{0.67}(0.30)^{0.5}$

$= (82.78)(1.23)(0.46)(0.55)$

$= 25.8\text{ CFS}$

$V_{FULL} = 20.9\text{ CFS}$

$Q/Q_{FULL} = 7.4/25.8 = 0.29$

$d/d_{FULL} = 0.41 \sim \text{DEPTH} = 0.41(1.25) = 0.51\text{ FT}$

$= 6.2''$

$V/V_{FULL} = 0.72 \sim V = (0.72)(20.9) = 15.1\text{ FPS}$

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REMARKS

AS-OUT $D = 30'' = 2.5$ FT
$Q = 34.6$ CFS

$Q_{FULL} = (1.49/0.02)((2.5)^2(.7854))(2.5(.25))^{.67}(0.24)^{0.5}$
$= 74.5(4.91)(0.73)(0.49)$
$= 130.8$ CFS

$V_{FULL} = 26.7$ FPS

$Q/Q_{FULL} = 34.6/130.8 = 0.26$

$d/d_{FULL} = 0.4 \rightsquigarrow$ DEPTH $= 0.4(2.5) = 1.0$ FT
$= 12''$

$V/V_{FULL} = 0.71 \rightsquigarrow V = (0.71)(26.7) = 19$ FPS

B1-OUT $D = 15'' = 1.25$ FT
$Q = 6.3$ CFS

$Q_{FULL} = (1.49/0.018)((1.25)^2(0.7854))((1.25)(0.25))^{0.67}(0.2794)^{0.5}$
$= (82.78)(1.23)(0.46)(0.53)$
$= 24.76$ CFS

$V_{FULL} = 20.2$ CFS

$Q/Q_{FULL} = 6.3/24.76 = 0.25$

$d/d_{FULL} = 0.39 \rightsquigarrow$ DEPTH $= 0.39(1.25) = 0.49$ FT
$= 5.9''$

$V/V_{FULL} = 0.7 \rightsquigarrow V = (0.7)(20.2) = 14.1$ FPS

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REMARKS

B4 - OUT $D = 36'' = 3\text{ FT}$

$Q = 36.2 \text{ CFS}$

$Q_{FULL} = (1.49/0.02)((3^2)(0.7854))(3(0.25))^{0.67}(0.30)^{0.5}$

$= 74.5(7.07)(0.82)(0.55)$

$= 237.55 \text{ CFS}$

$V_{FULL} = 33.6 \text{ FPS}$

$Q/Q_{FULL} = 36.2/237.55 = 0.15$

$d/d_{FULL} = 0.31 \rightsquigarrow \text{DEPTH} = 0.31(3) = 0.93 \text{ FT}$

$= 11.2''$

$V/V_{FULL} = 0.61 \rightsquigarrow V = 0.61(33.6) = 20.5 \text{ FPS}$

STILLING BASIN DESIGN:

GIVEN: $Q = \Sigma Q_{OUT} = 2.6 + 7.4 + 34.6 + 6.3 + 36.2 = 87.1 \text{ CFS}$

$V_{MAX} = 20.5 \text{ FPS}$

DIA MIN. $= 12'' = 1 \text{ FT}$

USE CLASS "B" RIP-RAP $d_{50} = 10''$

$d_{MAX} = 15'' = 1.25 \text{ FT}$

DEPTH OF BASIN $= h = \left[0.148\left(\frac{87.1}{(1)^{0.5}(1.25)^{0.5}}\right) - (1.82)(1.25)(1)^{0.5}\right]^{0.67}$

$h = [11.53 - 2.28]^{0.67}$

$h = 4.4 \text{ FT.} \rightsquigarrow 4.5 \text{ FT}$

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8-A

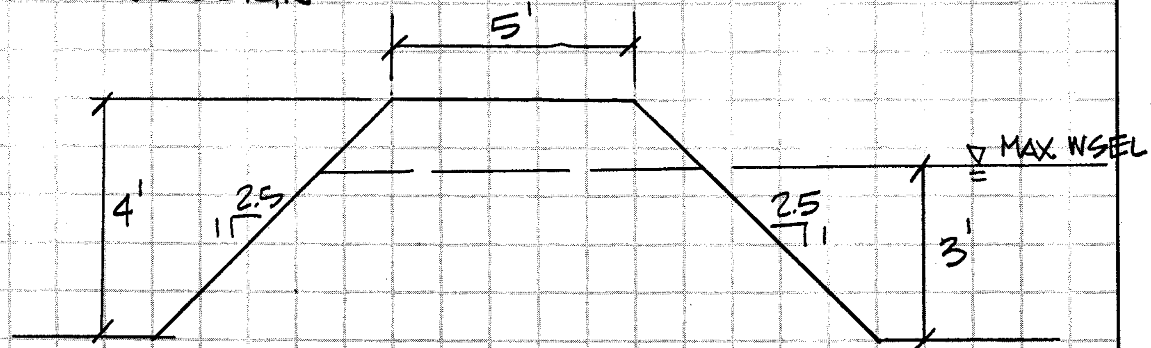
REMARKS

SEDIMENT TRAP - ST-1

DRAINAGE AREA = 10.4 Ac
DISTURBED AREA = 8.7 Ac
$C = 0.35$
T_c = 5 MIN
i_{10} = 7.5 IN/HR
$Q_{10} = (0.35)(7.5)(10.4) = 27.3$ CFS

BASIN VOLUME REQ'D = 1800(8.7) = 15,660 CF

BASIN DESIGN



STORAGE DEPTH = 3 FT
WATER SURFACE AREA = 0.31 Ac = 13,500 SF
STORAGE VOL. = (0.4)(13,500)(3) = 16,200 CF
> 15,600 (ok)

WEIR DESIGN:
Q = 27.3 CFS
H = 0.5 FT
$C_W = 3.0$

$Q = C_W(L)(H)^{1.5}$
$27.3 = 3(L)(0.5)^{1.5}$
$25.7 = L$
USE 28'

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8B

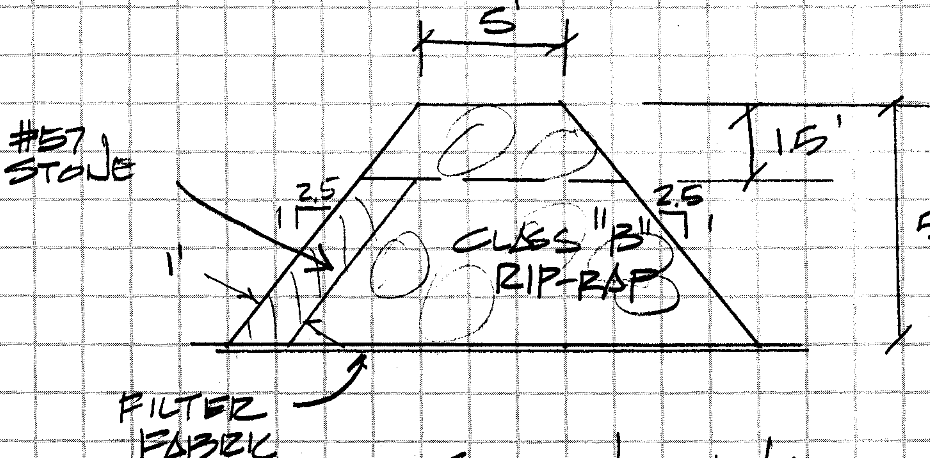
REMARKS

SEDIMENT TRAP DESIGN:

ST-2
DRAINAGE AREA = 0.8 Ac
DIST. AREA = 0.4 Ac

BASIN VOL. REQUIRED = 1800 (0.4) = 720 cf

NATURAL BASIN VOL. ≅ 0.4(620)(3.5) = 868 cf > 720 ok
NO EXCAVATED BASIN REQUIRED
WEIR LENGTH = 4 FT



SECTION THRU WEIR

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8C

REMARKS

SEDIMENT BASIN DESIGN

SB-A

DRAINAGE AREA = 7.2 AC
DISTURBED AREA = 7.2 AC
$\Delta H = 217 - 200 = 7'$
$L = 700'$
$T_c = (700^3/7)^{0.385}/128 = 7.1 \rightarrow 7_{MIN.}$
$i_{10} = 7$ IN/HR
$i_{25} = 7.5$ IN/HR
$C = 0.45$
$Q_{10} = (0.45)(7)(7.2) = 22.7$ CFS
$Q_{25} = (0.45)(7.5)(7.2) = 24.3$ CFS

BASIN VOL. REQUIRED = 1800(7.2) = 12,960 CF

→ EXCAVATED BASIN DIMENSION
AREA BOTTOM = 200 × 20 = 4000 SF
S: SLOPE = 2.5:1
MAX. DEPTH = 4 FT
AREA TOP = 220 × 40 = 8800 SF
VOL. = 24,977 CF > 12,960 (ok)

→ PRINCIPLE SPILLWAY
INVERT OUTLET = 199
INVERT BASIN = 200
MAX. DEPTH = 4 FT

TOTAL H = 5 FT

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REMARKS

VOLUME OF RUN-OFF INTO BASIN
ASSUME TIME TO PEAK = $2T_c$
= 2(7) = 14 MIN = 840 SEC

→ VOL. IN = 24.3 CFS (840 SEC) = 20,412 CF

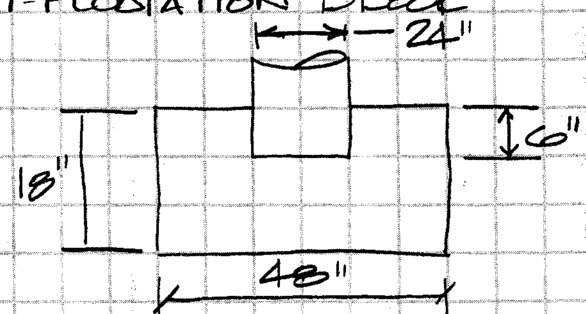
VOL. OUT = VOL. IN − (BASIN VOL. − SEDIMENT VOL.)
VOL. OUT = 20,412 − (24,977 − 12,960)
→ VOL. OUT = 8,395 CF
= 8,395/840 = 10 CFS

USE 18" CMP CONDUIT (SEE TABLE 8.07a ON SHEET 88)
Q_{ACT} = 1.12(12.23) = 13.7 > 10 CFS (ok)

18" CONDUIT
24" RISER
HEAD ABOVE RISER = 0.75 FT
} SEE FIG 8.07b ON SHEET 89

→ USE 36" Ø x 2' TRASHRACK

→ ANTI-FLOATATION BLOCK



→ ANTI-SEEP COLLAR
$L_s = (4)(2.5+4)(1 + \frac{1/48}{0.25 - 1/48}) = 28.4$
USE ONE 4.5' x 4.5' COLLAR
(SEE PLATE 1.26L ON SHEET 90)

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REMARKS

OUTLET PROTECTION:

$Q = 10$ CFS (SEE FIG. 8.06a ON SHEET 9L)

$D_o = 18"$ RCP

$L_a = 9$ FT

$W = 1.5 + 9 = 10.5$ FT

$d_{50} = 0.3$ FT $= 3.6"$ USE CLASS "A" RIP-RAP

SB-B

DRAINAGE AREA = 10.5 AC

DIST. AREA = 10.5 AC

$\Delta H = 219 - 180 = 39$

$L = 1130$ FT

$T_c = (1130^3/39)^{0.385}/128 = 6.4$

$C = 0.45$

$i_{10} = 7.2$ IN/HR

$i_{25} = 7.6$ IN/HR

$Q_{10} = (0.45)(7.2)(10.5) = 34.0$ CFS

$Q_{25} = (0.45)(7.6)(10.5) = 35.9$ CFS

BASIN VOL. REQUIRED = 1800(10.5) = 18,900 CF

NATURAL BASIN VOL.

MAX. DEPTH = 4 FT

SURFACE AREA = 9610 SF

APPROX. VOL. = (0.4)(9610)(4) = 15,376 < 18900

EXCAVATED BASIN REQUIRED

EXCAVATED VOLUME REQ'D = 18,900 − 15,376

= 3524 CF

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REMARKS

EXCAVATED BASIN DIMENSION
AREA BOTTOM = 50 X 40 = 2000 SF
SIDE SLOPE = 2.5:1
APPROX DEPTH = 2 FT
AREA TOP = 60 X 50 = 3000 SF
APPROX. VOL. = 4966 CF > 3524 (ok)

→ PRINCIPLE SPILLWAY DESIGN:
INVERT OUTLET = 176
INVERT BASIN = 180
MAX. DEPTH = 4 FT

TOTAL H = 8 FT

→ VOL. OF RUN-OFF INTO BASIN:
TIME TO PEAK = 2(T_c) = 2(6.4) = 12.8 MIN
= 768 SEC

→ VOL. IN = 35.9 CFS (768 SEC) = 27,571 CF

VOL. OUT = VOL. IN − (BASIN VOL. − SEDIMENT VOL.)

→ VOL. OUT = 27,571 − (15376 + 4966 − 18,900)
VOL. OUT = 26,129 CF / 768 SEC = 34.0 CFS

USE 24" CMP CONDUIT (SEE TAB. 8.07a ON SHEET 88)
Q_{ACT} = 31.19(1.01) = 34.3 CFS > 34 (ok)
NO EMERGENCY SPILLWAY REQUIRED

24" CMP CONDUIT
30" CMP RISER
HEAD ABOVE RISER = 1.2 FT

SEE FIG. 8.07 b ON SHEET 89

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REMARKS

→ USE 48" ⌀ X 2 CMP TRASH RACK

→ ANTI FLOAT BLOCK

DEPTH OF BLOCK = 18"

WIDTH = 2(Do) = 2(2.6) = 5 FT

INSERTED - 6"

→ ANTI - SEEP COLLARS

$L_s = (4.)(2.5+4)(1 + 4/50 / 0.25 - 4/50)$

$L_s = 38.2$ FT

USE ONE 6 X 6 COLLAR (SEE PLATE 1.261 ON SHEET 90)

→ OUTLET PROTECTION

$Q = 34.3$ CFS

$D_o = 24"$ (SEE FIG. 8.06a ON SHEET 91)

$L_a = 19$ FT

$W = 19 + 2 = 21$ FT

$d_{50} = 0.6$ FT $= 7.2"$ USE CLASS "B" RIP-RAP WITH FS-2 SUBLAYER

SB-C

DRAINAGE AREA = 12.6 Ac

DISTURBED AREA = 12.6 Ac

$\Delta H = 218 - 180 = 38$

$L = 1050$ FT

$T_c = (1050^3/38)^{0.385}/128 = 5.9 \rightarrow 6$ MIN

$i_{10} = 7.3$ IN/HR

$i_{25} = 7.7$ IN/HR

$C = 0.45$

$Q_{10} = (0.45)(7.3)(12.6) = 41.4$

$Q_{25} = (0.45)(7.7)(12.6) = 43.7$

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8 H

REMARKS

BASIN VOL. REQ'D = 1800(12.6) = 22,680 CF

EXCAVATED BASIN DIMENSION
AREA BOTTOM = 190 X 40 = 7600 SF
DEPTH = 3 FT
S: SLOPES = 2.5:1
AREA TOP = 205 X 55 = 11275
VOL = 28132 CF > 22680 CF

→ PRINCIPLE SPILLWAY
INVERT OUT = 174
BASIN INVERT = 175
MAX. DEPTH = 3 FT
TOTAL H = 4 FT

VOL. OF RUN-OFF INTO BASIN
TIME TO PEAK = 2(Tc) = 2(6) = 12 MIN = 720 SEC

→ VOL. IN = 43.7 CFS (720 SEC) = 31,464 CF

VOL. OUT = VOL. IN − (BASIN VOL. − SEDIMENT VOL.)
= 31,464 − (28132 − 22680)
→ VOL. OUT = 26,012/720 = 36.1 CFS

USE 30" CMP CONDUIT (SEE TAB. 8.07a ON SHEET 88)

30" CONDUIT
36" RISER
HEAD ABOVE RISER = 1.1 FT
(SEE FIG. 8.07 b ON SHEET 89)

→ USE 54" x 2 CMP TRASH RACK

CALCULATION

PROJECT DUNN ERWIN LANDFILL
CLIENT HARNETT COUNTY
SUBJECT VERTICAL EXPANSION

PROJ. NO.
DATE 12/92
DES. BY ARK
CHK. BY

8 I

REMARKS

→ ANTI-FLOATATION BLOCK
DEPTH = 18"
WIDTH = 2(Do) = 2(3) = 6 FT
INSERTED 6"

→ ANTI-SEEP COLLAR
$L_s = (3)(2.5+4)(1 + \frac{1}{50} / 0.25 - \frac{1}{50})$
$L_s = 21.2$ FT
USE ONE 5X5 COLLAR
(SEE PLATE 1.26L ON SHEET 90)

→ OUTLET PROTECTION
Q = 36 CFS
Do = 30" CONDUIT
La = 16 FT
W = 16 + 2.5 = 18.5 FT
$d_{50} = 0.5 = 6"$

(SEE FIG. 8.06a ON SHEET 91)

McKIM & CREED

CALCULATION

PROJECT DUNN-ERWIN LANDFILL
CLIENT HARNETT COUNTY
SUBJECT VERTICAL EXPANSION

PROJ. NO. ______
DATE 12/92
DES. BY AZK
CHK. BY ______

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(SEE FIGURE 8.03e ON PAGE 81)

CHANNEL NO	STATION FROM	STATION TO	SLOPE (FT/FT)	DRAINAGE AREA (AC)	ΔH (FT)	L (FT)	* T_c (MIN)	i_{10} (IN/HR)	C	** Q_{10} (CFS)	REMARKS
DC-A	0+00	2+00	0.005	0.2	2	200	5	7.5	0.35	0.5	
	2+00	3+00	0.04	0.3	6	300	5	7.5		0.8	
	3+00	10+00	0.014	2.2	13	1000	8	6.8		5.2	
	10+00	13+30	0.0182	3.5	19	1330	10	6.2		7.6	
	13+30	17+00	0.0081	6.5	22	1700	13	6.0		13.7	
DC-B	0+00	1+30	0.0154	0.1	1	130	5	7.5	0.35	0.3	
	1+30	3+30	0.04	0.2	9	330	5	7.5		0.5	
	3+30	4+40	0.0273	0.6	10	440	5	7.5		1.6	
DC-C	0+00	4+00	0.005	0.7	2	500	8	6.8	0.35	1.7	
	4+00	7+50	0.0143	1.2	7	850	9	6.5		2.7	
	7+50	10+00	0.008	1.8	9	1100	11	6.1		3.8	
	10+00	13+00	0.005	6.9	9	1400	14	5.5		13.3	

* $T_c = (L^3/\Delta H)^{0.385}/128$

** $Q = CiA$

CALCULATION

PROJECT DUNN - ERWIN LANDFILL

CLIENT HARNETT COUNTY

SUBJECT VERTICAL EXPANSION

PROJ. NO. ____

DATE 12/92

DES. BY ARK

CHK. BY ____

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CHANNEL NO	STATION FROM	STATION TO	SLOPE (FT/FT)	DRAINAGE AREA (Ac)	ΔH (FT)	L (FT)	* Tc (MIN)	i_{10} (IN/HR)	C	** Q_{10} (CFS)	REMARKS
DC-D	0+00	2+30	0.08	0.4	22	300	5	7.5	0.35	1.1	
	2+30	6+90	0.08	1.7	63	790	5	7.5		4.5	
	6+90	11+50	0.08	2.8	100	1260	5	7.5		7.4	
DC-E	0+00	3+60	0.0111	1.0	10	180	5	7.5	0.35	2.6	
DC-F	0+00	1+00	0.05	0.1	3	50	5	7.5	0.35	0.3	
	1+00	8+20	0.0139	2.4	10	820	7	7		5.9	
DC-G	0+00	7+10	0.0141	4.1	15	800	6	7.3	0.35	10.5	
	7+10	8+50	0.0357	5.2	20	950	7	7	0.35	12.7	
DC-H	0+00	2+70	0.0074	1.1	10	400	5	7.5	0.35	2.9	
DC-I	0+00	4+40	0.0068	2.2	10	750	7	7	0.35	5.4	

$* \; T_c = (L^3/\Delta H)^{0.385}/128$

$** \; Q = C i A$

McKIM & CREED

CALCULATION

PROJECT DUNN-ERWIN LANDFILL
CLIENT HARNETT COUNT
SUBJECT VERTICAL EXPANSION

PROJ. NO.
DATE 9/21
DES. BY ARK
CHK. BY

11

CHANNEL NO	STATION FROM	STATION TO	SLOPE (FT/FT)	DRAINAGE AREA (AC)	ΔH (FT)	L (FT)	* Tc (MIN)	i_{10} (IN/HR)	C	** Q_{10} (CFS)	REMARKS
DC-J	0+00	4+00	0.0068	2.1	10	750	7	7	0.35	5.2	
DC-K	0+00	6+40	0.0156	1.9	10	640	6	7.3	0.35	4.9	
DC-L	0+00	5+50	0.0273	2.6	20	750	5	7.5	0.35	6.8	
DC-M1	0+00	2+00	0.0100	0.6	17	400	5	7.5	0.35	1.6	
DC-M2	0+00	3+70	0.0054	1.3	22	530	5	7.5	0.35	3.4	
DC-N	0+00	5+10	0.0157	1.0	10	510	5	7.5	0.35	2.6	

* $T_c = (L^3/\Delta H)^{0.385}/128$
** $Q = CiA$

McKIM&CREED

CALCULATION

PROJECT DUNN-ERWIN LANDFILL
CLIENT HARNETT COUNTY
SUBJECT VERTICAL EXPANSION

PROJ. NO.
DATE 12/92
DES. BY ARK
CHK. BY

11A

CHANNEL NO.	STATION FROM	STATION TO	SLOPE (FT/FT)	DRAINAGE AREA (Ac)	ΔH (FT)	L (FT)	* T_c (MIN)	i_{10} (IN/HR)	C	* Q_{10} (CFS)	REMARKS
DC-O	0+00	5+40	0.0037	6.0	16	650	5	7.5	0.45	20.3	
DC-P	0+00	1+80	0.0111	0.3	2	300	5	7.5	0.45	1.0	
	1+80	3+10	0.0154	0.38	4	420	5	7.5		1.3	
	3+10	4+10	0.0200	0.51	6	550	6	7.3		1.7	
DC-Q	0+00	2+50	0.004	0.54	14	250	5	7.5	0.45	1.8	
DC-R	0+00	6+20	0.0032	2.41	24	300	5	7.5	0.45	8.1	
DC-S	0+00	6+00	0.005	6.0	36	1200	7	7	0.45	18.9	

$* T_c = (L^3/\Delta H)^{0.385}/128$

$** Q = C i A$

McKIM&CREED

DC-A 0+00-2+00 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	0.5
Channel Bottom Slope (feet per foot)...................	0.0050
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.33
Flow Velocity (feet per second)........................	1.53
Froude Number (Flow is Sub-Critical)...................	0.666
Velocity Head (feet)...................................	0.04
Energy Head (feet).....................................	0.37
Cross-Sectional Area of Flow (square feet).............	0.33
Top Width of Flow (feet)...............................	1.98

V = 1.53 FPS < 2.5 (ok) GRASS LINED

DC-A 2400-3400 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	0.8
Channel Bottom Slope (feet per foot)	0.0400
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.27
Flow Velocity (feet per second)	3.77
Froude Number (Flow is Super-Critical)	1.821
Velocity Head (feet)	0.22
Energy Head (feet)	0.49
Cross-Sectional Area of Flow (square feet)	0.21
Top Width of Flow (feet)	1.60

$V = 3.8 > 2.5$ USE TEMP. LINER

$T = \gamma d s = 62.4(0.27)(0.04) = 0.67$

USE STRAW W/NET $T = 1.45$

DC-A 2+00 - 3+00 NET W/STRAW

MAX. D = $1.45 / 62.4 (0.04) = 0.58'$

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	0.8
Channel Bottom Slope (feet per foot)...................	0.0400
Manning's Roughness Coefficient (n-value)..............	0.0650
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.41
Flow Velocity (feet per second).........................	1.55
Froude Number (Flow is Sub-Critical)....................	0.602
Velocity Head (feet)....................................	0.04
Energy Head (feet)......................................	0.45
Cross-Sectional Area of Flow (square feet)..............	0.51
Top Width of Flow (feet)................................	2.49

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

DEPTH = 0.41 < 0.58 ok

DC-A 2+00 - 3+00 GRASS

R = 0.19
V = 1.55
VR = 0.29 $\rightsquigarrow$ n = 0.2

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TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	0.8
Channel Bottom Slope (feet per foot)	0.0400
Manning's Roughness Coefficient (n-value)	0.2000
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.63
Flow Velocity (feet per second)	0.67
Froude Number (Flow is Sub-Critical)	0.209
Velocity Head (feet)	0.01
Energy Head (feet)	0.64
Cross-Sectional Area of Flow (square feet)	1.20
Top Width of Flow (feet)	3.79

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DC-A 3+00 - 10+00 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.2
Channel Bottom Slope (feet per foot)	0.0114
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.68
Flow Velocity (feet per second)	3.74
Froude Number (Flow is Super-Critical)	1.130
Velocity Head (feet)	0.22
Energy Head (feet)	0.90
Cross-Sectional Area of Flow (square feet)	1.39
Top Width of Flow (feet)	4.08

V = 3.74 > 2.5 USE TEMP. LINER

T = (62.4)(0.68)(0.014) = 0.48
USE JUTE NET W/ STRAW

DC-A 3+00- 10+00

NET W/STRAW

MAX. D= 145/62.4 (0.0114) = 2.03 FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.2
Channel Bottom Slope (feet per foot)	0.0114
Manning's Roughness Coefficient (n-value)	0.0330
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.82
Flow Velocity (feet per second)	2.56
Froude Number (Flow is Sub-Critical)	0.703
Velocity Head (feet)	0.10
Energy Head (feet)	0.92
Cross-Sectional Area of Flow (square feet)	2.03
Top Width of Flow (feet)	4.94

DEPTH = 0.82 < 2.03 ok

DC-A 3+00 - 10+00 GRASSED

V = 2.56
R = 0.39
VR = 1.0 → n = 0.084

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.2
Channel Bottom Slope (feet per foot)	0.0114
Manning's Roughness Coefficient (n-value)	0.0840
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.17
Flow Velocity (feet per second)	1.28
Froude Number (Flow is Sub-Critical)	0.295
Velocity Head (feet)	0.03
Energy Head (feet)	1.19
Cross-Sectional Area of Flow (square feet)	4.08
Top Width of Flow (feet)	6.99

DC-A 10+00 - 13+30 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	7.6
Channel Bottom Slope (feet per foot)	0.0182
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.72
Flow Velocity (feet per second)	4.90
Froude Number (Flow is Super-Critical)	1.441
Velocity Head (feet)	0.37
Energy Head (feet)	1.09
Cross-Sectional Area of Flow (square feet)	1.55
Top Width of Flow (feet)	4.31

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$V = 4.9 > 4.5$ ARMORIZE

$T = 62.4(0.72)(0.0182) = 0.82$

USE CLASS "A" RIP-RAP

DC-A 10+00 – 13+30 CLASS "A"

MAX. D = 2.5/62.4(0.0182) = 2.2 FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)....................	7.6
Channel Bottom Slope (feet per foot)....................	0.0182
Manning's Roughness Coefficient (n-value)..............	0.0540
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
* Channel Bottom Width (feet)...........................	0.5

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.96
Flow Velocity (feet per second).........................	2.32
Froude Number (Flow is Sub-Critical)....................	0.567
Velocity Head (feet)....................................	0.08
Energy Head (feet)......................................	1.05
Cross-Sectional Area of Flow (square feet)..............	3.27
Top Width of Flow (feet)................................	6.29

* INCREASED WIDTH

DEPTH = 0.96' < 2.2' ok

DC-A 13+30-17+00 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 16, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	13.7
Channel Bottom Slope (feet per foot)...................	0.0081
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)...	3.00
Channel Side Slope - Right Side (horizontal/vertical)..	3.00
Channel Bottom Width (feet)............................	0.5

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.96
Flow Velocity (feet per second)........................	4.18
Froude Number (Flow is Super-Critical).................	1.022
Velocity Head (feet)...................................	0.27
Energy Head (feet).....................................	1.24
Cross-Sectional Area of Flow (square feet).............	3.28
Top Width of Flow (feet)...............................	6.29

V= 4.2 > 2.5 USE TEMP. LINER

T= 62.4(0.96)(0.0081) = 0.49
USE JUTE NET W/STRAW

DC-A 13+30 - 17+00 NET W/STRAW

MAX. D = 1.45/62.4(0.0081) = 2.87 FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 16, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	13.7
Channel Bottom Slope (feet per foot)	0.0081
Manning's Roughness Coefficient (n-value)	0.0330
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.5

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.18
Flow Velocity (feet per second)	2.87
Froude Number (Flow is Sub-Critical)	0.638
Velocity Head (feet)	0.13
Energy Head (feet)	1.31
Cross-Sectional Area of Flow (square feet)	4.77
Top Width of Flow (feet)	7.58

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986 Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092 (713) 895-8322. A manual with equations & flow chart is available.

DEPTH = 1.2 < 2.87 ok

DC-A 13+30 - 17+00 GRASSED

V=4.2
R=0.60
VR=2.52 → n=0.05

22-A

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 16, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	13.7
Channel Bottom Slope (feet per foot)	0.0081
Manning's Roughness Coefficient (n-value)	0.0500
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.5

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.39
Flow Velocity (feet per second)	2.11
Froude Number (Flow is Sub-Critical)	0.434
Velocity Head (feet)	0.07
Energy Head (feet)	1.46
Cross-Sectional Area of Flow (square feet)	6.49
Top Width of Flow (feet)	8.84

V=2.1 < 4.5 (ok)

DC-B 0+00 - 1+30 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	0.3
Channel Bottom Slope (feet per foot).....................	0.0154
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet).............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.22
Flow Velocity (feet per second).........................	2.06
Froude Number (Flow is Super-Critical).................	1.096
Velocity Head (feet)....................................	0.07
Energy Head (feet)......................................	0.29
Cross-Sectional Area of Flow (square feet).............	0.15
Top Width of Flow (feet)................................	1.32

V = 2.1 < 2.5 ok

DC-B 1+30 - 3+30 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	0.5
Channel Bottom Slope (feet per foot)....................	0.0400
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.22
Flow Velocity (feet per second)........................	3.35
Froude Number (Flow is Super-Critical).................	1.770
Velocity Head (feet)...................................	0.17
Energy Head (feet).....................................	0.40
Cross-Sectional Area of Flow (square feet).............	0.15
Top Width of Flow (feet)...............................	1.34

V = 3.4 > 2.5 USE TEMP. LINER

T = 62.4 (0.22)(0.04) = 0.55

USE NET W/ STRAW

DC-B 1+30-3+30 NET W/STRAW

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MAX. D = 1.45/62.4(0.04) = 0.58'

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	0.5
Channel Bottom Slope (feet per foot)	0.0400
Manning's Roughness Coefficient (n-value)	0.0650
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.35
Flow Velocity (feet per second)	1.38
Froude Number (Flow is Sub-Critical)	0.585
Velocity Head (feet)	0.03
Energy Head (feet)	0.38
Cross-Sectional Area of Flow (square feet)	0.36
Top Width of Flow (feet)	2.08

DEPTH = 0.35 < 0.58 ok

DC-B 1+30-3+30 GRASSED

V = 1.38
R = 0.17
VR = 0.27 ⇝ n = 0.2

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TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)....................	0.5
Channel Bottom Slope (feet per foot)..................	0.0400
Manning's Roughness Coefficient (n-value)..............	0.2000
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)...........................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.53
Flow Velocity (feet per second)........................	0.59
Froude Number (Flow is Sub-Critical)...................	0.203
Velocity Head (feet)...................................	0.01
Energy Head (feet).....................................	0.54
Cross-Sectional Area of Flow (square feet).............	0.84
Top Width of Flow (feet)...............................	3.18

V = 0.53 < 4.5 ok

DC-B 3+30- 4+40 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	1.6
Channel Bottom Slope (feet per foot)...................	0.0273
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.37
Flow Velocity (feet per second)........................	3.88
Froude Number (Flow is Super-Critical).................	1.587
Velocity Head (feet)...................................	0.23
Energy Head (feet).....................................	0.60
Cross-Sectional Area of Flow (square feet).............	0.41
Top Width of Flow (feet)...............................	2.23

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986 Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092 (713) 895-8322. A manual with equations & flow chart is available.

V = 3.9 > 2.5 USE TEMP. LINER

T. = (62.4)(0.37)(0.0273) = 0.63

USE NET W/STRAW

DC-B 3+30 - 4+40 NET W/STRAW

28

MAX D. = 1.45/0.0273(62.4) = 0.85'

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	1.6
Channel Bottom Slope (feet per foot)...................	0.0273
Manning's Roughness Coefficient (n-value)..............	0.0650
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.58
Flow Velocity (feet per second)........................	1.60
Froude Number (Flow is Sub-Critical)...................	0.524
Velocity Head (feet)...................................	0.04
Energy Head (feet).....................................	0.62
Cross-Sectional Area of Flow (square feet).............	1.00
Top Width of Flow (feet)...............................	3.47

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

DEPTH = 0.58 FT < 0.85 ok

DC-B 3+30-4+40 GRASSED

V=1.60
R=0.28
VR=0.45 ⇝ n=0.2

29

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)..........................	1.6
Channel Bottom Slope (feet per foot)......................	0.0273
Manning's Roughness Coefficient (n-value)..............	0.2000
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)................................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)..	0.88
Flow Velocity (feet per second)...........................	0.69
Froude Number (Flow is Sub-Critical)....................	0.182
Velocity Head (feet)..	0.01
Energy Head (feet)..	0.89
Cross-Sectional Area of Flow (square feet).............	2.33
Top Width of Flow (feet)...................................	5.29

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986 Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092 (713) 895-8322. A manual with equations & flow chart is available.

V=0.9 < 4.5 ok

DC-C 0+00 -4+00 NATURAL

30

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	1.7
Channel Bottom Slope (feet per foot)....................	0.0050
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.52
Flow Velocity (feet per second)........................	2.08
Froude Number (Flow is Sub-Critical)...................	0.717
Velocity Head (feet)...................................	0.07
Energy Head (feet).....................................	0.59
Cross-Sectional Area of Flow (square feet).............	0.82
Top Width of Flow (feet)...............................	3.13

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

$V = 2.1 < 2.5$ ok

DC-C 4+00 - 7+50 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	2.7
Channel Bottom Slope (feet per foot)	0.0143
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.51
Flow Velocity (feet per second)	3.46
Froude Number (Flow is Super-Critical)	1.209
Velocity Head (feet)	0.19
Energy Head (feet)	0.70
Cross-Sectional Area of Flow (square feet)	0.78
Top Width of Flow (feet)	3.06

$V = 3.5 > 2.5$ USE TEMP. LINER

$T = 62.4(0.51)(0.0143) = 0.46$

USE NET W/ STRAW

DC-C 4+00 - 7+50 NET/STRAW

32

MAX D = 1.45/62.4(0.0143) = 1.62 FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)........................	2.7
Channel Bottom Slope (feet per foot).....................	0.0143
Manning's Roughness Coefficient (n-value)..............	0.0330
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet).............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.62
Flow Velocity (feet per second).........................	2.38
Froude Number (Flow is Sub-Critical)....................	0.755
Velocity Head (feet)....................................	0.09
Energy Head (feet)......................................	0.70
Cross-Sectional Area of Flow (square feet)..............	1.14
Top Width of Flow (feet)................................	3.69

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986 Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092 (713) 895-8322. A manual with equations & flow chart is available.

DEPTH = 0.62 FT < 1.62 ok

DC-C 4+00 - 7+50 GRASSED

V = 2.38
R = 0.29
VR = 0.69 → n = 0.11

33

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	2.7
Channel Bottom Slope (feet per foot)....................	0.0143
Manning's Roughness Coefficient (n-value)...............	0.1100
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet).............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.97
Flow Velocity (feet per second).........................	0.96
Froude Number (Flow is Sub-Critical)....................	0.244
Velocity Head (feet)....................................	0.01
Energy Head (feet)......................................	0.98
Cross-Sectional Area of Flow (square feet)..............	2.81
Top Width of Flow (feet)................................	5.80

V = 0.96 < 4.5 ok

DC-C 7+50 - 10+00 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)..............................	3.8
Channel Bottom Slope (feet per foot)..................	0.0080
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)......................................	0.65
Flow Velocity (feet per second).......................	3.03
Froude Number (Flow is Sub-Critical)................	0.939
Velocity Head (feet).....................................	0.14
Energy Head (feet).......................................	0.79
Cross-Sectional Area of Flow (square feet)............	1.25
Top Width of Flow (feet)................................	3.88

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

$V = 3.0 > 2.5$ USE TEMPORARY LINER

$T = 62.4(0.65)(0.008) = 0.32$
USE JUTE NET W/STRAW

DC-C 7+50-10+00 NET W/STRAW

35

MAX D = 1.45/62.4(0.008) = 2.90'

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	3.8
Channel Bottom Slope (feet per foot)...................	0.0080
Manning's Roughness Coefficient (n-value)..............	0.0220
Channel Side Slope - Left Side (horizontal/vertical)...	3.00
Channel Side Slope - Right Side (horizontal/vertical)..	3.00
Channel Bottom Width (feet)............................	0.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.67
Flow Velocity (feet per second)........................	2.82
Froude Number (Flow is Sub-Critical)...................	0.859
Velocity Head (feet)...................................	0.12
Energy Head (feet).....................................	0.79
Cross-Sectional Area of Flow (square feet).............	1.35
Top Width of Flow (feet)...............................	4.02

==

DEPTH = 0.67 < 2.90 ok

DC-C 7+50 -10+00 GRASSED

V = 2.82
R = 0.32
VR = 0.90 → n = 0.09

36

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	3.8
Channel Bottom Slope (feet per foot)...................	0.0080
Manning's Roughness Coefficient (n-value)..............	0.0900
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	1.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.98
Flow Velocity (feet per second)........................	0.98
Froude Number (Flow is Sub-Critical)...................	0.230
Velocity Head (feet)...................................	0.01
Energy Head (feet).....................................	1.00
Cross-Sectional Area of Flow (square feet).............	3.88
Top Width of Flow (feet)...............................	6.90

==

V = 0.98 > 4.5 (ok)

DC-C 10+00 - 13+00 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	13.3
Channel Bottom Slope (feet per foot)	0.0050
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.98
Flow Velocity (feet per second)	3.47
Froude Number (Flow is Sub-Critical)	0.817
Velocity Head (feet)	0.19
Energy Head (feet)	1.16
Cross-Sectional Area of Flow (square feet)	3.84
Top Width of Flow (feet)	6.86

$V = 3.5 > 2.5$ USE TEMP. LINER

$T = 62.4(0.98)(0.005) = 0.31$
USE NET W/ STRAW

DC-C 10+00-13+00 NET W/STRAW

38

MAX D = 1.45/62.4(0.005) = 4.65'

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	13.3
Channel Bottom Slope (feet per foot)....................	0.0050
Manning's Roughness Coefficient (n-value)...............	0.0220
* Channel Side Slope - Left Side (horizontal/vertical)....	2.50
* Channel Side Slope - Right Side (horizontal/vertical)...	2.50
Channel Bottom Width (feet).............................	2.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.93
Flow Velocity (feet per second).........................	3.30
Froude Number (Flow is Sub-Critical)....................	0.748
Velocity Head (feet)....................................	0.17
Energy Head (feet)......................................	1.10
Cross-Sectional Area of Flow (square feet)..............	4.03
Top Width of Flow (feet)................................	6.65

==

* DECREASED SIDE SLOPES !

DEPTH = 0.93 FT < 4.65 ok

DC-C 10+00 - 13+00 GRASS

V = 3.3
R = 0.57
VR = 1.9 → n = 0.058

39

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)........................	13.3
Channel Bottom Slope (feet per foot)....................	0.0050
Manning's Roughness Coefficient (n-value)...............	0.0580
Channel Side Slope - Left Side (horizontal/vertical)....	2.50
Channel Side Slope - Right Side (horizontal/vertical)...	2.50
Channel Bottom Width (feet).............................	2.5

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	1.39
Flow Velocity (feet per second).........................	1.60
Froude Number (Flow is Sub-Critical)....................	0.301
Velocity Head (feet)....................................	0.04
Energy Head (feet)......................................	1.43
Cross-Sectional Area of Flow (square feet)..............	8.30
Top Width of Flow (feet)................................	9.45

V = 1.6 < 4.5 FPS ok

DC-D 0+00 - 2+30 NATURAL

40

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	1.1
Channel Bottom Slope (feet per foot)...................	0.0800
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.26
Flow Velocity (feet per second)........................	5.29
Froude Number (Flow is Super-Critical).................	2.571
Velocity Head (feet)...................................	0.43
Energy Head (feet).....................................	0.70
Cross-Sectional Area of Flow (square feet).............	0.21
Top Width of Flow (feet)...............................	1.58

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986 Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092 (713) 895-8322. A manual with equations & flow chart is available.

V = 5.3 > 4.5 ARMORIZE

T = 62.4 (0.26)(0.08) = 1.30

USE CLASS "A" RIP-RAP

DC-D 0400-2430 CLASS "A"

41

MAX D = 2.5/62.4(0.08) = 0.50 FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	1.1
Channel Bottom Slope (feet per foot).....................	0.0800
Manning's Roughness Coefficient (n-value)..............	0.1060
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.49
Flow Velocity (feet per second)........................	1.51
Froude Number (Flow is Sub-Critical)...................	0.536
Velocity Head (feet)...................................	0.04
Energy Head (feet).....................................	0.53
Cross-Sectional Area of Flow (square feet).............	0.73
Top Width of Flow (feet)...............................	2.96

==

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

DEPTH = 0.49 < 0.5 (ok)

DC-D 2+30 - 6+90 CLASS "B"

MAX D = $5/62.4(0.08) = 1.0$ FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	4.5
Channel Bottom Slope (feet per foot)...................	0.0800
Manning's Roughness Coefficient (n-value)..............	0.0680
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.56
Flow Velocity (feet per second)........................	2.96
Froude Number (Flow is Sub-Critical)...................	0.887
Velocity Head (feet)...................................	0.14
Energy Head (feet).....................................	0.70
Cross-Sectional Area of Flow (square feet).............	1.52
Top Width of Flow (feet)...............................	4.39

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DEPTH = 0.56 > 1.0 ok

DC-D 6+90 -11+50 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	7.4
Channel Bottom Slope (feet per foot)...................	0.0800
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.40
Flow Velocity (feet per second)........................	8.34
Froude Number (Flow is Super-Critical).................	2.884
Velocity Head (feet)...................................	1.08
Energy Head (feet).....................................	1.48
Cross-Sectional Area of Flow (square feet).............	0.89
Top Width of Flow (feet)...............................	3.41

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092
(713) 895-8322. A manual with equations & flow chart is available.

$V = 8.3 > 4.5$ ARMORIZE

$T = 62.4(0.40)(0.08) = 2.0$

USE CLASS "B" RIP-RAP

DC-D 6+90 - 11+50 CLASS "B"

45

MAX D = 5/62.4 (0.08) = 1.0 FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 12, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	7.4
Channel Bottom Slope (feet per foot)	0.0800
Manning's Roughness Coefficient (n-value)	0.0680
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.71
Flow Velocity (feet per second)	3.36
Froude Number (Flow is Sub-Critical)	0.914
Velocity Head (feet)	0.18
Energy Head (feet)	0.88
Cross-Sectional Area of Flow (square feet)	2.20
Top Width of Flow (feet)	5.24

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DEPTH = 0.71 FT < 1.0 ok

DC-E 0+00-3+60 NATURAL

FLOWS INCLUDES DC-E, DC-D & PIPE C2-OUT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 16, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	18.0
Channel Bottom Slope (feet per foot)	0.0111
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.09
Flow Velocity (feet per second)	5.05
Froude Number (Flow is Super-Critical)	1.206
Velocity Head (feet)	0.40
Energy Head (feet)	1.49
Cross-Sectional Area of Flow (square feet)	3.56
Top Width of Flow (feet)	6.54

$V = 5.1 > 4.5$ ARMORIZE

$T = 62.4(1.09)(0.0111) = 0.75$

USE FS-2

DC-E 0400-3+60 FS-2

MAX. D = 0.8/62.4(0.0111) = 1.16

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 16, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	18.0
Channel Bottom Slope (feet per foot)	0.0111
Manning's Roughness Coefficient (n-value)	0.0340
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
* Channel Bottom Width (feet)	1.5

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.11
Flow Velocity (feet per second)	3.38
Froude Number (Flow is Sub-Critical)	0.735
Velocity Head (feet)	0.18
Energy Head (feet)	1.28
Cross-Sectional Area of Flow (square feet)	5.33
Top Width of Flow (feet)	8.14

* INCREASED CHANNEL WIDTH

DEPTH = 1.11 < 1.16 (ok)

DC-F 0+00-1+00 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)........................	0.3
Channel Bottom Slope (feet per foot).....................	0.0500
Manning's Roughness Coefficient (n-value)................	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)..............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)......................................	0.18
Flow Velocity (feet per second)..........................	3.21
Froude Number (Flow is Super-Critical)...................	1.906
Velocity Head (feet).....................................	0.16
Energy Head (feet).......................................	0.34
Cross-Sectional Area of Flow (square feet)...............	0.09
Top Width of Flow (feet).................................	1.06

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986 Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092 (713) 895-8322. A manual with equations & flow chart is available.

V = 3.2 > 2.5 USE TEMP. LINER

T = 62.4(0.18)(0.05) = 0.46 FT

USE NET W/STRAW

DC-F 0400-1400 NET W/STRAW

50

MAX D = 1.45/62.4(0.05) = 0.46 FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	0.3
Channel Bottom Slope (feet per foot)...................	0.0500
Manning's Roughness Coefficient (n-value)..............	0.0650
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.27
Flow Velocity (feet per second)........................	1.32
Froude Number (Flow is Sub-Critical)...................	0.630
Velocity Head (feet)...................................	0.03
Energy Head (feet).....................................	0.30
Cross-Sectional Area of Flow (square feet).............	0.23
Top Width of Flow (feet)...............................	1.65

==

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DEPTH = 0.27 > 0.45 (ok)

DC-F 0+00 - 1+00 GRASS

51

V = 1.32
R = 0.13
VR = 0.17 → n = 0.26

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	0.3
Channel Bottom Slope (feet per foot)	0.0500
Manning's Roughness Coefficient (n-value)	0.2600
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.46
Flow Velocity (feet per second)	0.47
Froude Number (Flow is Sub-Critical)	0.171
Velocity Head (feet)	0.00
Energy Head (feet)	0.47
Cross-Sectional Area of Flow (square feet)	0.64
Top Width of Flow (feet)	2.78

V = 0.5 <4.5 ok

DC-F 1+00-8+20 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.9
Channel Bottom Slope (feet per foot)	0.0139
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.69
Flow Velocity (feet per second)	4.16
Froude Number (Flow is Super-Critical)	1.250
Velocity Head (feet)	0.27
Energy Head (feet)	0.96
Cross-Sectional Area of Flow (square feet)	1.42
Top Width of Flow (feet)	4.13

V = 4.2 > 2.5 USE TEMP LINER

T = 62.4 (0.69)(0.0139) = 0.60

USE NET W/STRAW

DC-F 1+00 - 8+20 NET W/STRAW

53

MAX D = 1.45/62.4 (0.0139) = 1.67

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	5.9
Channel Bottom Slope (feet per foot)...................	0.0139
Manning's Roughness Coefficient (n-value)..............	0.0330
Channel Side Slope - Left Side (horizontal/vertical)...	3.00
Channel Side Slope - Right Side (horizontal/vertical)..	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.83
Flow Velocity (feet per second)........................	2.85
Froude Number (Flow is Sub-Critical)...................	0.778
Velocity Head (feet)...................................	0.13
Energy Head (feet).....................................	0.96
Cross-Sectional Area of Flow (square feet).............	2.07
Top Width of Flow (feet)...............................	4.99

DEPTH = 0.83 < 1.67 ok

DC-F 1+00 - 8+20 GRASSED

54

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.9
Channel Bottom Slope (feet per foot)	0.0139
Manning's Roughness Coefficient (n-value)	0.0800
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.16
Flow Velocity (feet per second)	1.47
Froude Number (Flow is Sub-Critical)	0.341
Velocity Head (feet)	0.03
Energy Head (feet)	1.19
Cross-Sectional Area of Flow (square feet)	4.01
Top Width of Flow (feet)	6.94

$V = 1.5 < 4.5$ (ok)

DC-9 0+00-7+10 NATURAL

55

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	10.5
Channel Bottom Slope (feet per foot)....................	0.0141
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.85
Flow Velocity (feet per second)........................	4.81
Froude Number (Flow is Super-Critical).................	1.299
Velocity Head (feet)...................................	0.36
Energy Head (feet).....................................	1.21
Cross-Sectional Area of Flow (square feet).............	2.18
Top Width of Flow (feet)...............................	5.12

$V = 4.8 > 4.5$ ARMORIZE

$T = 62.4(0.85)(0.0141) = 0.75$

USE FS-2 FILTER STONE

DC-4 0400-7410 FS-2

56

MAX. D = 0.80/62A (0.0141) = 0.91'

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	10.5
Channel Bottom Slope (feet per foot)...................	0.0141
Manning's Roughness Coefficient (n-value)..............	0.0340
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
*Channel Bottom Width (feet)............................	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.89
Flow Velocity (feet per second)........................	3.23
Froude Number (Flow is Sub-Critical)...................	0.793
Velocity Head (feet)...................................	0.16
Energy Head (feet).....................................	1.05
Cross-Sectional Area of Flow (square feet).............	3.25
Top Width of Flow (feet)...............................	6.33

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* INCREASED WIDTH

DEPTH = 0.89 < 0.91 (ok)

DC-G 7+10 - 8+50 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	12.7
Channel Bottom Slope (feet per foot)...................	0.0357
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.62
Flow Velocity (feet per second)........................	7.11
Froude Number (Flow is Super-Critical).................	2.041
Velocity Head (feet)...................................	0.79
Energy Head (feet).....................................	1.41
Cross-Sectional Area of Flow (square feet).............	1.79
Top Width of Flow (feet)...............................	4.74

V = 7.11 > 4.5 ARMORIZE

T = 62.4 (0.62)(0.0357) = 1.38

USE CLASS "A" RIP-RAP

DC-9 7+10 - 8+50 CLASS "A"

58

MAX D = 2.5/62.4 (0.0357) = 1.12 FT

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	12.7
Channel Bottom Slope (feet per foot)	0.0357
Manning's Roughness Coefficient (n-value)	0.0540
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.96
Flow Velocity (feet per second)	3.39
Froude Number (Flow is Sub-Critical)	0.805
Velocity Head (feet)	0.18
Energy Head (feet)	1.14
Cross-Sectional Area of Flow (square feet)	3.74
Top Width of Flow (feet)	6.77

DEPTH = 0.96 < 1.12 (ok)

DC-H 0+00 -2+70 NATURAL

59

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	2.9
Channel Bottom Slope (feet per foot)....................	0.0074
Manning's Roughness Coefficient (n-value)...............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet).............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.59
Flow Velocity (feet per second).........................	2.75
Froude Number (Flow is Sub-Critical)....................	0.891
Velocity Head (feet)....................................	0.12
Energy Head (feet)......................................	0.71
Cross-Sectional Area of Flow (square feet)..............	1.05
Top Width of Flow (feet)................................	3.56

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$V = 2.8 > 2.5$ USE TEMP. LINER

$T = 62.4(0.59)(0.0074) = 0.27$

USE NET W/ STRAW

DC-H 0+00 - 2+70 NET W/STRAW

60

MAX. D = 1.45/62.4 (0.0074) = 3.14

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	2.9
Channel Bottom Slope (feet per foot)....................	0.0074
Manning's Roughness Coefficient (n-value)...............	0.0220
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet).............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.61
Flow Velocity (feet per second).........................	2.56
Froude Number (Flow is Sub-Critical)....................	0.814
Velocity Head (feet)....................................	0.10
Energy Head (feet)......................................	0.72
Cross-Sectional Area of Flow (square feet)..............	1.13
Top Width of Flow (feet)................................	3.69

DEPTH = 0.61 < 3.14 ok

DC-H 0+00 - 2+70 GRASS

$V = 2.56$
$R = 0.29$
$VR = 0.74 \rightarrow n = 0.10$

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	2.9
Channel Bottom Slope (feet per foot)	0.0074
Manning's Roughness Coefficient (n-value)	0.1000
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.08
Flow Velocity (feet per second)	0.82
Froude Number (Flow is Sub-Critical)	0.197
Velocity Head (feet)	0.01
Energy Head (feet)	1.09
Cross-Sectional Area of Flow (square feet)	3.53
Top Width of Flow (feet)	6.51

$V = 0.82 < 4.5$ (ok)

DC-I 0+00 - 4+40 NATURAL

62

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.4
Channel Bottom Slope (feet per foot)	0.0068
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.76
Flow Velocity (feet per second)	3.11
Froude Number (Flow is Sub-Critical)	0.889
Velocity Head (feet)	0.15
Energy Head (feet)	0.91
Cross-Sectional Area of Flow (square feet)	1.74
Top Width of Flow (feet)	4.56

V = 3.1 > 2.5 FPS USE TEMP. LINER

T = 62.4(0.76)(0.0068) = 0.32

USE NET W/STRAW

DC-I 0400-4440 NET W/STEAM

63

MAX D = 1.45/62.4 (0.0068) = 3.42

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.4
Channel Bottom Slope (feet per foot)	0.0068
Manning's Roughness Coefficient (n-value)	0.0220
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.79
Flow Velocity (feet per second)	2.90
Froude Number (Flow is Sub-Critical)	0.813
Velocity Head (feet)	0.13
Energy Head (feet)	0.92
Cross-Sectional Area of Flow (square feet)	1.86
Top Width of Flow (feet)	4.73

DEPTH = 0.79 < 3.42 (ok)

DC-I 0+00 - 4+40 GRASS

V = 2.90
R = 0.37
VR = 1.07 → n = 0.08

6A

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	5.4
Channel Bottom Slope (feet per foot)...................	0.0068
Manning's Roughness Coefficient (n-value)...............	0.0800
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet).............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	1.28
Flow Velocity (feet per second).........................	1.10
Froude Number (Flow is Sub-Critical)....................	0.242
Velocity Head (feet)....................................	0.02
Energy Head (feet)......................................	1.30
Cross-Sectional Area of Flow (square feet)..............	4.92
Top Width of Flow (feet)................................	7.69

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V = 1.1 < 4.5 ok

DC-J 0+00 - 4+00 NATURAL

65

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.2
Channel Bottom Slope (feet per foot)	0.0068
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.75
Flow Velocity (feet per second)	3.08
Froude Number (Flow is Sub-Critical)	0.887
Velocity Head (feet)	0.15
Energy Head (feet)	0.90
Cross-Sectional Area of Flow (square feet)	1.69
Top Width of Flow (feet)	4.50

V = 3.1 > 2.5 USE TEMP. LINER

T = 62.4(0.75)(0.0068) = 0.32

USE NET W/STRAW

DC-J 0+00 - 4+00 NET W/STRAW

66

MAX D = 1.45/62.4(0.0068) = 3.42

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	5.2
Channel Bottom Slope (feet per foot)	0.0068
Manning's Roughness Coefficient (n-value)	0.0220
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.78
Flow Velocity (feet per second)	2.87
Froude Number (Flow is Sub-Critical)	0.811
Velocity Head (feet)	0.13
Energy Head (feet)	0.91
Cross-Sectional Area of Flow (square feet)	1.81
Top Width of Flow (feet)	4.66

DEPTH = 0.78 < 3.42 ok

DC-J 0+00 - 4+00 GRASS

V = 2.87
R = 0.37
VR = 1.06 ⟶ n = 0.08

67

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	5.2
Channel Bottom Slope (feet per foot)..................	0.0068
Manning's Roughness Coefficient (n-value)..............	0.0800
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	1.26
Flow Velocity (feet per second)........................	1.09
Froude Number (Flow is Sub-Critical)...................	0.241
Velocity Head (feet)...................................	0.02
Energy Head (feet).....................................	1.28
Cross-Sectional Area of Flow (square feet).............	4.78
Top Width of Flow (feet)...............................	7.58

V = 1.1 < 4.5 (ok)

DC-K 0+00-6+40 NATURAL

68

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 16, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	4.9
Channel Bottom Slope (feet per foot)...................	0.0156
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.63
Flow Velocity (feet per second)........................	4.15
Froude Number (Flow is Super-Critical).................	1.305
Velocity Head (feet)...................................	0.27
Energy Head (feet).....................................	0.89
Cross-Sectional Area of Flow (square feet).............	1.18
Top Width of Flow (feet)...............................	3.76

$V = 4.2 > 2.5$
USE TEMP. LINER

$T = 62.4(0.63)(0.0156) = 0.61$

USE NET W/STRAW

DC-K 0+00-6+40 NET W/STRAW

69

MAX. D = 1.45 / 62.4(0.0156) = 1.49

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 16, 1992

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	4.9
Channel Bottom Slope (feet per foot)....................	0.0156
Manning's Roughness Coefficient (n-value)...............	0.0330
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet).............................	0.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.76
Flow Velocity (feet per second).........................	2.85
Froude Number (Flow is Sub-Critical)....................	0.815
Velocity Head (feet)....................................	0.13
Energy Head (feet)......................................	0.88
Cross-Sectional Area of Flow (square feet)..............	1.72
Top Width of Flow (feet)................................	4.54

==

DEPTH = 0.76 < 1.49 (ok)

DC-K 0+00 - 6+40 GRASSED

V=4.2
R=0.30
VR=1.26 → n=0.075

69-A

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 16, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	4.9
Channel Bottom Slope (feet per foot)	0.0156
Manning's Roughness Coefficient (n-value)	0.0750
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.03
Flow Velocity (feet per second)	1.53
Froude Number (Flow is Sub-Critical)	0.376
Velocity Head (feet)	0.04
Energy Head (feet)	1.07
Cross-Sectional Area of Flow (square feet)	3.19
Top Width of Flow (feet)	6.19

V=1.53 < 4.5 ok

DC-L 0+00-5+50 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

==

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)....................	6.8
Channel Bottom Slope (feet per foot)....................	0.0273
Manning's Roughness Coefficient (n-value)...............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.64
Flow Velocity (feet per second)........................	5.55
Froude Number (Flow is Super-Critical).................	1.732
Velocity Head (feet)...................................	0.48
Energy Head (feet).....................................	1.12
Cross-Sectional Area of Flow (square feet).............	1.22
Top Width of Flow (feet)...............................	3.83

==

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V = 5.6 > 4.5 ARMORIZE

T = 62.4 (0.64)(0.0273) = 1.09

USE CLASS "A" RIP-RAP

DCL 0+00-5+50 CLASS "A"

71

MAX. D = 2.5/62.4 (0.0273) = 1.47

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	6.8
Channel Bottom Slope (feet per foot)	0.0273
Manning's Roughness Coefficient (n-value)	0.0540
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.93
Flow Velocity (feet per second)	2.63
Froude Number (Flow is Sub-Critical)	0.680
Velocity Head (feet)	0.11
Energy Head (feet)	1.04
Cross-Sectional Area of Flow (square feet)	2.59
Top Width of Flow (feet)	5.57

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DEPTH = 0.93 < 1.47 ok

DC-M1 0+00 - 2+00 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 17, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	1.6
Channel Bottom Slope (feet per foot)	0.0100
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.45
Flow Velocity (feet per second)	2.66
Froude Number (Flow is Sub-Critical)	0.990
Velocity Head (feet)	0.11
Energy Head (feet)	0.56
Cross-Sectional Area of Flow (square feet)	0.60
Top Width of Flow (feet)	2.69

$V = 2.7 > 2.5$ USE TEMP LINER

$T = 62.4(0.45)(0.01) = 0.28$

USE NET/STRAW

DC-M1 0+00 -2+00 NET W/STRAW

MAX. D = 1.45/62.4 (0.01) = 2.32

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 17, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	1.6
Channel Bottom Slope (feet per foot)	0.0100
Manning's Roughness Coefficient (n-value)	0.0330
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.54
Flow Velocity (feet per second)	1.82
Froude Number (Flow is Sub-Critical)	0.618
Velocity Head (feet)	0.05
Energy Head (feet)	0.59
Cross-Sectional Area of Flow (square feet)	0.88
Top Width of Flow (feet)	3.24

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DEPTH = 0.54 < 2.32 (ok)

DC-M1 0+00 -2+00 NET W/STRAW

73

MAX. D = 1.45/62.4 (0.01) = 2.32

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 17, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)........................	1.6
Channel Bottom Slope (feet per foot)..................	0.0100
Manning's Roughness Coefficient (n-value)..............	0.0330
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)...........................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.54
Flow Velocity (feet per second)........................	1.82
Froude Number (Flow is Sub-Critical)..................	0.618
Velocity Head (feet)....................................	0.05
Energy Head (feet)......................................	0.59
Cross-Sectional Area of Flow (square feet).............	0.88
Top Width of Flow (feet)................................	3.24

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986 Dodson & Associates, Inc., 7015 W. Tidwell, #107, Houston, TX 77092 (713) 895-8322. A manual with equations & flow chart is available.

DEPTH = 0.54 < 2.32 (ok)

DC-M1 0+00 - 2+00 GRASS

Y = 1.82
R = 0.26
VR = 0.47 → n = 0.14

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 17, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	1.6
Channel Bottom Slope (feet per foot)	0.0100
Manning's Roughness Coefficient (n-value)	0.1400
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.93
Flow Velocity (feet per second)	0.61
Froude Number (Flow is Sub-Critical)	0.159
Velocity Head (feet)	0.01
Energy Head (feet)	0.94
Cross-Sectional Area of Flow (square feet)	2.60
Top Width of Flow (feet)	5.59

V = 0.61 < 4.5 (ok)

DC-M3 0+00 - 3+70 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 17, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	3.4
Channel Bottom Slope (feet per foot)	0.0054
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.67
Flow Velocity (feet per second)	2.54
Froude Number (Flow is Sub-Critical)	0.776
Velocity Head (feet)	0.10
Energy Head (feet)	0.77
Cross-Sectional Area of Flow (square feet)	1.34
Top Width of Flow (feet)	4.01

V=2.54 > 2.5 USE TEMP. LINER

T= 62.4(0.67)(0.0054) = 0.23

USE NET W/STRAW

DC-M1- 0+00-3+70 NET W/STRAW

76

MAX D= $1.45/62.4(0.0054) = 4.3$

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 17, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	3.4
Channel Bottom Slope (feet per foot)	0.0054
Manning's Roughness Coefficient (n-value)	0.0220
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.69
Flow Velocity (feet per second)	2.37
Froude Number (Flow is Sub-Critical)	0.709
Velocity Head (feet)	0.09
Energy Head (feet)	0.78
Cross-Sectional Area of Flow (square feet)	1.44
Top Width of Flow (feet)	4.15

DEPTH = $0.69 < 4.3$ (ok)

DC-M2 0+00-3+70 GRASS

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 17, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	3.4
Channel Bottom Slope (feet per foot)	0.0054
Manning's Roughness Coefficient (n-value)	0.0900
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.17
Flow Velocity (feet per second)	0.82
Froude Number (Flow is Sub-Critical)	0.189
Velocity Head (feet)	0.01
Energy Head (feet)	1.19
Cross-Sectional Area of Flow (square feet)	4.14
Top Width of Flow (feet)	7.05

$V = 0.82 < 4.5$ ok

DC-N 0+00 - 5+10 NATURAL

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	2.6
Channel Bottom Slope (feet per foot)...................	0.0157
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.49
Flow Velocity (feet per second)........................	3.55
Froude Number (Flow is Super-Critical).................	1.260
Velocity Head (feet)...................................	0.20
Energy Head (feet).....................................	0.69
Cross-Sectional Area of Flow (square feet).............	0.73
Top Width of Flow (feet)...............................	2.96

V = 3.6 > 2.5 USE TEMP. LINER

T = 62.4(0.49)(0.0157) = 0.48

USE NET W/STRAW

DC-N 0+00-5+10 NET W/STRAW

79

MAX. D= 1.45/62.4 (0.0157) = 1.48

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

===

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	2.6
Channel Bottom Slope (feet per foot)....................	0.0157
Manning's Roughness Coefficient (n-value)..............	0.0220
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet).............................	0.0

===

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	0.51
Flow Velocity (feet per second).........................	3.31
Froude Number (Flow is Super-Critical)..................	1.152
Velocity Head (feet)....................................	0.17
Energy Head (feet)......................................	0.68
Cross-Sectional Area of Flow (square feet)..............	0.79
Top Width of Flow (feet)................................	3.07

===

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
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DEPTH = 0.51 < 1.48 (ok)

DC-N 0+00-5+10 GRASS

80

V=3.31
R=0.24
VR=0.79 ⟶ n=0.095

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
November 13, 1992

===

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	2.6
Channel Bottom Slope (feet per foot)...................	0.0157
Manning's Roughness Coefficient (n-value)..............	0.0950
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

===

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.89
Flow Velocity (feet per second)........................	1.10
Froude Number (Flow is Sub-Critical)...................	0.291
Velocity Head (feet)...................................	0.02
Energy Head (feet).....................................	0.91
Cross-Sectional Area of Flow (square feet).............	2.37
Top Width of Flow (feet)...............................	5.33

===

V=1.1 <4.5 ok

DC-0 0400-5+40 NATURAL

80A

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

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PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)........................	20.3
Channel Bottom Slope (feet per foot).....................	0.0037
Manning's Roughness Coefficient (n-value)................	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)..............................	2.0

===

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)......................................	1.11
Flow Velocity (feet per second)..........................	3.42
Froude Number (Flow is Sub-Critical).....................	0.728
Velocity Head (feet).....................................	0.18
Energy Head (feet).......................................	1.29
Cross-Sectional Area of Flow (square feet)...............	5.94
Top Width of Flow (feet).................................	8.68

===

TRAPEZOIDAL CHANNEL ANALYSIS COMPUTER PROGRAM, Version 1.1 (c) 1986
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(713) 895-8322. A manual with equations & flow chart is available.

V = 3.42 > 2.5 USE TEMP. LINER

SHEAR STRESS = T = 62.4(1.11)(0.0037) = 0.26

USE JUTE NET W/STRAW

DC-0 0+00 - 5+40 JUTE NET W/STRAW

MAX. D = 1.45/62.4(0.0037) = 6.28 FT

80B

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	20.3
Channel Bottom Slope (feet per foot)	0.0037
Manning's Roughness Coefficient (n-value)	0.0330
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	2.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.39
Flow Velocity (feet per second)	2.36
Froude Number (Flow is Sub-Critical)	0.456
Velocity Head (feet)	0.09
Energy Head (feet)	1.48
Cross-Sectional Area of Flow (square feet)	8.61
Top Width of Flow (feet)	10.36

DEPTH = 1.39 < 6.28 ok

DC-O 0+00-5+40 GRASSED

V= 3.42
R= 0.66
VR= 2.26 → n = 0.055

80 C

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	20.3
Channel Bottom Slope (feet per foot)	0.0037
Manning's Roughness Coefficient (n-value)	0.0550
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	2.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.75
Flow Velocity (feet per second)	1.61
Froude Number (Flow is Sub-Critical)	0.282
Velocity Head (feet)	0.04
Energy Head (feet)	1.79
Cross-Sectional Area of Flow (square feet)	12.63
Top Width of Flow (feet)	12.47

V=1.61 FPS <4.5 ok

DC-P 0+00 - 1+80 NATURAL

80 D

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	1.0
Channel Bottom Slope (feet per foot)	0.0111
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.37
Flow Velocity (feet per second)	2.46
Froude Number (Flow is Super-Critical)	1.011
Velocity Head (feet)	0.09
Energy Head (feet)	0.46
Cross-Sectional Area of Flow (square feet)	0.41
Top Width of Flow (feet)	2.21

$V = 2.46 < 2.5$ ok

DC-P 1+80 - 3+10 NATURAL

80E

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	1.3
Channel Bottom Slope (feet per foot)...................	0.0154
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.38
Flow Velocity (feet per second)........................	2.97
Froude Number (Flow is Super-Critical).................	1.198
Velocity Head (feet)...................................	0.14
Energy Head (feet).....................................	0.52
Cross-Sectional Area of Flow (square feet).............	0.44
Top Width of Flow (feet)...............................	2.29

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(713) 895-8322. A manual with equations & flow chart is available.

$V = 2.97 > 2.5$ USE TEMP. LINER

$T = 62.4\,(0.38)(0.0154) = 0.37$

USE JUTE NET W/STRAW

DC-P 1+80-3+10 JUTE NET W/STRAW

MAX. D= 1.45/62.4(0.0154) = 1.51 FT .80 F

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

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PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	1.3
Channel Bottom Slope (feet per foot)	0.0154
Manning's Roughness Coefficient (n-value)	0.0330
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

==

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.46
Flow Velocity (feet per second)	2.04
Froude Number (Flow is Sub-Critical)	0.748
Velocity Head (feet)	0.06
Energy Head (feet)	0.53
Cross-Sectional Area of Flow (square feet)	0.64
Top Width of Flow (feet)	2.77

==

DEPTH = 0.46 FT < 1.51 (ok)

DC-P 1+80 - 3+10 GRASSED

V = 2.97
R = 0.18
VR = 0.53 → n = 0.14

80G

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	1.3
Channel Bottom Slope (feet per foot)	0.0154
Manning's Roughness Coefficient (n-value)	0.1400
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.79
Flow Velocity (feet per second)	0.69
Froude Number (Flow is Sub-Critical)	0.192
Velocity Head (feet)	0.01
Energy Head (feet)	0.80
Cross-Sectional Area of Flow (square feet)	1.89
Top Width of Flow (feet)	4.76

V = 0.69 < 4.5 (o.k.)

DC-P 3+10 - 4+10 NATURAL

80 H

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	1.7
Channel Bottom Slope (feet per foot)	0.0200
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.40
Flow Velocity (feet per second)	3.50
Froude Number (Flow is Super-Critical)	1.376
Velocity Head (feet)	0.19
Energy Head (feet)	0.59
Cross-Sectional Area of Flow (square feet)	0.49
Top Width of Flow (feet)	2.41

$V = 3.5 > 2.5$ USE TEMP. LINER

$T = 62.4(0.4)(0.02) = 0.50$

USE JUTE NET W/STRAW

DCP 3+10 - 4+10 NET W/STRAW

MAX D = 1.45/62.4 (0.02) = 1.16 FT

80 I

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)..........................	1.7
Channel Bottom Slope (feet per foot)......................	0.0200
Manning's Roughness Coefficient (n-value)...............	0.0330
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)..............................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)......................................	0.49
Flow Velocity (feet per second)..........................	2.40
Froude Number (Flow is Sub-Critical).....................	0.860
Velocity Head (feet).....................................	0.09
Energy Head (feet).......................................	0.58
Cross-Sectional Area of Flow (square feet)...............	0.71
Top Width of Flow (feet).................................	2.91

DEPTH = 0.49 < 1.16 (ok)

DC-P 3+10 - 4+10 GRASSED

V = 3.5
R = 0.19
VR = 0.67 → n = 0.11

80J

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

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PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	1.7
Channel Bottom Slope (feet per foot)...................	0.0200
Manning's Roughness Coefficient (n-value)..............	0.1100
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)............................	0.0

===

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	0.76
Flow Velocity (feet per second)........................	0.97
Froude Number (Flow is Sub-Critical)...................	0.277
Velocity Head (feet)...................................	0.01
Energy Head (feet).....................................	0.78
Cross-Sectional Area of Flow (square feet).............	1.75
Top Width of Flow (feet)...............................	4.58

===

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V = 0.97 < 4.5 (ok)

DC-Q 0+00 – 2+50 NATURAL

80 K

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	1.8
Channel Bottom Slope (feet per foot)	0.0040
Manning's Roughness Coefficient (n-value)	0.0200
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	0.56
Flow Velocity (feet per second)	1.94
Froude Number (Flow is Sub-Critical)	0.648
Velocity Head (feet)	0.06
Energy Head (feet)	0.61
Cross-Sectional Area of Flow (square feet)	0.93
Top Width of Flow (feet)	3.34

$V = 1.94 < 2.5$ (ok)

DC-R 0+00 -6+20 NATURAL

80L

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second).....................	8.1
Channel Bottom Slope (feet per foot)..................	0.0032
Manning's Roughness Coefficient (n-value).............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
Channel Bottom Width (feet)...........................	0.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	1.02
Flow Velocity (feet per second)........................	2.59
Froude Number (Flow is Sub-Critical)...................	0.639
Velocity Head (feet)...................................	0.10
Energy Head (feet).....................................	1.13
Cross-Sectional Area of Flow (square feet).............	3.13
Top Width of Flow (feet)...............................	6.13

V=2.59 > 2.5 USE TEMP. LINER

T= 62.4(1.02)(0.0032) = 0.20

USE NET W/STRAW

DC-R 0+00 -6+20 NET W/STRAW

MAX. D= 1.45/.62A(0.0032)=7.26 80M

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	8.1
Channel Bottom Slope (feet per foot)...................	0.0032
Manning's Roughness Coefficient (n-value)..............	0.0330
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
*Channel Bottom Width (feet)...........................	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)....................................	1.08
Flow Velocity (feet per second)........................	1.78
Froude Number (Flow is Sub-Critical)...................	0.402
Velocity Head (feet)...................................	0.05
Energy Head (feet).....................................	1.13
Cross-Sectional Area of Flow (square feet).............	4.55
Top Width of Flow (feet)...............................	7.46

* INCREASED WIDTH

DEPTH= 1.08 < 7.26 (ok)

DC-R 0+00 - 6+20 GRASSED

80 N

V=2.59
R=0.48
VR=1.24 $n \rightarrow 0.075$

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	8.1
Channel Bottom Slope (feet per foot)	0.0032
Manning's Roughness Coefficient (n-value)	0.0750
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.52
Flow Velocity (feet per second)	0.96
Froude Number (Flow is Sub-Critical)	0.186
Velocity Head (feet)	0.01
Energy Head (feet)	1.53
Cross-Sectional Area of Flow (square feet)	8.42
Top Width of Flow (feet)	10.10

V= 0.96 < 4.5 ok

DC-S 0+00-6+00 NATURAL

800

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)......................	18.9
Channel Bottom Slope (feet per foot)...................	0.0050
Manning's Roughness Coefficient (n-value)..............	0.0200
Channel Side Slope - Left Side (horizontal/vertical)....	3.00
Channel Side Slope - Right Side (horizontal/vertical)...	3.00
*Channel Bottom Width (feet)...........................	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet).....................................	1.13
Flow Velocity (feet per second).........................	3.78
Froude Number (Flow is Sub-Critical)....................	0.833
Velocity Head (feet)....................................	0.22
Energy Head (feet)......................................	1.36
Cross-Sectional Area of Flow (square feet)..............	5.00
Top Width of Flow (feet)................................	7.81

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* INCREASED WIDTH

V=3.78 >2.5 USE TEMP LINER

T=62.4(1.13)(0.005)=0.35

USE NET W/ STRAW

DC-5 0+00 - 6+00 NET W/STRAW

MAX D = 1.45/62A(0.005) = 4.65

80P

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	18.9
Channel Bottom Slope (feet per foot)	0.0050
Manning's Roughness Coefficient (n-value)	0.0330
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.40
Flow Velocity (feet per second)	2.60
Froude Number (Flow is Sub-Critical)	0.520
Velocity Head (feet)	0.10
Energy Head (feet)	1.50
Cross-Sectional Area of Flow (square feet)	7.28
Top Width of Flow (feet)	9.40

DEPTH = 1.4 < 4.65 (ok)

DC-5 0+00 - 6+00 GRASS

80 Q

V = 3.78
R = 0.61
VR = 2.31

n → 0.06

TRAPEZOIDAL CHANNEL ANALYSIS
NORMAL DEPTH COMPUTATION
December 18, 1992

PROGRAM INPUT DATA:

DESCRIPTION	VALUE
Flow Rate (cubic feet per second)	18.9
Channel Bottom Slope (feet per foot)	0.0050
Manning's Roughness Coefficient (n-value)	0.0600
Channel Side Slope - Left Side (horizontal/vertical)	3.00
Channel Side Slope - Right Side (horizontal/vertical)	3.00
Channel Bottom Width (feet)	1.0

PROGRAM RESULTS:

DESCRIPTION	VALUE
Normal Depth (feet)	1.79
Flow Velocity (feet per second)	1.66
Froude Number (Flow is Sub-Critical)	0.298
Velocity Head (feet)	0.04
Energy Head (feet)	1.83
Cross-Sectional Area of Flow (square feet)	11.36
Top Width of Flow (feet)	11.72

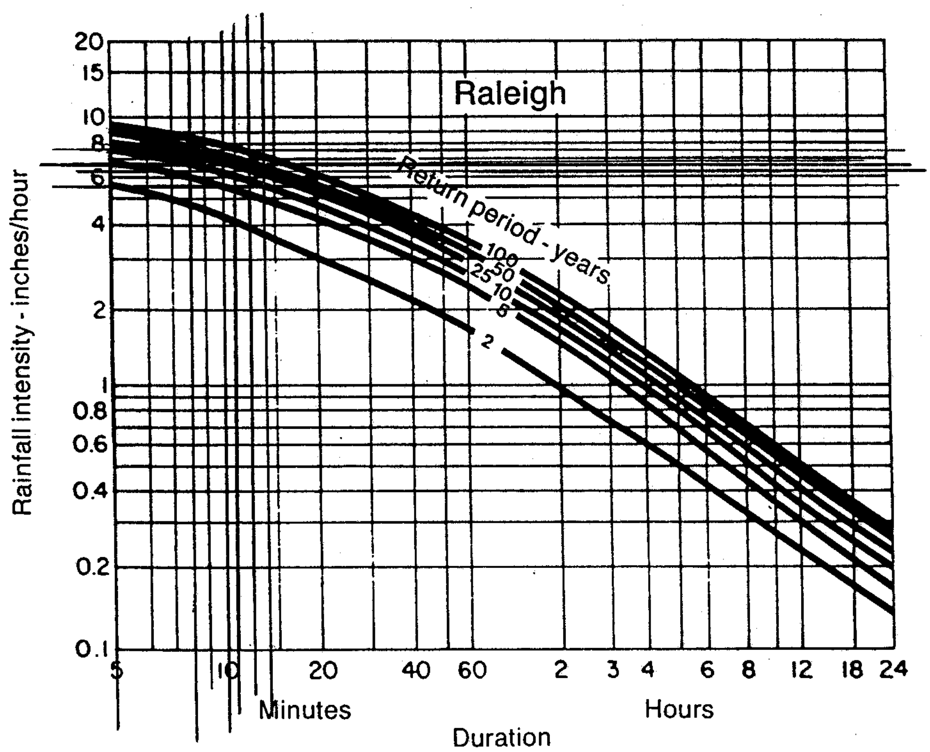
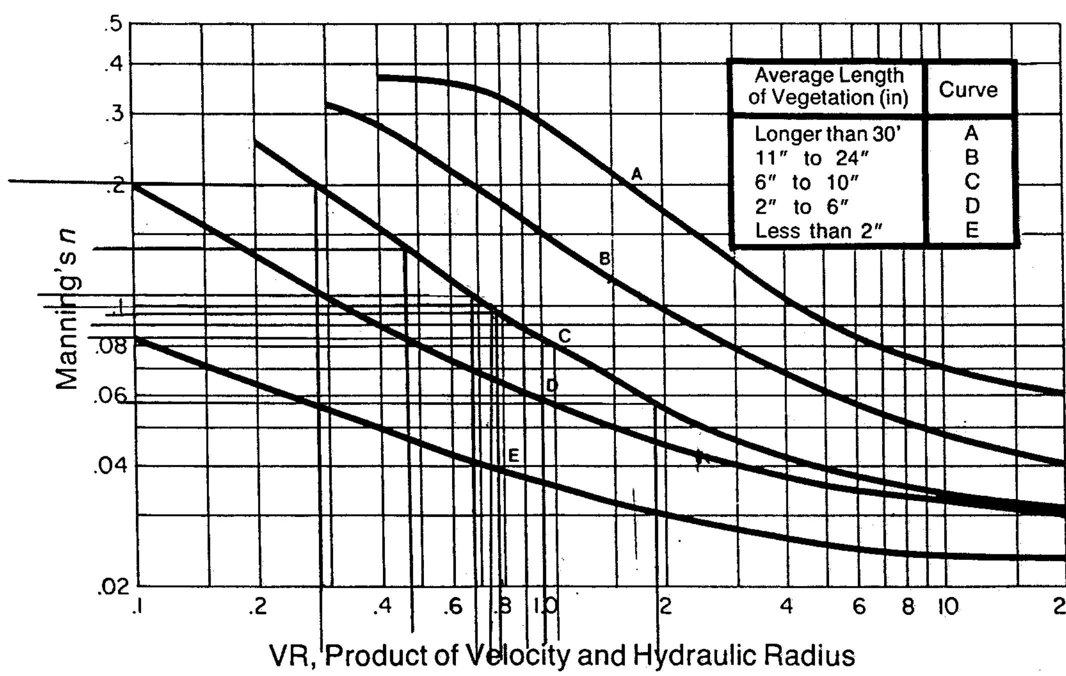


Figure 8.03e Rainfall intensity duration curves—Raleigh.



Average Length of Vegetation (in)	Curve
Longer than 30'	A
11" to 24"	B
6" to 10"	C
2" to 6"	D
Less than 2"	E

Figure 8.05c Manning's *n* related to velocity, hydraulic radius, and vegetal retardance.

Table 8.05e
Manning's Roughness Coefficients for Temporary Lining Materials

Lining Type	*n* value for Depth Ranges 0-0.5 ft	0.5-2.0 ft	>2.0 ft
Woven Paper Net	0.016	0.015	0.015
Jute Net	0.028	0.022	0.019
Fiberglass Roving	0.028	0.021	0.019
Straw with Net	0.065	0.033	0.025
Curled Wood Mat	0.066	0.035	0.028
Synthetic Mat	0.036	0.025	0.021

Table 8.05f
Manning's Roughness Coefficient for Riprap and Gravel

Material	d_{50} (inches)	*n* value for Depth Ranges 0-0.5 ft	0.5-1.0 ft	1.0-2.0 ft	> 2.0 ft
Gravel	1	0.033	0.028	0.026	0.025
	2	0.045	0.034	0.034	0.031
Riprap	6	0.106	0.054	0.044	0.041
	9	0.215	0.068	0.062	0.047
	12	0.797	0.084	0.060	0.053
	15	—	0.104	0.068	0.059
	18	—	0.127	0.076	0.064
	21	—	0.158	0.085	0.070
	24	—	0.199	0.095	0.076

Table 8.05g
Permissible Shear Stresses for Riprap and Temporary Liners

Lining Category	Lining Type	Permissible Unit Shear Stress, T_d (lb/ft^2)
Temporary	Woven Paper Net	0.15
	Jute Net	0.45
	Fiberglass Roving:	
	Single	0.60
	Double	0.85
	Straw with Net	1.45
	Curled Wood mat	1.55
	Synthetic Mat	2.00
	d_{50} Stone Size (inches)	
Gravel Riprap	1	0.40
	2	0.80
Rock Riprap	6	2.50
	9	3.80
	12	5.00
	15	6.30
	18	7.50
	21	8.80
	24	10.00

SLOPE DRAIN SYSTEM DESIGN:

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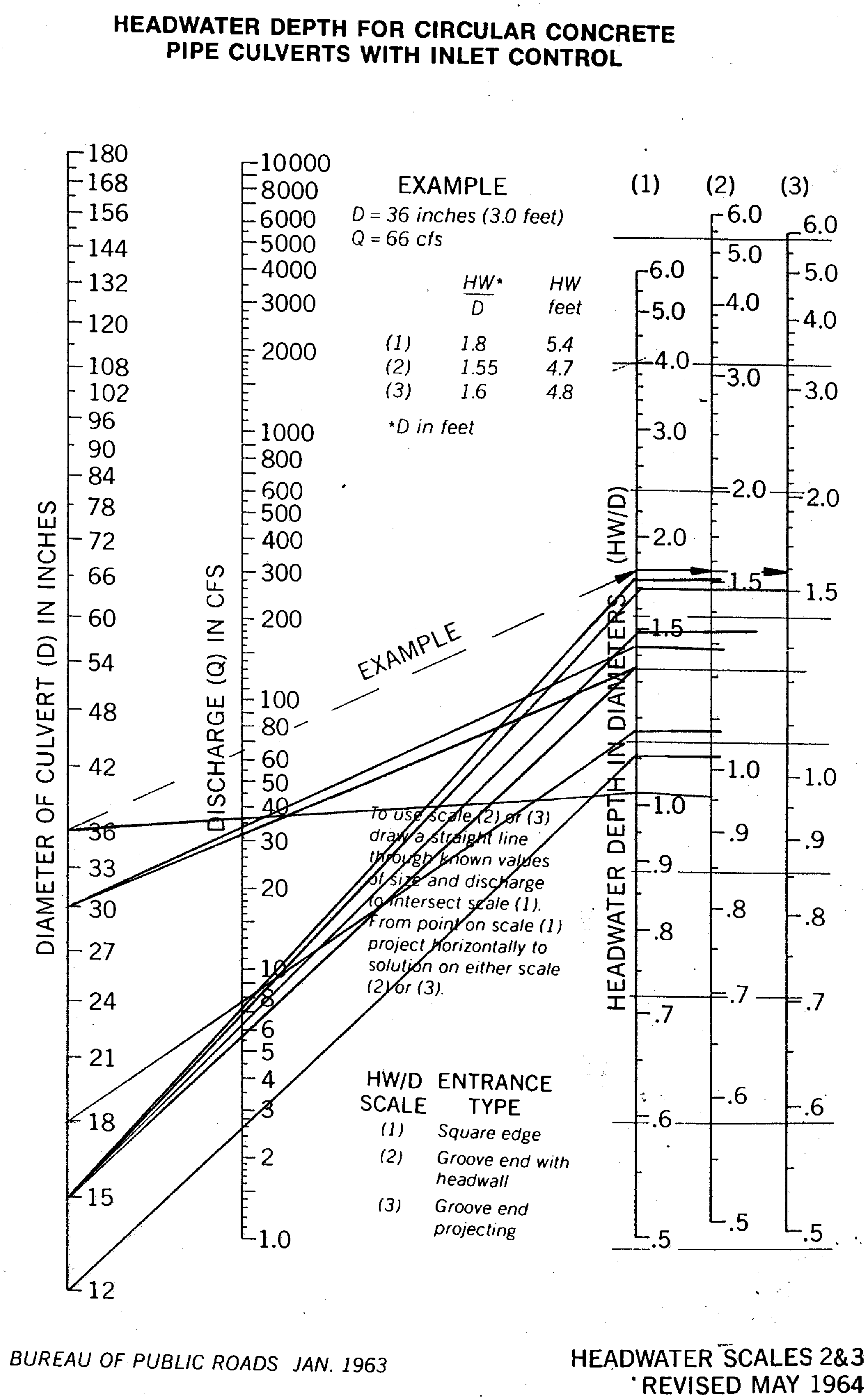
FIGURE 33



CULVERT CROSSING DESIGN.

FIGURE 33

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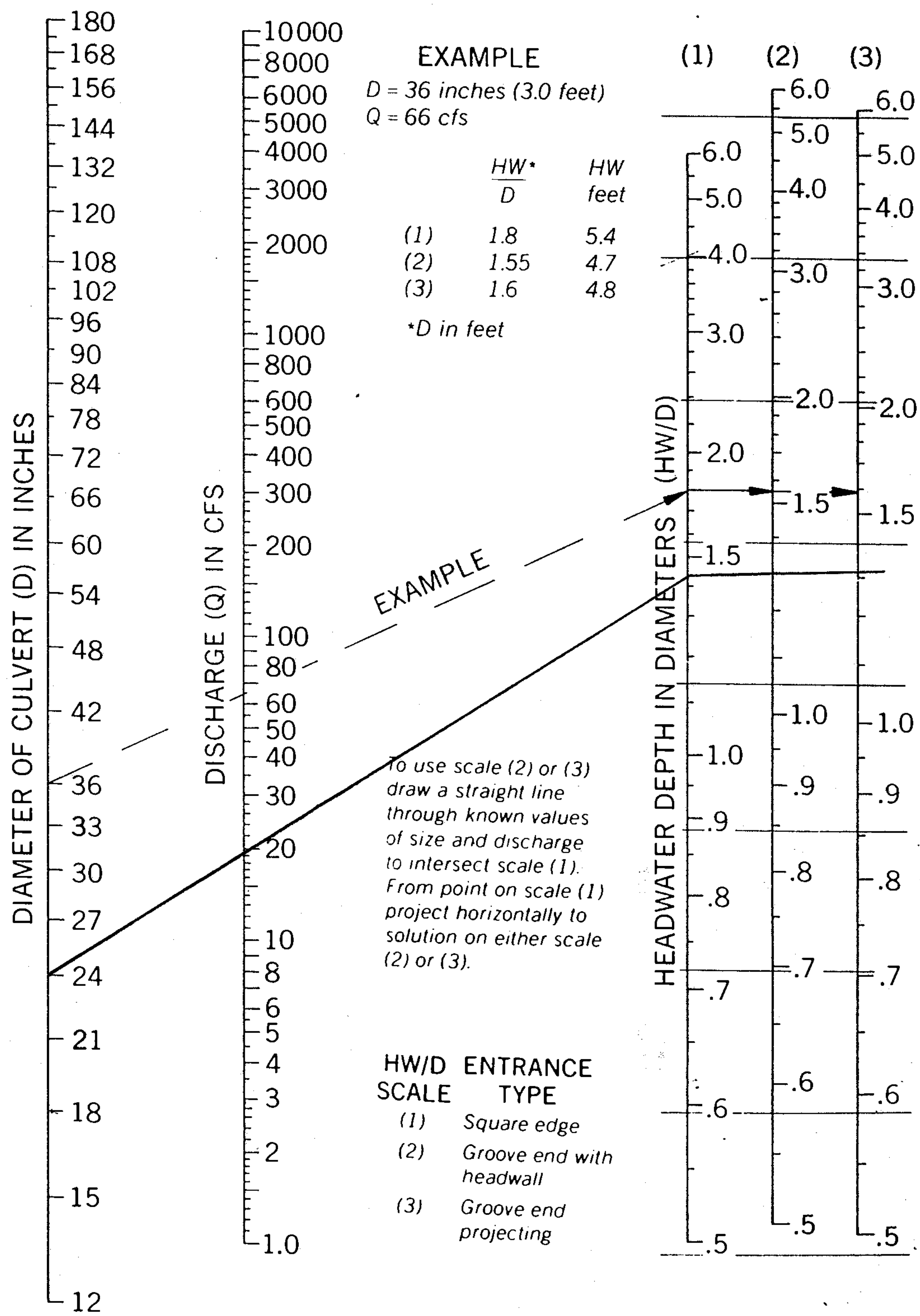
HEADWATER DEPTH FOR CIRCULAR CONCRETE PIPE CULVERTS WITH INLET CONTROL



BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER SCALES 2&3 REVISED MAY 1964

STILLING BASIN DESIGN:

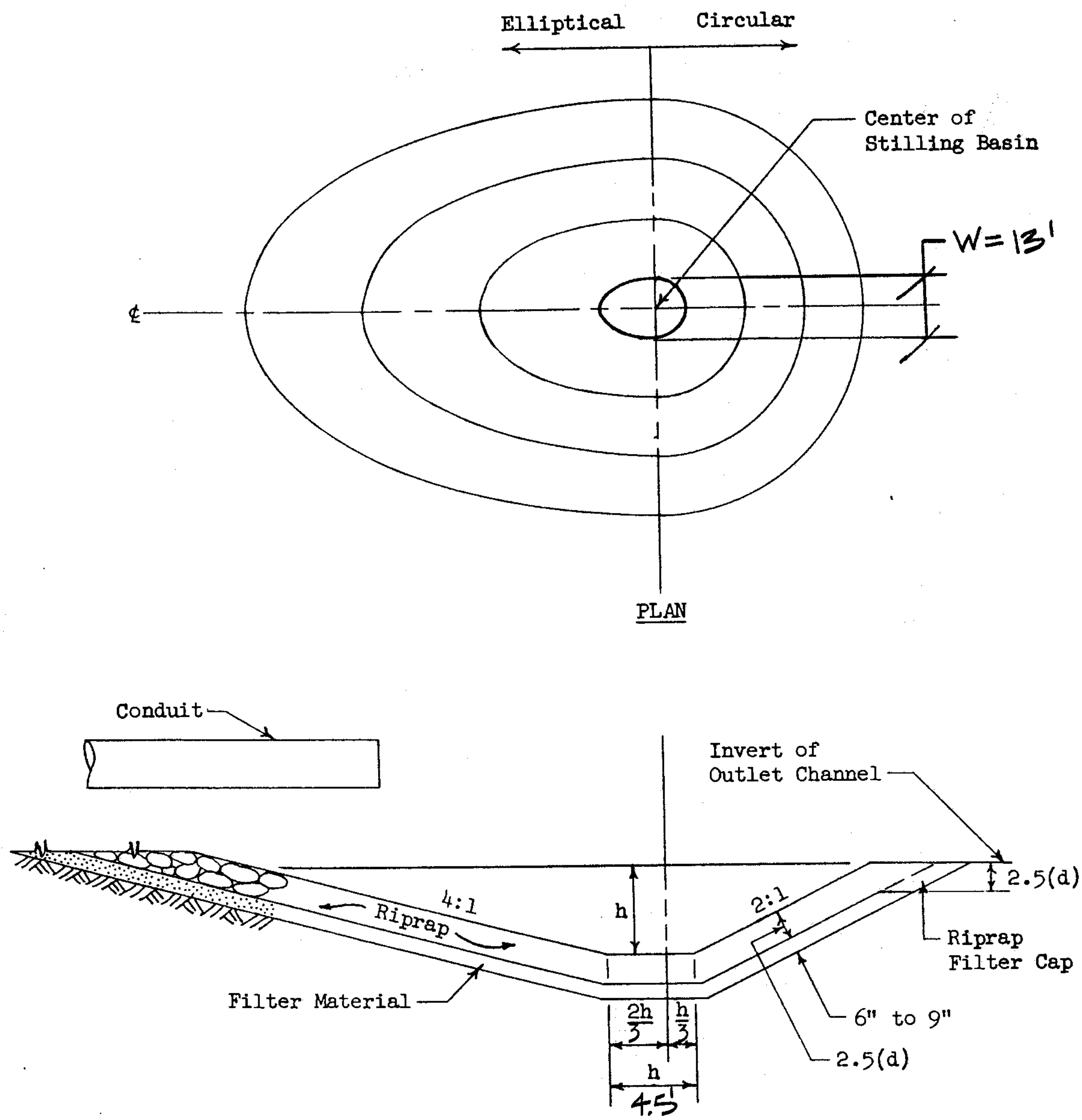


Figure 1. Stilling basin configuration

STILLING BASIN DESIGN:

Appendix C: Circular Channel Ratios

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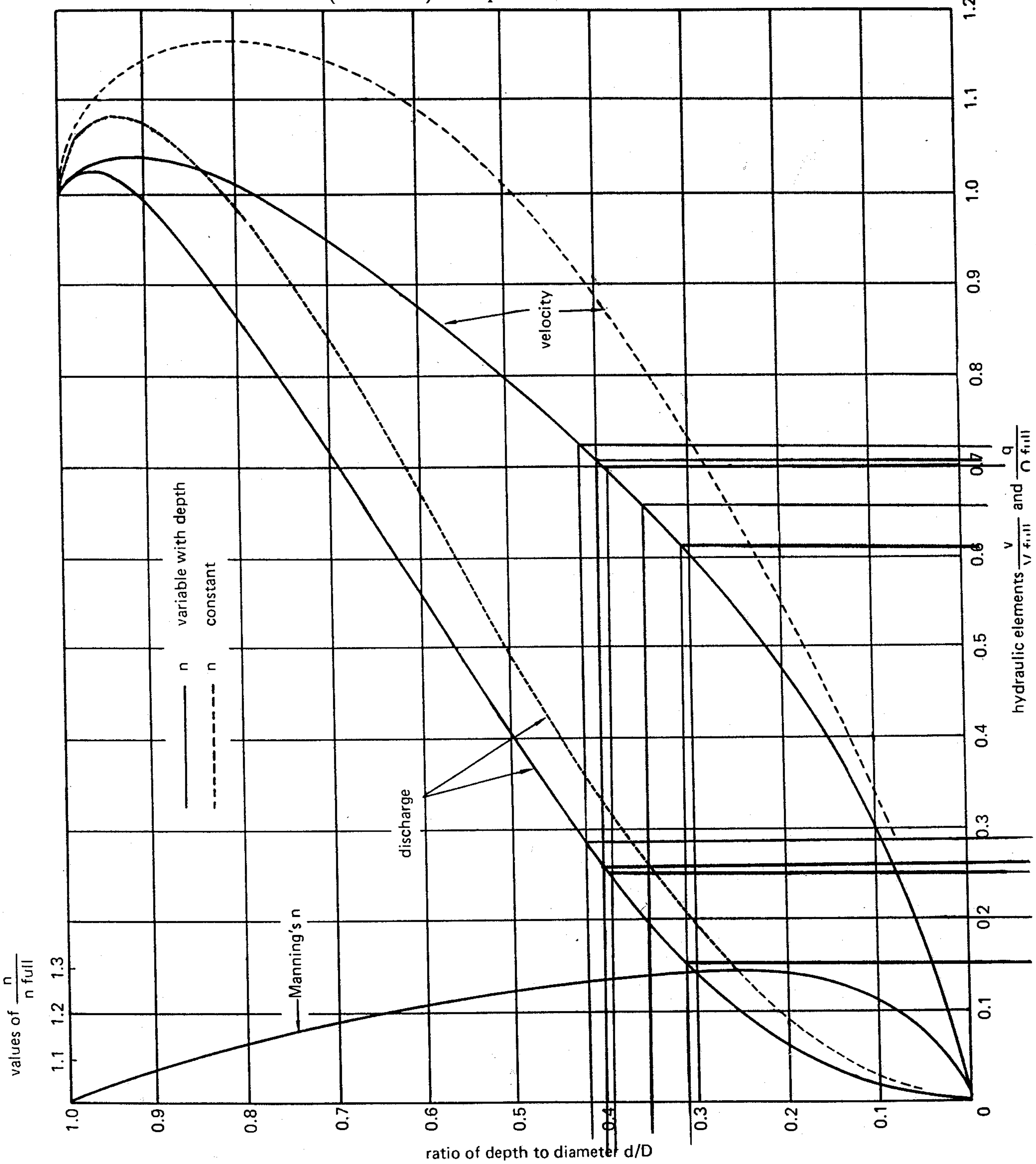
Experiments have shown that n varies slightly with depth. This figure gives velocity and flow rate ratios for varying n (solid line) and constant n (broken line) assumptions.



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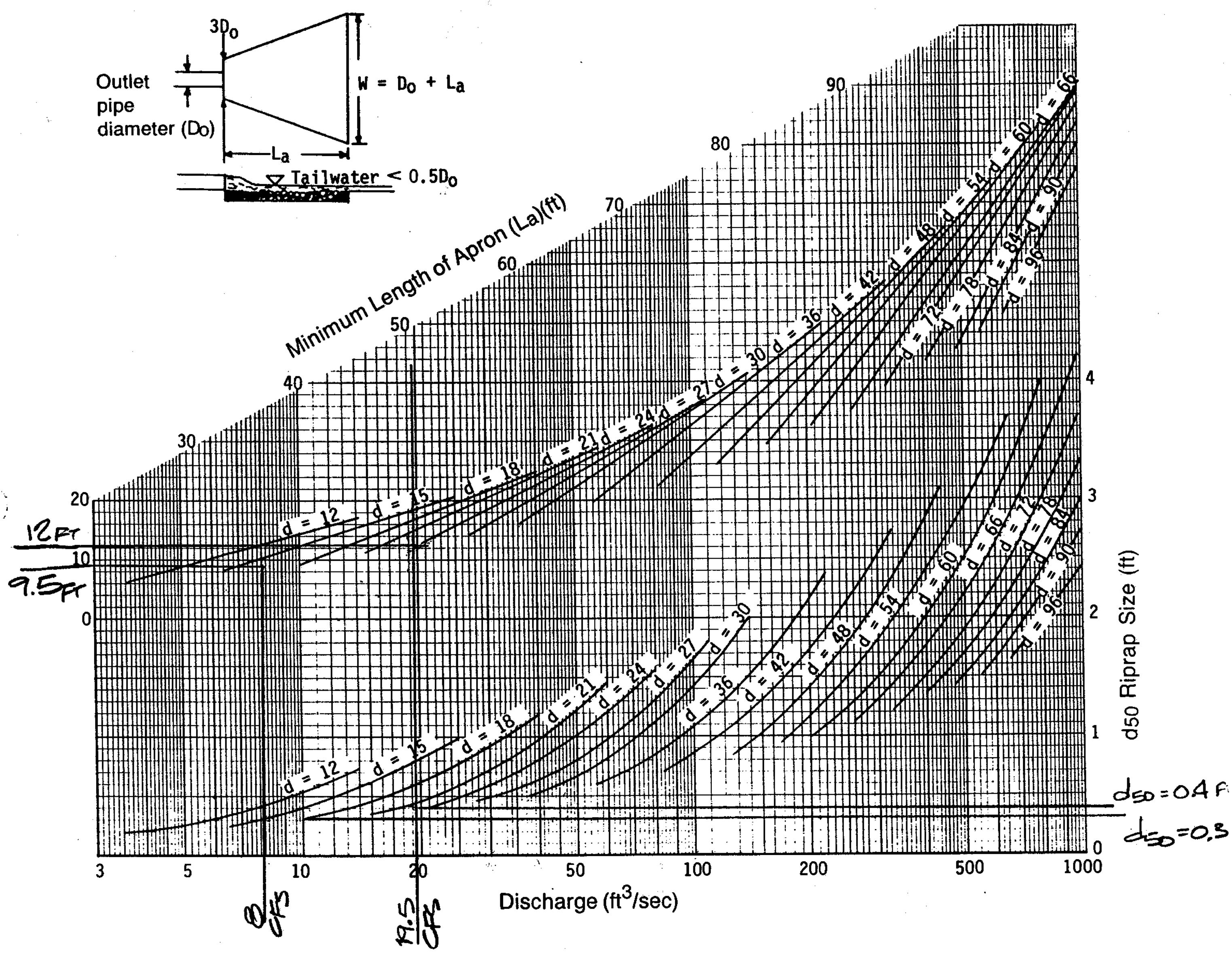


Curves may not be extrapolated.

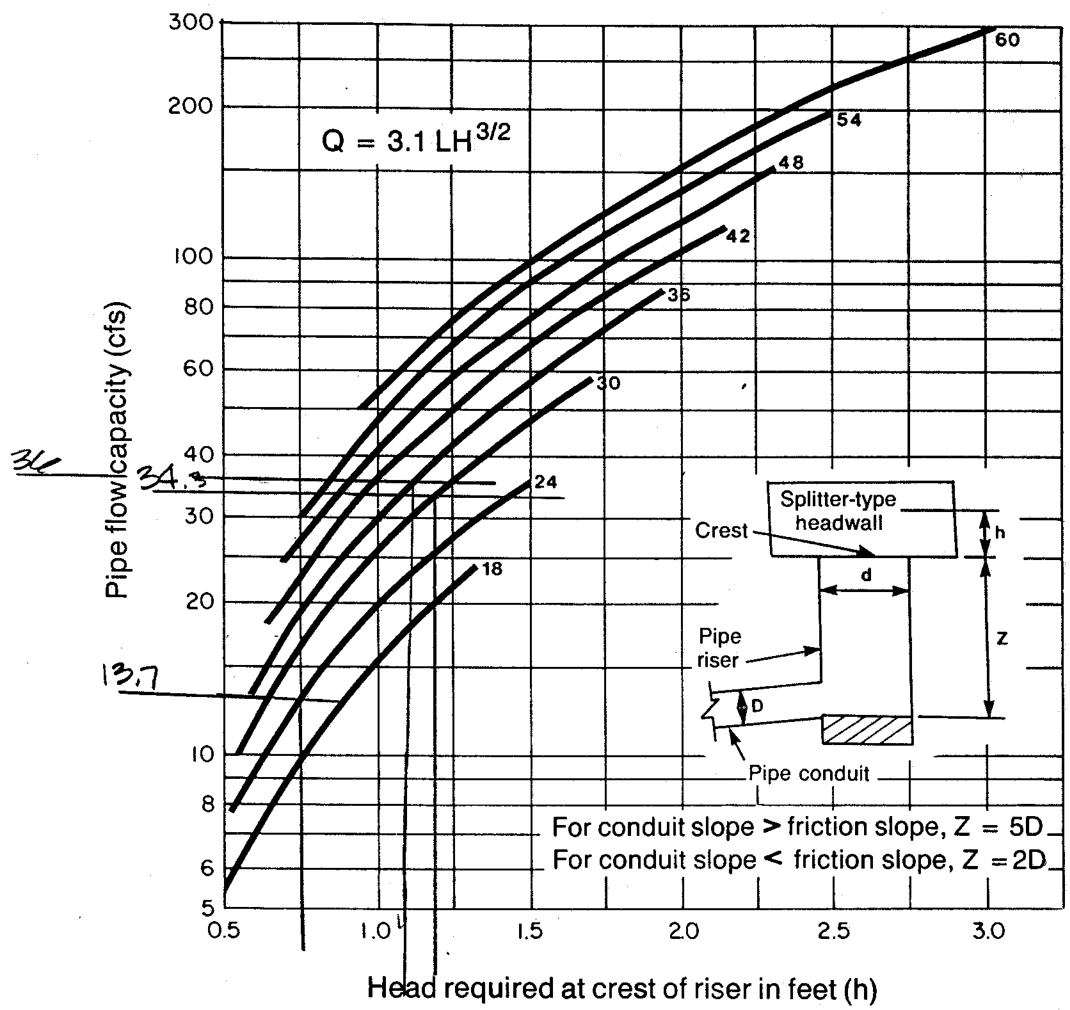
Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter).

Table 8.07a
Pipe Flow Chart for Design of Corrugated Metal Outlet Conduit
(Q in cubic ft/sec)

For Corrugated Metal Pipe Inlet $K_e + K_b = 1.0$ and 70 feet of Corrugated Metal Pipe Conduit n = 0.025. Note correction factors for other pipe lengths.

Dia. / H	12"	15"	18"	21"	24"	30"	36"	42"
2	2.84	4.92	7.73	11.30	15.60	26.60	40.77	58.12
3	3.48	6.03	9.47	13.84	19.10	32.58	49.93	71.19
4	4.02	6.96	10.94	15.98	22.06	37.62	57.66	82.20
5	4.49	7.78	12.23	17.87	24.66	42.06	64.46	91.90
6	4.92	8.52	13.40	19.57	27.01	46.07	70.60	100.65
7	5.32	9.21	14.47	21.14	29.19	49.77	76.28	108.75
8	5.68	9.84	15.47	22.60	31.19	53.19	81.53	116.23
9	6.03	10.44	16.41	23.97	33.09	56.43	86.49	123.30
10	6.36	11.00	17.30	25.26	34.88	59.48	91.16	129.96
11	6.67	11.54	18.14	26.50	36.59	62.39	95.63	136.33
12	6.96	12.05	18.95	27.68	38.21	65.16	99.87	142.37
13	7.25	12.55	19.72	28.81	39.77	67.83	103.96	148.21
14	7.52	13.02	20.47	29.90	41.27	70.39	107.88	153.80
15	7.78	13.48	21.19	30.95	42.72	72.85	111.66	159.18
16	8.04	13.92	21.88	31.96	44.12	75.24	115.32	164.40
17	8.29	14.35	22.55	32.94	45.48	77.55	118.87	169.46
18	8.53	14.77	23.21	33.90	46.80	79.81	122.33	174.39
19	8.76	15.17	23.84	34.83	48.08	81.99	125.67	179.15
20	8.99	15.56	24.46	35.73	49.33	84.12	128.93	183.80
21	9.21	15.95	25.07	36.62	50.55	86.21	132.13	188.36
22	9.43	16.32	25.65	37.47	51.73	88.22	135.21	192.76
23	9.64	16.69	26.23	38.32	52.90	90.21	138.27	197.12
24	9.85	17.05	26.80	39.14	54.04	92.15	141.24	201.35
25	10.05	17.40	27.35	39.95	55.15	94.05	144.15	205.50
L	Correction Factors For Other Pipe Lengths							
40	1.23	1.22	1.20	1.19	1.16	1.14	1.13	1.11
50	1.14	1.13	1.12	1.11	1.10	1.09	1.08	1.07
60	1.07	1.06	1.06	1.05	1.05	1.04	1.04	1.03
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	0.95	0.95	0.95	0.96	0.96	0.96	0.97	0.97
90	0.90	0.91	0.91	0.92	0.92	0.93	0.94	0.94
100	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.92

Circular risers with splitter wall



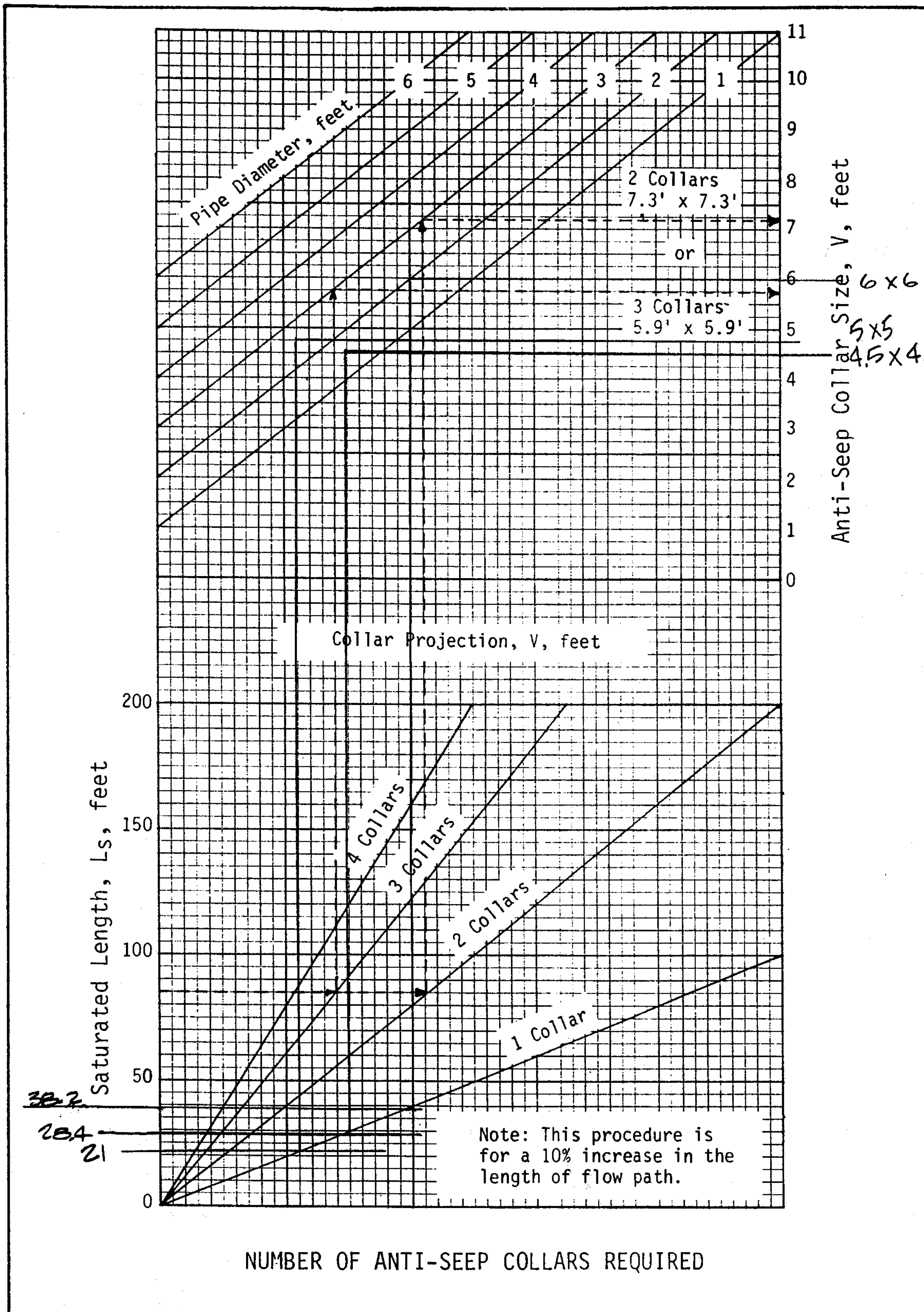
Inlet Proportions	
Pipe Conduit (D) - in	Pipe Riser (D) - in
8-12	18
15	21
18	24
21	30
24	30
~~30~~	~~36~~
36	48
42	54
48	60

Pipe drop inlet spillway design:

For a given Q and H, refer to Table 8.07a or 8.07b for conduit size. Then determine the riser diameter (d) from the Inlet Proportions Table on this figure. Next, refer to the above curves, using the conduit capacity and riser diameter, and find the head (h) required above the crest of the riser. The height of the riser should not be less than 5D - h, except as noted in the above sketch.

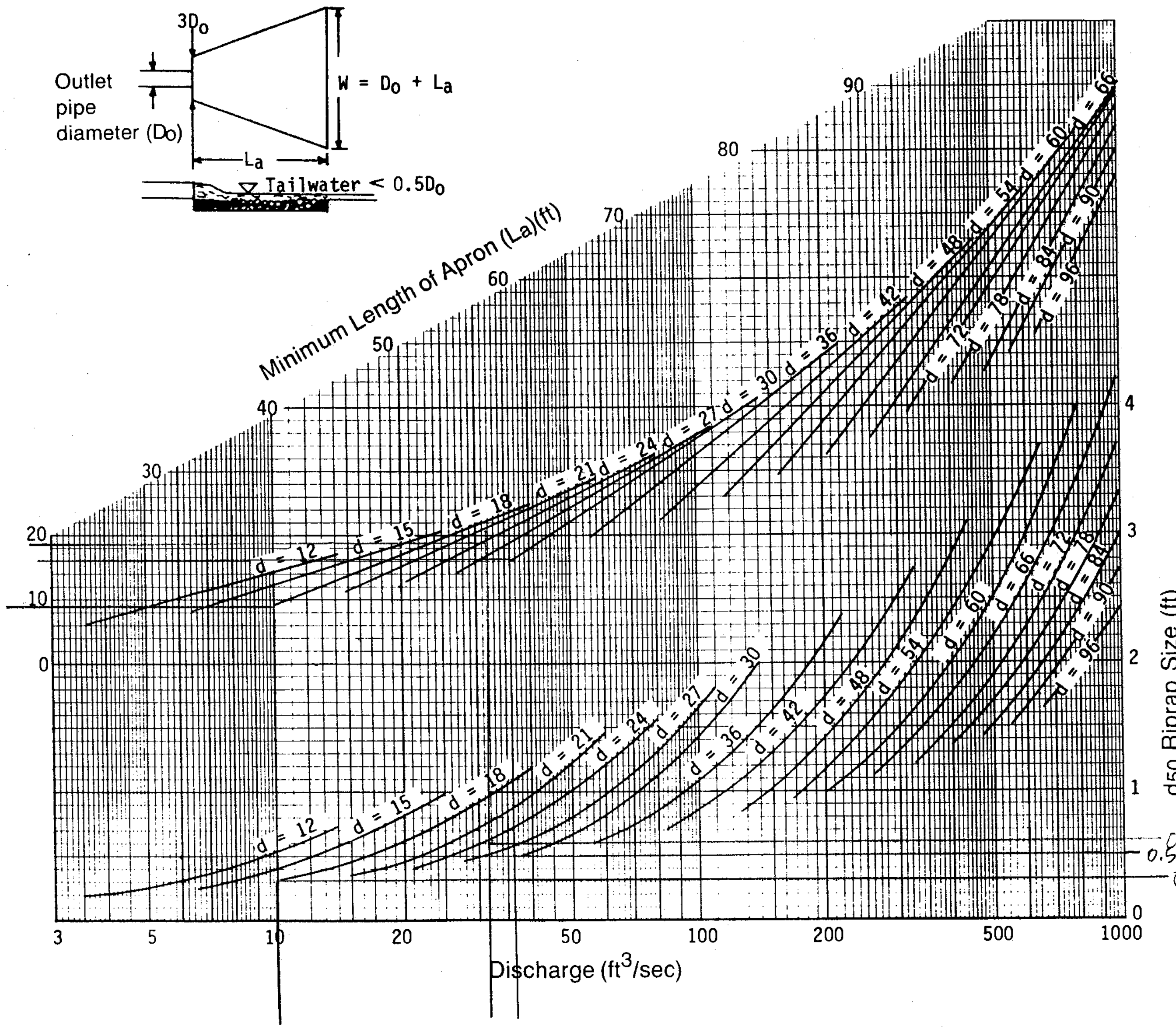
Example - Given: CMP; Q = 20 cfs; H = 14 ft, h max. 1.0 ft; L = 70 ft. From Table 8.07a find conduit size (D) = 18 inches. From Inlet Proportions Table, riser size = 24 inches. Head (h) required for Q = 20 and d = 24 is 1.0 ft.

Figure 8.07b Design chart for riser outlet.



Source: USDA-SCS

Plate 1.261



Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter).

APPENDIX C

S & M E GEOTECHNICAL REPORT

McKIM&CREED

GEOLOGIC AND HYDROGEOLOGIC STUDY
FOR
DUNN-ERWIN
LANDFILL EXPANSION
HARNETT COUNTY, NORTH CAROLINA
WESTINGHOUSE PROJECT No. REW-A-130

Prepared For:

McKim and Creed
5580 Centerview Drive
Raleigh, North Carolina 27606

Prepared By:

Westinghouse Environmental and Geotechnical Services, Inc.
3100 Spring Forest Road (27604)
Post Office Box 58069
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July, 1991

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July 9, 1991

McKim and Creed
5580 Centerview Drive
Suite 100
Raleigh, North Carolina 27606

Attention: Mr. Charles A. Musser

Reference: Geologic and Hydrogeologic Study for
Dunn-Erwin
Landfill Expansion
Harnett County, North Carolina
Westinghouse Project No. REW-A-130

Dear Mr. Musser:

This report presents the appropriate geologic and hydrogeologic information required for the permit application for the Dunn-Erwin Landfill Expansion, Phase IV, in Harnett County, North Carolina. Enclosed are the maps, profiles, charts and reports as they pertain to ground water and geology to substantiate site application as required in Section .0504 "Application Requirements for Sanitary Landfills" of the North Carolina Solid Waste Management Rules as amended March, 1988. At your request, we have also submitted an evaluation of a proposed borrow area for soils to be used as liner and cover materials. Preliminary recommendations concerning liner considerations and slope stability are also included in this report.

We look forward to your positive response after you have had time to review the enclosed information such that the Geologic and Hydrogeologic Report may be finalized in the near future and forwarded for your approval.

If you should have any questions regarding the enclosed information, or if we may be of any further assistance to you, please feel free to contact us at your convenience.

Very truly yours,

WESTINGHOUSE ENVIRONMENTAL AND GEOTECHNICAL SERVICES, INC.

Abner F. Riggs, Jr., P.E.
NC Registration No. 14155

Ann M. Borden, P.G.
Senior Project Manager

AFR/AMB/als/R91A130A

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SECTION 1

INTRODUCTION

1.1 SITE DESCRIPTION

A geologic and hydrogeologic assessment of the proposed Dunn-Erwin Landfill expansion site and adjacent borrow area has been completed. The proposed site is located adjacent to the existing Dunn-Erwin Landfill in Harnett County, North Carolina. The Dunn-Erwin Landfill is located to the east of NC Highway 55 between State Roads (SR) 1723 and 1725 approximately 3 miles northeast of Erwin and 4 miles northwest of Dunn, North Carolina (see Figure 1). The expansion site and borrow area encompass approximately 30 acres each. The sites presently are predominately undeveloped woodland with open uncultivated farmland, fenced pasture land, identified wetlands and a pond. The only structures currently standing on the proposed sites are the Harnett County Dog Pound, a silo, and a farm shed. The southern portion of the site is to be developed as a landfill cell and the northern portion, separated by a designated wetland area, is to be utilized as a borrow site.

Topographically, the project site is gently sloping with several knolls dissected by shallow drainage features. Ground surface elevations range from 162 feet along the southwest corner of the site to 230 feet along the northeast corner of the site.

1.2 PURPOSE

An exploration program was performed to explore the general subsurface conditions in the proposed landfill area and to obtain the necessary geologic and hydrogeologic information required by the North Carolina Solid Waste Management rules for the site permit application. The primary focus of this study was to characterize the geologic stratigraphy and hydrogeologic conditions of both the proposed expansion cell and the area immediately downgradient. Additionally, the soils of the borrow area to the north were evaluated as a source of liner and cover material for the proposed landfill expansion cell. The results of our field and laboratory tests are attached in the Appendices to this report.

SECTION 2
EXPLORATION PROCEDURES

2.1 SUBSURFACE INVESTIGATION

Subsurface conditions at the site were investigated with fourteen soil test borings and five test pits performed within the proposed expansion area at the approximate locations as shown on the attached Boring Location Plan (Figure 2). The boring locations and ground surface elevations were surveyed in the field. The borings were advanced to termination depths of 15 to 55 feet beneath existing site grade with a CME-45 drill rig mounted on an all-terrain vehicle (ATV) utilizing wash boring and hollow stem auger techniques to advance the borings. Standard penetration test procedures (ASTM D-1586) were performed at selected intervals to evaluate the consistency and relative density of the in-situ soils. The test pits were excavated with a rubber-tired backhoe to depths of 10 to 10.5 feet beneath existing site grade and were observed by a geotechnical engineer. Additionally, one 25 foot soil test boring (PB-9) and two test pits (TP-9 and TP-29) excavated to depths of 10 and 8 feet, respectively, were performed as requested to better characterize subsurface conditions within the present landfill cell located to the east of the proposed expansion site. Split-spoon samples obtained from the standard penetration tests were visually classified by a geologist in the field in accordance with the Unified Soil Classification System guidelines. Laboratory grain size analyses, natural moisture contents, specific gravities and Atterberg limits testing were performed on selected split-spoon samples to verify visual classifications. A summary of the field and laboratory methods is presented in Appendix A.

Additionally, four bulk soil samples were obtained to perform standard Proctor compaction tests (ASTM D-698) and remolded falling head permeability tests to evaluate the suitability of the borrow soils as liner and cover materials. In addition, one relatively undisturbed soil sample was obtained to determine the permeability characteristics of the in-situ soils. A summary of the laboratory tests conducted and test data are presented on Tables I, II, and III attached to this report.

A generalized subsurface profile prepared from the test boring and test pit data is attached to this report as Figures 3 A and B to graphically illustrate subsurface conditions encountered at this site. More detailed descriptions of the conditions encountered at the individual test boring locations have been presented on the attached Test Boring Records (Appendix C). Additionally, a summary of the Test Pit Data is attached to this report as Table IV.

2.2 PIEZOMETER INSTALLATION

A total of nine of the soil test borings were used in the construction of temporary piezometers with the purpose of evaluating the potentiometric surface and hydrogeologic characteristics of the proposed expansion site and downgradient areas. Four additional borings were offset 5 to 10 feet from deep piezometers for the installation of shallow piezometers. The piezometers were installed with the hollow stem augers in the ground. The screens and risers used in the piezometer construction were made of 1.25 inch O.D. schedule 40 PVC pipe. The piezometers have either 5 or 10 foot screen sections with 0.010 inch pre-cut slots. After the piezometer was placed in the ground, a sand pack was placed to roughly 2 feet above the top of the screen. A bentonite seal was placed above the sand pack to hydraulically isolate the screened interval. The remainder of the bore-hole was then sealed with cement grout. The piezometer construction data is summarized on Table V.

Four of the piezometers were installed at a depth of approximately 50 feet. The remaining nine piezometers are shallower and vary in depth from 15 to 30 feet. The piezometers were arranged as four nests (one deep and one shallow) and five isolated piezometers (see Figure 2).

2.3 GROUND WATER

The water level in the bore-holes were measured relative to the ground surface elevation using a weighted tape. Water levels in bore-holes were measured at the time of boring termination and after 24 hours from completion of boring in some of the borings. If the bore-hole remained open, the water level was remeasured approximately two weeks after completion (March 19, 1991).

Heavy intermittent rains did not permit recording accurate water levels prior to this date. The water level data collected on March 19 were preceded by four consecutive non-rain days. The levels recorded on this day are assumed to represent equilibrium conditions. The water level for each bore-hole is noted on Figures 3 A and B.

Ground water levels in piezometers were recorded using an electric water level probe. The probe was used to measure the distance from the top of the piezometer casing to the water level in the piezometer. The ground water elevation was then calculated using the surveyed elevation at the top of the casing. If possible, the water level was recorded at the time of boring and 24 hours after the installation of the piezometer. Equilibrium water levels were then recorded on March 19, March 26, April 12 and again on June 27, 1991. Ground water elevations during this period showed only minor fluctuations. Piezometer ground water elevation data is listed in Table VI and discussed in Section 3.4.

2.4 FIELD PERMEABILITY TESTS

Falling-head slug tests using a "THOR" pressure transponder system were conducted to determine typical permeabilities of the in-situ soils. The static height of the water level in each piezometer was measured by the pressure transponder prior to the addition of the slug. The rise in head in the piezometer was accomplished using 1 gallon of distilled water as a slug. The height of the water column in the piezometer during the recovery phase was recorded at preprogrammed intervals by the "THOR" system. The raw data from the slug tests, as well as the permeability calculations can be found in Appendix B. The results of the field permeability tests are discussed in Section 4.3.

2.5 LABORATORY

A geologist visually examined each split-spoon sample to estimate grain size distribution, plasticity, organic content, moisture condition, color, presence of lenses or seams, and apparent geological origin. Soils were classified in accordance with the Unified Soil Classification System (USCS). Soil descriptions, USCS classifications, and field results are presented on the individual Test Boring Records included in Appendix C.

Representative soil samples obtained during field exploration were tested in our laboratory. Classification tests included natural moisture content, grain size distribution (with sieve and hydrometer), Atterberg limits, and specific gravity. In addition, standard Proctor compaction tests and laboratory falling head permeability tests were performed on selected bulk and relatively undisturbed samples. A summary of the number of tests performed along with the applicable procedure used is provided in Table I.

2.6 LABORATORY PERMEABILITY

The permeability of the on-site soils was evaluated by performing laboratory permeability tests on 4 bulk samples of prospective cover and liner material obtained from test pits. Laboratory permeability tests were performed on remolded samples compacted to 94.6 to 99.0 percent of the standard Proctor (ASTM D-698) maximum dry density. Additionally, two laboratory permeability tests were conducted on relatively undisturbed samples to determine the hydraulic conductivity of the in-situ soils. These tests were performed in a triaxial type permeability cell. Tests continued until steady state flow was achieved and relatively constant values of hydraulic conductivity were obtained. Results of the permeability tests are provided on the Summary of Laboratory Falling Head Permeability Test Data in Table III and on Data sheets included in Appendix D.

SECTION 3
PHYSIOGRAPHY AND REGIONAL HYDROGEOLOGY

3.1 PHYSIOGRAPHY

North Carolina is divided into three physiographic provinces: the Blue Ridge, Piedmont, and Coastal Plain. Harnett County is located in the western portion of the Coastal Plain Province of North Carolina. The Coastal Plain Geologic Region has been formed during past transgressive and regressive movements of the oceans in North Carolina. The Coastal Plain Province is characterized by subdued topographic features and relatively flat, low-lying terrain.

According to the Erwin 7.5 Minute Topographic Quadrangle Map (USGS, 1981) and a site specific contour map, the subject property is located within a generally southwest flowing drainage sub-basin of Stewart Creek. Surface drainage within the proposed expansion cell is to the southwest. Site elevations range from a high of 230 feet along the northeast corner of the site to a low of 162 feet along a small drainage feature at the southwest corner of the site.

3.2 REGIONAL CHARACTERISTICS

The proposed landfill expansion site is located in the eastern portion of Harnett County in the western portion of the Coastal Plain Province of North Carolina. Stratigraphically, the Coastal Plain consists of Cretaceous and younger sediments unconformably deposited above the older Paleozoic crystalline rocks of the Piedmont. Sediments of the Coastal Plain are typically undeformed and include both unconsolidated sediments and lithified units. Data from well logs in the towns of Dunn and Coats suggest that Cretaceous sediments in the area are underlain by slate bedrock at a depth of 120 to 200 feet (Geology and Ground Water Resources of the Fayetteville Area, 1961). The depth to crystalline bedrock and the thickness of the sediments of the Coastal Plain increase to the east. The Coastal Plain generally has gentle topography and is dissected by east flowing rivers. Ground water in Harnett County is found in and recovered from both the unconsolidated Mesozoic and younger sediments and the Paleozoic metamorphic basement (Geology and Ground Water Resources of the Fayetteville Area, 1961).

Average annual rainfall in this portion of North Carolina averages 41.76 inches (National Weather Service 45 year average for the RDU Station). Rainfall in the 86-90 period averaged 41.67 inches. The total rainfall for 1990 was slightly below average at 37.50 inches, but the total rainfall for the previous year was well above average at 54.15 inches. The North Carolina Climate Office reports that rainfall for the first three months of 1991 was close to average and totaled 9.4 inches.

3.3 SITE GEOLOGY

The site is underlain by sands, silts, and clays of the Cretaceous Middendorf formation (Geologic Map of North Carolina, 1985). The Middendorf Formation includes grey to reddish grey sands, silts and clays. The Middendorf Formation tends to have laterally discontinuous beds. The stratigraphy of the Middendorf Formation is therefore comprised of lenses of sand, clay, and silt. The Middendorf Formation is underlain by the Cape Fear Formation. The Cape Fear Formation consists of grey to blue-grey silty and clayey sands, silts and clays. Beds in the Cape Fear Formation are laterally more continuous than those of the Middendorf Formation. These two sedimentary units combined have also been referred to as the Tuscaloosa Formation. No lithified sediments or crystalline rocks were encountered on the site within the 55 feet depth of exploration.

Although it is difficult to differentiate between the Middendorf and Cape Fear Formations from the available boring data, field evidence suggests that clays and silts from the Cape Fear Formation are exposed or exist at a relatively shallow depth in the lower elevations of the site. The Generalized Subsurface Profile (Figures 3, A and B) indicate that site stratigraphy is highly discontinuous above an elevation of about 160 feet. At an elevation of approximately 160 feet, the clay and clayey silt units appear to be more continuous. This more continuous unit may be the upper boundary of the Cape Fear Formation. The 160 foot elevation coincides with a nearby wetland area near boring B-42 which appears to be lying on this clay stratum. The boring profiles along two cross-sections (A-A′ and B-B′) are shown in Figures 4 A and B. Due to the complexity of the Middendorf sediments, a simplified cross-section sketch was constructed to depict the site geology and hydrogeology (Figure 5).

3.4 SITE HYDROGEOLOGY

As stated previously, sediments of the Middendorf Formation include laterally discontinuous clay layers. These clay layers are relatively impervious and higher perched conditions may occur during periods of wet weather due to perching of surface water on the soils. As indicated on Figures 3A and 3B, piezometer B-48S was installed above a clay layer and had an anomalously high apparent ground water elevation. The water level in B-46S is 5 feet lower, but is at a higher topographic elevation than B-48S and did not encounter a clay layer. A similar condition as B-48S exists in B-41S, which also has a piezometer installed above an apparently discontinuous clayey silt layer. The water level in B-41S, which may also be perched, is higher than expected from topography and ground water elevation data from two nearby piezometers. The relatively continuous layer of clays and clayey silts of the Cape Fear Formation would be expected to form a leaky aquitard to sediments below these beds. Piezometer nests B-47 and B-44 had screens both above and below this horizon. In these nests, the ground water elevation of the deeper piezometer was between 12 to 20 feet lower than that of the shallow piezometer (see Table VI). This data implies that these beds locally separate ground water in the sediments of the Middendorf Formation from those of the deeper Cape Fear Formation, and that the vertical hydraulic gradient is downward.

A hydrogeologic cross-section (Figure 6) was constructed from the logs of piezometers B-42S, B-42D, B-44S, B-44D, B-47S, and B-47D in the southwestern portion of the site to study the relationships between geology and ground water levels. The ground water levels shown in the shallow piezometers are all close to the ground surface and contrast sharply with the deeper ground water levels found in the deep piezometers. The logs of the deeper piezometers indicate the presence of clay layers at elevations above 155 feet. These contrasting ground water levels and the presence of clay layers support the concept of shallow perched ground water near the ground surface and a hydraulically continuous ground water zone at greater depth. The relatively high potentiometric elevation of the deep ground water zone presented in piezometer B-44D is attributed to the hillside location of this piezometer.

Piezometers B-42S and B-42D are located near the edge of a wetland area in the southwest portion of the property. The respective ground water elevations in these two borings indicate a significant potentiometric contrast and tend to support the concept of a perched wetland area, rather than a universal ground water discharge area, to the southwest.

Based on ground water elevation data collected from "non-perched" piezometers, a ground water contour map was constructed. The ground water contours calculated from piezometers installed below the top of the Cape Fear Formation are illustrated on the Ground Water Contour Map, (Figure 7). The water level in B-48S is believed to be perched on a clay layer and the data from this boring was not used in this evaluation.

The Hydrogeological Supervisor, Mr. James Bales, of the Fayetteville Regional Office of the Ground Water Section of the Department of Environmental Management was contacted regarding the seasonal variation of ground water levels in Harnett County. Mr. Bales stated that he knew of no such data compilation for Harnett County; however, he said that ground water levels are usually highest in the period from December to April and lowest from August to October in this area of the Coastal Plain. He also noted that the annual fluctuation in the county can range from 5 to 8 feet.

Monthly ground water level elevations were recorded from borings previously installed at the site (Location Map 8). These elevations were taken from May 1985 through April 1986. The mean seasonal fluctuation of the groundwater table at the site was approximately 2.8 feet (See Table VII). Since rainfall for the last 5 years has been very close to the average precipitation and groundwater levels are usually highest from December to April, the ground water data presented in Table VI, as well as the ground water contour map constructed from this data (Figure 7) probably approximate seasonal high annual ground water levels for this site.

Based on ground water elevation data, the average hydraulic gradient between B-46S and B-40S is 0.023 (vertical foot/horizontal foot) and 0.19 between B-46S and B-42S. However, as expected, areas of steep topography have much higher gradients. In the proximity of B-40S the gradient appears to be as high as 0.67.

Due to the extreme geologic heterogeneity of the site, it is very difficult to estimate a ground water velocity for the site. However, assuming preferential flow along units with higher conductivities (roughly 1 x 10^{-4} cm/sec), the measured hydraulic gradient of approximately 0.02 and with an estimated effective porosity of 30 percent, a rough estimate of ground water velocity can be made. This estimate is based on the following relationship - Ks = (KxI)/N, where Ks is the ground water velocity, K is the hydraulic conductivity, I is the hydraulic gradient and N is the effective porosity. Using the estimated values for the required parameters, the equation yields a value of 6.7 x 10^{-6} cm/sec. This means that "perched" ground water flowing under the proposed expansion site would travel on the order of 2 meters per year.

3.5 SITE SOILS

The site area has been mapped by the Soil Conservation Service (SCS) to identity near surface soil series. This information is presented in the published manual for Harnett County, and the site is shown on sheets P-5, P-6 and Q-4 of that publication. The soil survey of Harnett County shows six soil series that exist on this site. The soil series encountered consist of the Bibb, Blaney, Gilead, Marboro, Norfolk, and Wagram. These soils are comprised mostly of loamy sand and sandy loam which are well to moderately well drained with the exception of the Bibb series which is poorly drained and generally is associated with wetlands. These soil series commonly exist in areas with slopes ranging from 0 to 15 percent. High water tables within these type soil series generally range from perched and apparent conditions at depths of 0.5 to 6.0 feet to ground water tables of greater than 6 feet beneath the surface. Organic contents vary from 0.5 to 2.0 percent to depths of up to 24 inches beneath the surface. These soil characteristics generally apply to soils encountered within the upper 60 to 75 inches from the surface and may not be valid at depths below this level. Selected SCS soil characteristics useful for planning and development such as, sanitary landfill area, daily cover for landfill, shallow excavations, embankments dike and levees, are listed in Table VIII.

SECTION 4
SUBSURFACE CONDITIONS

Figures 3 A and B graphically illustrate subsurface conditions at this site. The profiles have been generalized and may not depict actual subsurface conditions at boring locations. The actual subsurface profile transitions between material types, gradational and not abrupt as indicated in the profiles. Detailed descriptions of the conditions encountered at the individual test boring locations are presented on the attached Test Boring Records (Appendix C) Summary of Test Pit Data Table IV.

4.1 TOPSOIL

A relatively thin 3.5 to 6 inch veneer of topsoil with rootmat and organics was encountered at most of the boring locations. An exception to this exists at boring B-45 which encountered dark brown clayey silty sand with organics to a depth of 24 inches beneath the surface.

4.2 SEDIMENTS

The underlying Coastal Plain sediments consist of interbedded relatively clean to silty and clayey fine sands (SP, SM, SC) with occasional gravel zones (GP), with layers of fine sandy to silty clays (CL, CH) and fine sandy to clayey silts (ML,MH) that often vary abruptly both horizontally and vertically. Sands predominate in most places, with clays scattered throughout the subsurface profile; clays and silts predominate in other areas with sands scattered throughout. Standard penetration resistance values in the sands range from 3 to greater than 100 blows per foot (bpf) with typical values on the order of 20 to 30 bpf exhibiting very loose to very dense relative densities. Standard penetration resistances in the clays and silts range from 3 to greater than 100 bpf, with typical values on the order of 15 to 25 bpf, exhibiting soft to hard consistencies. At depths of greater than 30 to 40 feet beneath the existing ground surface, the consistencies and relative densities become harder and more dense with standard penetration resistances on the order of 50 bpf to 50 blow per

0.2 feet of penetration. Although these materials exhibit consistencies of partially weathered rock materials, they are classified as overconsolidated sedimentary soils typical of this geologic formation.

4.3 FIELD AND LABORATORY PERMEABILITY

Soil permeability values were calculated from both field and laboratory tests. The results of the field test indicate hydraulic conductivities that range from 1×10^{-3} to 1×10^{-6} cm/sec, whereas laboratory tests yielded values in the 5×10^{-5} to 5×10^{-7} cm/sec range.

Field permeability tests were performed to evaluate the need for a lined landfill to impede leachate from easily entering the underlying ground water. A rate of recovery plot (see Appendix B) was created using these data. The recovery data was obtained and a hydraulic conductivity for each piezometer was calculated using the Rice-Bouwer equations for an unconfined aquifer (H. Bouwer, 1989). A brief explanation of the Rice-Bouwer technique, piezometer recovery plots and parameters used in solving the Rice-Bouwer equations can also be found in Appendix B. The hydraulic permeability calculated for each piezometer and the soil type in which the test was performed are summarized in Table III.

Laboratory permeability testing was performed on relatively undisturbed (shelby tube) and remolded (bulk bag) samples obtained from test borings and test pits at depths between 2 and 10.5 feet beneath the existing ground surface. The remolded samples were compacted in accordance with ASTM D-698 at moisture contents within ± 2 percent of optimum. This moisture range was selected to simulate the soil moisture content likely to be utilized for liner construction.

The remolded and undisturbed samples were encapsulated in a rubber membrane and placed in a triaxial type permeability cell. An effective confining stress of 2 psi was used to establish a tight fit between the membrane and the sample. Test specimens were saturated under a back pressure of 100 psi prior to running the falling head permeability test. The permeability tests were performed with an effective confining pressure of 2 pounds per square inch (psi) and hydraulic heads of about 40 centimeters (cm) of water across typical sample lengths of 7.59

to 8.10 cm. Inflow and outflow during each test was monitored and the hydraulic conductivity was calculated from each recorded increment. The soil samples collected were the potentially low permeability materials planned for use as liner and top cover material in the development of the proposed landfill.

Following completion of the falling head permeability tests, representative samples were subjected to specific gravity, Atterberg Limits, and grain size analyses to further characterize the on-site soils. Results of the permeability testing performed on undisturbed and remolded samples, including hydraulic conductivity, porosity, molding conditions, and the classification based on the Unified Soil Classification System are included in Table III.

The laboratory test results indicate that the on-site (SC and CL) soils recompacted should provide hydraulic conductivity values on the order of 5×10^{-5} to 1×10^{-6} cm/sec, provided that the in-place dry densities are at least 95 percent of the standard Proctor maximum. Increasing the degree of compaction of these soils to at least 98 percent of the standard Proctor maximum dry density will decrease the hydraulic conductivities to values on the order of 1×10^{-5} to 5×10^{-7} cm/sec. Based on our past experience with similar subsurface conditions, hydraulic conductivity values on compacted samples under controlled laboratory conditions may be as much as a half of an order of magnitude higher than that obtained in the field. Therefore, hydraulic conductivity values of these soils compacted to approximately 98 percent of the maximum dry density in the field may only provide values on the order of 5×10^{-5} to 1×10^{-6} cm/sec. It should be noted that there do exist (CH) soils on-site that were not obtained for laboratory testing and that these soils are anticipated to provide hydraulic conductivity values in the range of 5×10^{-7} to 1×10^{-7} cm/sec when recompacted in the field. However, this should be verified by further laboratory testing and in the field prior to the start of construction with a test strip section.

SECTION 5
CONCLUSIONS AND PRELIMINARY RECOMMENDATIONS

5.1 EXCAVATION CHARACTERISTICS

The sedimentary soils at the site can generally be excavated using conventional equipment such as pans, scrapers, backhoes, and dozers. Based on our past experience with similar materials, the hard to very dense materials exhibiting standard penetration resistances as hard as 50 blows per 3 inches of penetration to 100 bpf will require preloosening by ripping during general site grading to expedite excavation procedures. This can be performed using conventional methods by first loosening the materials with a single-toothed ripper attached to a suitable sized dozer such as a Caterpillar D8 or D9.

5.2 LINER

Based on the results of laboratory permeability tests conducted on bulk samples (2 feet to 10.5 feet) at selected test pits, from within the borrow area, a composite liner system may be necessary to control leachate seepage from the proposed landfill. This system would require the installation of a minimum 60 mil high-density polyethylene, liner overlying low permeability soils. It is our understanding that the state requires a minimum 18 inch thick layer of recompacted low permeable soil such as those sporadically encountered at the site to be used as a liner material beneath the synthetic liner. The presence of occasional quartz rock fragments and gravel may eliminate portions of the low permeable soils on-site to be used as liner materials.

The permeabilities of the in-place recompacted materials to be used as liner material should be at least 5×10^{-7} cm/sec, however, this would be confirmed by the State. It is our opinion that the silty clay (CH) materials encountered at this site, recompacted to at least 98 to 100 percent of the standard Proctor maximum dry density, will provide hydraulic conductivity values in the field on the order of 5×10^{-7} cm/sec to 1×10^{-7} cm/sec. However, this should be verified in the field prior to construction by a test strip. Because of the limited amount of availability of these materials at the site, it may be necessary to obtain soils from off-site. The quantity of material needed for development of the proposed landfill cell has not been determined at this time.

Additive enrichment of on-site materials is an alternative to obtaining off-site soils for use as liner materials in subsequent cells. If additive enriched soils are used, hydraulic conductivity values on the order of 1 x 10^{-7} cm/sec can be obtained. This would enable the use of a larger quantity of the on-site materials to be used and reduce or eliminate the use of off-site materials. The additive enriched material should be placed in no greater than 6 to 8 inch lifts, compacted to at least 95 percent of standard Proctor maximum dry density.

We recommend that the synthetic liner be placed at least 6 feet above the March 19, 1991, ground water levels presented in Table VI. These correspond to the water levels utilized in constructing the Ground Water Contour Map (Figure 7). This recommendation is provided for two purposes: 1) to allow ease in construction of the soil liner below the synthetic liner, and 2) to provide the minimum 4 foot separation as required by the North Carolina Administrative Code, Subchapter G, by allowing for potential variations in seasonal high water table across the site.

We do not recommend excavating below 4 feet above the anticipated high water table due to capillary rise and softening of the base of the excavation by construction equipment. It is our opinion that should the excavations proceed below the 4 foot level rutting and pumping would likely occur which may deteriorate the base of the landfill.

5.3 SLOPES

Interior slopes of the landfill cell constructed of adequately compacted on-site soils and placed at 1 on 3 slopes should provide adequate stability against shear failure. The final slope design should consider slope heights, duration of exposure to erosion, and type of backfill used as cover material. Further laboratory tests will be warranted in the final design to confirm the shear strength and frictional characteristics of the proposed cover material on these slopes. Due to the shear strength of the liner materials and soil to liner materials, side slopes at 1 on 4 may be necessary or a textured liner used.

5.4 SOIL LINER PLACEMENT

Clayey silts, such as those encountered on site, will sometimes rut and pump beneath heavy construction equipment, especially if the moisture content is on the wet side of optimum. Rutting and pumping may also occur in a properly compacted soil due to the low shear strength of the soil. For this reason, we recommend that a separation of 4 feet be maintained between the high water table and heavy construction equipment. Rounded tooth sheepsfoot rollers should be utilized for compaction of the clayey silt liner. Vibratory steel drum or pneumatic tired rollers should not be used to compact soil lifts. The final surface of the soil liner should, however, be smoothed with a smooth drum roller, but vibration of the roller should not be permitted. We recommend that soils be placed and compacted in layers no greater than 6 to 8 inches.

Due to the characteristics of the on-site soil, moisture control will be necessary during spreading and compaction. We recommend that the soil liner material be compacted from 0 to plus 4 percent of optimum moisture content. The soil liner will not be conducive to wet weather grading, thus, it will be advantageous to place the liner during dry weather. It is anticipated that in-place moisture content of the on-site soils will vary according to topography and existing drainage on the site. Ground water conditions were encountered within the borrow area at depths of 6.5 to 9.5 feet beneath the surface. However, it is anticipated that these shallow ground water conditions are perched and that the true ground water level is lower. Therefore, some drying of the borrow soils will be required before they can be adequately compacted. It is anticipated that these perched ground water conditions can be controlled by positive surface drainage.

Proper selection and construction of liner material will be an important aspect for successful utilization of the liner. If on-site soils are used, selection and separation of these materials in the field should be based upon classification testing and evaluation by an experienced soils technician working directly under the supervision of a geotechnical engineer. Liner soils should contain no more than 40 percent of materials coarser than a No. 200 sieve with less than 5 percent retained on a No. 4 sieve and have a Plasticity Index greater than 10 percent with associated Liquid Limits of at least 25 percent. It is our opinion that these soils can be found within the proposed excavation depths in the proposed borrow area. The contractor should separate liner material from general fill and not include rock fragments, cobbles, or organic materials with potential liner soils.

5.5 GENERAL EMBANKMENT CONSTRUCTION CONSIDERATIONS

Prior to placement of fill for the perimeter embankment, the subgrade should be thoroughly stripped of all topsoil and organics, including removal of old stumps and roots. The exposed subgrade should be proofrolled with a loaded dump truck to identify any areas of soft surface soils. Areas that rut or pump after successive passes of the roller should be undercut to suitable soils and replaced with compacted backfill. For preliminary design, the cut or fill slopes should be constructed no steeper than 1 on 3.

SECTION 6

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TABLES

TABLE I
SUMMARY OF LABORATORY TESTS CONDUCTED

TYPE OF TEST	PROCEDURE	TEST NUMBER
Natural Moisture Content	ASTM D-2216-80	28
Grain Size Distribution - Hydrometer and Sieve	ASTM D-422-72	10
Atterberg Limits	ASTM D-4318-83	10
Specific Gravity	ASTM D-854-83	10
Standard Proctor Compaction	ASTM D-698	4
Falling Head Permeability	ASTM D-1110-2-1906	9

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TABLE II
SUMMARY OF LABORATORY TEST DATA
DUNN-ERWIN LANDFILL

LOCATION	DEPTH	NATURAL MOISTURE CONTENT %	PERCENT PASSING NO. 200 SERIES	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIFIED SOILS CLASSIFICATION
PB-9	8.5-10.0	31.6	--	--	--	--	--
PB-9	23.5-25.0	21.1	--	--	--	--	--
B-41	33.5-35.0	28.8	--	--	--	--	--
B-41	38.5-40.0	26.7	--	--	--	--	--
B-41	48.5-50.0	25.8	--	--	--	--	--
B-42	3.5-5.0	26.7	--	--	--	--	--
B-42	4.0-5.0	32.5	94.0	60	29	31	CH
B-42	5.0-6.0	30.1	83.0	53	26	27	CH
B-42	8.5-10.0	28.5	--	--	--	--	--
B-42	43.5-45.0	21.1	--	--	--	--	--
B-42	48.5-50.0	21.1	--	--	--	--	--
B-44	8.5-10.0	21.4	42.0	64	18	46	SC
B-44	23.5-25.0	22.6	--	--	--	--	--
B-44	28.5-30.0	25.1	--	--	--	--	--
B-44	33.5-35.0	24.0	--	--	--	--	--
B-45	33.5-35.0	17.8	--	--	--	--	--
B-45	43.5-45.0	23.6	--	--	--	--	--

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TABLE II (CONTINUED)
SUMMARY OF LABORATORY TEST DATA
DUNN-ERWIN LANDFILL

LOCATION	DEPTH	NATURAL MOISTURE CONTENT %	PERCENT PASSING NO. 200 SERIES	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIFIED SOILS CLASSIFICATION
B-45	48.5-50.0	19.8	--	--	--	--	--
B-46	13.5-15.0	20.5	69.0	46	16	30	CL
B-47	23.5-25.0	19.8	--	--	--	--	--
B-47	28.5-30.0	18.0	--	--	--	--	--
B-47	33.5-35.0	23.3	--	--	--	--	--
B-48	13.5-15.0	29.2	92.0	55	29	26	CH
TP-49	7.0-8.0	19.0	58.9	33	15	18	CL
TP-50	2.0-6.0	19.5	31.0	54	25	29	SC
TP-52	7.0-10.5	19.0	41.0	43	18	25	SC
TP-54	3.5-10.0	25.8	24.0	33	24	9	SC-SM
TP-56	8.0-10.5	22.6	66.0	35	22	13	CL

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TABLE III
SUMMARY OF LABORATORY FALLING HEAD PERMEABILITY TEST DATA
DUNN-ERWIN LANDFILL

	DEPTH	MAXIMUM DRY DENSITY	STANDARD PROCTOR OPTIMUM MOISTURE CONTENT %	COMPACTION MOISTURE (%)	PERCENT COMPACTION	PERMEABILITY AVE (K) CM/SEC	POROSITY (%)	UNIFIED SOILS CLASSIFICATION
B-42	4′-5′	--	--	--	Undisturbed	3.73×10^{-6}	49.7	CH
B-42	5′-6′	--	--	--	Undisturbed	1.36×10^{-6}	48.2	CH
TP-49	7′-10′	117.8	12.8	14.8	96.6	1.43×10^{-6}	30.4	CL
TP-49	7′-10′	117.8	12.8	14.7	98.1	2.60×10^{-7}	29.3	CL
TP-50	2′-6′	107.8	16.6	19.0	95.4	6.88×10^{-6}	37.1	SC
TP-50	2′-6′	107.8	16.6	18.5	99.0	7.76×10^{-7}	34.7	SC
TP-52	7′-10.5′	112.6	14.5	16.6	95.3	2.07×10^{-6}	35.1	SC
TP-52	7′-10.5′	112.6	14.5	16.6	97.9	7.80×10^{-7}	33.4	SC
TP-54	3.5′-10.0′	113.5	14.8	17.3	94.6	6.73×10^{-5}	34.8	SM-SC

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TABLE III
SUMMARY OF LABORATORY FALLING HEAD PERMEABILITY TEST DATA
DUNN-ERWIN LANDFILL

LOCATION	DEPTH	MAXIMUM DRY DENSITY	STANDARD PROCTOR OPTIMUM MOISTURE CONTENT %	COMPACTION MOISTURE (%)	PERCENT COMPACTION	PERMEABILITY AVE (K) CM/SEC	POROSITY (%)	UNIFIED SOILS CLASSIFICATION
B-42	4'-5'	--	--	--	Undisturbed	3.73×10^{-6}	49.7	CH
B-42	5'-6'	--	--	--	Undisturbed	1.36×10^{-6}	48.2	CH
TP-49	7'-10'	117.8	12.8	14.8	96.6	1.43×10^{-6}	30.4	CL
TP-49	7'-10'	117.8	12.8	14.7	98.1	2.60×10^{-7}	29.3	CL
TP-50	2'-6'	107.8	16.6	19.0	95.4	6.88×10^{-6}	37.1	SC
TP-50	2'-6'	107.8	16.6	18.5	99.0	7.76×10^{-7}	34.7	SC
TP-52	7'-10.5'	112.6	14.5	16.6	95.3	2.07×10^{-6}	35.1	SC
TP-52	7'-10.5'	112.6	14.5	16.6	97.9	7.80×10^{-7}	33.4	SC
TP-54	3.5'-10.0'	113.5	14.8	17.3	94.6	6.73×10^{-5}	34.8	SM-SC

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TABLE IV
SUMMARY OF TEST PIT DATA
DUNN-ERWIN LANDFILL

TEST PIT	DEPTH (FT.)	DESCRIPTION
TP-9	0.0-4.0	Brown Tan Fine Sandy Silty CLAY (CL)
	4.0-10.0	Dark Gray Silty CLAY (CH)
		No Ground Water Encountered at Completion
TP-29	0.0-8.0	Dark Gray Tan Mottled Slightly Fine Sandy Silty CLAY (CH)
		No Ground Water Encountered at Completion
TP-49	0.0-2.5	Brown Gray Silty Fine SAND with Roots (SM)
	2.5-7.0	Gray and Orange Clayey Fine SAND (SC-CL)
	7.0-10.0	Light Gray Fine Sandy Silty CLAY (CL)
		Ground Water Level at 6.5 Feet at Completion
TP-50	0.0-2.0	Tan Gray Clayey Silty Fine SAND (SC)
	2.0-6.0	Gray Tan Mottled Slightly Silty Clayey Fine SAND (SC)
	6.0-10.0	Tan and Gray Mottled Fine Sandy Silty CLAY (CL)
		Ground Water Level at 8.0 Feet at Completion
TP-52	0.0-1.3	Tan and Gray Silty Fine SAND (SM)
	1.3-7.0	Red-Orange Clayey Silty Fine SAND (SC) With Gravel At Bottom
	7.0-10.5	Gray Tan Mottled Silty Clayey Fine SAND (SC)

TABLE IV (CONTINUED)
SUMMARY OF TEST PIT DATA
DUNN-ERWIN LANDFILL

TEST PIT	DEPTH (FT.)	DESCRIPTION
		Ground Water Level at 9.0 Feet at Completion
TP-54	0.0-2.0	Brown Gray Slightly Silty Fine SAND (SP-SM)
	2.0-3.5	Tan Silty Fine SAND (SM)
	3.5-10.0	Yellow Tan and Light Gray Mottled Slightly Silty Clayey Fine SAND (SM-SC) with Gravel at Bottom
	10.0-10.5	Light Gray Fine Sandy Silty CLAY (CL)
		Ground Water Level at 9.0 Feet at Completion
TP-56	0.0-0.3	Brown Silty Fine SAND (SM)
	0.3-8.0	Tan Orange Slightly Silty Fine SAND (SP-SM)
	8.0-10.5	Gray, Brown and Red Mottled Fine Sandy Silty CLAY (CL)
	10.5-11.0	Light Gray Silty CLAY (CH)
		Ground Water Level at 9.5 Feet at Completion

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TABLE V
PIEZOMETER CONSTRUCTION DATA
DUNN-ERWIN LANDFILL
ELEVATION TO TOP OF

PIEZOMETER	SCREEN INTERVAL	SAND	BENTONITE	CASING
40-S	158.8-163.7	164.90	166.40	176.17
41-S	187.4-192.4	193.90	195.40	208.58
42-D	116.7-126.6	129.40	131.30	167.96
42-S	142.5-152.4	153.10	156.60	168.05
44-D	133.5-143.4	146.20	148.50	184.48
44-S	167.1-172.0	173.30	176.00	184.20
45-S	178.9-183.9	185.20	187.00	202.71
46-D	169.2-179.2	180.70	183.00	221.38
46-S	187.7-197.7	199.70	201.70	220.77
47-D	135.2-145.2	147.30	149.30	190.10
47-S	168.6-178.6	182.20	183.90	189.89
48-S	185.1-195.1	199.00	201.50	208.27
PB-9	183.6-203.6	204.50	208.80	211.24

TOC - Top of Cap

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TABLE VI
PIEZOMETER GROUND WATER ELEVATIONS

PIEZOMETER	T.O.B.	GROUND WATER ELEVATION AT 24 HOUR	3/19/91	3/26/91	4/12/91	6/27/91
40-S	ND	ND	171.68	171.44	171.38	170.61
41-S	192.1	ND	192.83	192.85	192.89	192.21
42-D	127.1	140.0	148.23	148.08	148.07	147.68
42-S	145.0	160.7	163.03	162.81	162.32	162.63
44-D	ND	ND	173.13	171.86	171.17	170.30
44-S	169.1	ND	180.86	180.79	179.20	180.46
45-S	181.4	ND	181.26	181.16	181.82	180.54
46-D	174.4	ND	190.04	189.87	191.61	192.70
46-S	ND	ND	193.17	194.14	193.23	193.76
47-D	ND	ND	163.39	161.38	161.13	161.03
47-S	ND	ND	184.25	183.81	183.46	181.83
48-S	DRY	195.2	197.22	197.01	196.85	196.41
PB-9	DRY	188.4	190.82	190.40	190.07	189.93

ND - No Data
T.O.B. - Time of Boring
(All elevations in feet.)

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TABLE VII
DUNN ERWIN LANDFILL
WATER LEVEL RECORDINGS

BORE ID NUMBER	GROUND WATER ELEVATION	WATER TABLE ELEVATION (FEET)												
		MAY 1, 1985	MAY 30, 1985	JULY 8, 1985	JULY 30,1985	SEPT 5, 1985	OCT 4, 1985	Nov 1, 1985	DEC 86	JAN 86	FEB 86	MAR 86	APRIL 86	**CHANGE in GW ELEVATION (FT)
1	234.6	GONE	219.0	220.0	221.6	219.1	220.8	219.0	218.4	218.7	---	218.9	218.7	3.2
2	204.1	187.6	187.1	187.0	187.2	186.9	187.1	187.0	185.9	185.9	183.5	186.2	185.9	4.1
3	203.7	183.7	183.7	184.1	184.7	184.6	184.6	184.1	183.1	183.0	183.8	182.8	183.20	1.9
4	207.6	196.9	196.4	197.1	197.0	196.5	196.1	195.9	193.4	194.0	194.0	193.8	193.00	4.1
5	214.3	197.7	197.9	198.8	199.4	198.8	199.0	198.3	195.3	195.7	196.4	195.5	195.6	4.1
6	203.1	187.9	187.8	188.6	188.4	188.2	187.8	187.9	186.9	187.7	187.4	187.2	186.9	1.7
7	217.1	208.1	207.2	GONE	*214.5	209.9	207.3	208.9	204.1	209.4	205.8	203.3	203.1	*11.2
8	200.3	189.8	190.1	191.1	190.7	190.4	190.5	190.4	191.2	189.9	190.3	190.6	190.0	1.4
9	230.4	212.1	211.8	212.4	212.3	211.9	211.1	211.3	210.3	210.8	211.40	210.9	210.7	2.1
10	193.2	181.4	181.6	182.4	183.3	182.6	184.9	185.0	184.1	184.3	183.8	182.4	183.4	3.6
11	210.0	192.5	192.7	192.5	192.4	192.8	192.6	192.2	191.3	191.3	191.6	191.7	191.3	1.5
12	214.8	192.1	191.8	191.6	191.8	191.6	191.4	191.3	189.3	186.4	188.7	186.7	186.1	6.0
13	202.2	183.3	183.3	183.2	183.2	183.1	183.1	182.9	181.9	181.7	182.4	182.0	182.3	1.6
14	207.6	190.5	190.1	190.6	190.8	190.6	190.6	189.4	189.2	189.7	189.4	189.6	189.7	1.6
15	200.3	192.1	191.9	192.4	192.7	192.3	192.2	192.0	191.0	191.5	191.8	191.5	191.2	1.7

*Well repaired - anomalous data

**Groundwater table mean seasonal fluctuation-2.8 feet

T91A382.VDB

TABLE VIII
SELECTED SCS SOIL CHARACTERISTICS
DUNN-ERWIN LANDFILL

SOIL SERIES	RANGE IN SLOPE %	SANITARY LANDFILL AREA	DAILY COVER FOR LANDFILL	SHALLOW EXCAVATIONS	EMBANKMENTS DIKES AND LEVEES
Bibb	0	Severe-Flooding, Wetness	Poor-Wetness	Severe-Wetness	Severe-Piping, Wetness
Blaney	8-15	Severe-Slope, Seepage	Fair-Slope	Severe-Cutbanks Cave	Severe-Piping
Gilead	2-8	Moderate-Wetness	Fair-Too Clayey, Wetness	Severe-Wetness	Moderate-Wetness
Marboro	2-6	Slight	Fair-Too Clayey	Moderate-Too Clayey	Severe-Piping
Norfolk	0-2 2-6 6-10	Slight Slight Slight	Slight Slight Fair-Slope	Moderate-Wetness Moderate-Wetness Moderate-Wetness, Slope	Slight Slight Slight
Wagram	0-6	Slight	Good	Slight	Slight

Good, Slight - Means that the soil properties are generally favorable for the specified use and that any limitations are minor and easily overcome.

Fair, Moderate - Means that some soil properties are unfavorable but can be overcome or modified by special planning and design.

Poor, Severe - Means that the soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance.

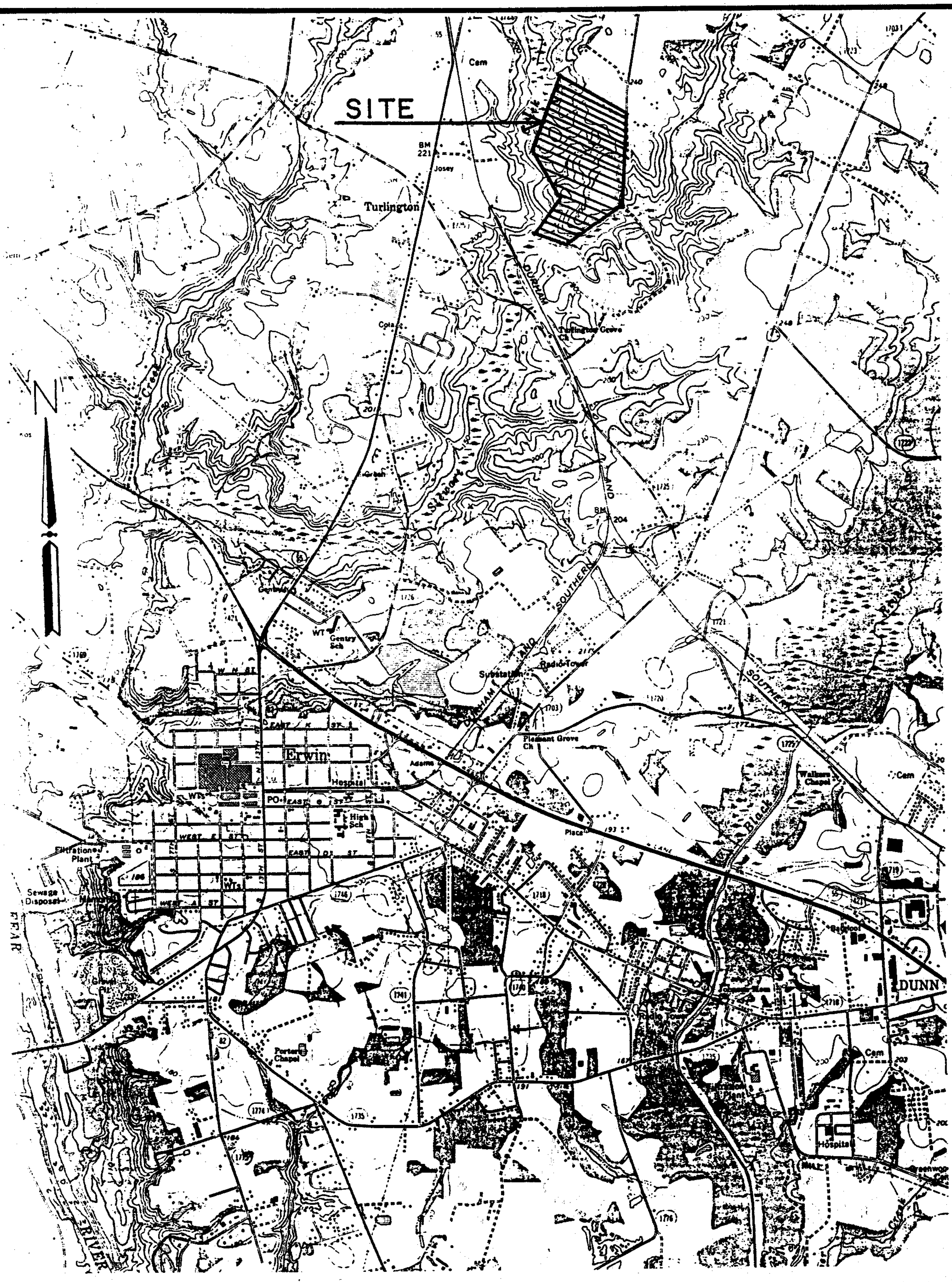
Ratings apply only to a depth of about 60-75 inches and therefore may not be valid if excavations are much deeper.

R91A130A/als

TABLE IX SUMMARY OF FIELD PERMEABILITY TEST RESULTS				
PIEZOMETER No.	SCREEN INTERVAL ELEVATION (ft)		SOIL TYPE	HYDRAULIC CONDUCTIVITY k (cm/sec)
	FROM	TO		
40S	158.8	163.7	MH and SC	2.9×10^{-5}
41S	187.4	192.4	SM/SC	1.3×10^{-3}
44S	167.1	172.0	SM and CL	1.8×10^{-5}
46D	169.2	179.2	ML	1.0×10^{-6}
47S	168.6	178.6	ML and SM	7.6×10^{-6}

R91A130A/als

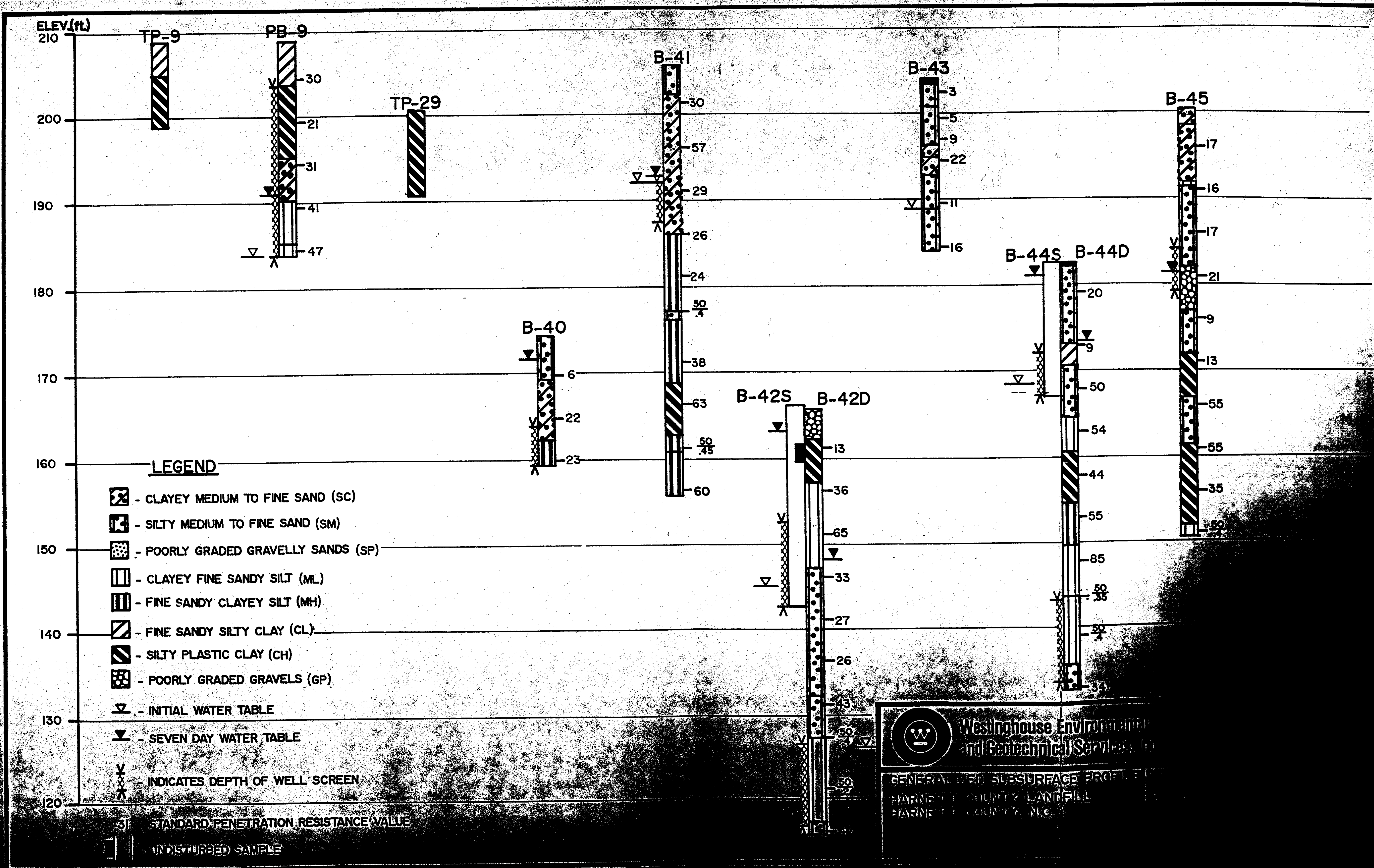
FIGURES



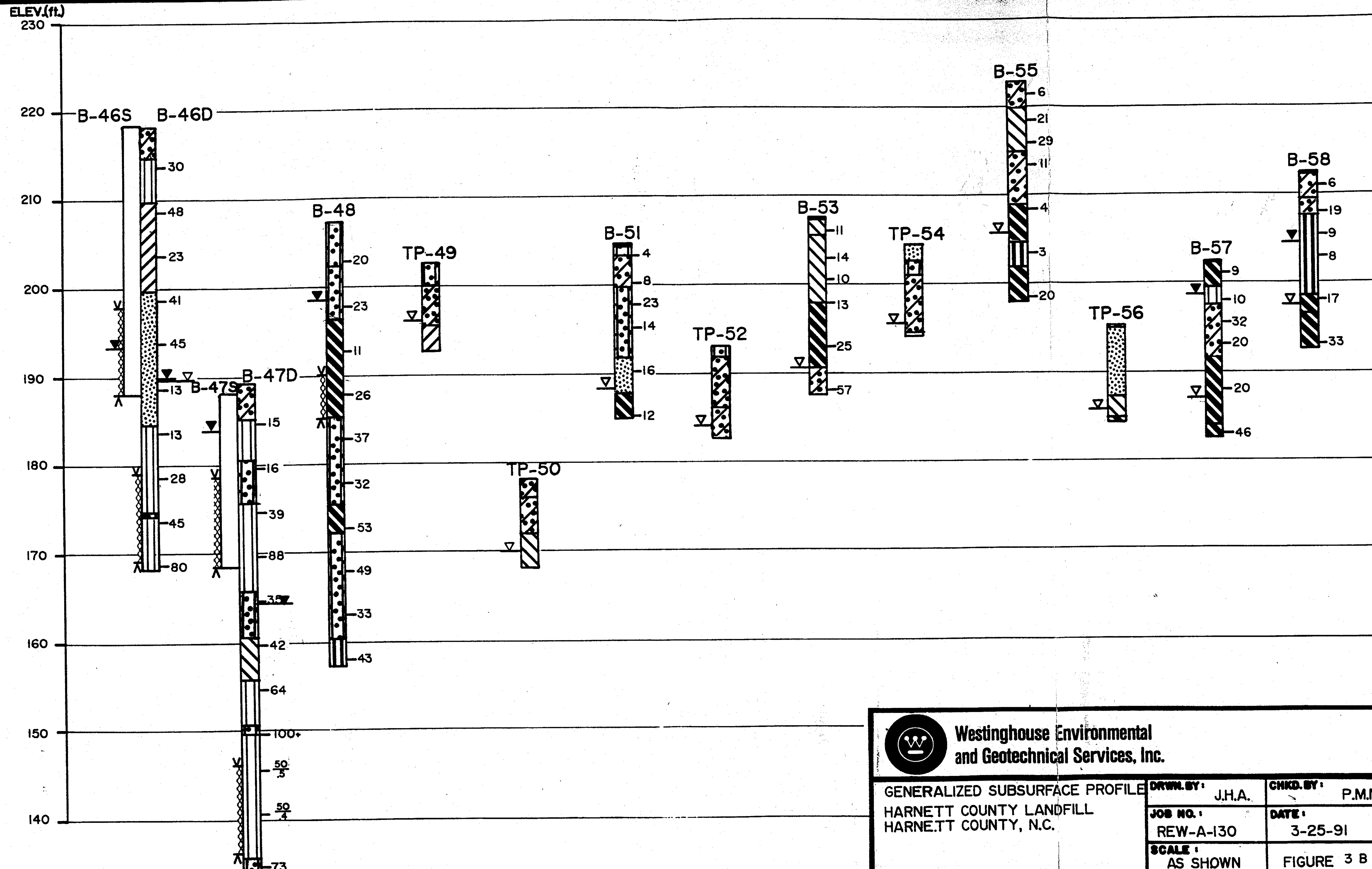
VICINITY MAP

PROJECT DUNN ERWIN LANDFILL HARNETT COUNTY, N. C.	Westinghouse	SCALE: 1" = 1000' JOB NO: REW-A-130 FIG. NO: 1

SME-4



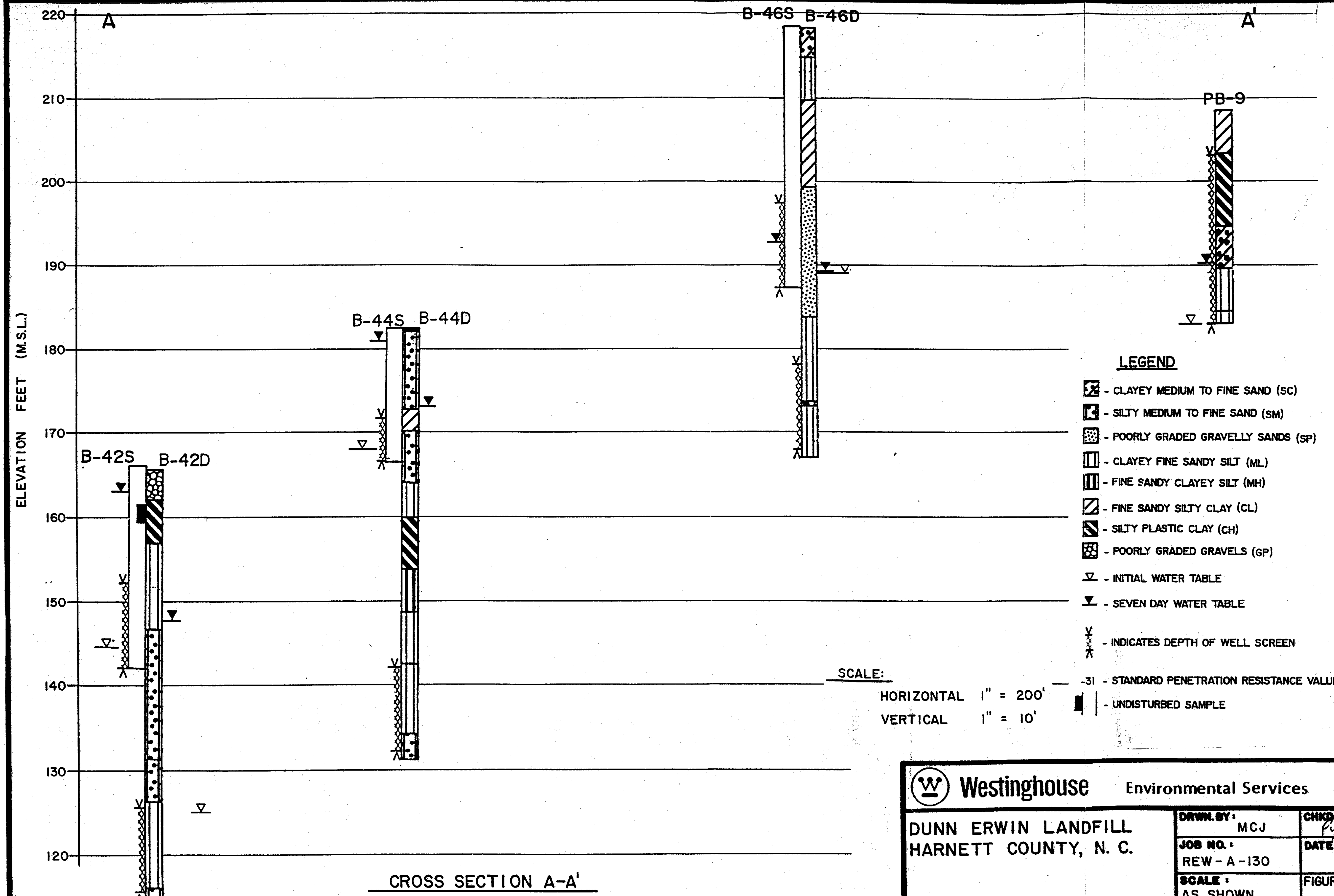
ELEV.(ft.)
210
200
190
180
170
160
150
140
130
120
TP-9
PB-9
TP-29
B-40
B-41
B-42S
B-42D
B-43
B-44S
B-44D
B-45
LEGEND
- CLAYEY MEDIUM TO FINE SAND (SC)
- SILTY MEDIUM TO FINE SAND (SM)
- POORLY GRADED GRAVELLY SANDS (SP)
- CLAYEY FINE SANDY SILT (ML)
- FINE SANDY CLAYEY SILT (MH)
- FINE SANDY SILTY CLAY (CL)
- SILTY PLASTIC CLAY (CH)
- POORLY GRADED GRAVELS (GP)
- INITIAL WATER TABLE
- SEVEN DAY WATER TABLE
INDICATES DEPTH OF WELL SCREEN
31 - STANDARD PENETRATION RESISTANCE VALUE
- UNDISTURBED SAMPLE
and Geotechnical Services
SUBSURFACE
COUNTY LANDFILL
COUNTY, N.C.



Westinghouse Environmental and Geotechnical Services, Inc.

GENERALIZED SUBSURFACE PROFILE HARNETT COUNTY LANDFILL HARNETT COUNTY, N.C.	DRWN. BY: J.H.A.	CHKD. BY: P.M.N.
	JOB NO.: REW-A-130	DATE: 3-25-91
	SCALE: AS SHOWN	FIGURE 3 B

155A

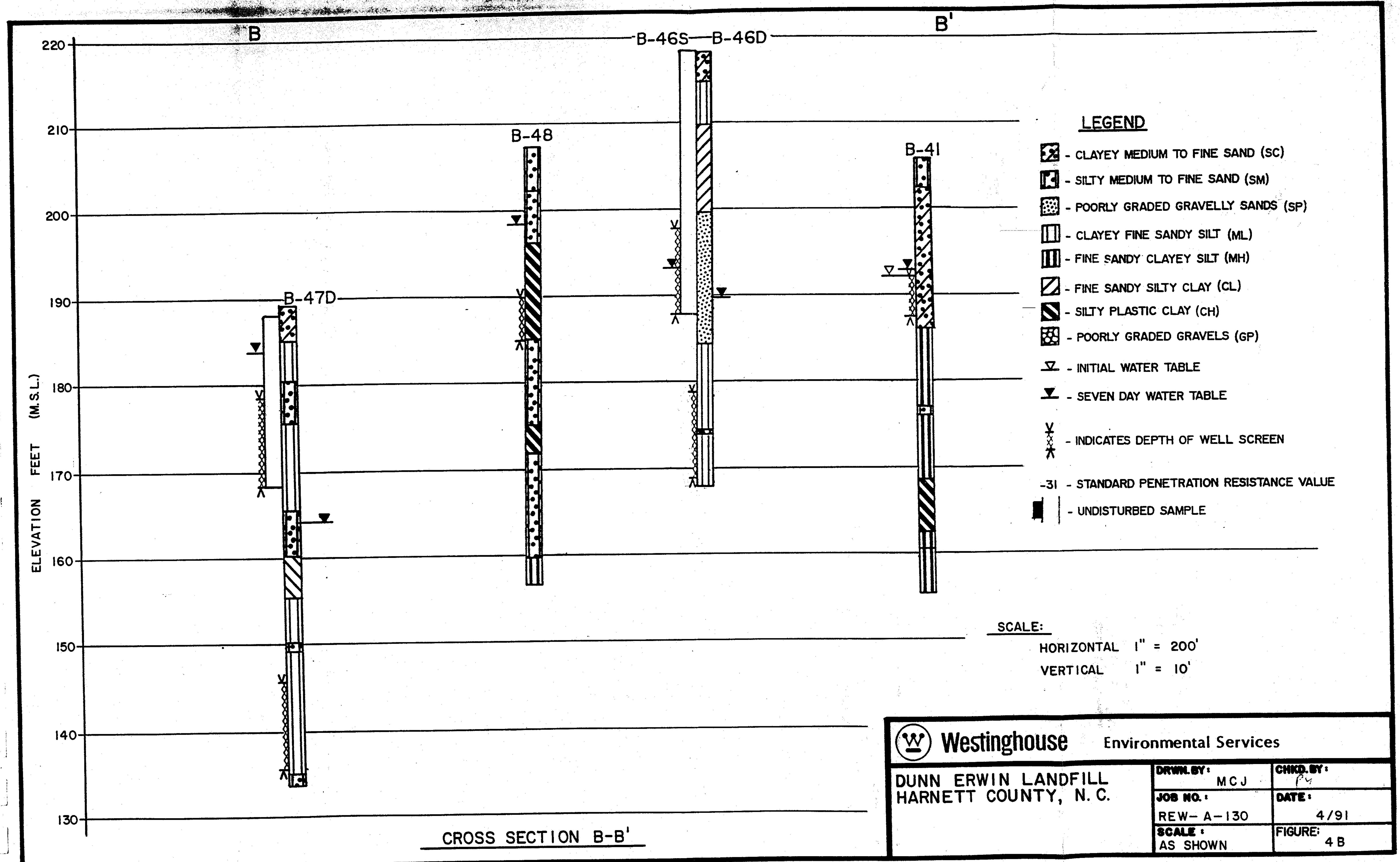


CROSS SECTION A-A'

Westinghouse Environmental Services

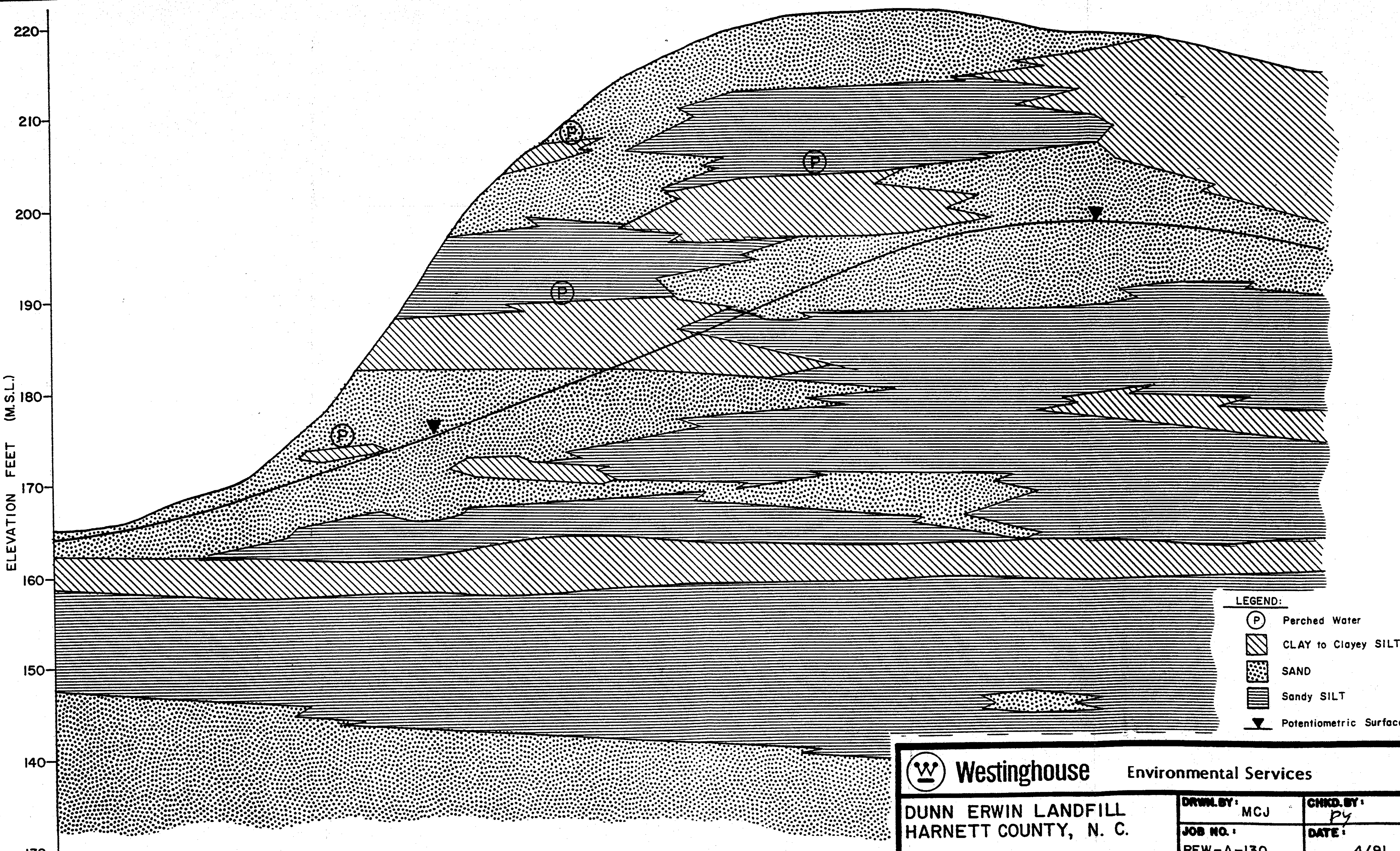
DUNN ERWIN LANDFILL
HARNETT COUNTY, N. C.

DRWN. BY: MCJ	CHKD. BY:
JOB NO.: REW-A-130	DATE: 4/91
SCALE: AS SHOWN	FIGURE: 4 A



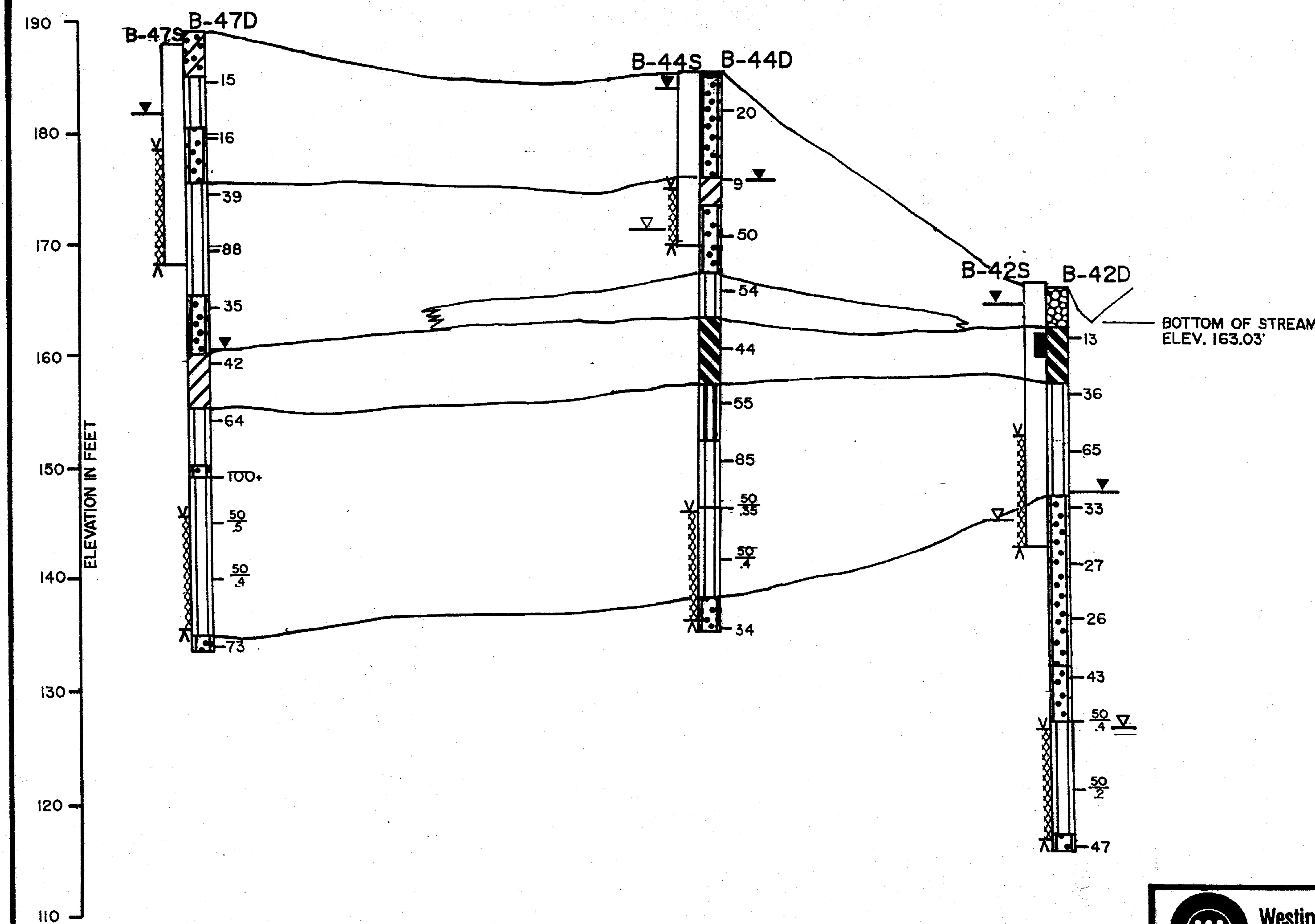
CROSS SECTION B-B'

DUNCAN-PARNELL, INC., RALEIGH 988 919-833-4677



GENERALIZED GEOLOGIC CROSS SECTION

Westinghouse Environmental Services		
DUNN ERWIN LANDFILL HARNETT COUNTY, N. C.	DRWN.BY: MCJ	CHKD.BY: PY
	JOB NO.: REW-A-130	DATE: 4/91
	SCALE: AS SHOWN	FIGURE: 5



LEGEND

- CLAYEY MEDIUM TO FINE SAND (SC)
- SILTY MEDIUM TO FINE SAND (SM)
- POORLY GRADED GRAVELLY SANDS (SP)
- CLAYEY FINE SANDY SILT (ML)
- FINE SANDY CLAYEY SILT (MH)
- FINE SANDY SILTY CLAY (CL)
- SILTY PLASTIC CLAY (CH)
- POORLY GRADED GRAVELS (GP)
- INITIAL WATER TABLE
- WATER TABLE 6/27/91
- INDICATES DEPTH OF WELL SCREEN

-31 - STANDARD PENETRATION RESISTANCE VALUE
- UNDISTURBED SAMPLE

SCALE:

HORIZONTAL 1" = 200'
VERTICAL 1" = 10'

Westinghouse Environmental and Geotechnical Services, Inc.

DUNN ERWIN LANDFILL HARNETT COUNTY, NORTH CAROLINA	DRWN. BY: J.H.A.	CHKD. BY: A.M.B.
	JOB NO.: REW-A-130	DATE: 7-1-91
HYDROGEOLOGIC CROSS-SECTION	SCALE: AS SHOWN	FIGURE: 6

APPENDIX A

FIELD AND LABORATORY METHODS

SOIL TEST BORINGS

Borings were advanced with 3-1/4 inch hollow-stem augers and, at standard intervals, soil samples were obtained with standard 1.4-inch I.D., 2-inch O.D., split-tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows, designated as Standard Penetration Resistance, when properly evaluated is an index to soil strength and relative density.

Representative portions of each split-tube sample were placed in glass jars and classified by a geologist in our laboratory. Laboratory analyses of plasticity, grain size, and specific gravity were used to confirm visual classifications. Test Boring Records showing the soil descriptions and standard Penetration Resistances are included in Appendix C.

MOISTURE CONTENT

The moisture content of several samples was determined. The moisture content is the ratio of the weight of water in a given mass of soil to the dry weight of the solids. This test was conducted in accordance with ASTM Designation D 2216-66. Test results are presented on the attached Summary of Laboratory Data Sheet (Table II).

GRAIN SIZE TESTS

Grain size tests were performed to examine the particle size and distribution of the bulk samples tested. Grain size distribution of soils coarser than a No. 200 sieve was determined by passing the samples through a set of nested sieves. Soil particles passing the No. 200 sieve were suspended in solution and the grain size distribution determined from the rate of settlement.

The results are presented on the attached Grain Size Distribution Sheets. (Appendix D).

SOIL PLASTICITY TESTS (ATTERBERG LIMITS)

Samples were selected for Atterberg limits testing to determine the soil's plasticity characteristics. Plastic Index (PI) is representative of this characteristic and is the difference between the Liquid Limit (LL) and the Plastic Limit (PL). Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid as determined in accordance with ASTM D-423. Plastic Limit is the moisture content at which the soil begins to loose its plasticity as determined in accordance with ASTM D-424. Analytical data is presented in Table II.

SPECIFIC GRAVITY

Specific gravity is the ratio of the weight in air of a given volume of soil to the weight in air of an equal volume of water and is determined in accordance with ASTM Designation D 854-58. The results of the test are presented on the attached data sheets (Appendix D).

APPENDIX B

Well Number: ______ Drilling Method: ______

Date Started: ______ Drilling Fluids: ______

Date Finished: ______ Static Water Level: ______ Date: ______

Geologist/Engineer: P. Nelis / P. Yanez Observed By: ______

Remarks: ______

Generalized Piezometer Schematic

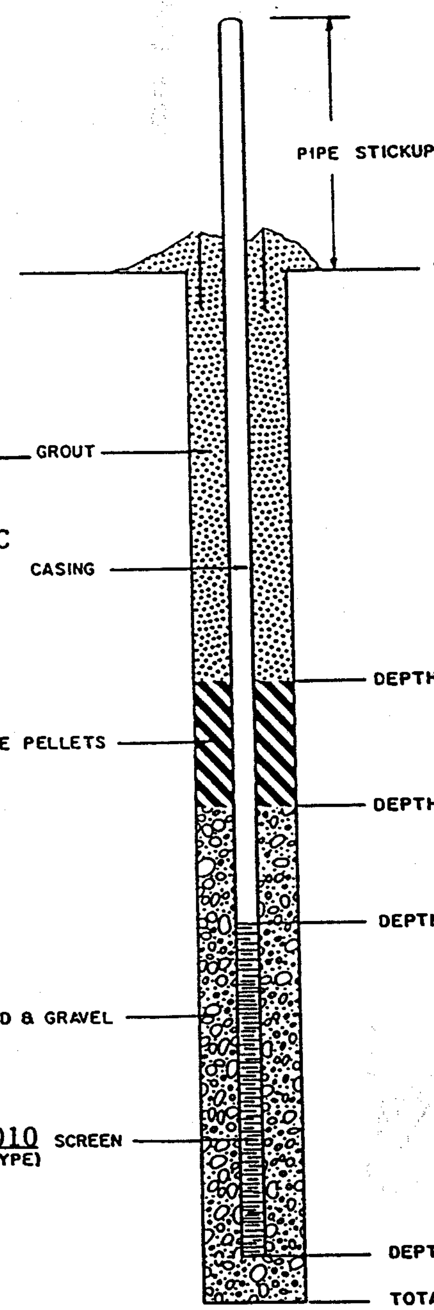
O.D. of Borehole: 6.5"

O.D. of Casing: 1.25"

Length of Screen: varies

Screen Opening Size: 0.010

ALL DEPTHS REFERENCED FROM GROUND SURFACE



PROJECT		
Dunn-Erwin Landfill	Westinghouse	SCALE: NTS JOB NO: REW-A- 130 FIG. NO:

Harnett Co. Landfill
REW A 382
4/11/91

Well 41-S - Slug Test Data

Static Water Level Reading (FT-H2O) = 4.54

Y = Water Level Reading During Test (FT-H2O)
Del Y = Y - Static Water Level at Time t
t = Time in Seconds Since Start of Test

41-S

Y	Del Y	Log Del Y	t
6.84	2.3	0.361727	6
5.7	1.16	0.064457	12
5.31	0.77	-0.11350	18
5.13	0.59	-0.22914	24
5.03	0.49	-0.30980	30
4.96	0.42	-0.37675	36
4.92	0.38	-0.42021	42
4.88	0.34	-0.46852	48
4.85	0.31	-0.50863	54
4.83	0.29	-0.53760	60
4.81	0.27	-0.56863	66
4.8	0.26	-0.58502	72
4.78	0.24	-0.61978	78
4.77	0.23	-0.63827	84
4.76	0.22	-0.65757	90
4.75	0.21	-0.67778	96
4.74	0.2	-0.69897	102
4.73	0.19	-0.72124	108
4.72	0.18	-0.74472	114
4.72	0.18	-0.74472	120
4.71	0.17	-0.76955	126
4.71	0.17	-0.76955	132
4.67	0.13	-0.88605	168
4.66	0.12	-0.92081	198
4.66	0.12	-0.92081	228
4.66	0.12	-0.92081	258
4.65	0.11	-0.95860	288
4.64	0.1	-1	318
4.64	0.1	-1	348
4.63	0.09	-1.04575	378
4.62	0.08	-1.09691	408
4.62	0.08	-1.09691	468
4.61	0.07	-1.15490	528
4.6	0.06	-1.22184	588
4.6	0.06	-1.22184	648
4.6	0.06	-1.22184	708
4.58	0.04	-1.39794	1038
4.55	0.01	-2	1338

Harnett Co. Landfill
REW A 382
4/12/91

Well 44-S - Slug Test Data

Static Water Level Reading (FT-H20) = 10.03

Y = Water Level Reading During Test (FT-H20)
Del Y = Y - Static Water Level at Time t
t = Time in Seconds Since Start of Test

44-S

Y	Del Y	Log Del Y	t
12.23	2.2	0.342422	6
12.24	2.21	0.344392	12
12.23	2.2	0.342422	18
12.22	2.19	0.340444	24
12.22	2.19	0.340444	30
12.21	2.18	0.338456	40
12.2	2.17	0.336459	58
12.19	2.16	0.334453	82
12.19	2.16	0.334453	107
12.19	2.16	0.334453	137
12.17	2.14	0.330413	263
12.15	2.12	0.326335	413
12.13	2.1	0.322219	593
12.13	2.1	0.322219	713
12.09	2.06	0.313867	1042
11.98	1.95	0.290034	2242
11.89	1.86	0.269512	3742
11.8	1.77	0.247973	5242
11.69	1.66	0.220108	7042
11.59	1.56	0.193124	9442
11.5	1.47	0.167317	11542
11.4	1.37	0.136720	13642
11.31	1.28	0.107209	16342
11.25	1.22	0.086359	18142

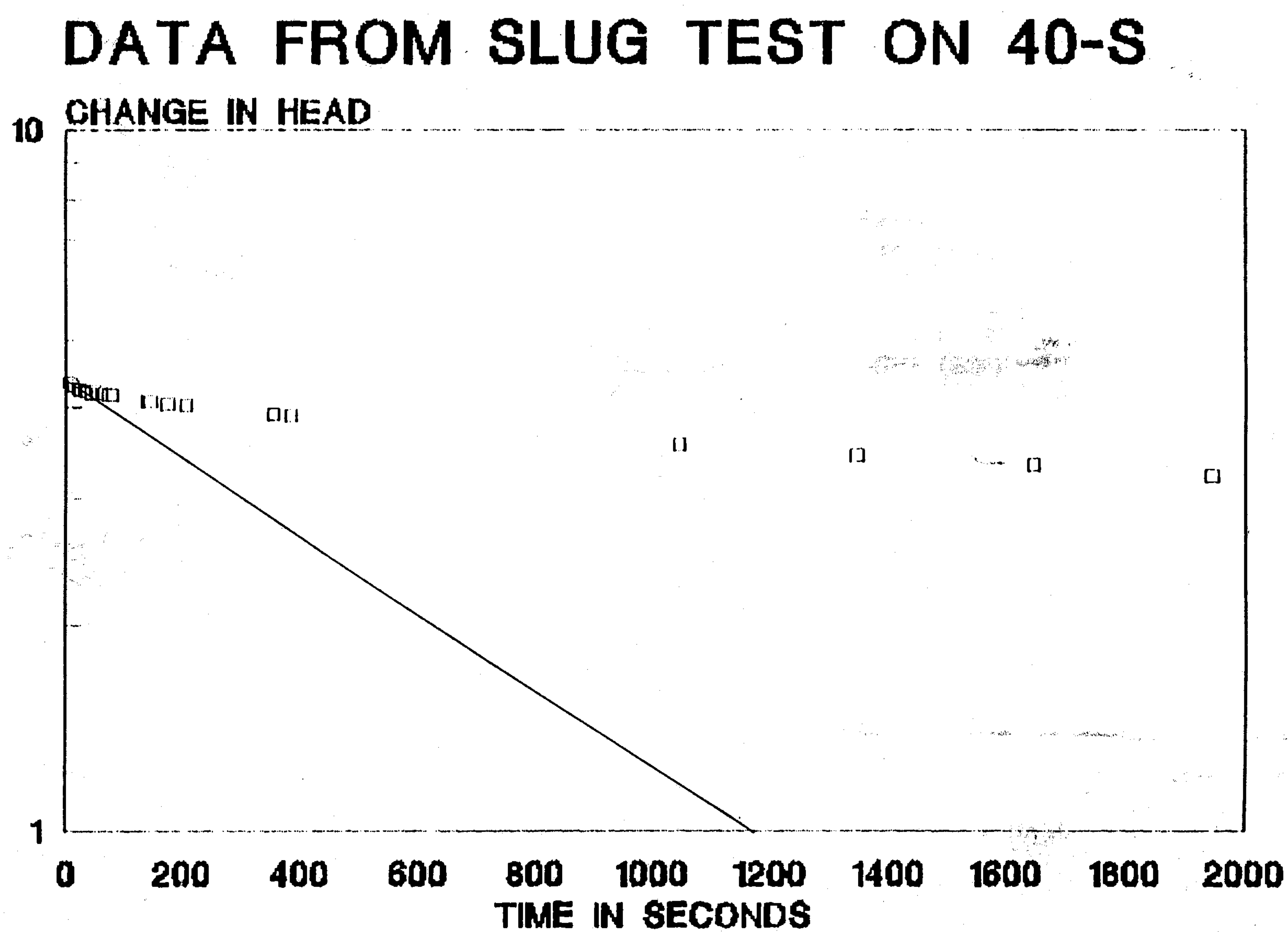
SLUG TEST ON PIEZOMETER 46-D

SECONDS	W HEIGHT	DELTA
10	27.19	7.64
20	27.17	7.61
30	27.16	7.61
60	27.12	7.57
90	27.11	7.56
120	27.07	7.52
150	27.06	7.51
180	27.04	7.49
210	27.01	7.46
240	27.00	7.45
270	26.99	7.44
300	26.97	7.42
330	26.96	7.41
360	26.95	7.40
390	26.95	7.40
420	26.93	7.38
450	26.92	7.37
480	26.91	7.36
510	26.91	7.36
540	26.91	7.36
570	26.91	7.36
600	26.89	7.34
630	26.89	7.34
750	26.86	7.31
870	26.83	7.28
990	26.81	7.26
1110	26.80	7.25
1230	26.78	7.23
1350	26.75	7.20
1470	26.74	7.19
1590	26.73	7.18
1710	26.72	7.17
1830	26.70	7.15
1950	26.68	7.13
2070	26.67	7.12
2190	26.66	7.11
2310	26.65	7.10
2430	26.63	7.08
2550	26.62	7.07
2670	26.61	7.06
2790	26.59	7.04
2910	26.58	7.03
3030	26.57	7.02
3150	26.57	7.02
3270	26.54	6.99
3390	26.53	6.98
3510	26.52	6.97

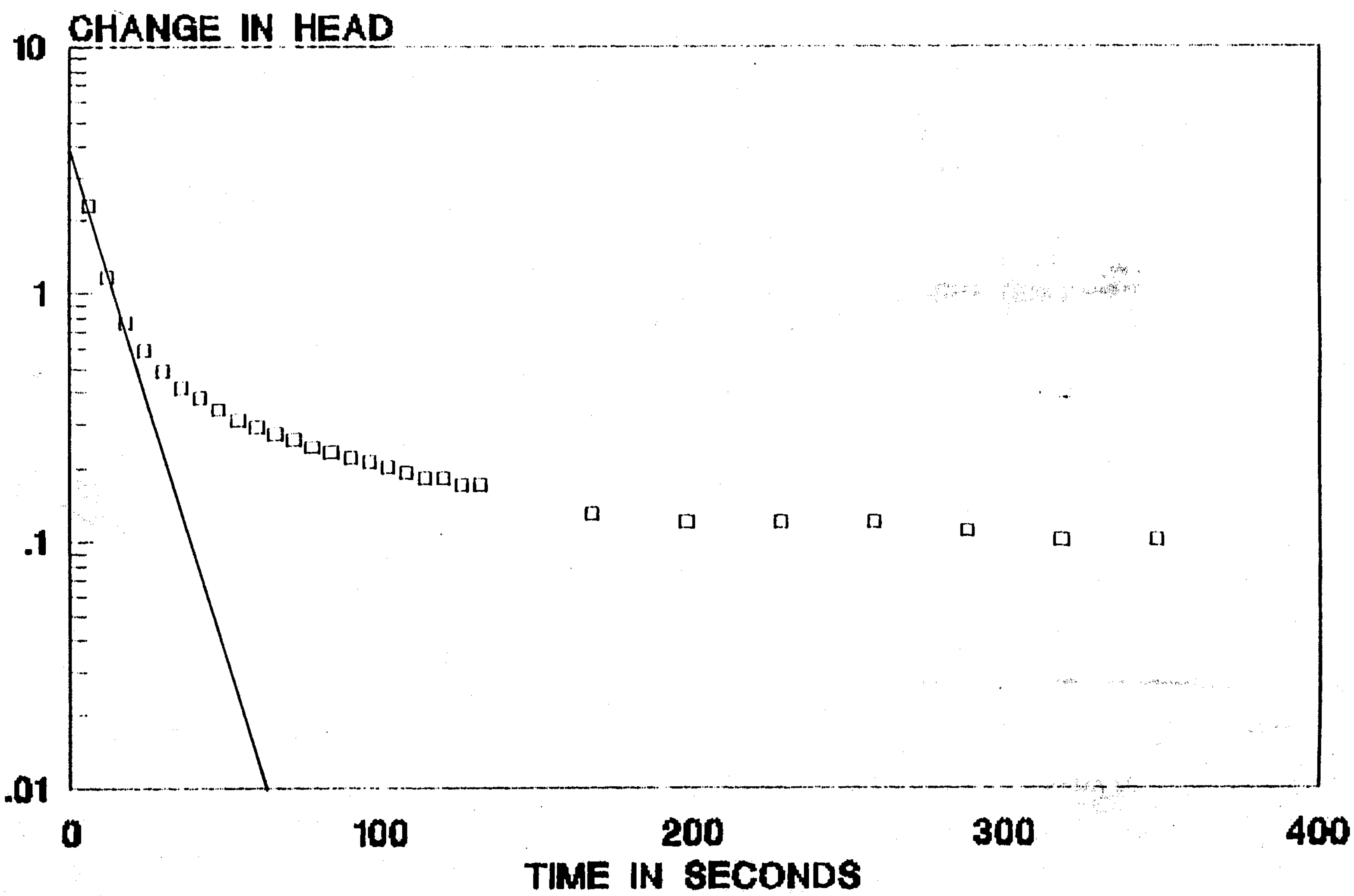
3630	26.51	6.96
3750	26.50	6.95
3870	26.47	6.92
3990	26.48	6.93
4110	26.26	6.70
4230	26.46	6.90
4350	26.45	6.90
4470	26.44	6.89
4590	26.42	6.87
4710	26.40	6.85

SLUG TEST ON PIEZOMETER 47-S

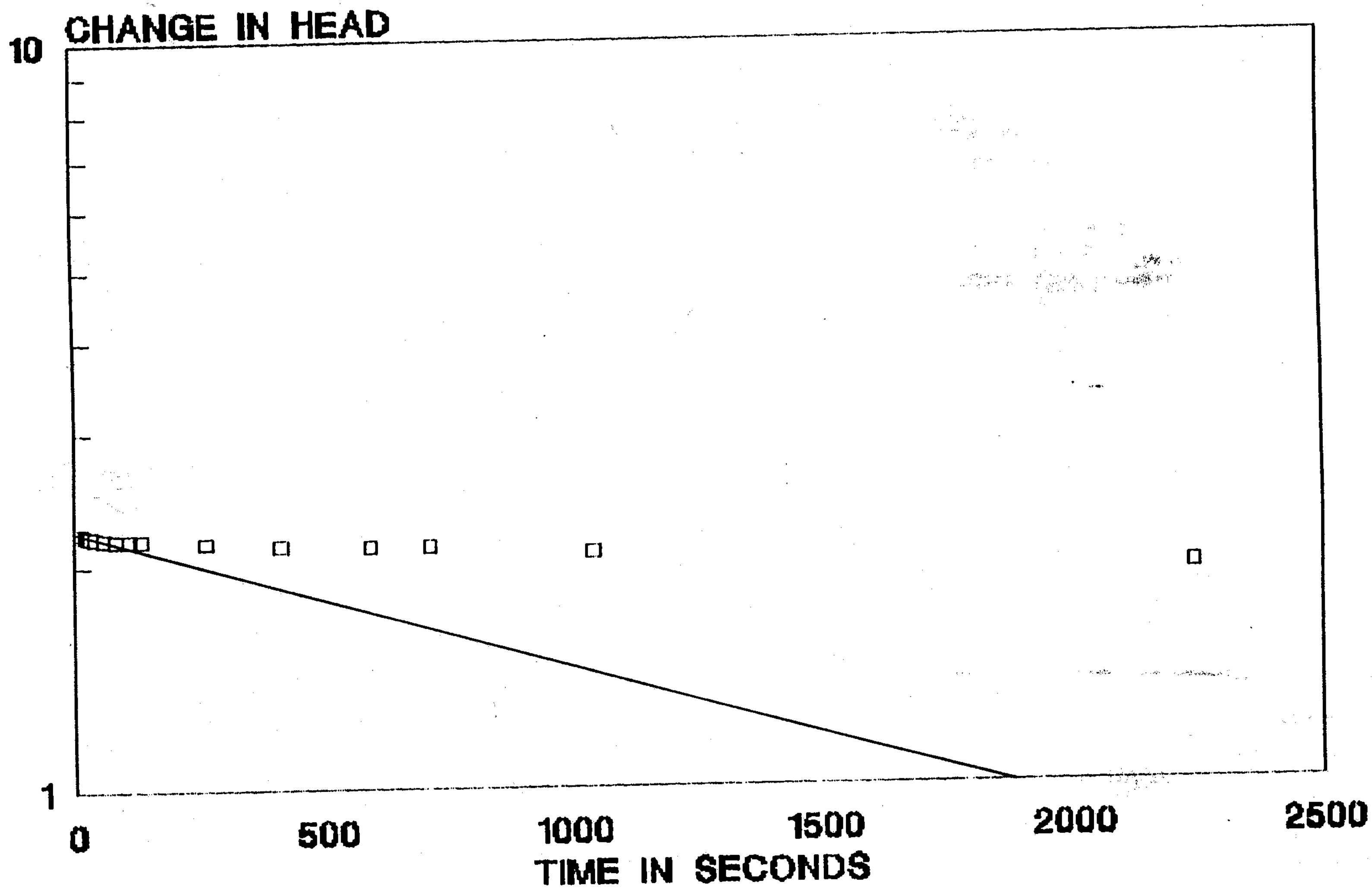
SECONDS	W HEIGHT	DELTA
10	18.70	5.05
20	18.68	5.03
30	18.56	4.91
40	18.51	4.86
50	18.47	4.82
60	18.45	4.80
70	18.41	4.76
80	18.39	4.74
90	18.37	4.72
100	18.34	4.69
110	18.32	4.67
120	18.29	4.64
130	18.27	4.62
140	18.24	4.59
150	18.22	4.57
160	18.19	4.54
280	17.95	4.30
400	17.75	4.10
520	17.55	3.90
640	17.38	3.73
760	17.22	3.57
880	17.09	3.44
1000	16.91	3.26
1120	16.78	3.13
1240	16.67	3.02
1360	16.56	2.91
1480	16.40	2.75
1600	16.31	2.66
1720	16.22	2.57


DATA FROM SLUG TEST ON 40-S
CHANGE IN HEAD
10
1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
TIME IN SECONDS

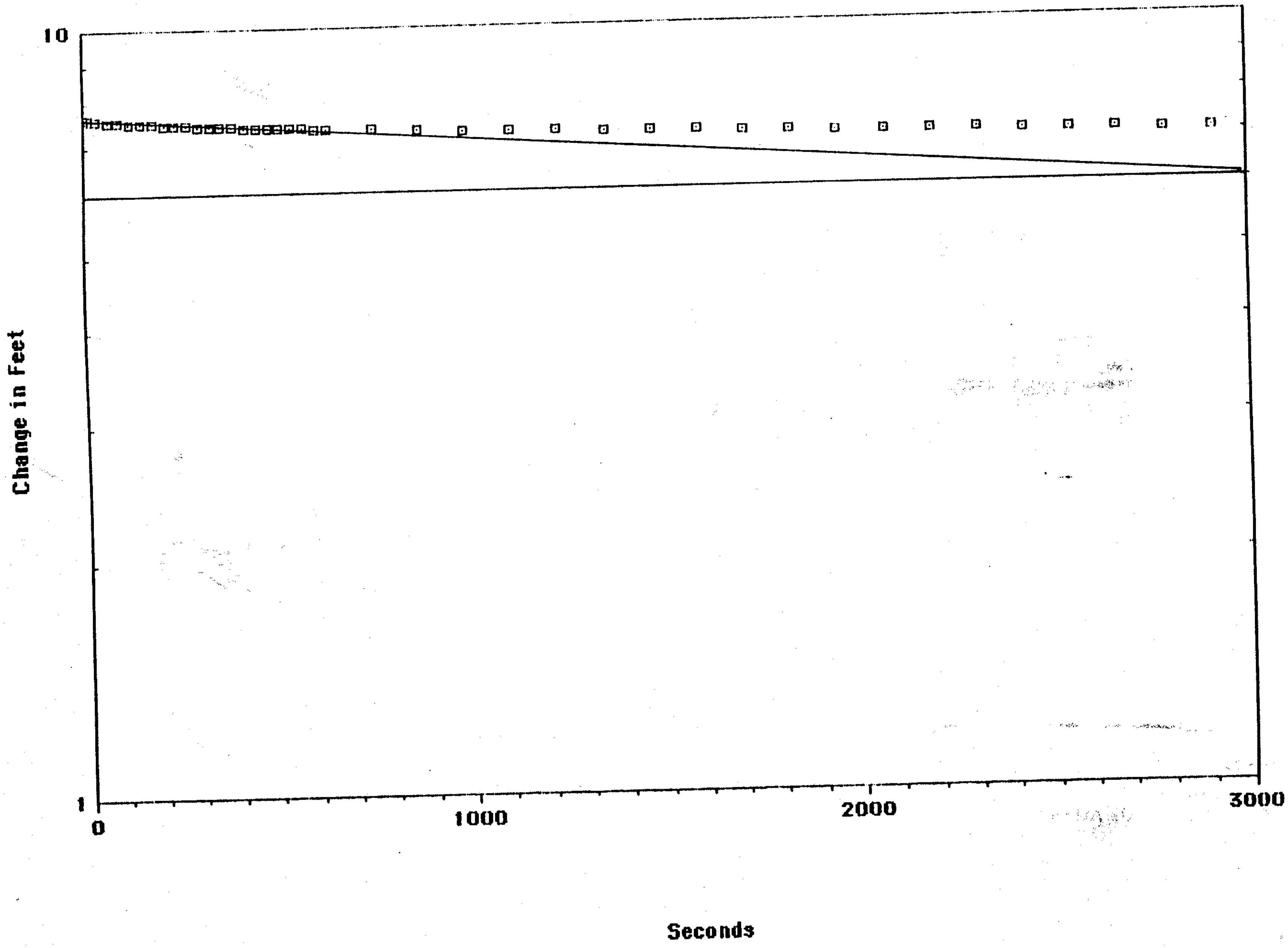
SLUG TEST ON 41-S



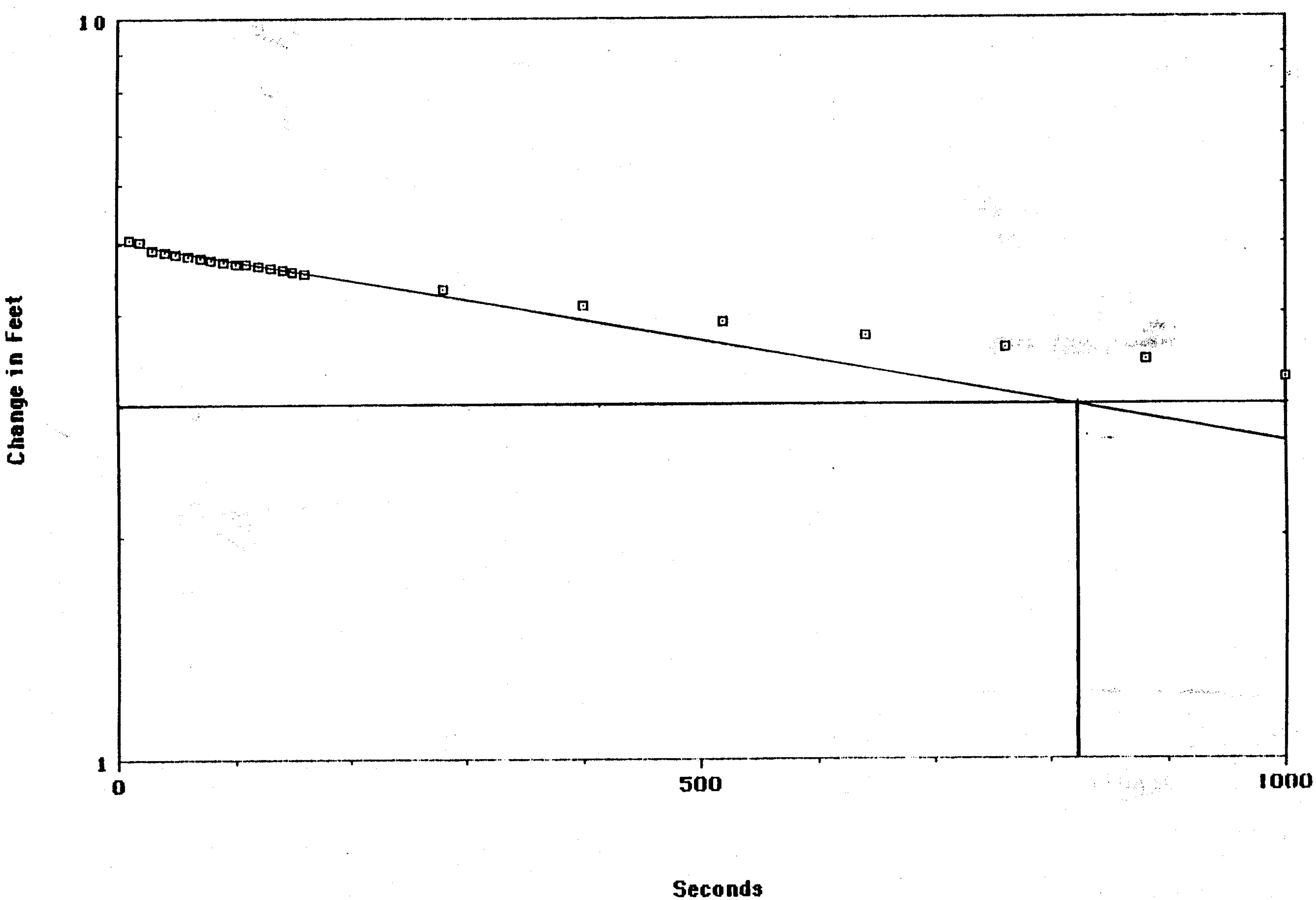
DATA FROM SLUG TEST ON 44-S



Data from "46-D Slug Test"



Data from "47-S slug Test"



PIEZOMETER	RICE-BOUWER EQUATION PARAMETERS							
	L_e	r_c	r_w	y_0	y_t	t	L_w	H
40-S	58.8	0.625	3	4.34	1.0	1,164	151.0	151.0
41-S	60.0	0.625	3	3.90	0.01	64	65.8	290.8
44-S	58.8	0.625	3	2.22	1.0	1,875	169.2	247.9
46-D	120.0	0.625	3	7.6	6.0	3,000	250.1	340.0
47-S	120.0	0.625	3	5.0	3.0	820	187.8	270.0

y_t and y_0 in feet
all other variables in inches

R91A130A/als

PROCEDURE FOR DETERMINING THE HYDRAULIC CONDUCTIVITY (K) OF AN AQUIFER FROM SLUG TEST DATA USING THE BOUWER AND RICE ANALYSIS

Reference: The Bouwer and Rice Slug Test - An Update by H. Bouwer, pp. 304-309, Ground Water, May - June 1989.

Conditions: The well can be partially penetrating and partially screened. The test may be performed by either adding or evacuating water. Consult the reference for further information.

Step 1: Determine the well dimensions required for this analysis and complete Figure 1.

Step 2: The elevational difference in feet between the static water level and the water level at time t seconds during the test is defined as (Y_t). Plot Y_t versus t on the semilog paper provided, following the example shown on Figure 3.

Step 3: Determine the natural (static) ground water elevation relative to the top of the well screen and the top of the gravel pack. If the slug test is expected to either drain or flood the gravel pack, a double straight line effect may appear in the data plot due to the relatively high K values of the gravel pack or developed zone versus the formation, as shown on Figure 4. Draw a "best fit" straight line through the "B-C" segment of the data and extrapolate this line to the log Y_t axis and the t axis, as shown in Figures 3 and 4.

Step 4: Having ascertained the values of Y_o (line intersection with Y axis), t (line intersection with t axis), and Y_t (y coordinate with t value) from the extrapolated line drawn in Step 3, calculate the value of 1/t ln (Y_o/Y_t)

Step 5: Using well construction and hydrogeologic information (Figure 1) ascertain the values of r_w, r_c, L_e, L_w, and H (saturated thickness). From the information, calculate the value of L_e/r_w.
If $L_w < H$ (Partially penetrating well), ascertain the values of A and B from Figure 2 and substitute them into the following equation to determine the value of $\ln(R_e/r_w)$. The values of L_w, r_w, H and L_e are all expressed in inches.

$$\ln (R_e/r_w) = \frac{1}{\dfrac{1.1}{\ln (L_w/r_w)} + \left(\dfrac{A + B \ln\left(\dfrac{H-L_w}{r_w}\right)}{L_e/r_w}\right)}$$

If $L_w = H$, ascertain the value of C from Figure 2 and substitute it into the following equation to determine the value of $\ln (R_e/r_w)$

$$\ln (R_e/r_w) = \frac{1}{\dfrac{1.1}{\ln (L_w/r_w)} + \dfrac{C}{(L_e/r_w)}}$$

Step 6: Substitute the values of $(1/t \ln (Y_o/Y_t))$ and $(\ln (R_e/r_w))$, determined in Steps 4 and 5, respectively, along with r^2_c and $2L_e$ into the following equation to determine the hydraulic conductivity (K) in inches per second:

$$K = \frac{r^2_c \ln (R_e/r_w)}{2L_e} \frac{1}{t} \ln (Y_o/Y_t)$$

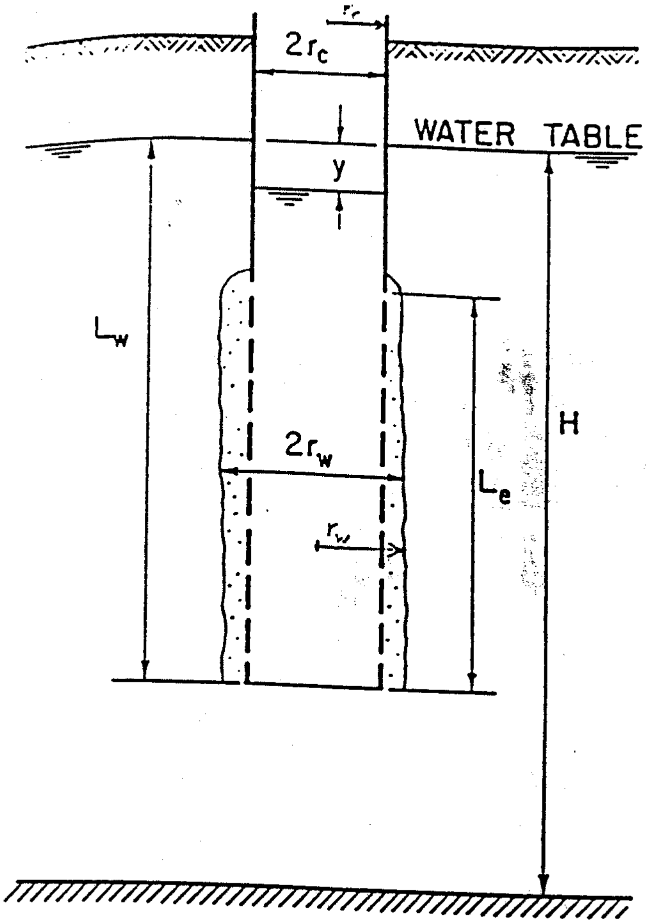
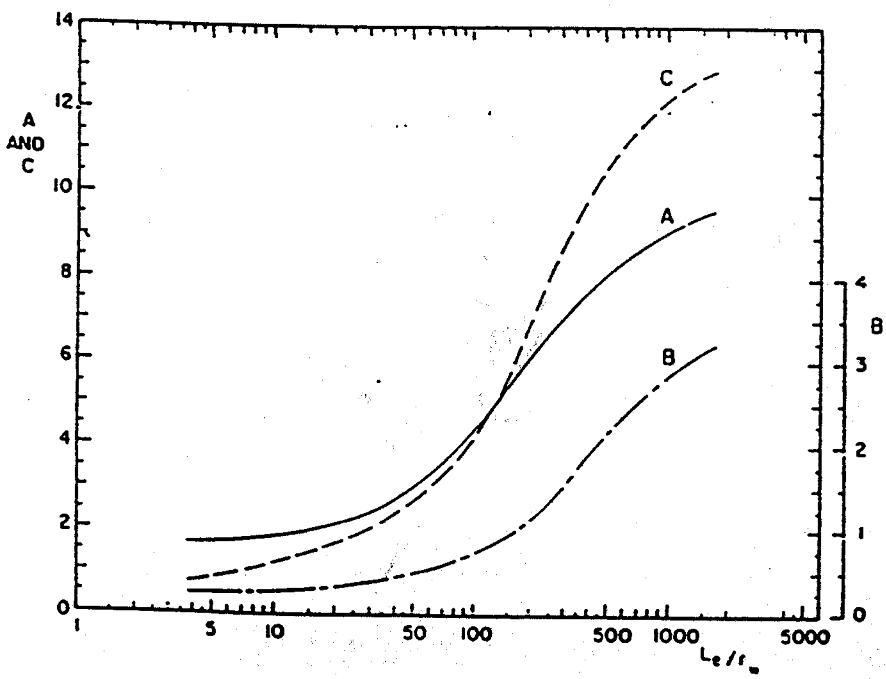


FIGURE 1



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

PIEZOMETER	RICE-BOUWER EQUATION PARAMETERS							
	L_e	r_c	r_w	y_0	y_t	t	L_w	H
40-S	58.8	0.625	3	4.34	1.0	1,164	151.0	151.0
41-S	60.0	0.625	3	3.90	0.01	64	65.8	290.8
44-S	58.8	0.625	3	2.22	1.0	1,875	169.2	247.9
46-D	120.0	0.625	3	7.6	6.0	3,000	250.1	340.0
47-S	120.0	0.625	3	5.0	3.0	820	187.8	270.0

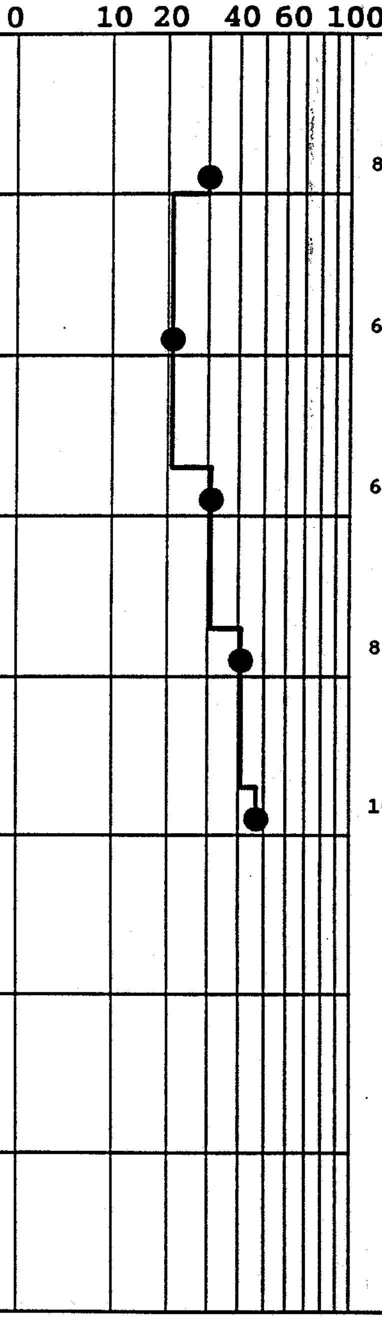
y_t and y_0 in feet
all other variables in inches

R91A130A/als

APPENDIX C

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.	
0.0	Hard Reddish Brown to Gray Fine Sandy Silty CLAY	CL	208.8		
				8-11-19	
5.0	Very Stiff Gray Silty CLAY	CH	203.8		
				6-9-12	
			198.8		
13.5	Dense Medium Gray Clayey Silty Fine SAND	SM/SC		6-16-15	
			193.8		
18.5	Hard Medium Gray Clayey SILT with Medium Gray Silty Fine to Medium SAND	ML/SM		8-18-23	17.9
			188.8		
23.5	Hard Medium Gray Clayey SILT	ML		10-20-27	
25.0	Boring Terminated at 25.0'. No ground water encountered at termination of boring. Ground water encountered at 17.9' after 7 days.		183.8		



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

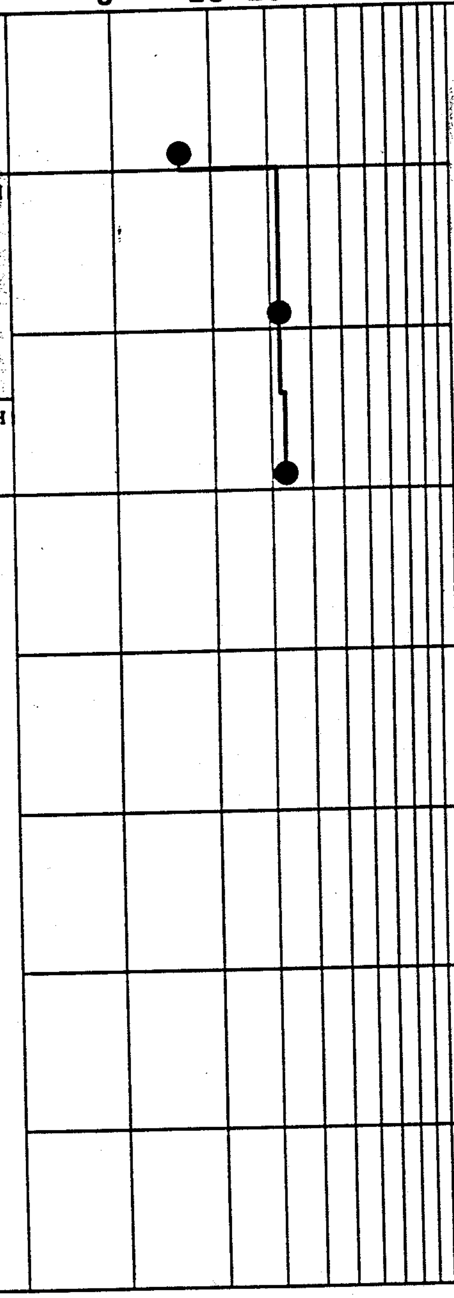
JOB NUMBER REW-A-130
BORING NUMBER PB-9
DATE 3-4-91

PAGE 1 OF 1

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.	
0.0	Loose Gray to Brown Silty Coarse SAND	SM			2-2-4	2.4
5.0	Very Stiff Gray Very Silty Clayey Medium to Fine SAND	SM			5-8-14	
12.0	Very Stiff Gray Clayey Plastic SILT	MH			6-10-13	
15.0	Boring Terminated at 15.0'. No ground watet data at termination of boring. Ground water encountered at 2.4' after 7 days.					



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER 1051-91-141
BORING NUMBER B-40
DATE 3-5-91

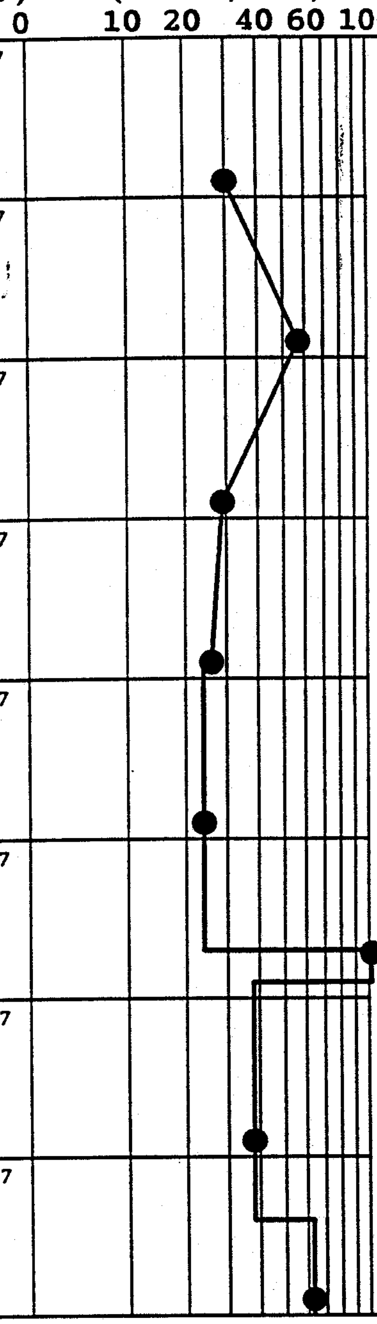
PAGE 1 OF 1

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Brown Tan Silty Medium to Coarse SAND	SM	205.7	
3.5	Medium Dense to Very Dense Light Brown-Tan Clayey Silty Medium to Coarse SAND	SM / SC		5-10-20
			200.7	19-26-31
			195.7	14-14-15
			190.7	14-16-10
19.5	Very Stiff Gray to Tan Fine Sandy Clayey SILT	MH	185.7	7-11-13
			180.7	
28.5	Tan Orange Silty Medium to Fine SAND with Gravel with Small Rock Fragments	SM		50/4.8"
29.5	Hard Gray Brown Fine Sandy Clayey SILT	MH	175.7	19-19-19
			170.7	
37.0	Hard Gray Fine Sandy Silty CLAY	CH		19-24-39

PENETRATION (BLOWS/FT.)



12.9
13.6

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REEW-A-130
BORING NUMBER B-41
DATE 3-5-91

PAGE 1 OF 2

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
			165.7		
43.0	Hard Gray Green Medium to Fine Sandy Clayey SILT	MH			20-27-50/4.8"
45.0	Hard Gray Green Fine Sandy Clayey SILT	MH	160.7		13-20-40
50.0	Boring Terminated at 50.0' Ground Water Encountered at 13.6' at Termination of Boring. Ground Water Encountered at 12.9' after 7 days		155.7		

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

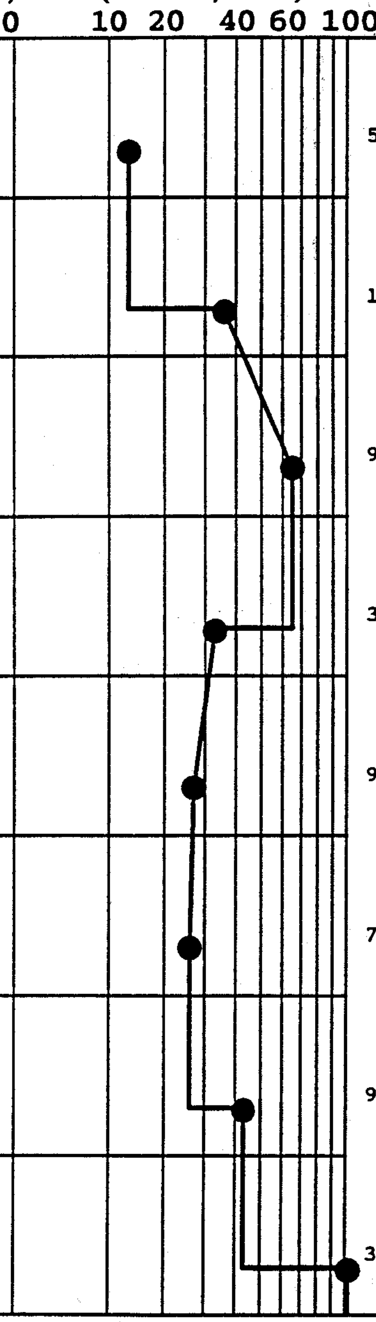
JOB NUMBER REW-A-130
BORING NUMBER B-41
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.	
0.0	Loose Tan Brown Sandy GRAVEL	GP	165.8		
				5-5-8	
3.5	Stiff Light Gray Sandy Silty CLAY	CH			
			160.8		
				11-14-22	
8.5	Hard Gray Red Mottled Clayey SILT	ML			
			155.8		
				9-15-50	
			150.8		
					17.6
18.5	Medium Dense to Dense Light Gray Silty Medium to Coarse SAND	SM		3-12-21	
			145.8		
				9-12-15	
			140.8		
				7-12-14	
			135.8		
				9-19-24	
33.5	Dense Light Gray Silty Medium to Medium SAND	SM			
			130.8		
				30-50/4.8"	38.7
38.5	SEE NEXT PAGE	ML			

PENETRATION (BLOWS/FT.)



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REEW-A-130
BORING NUMBER B-42
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
	Hard Light Gray Red Mottled Clayey SILT		125.8		15-38-50/2.4"
			120.8		9-15-32
48.5	Dense Light Gray Silty Fine SAND	SM			
50.0	Boring Terminated at 50.0' Ground Water Encountered at 38.7' at Termination of Boring. Ground Water Encountered at 17.6' after 7 days.		115.8		

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

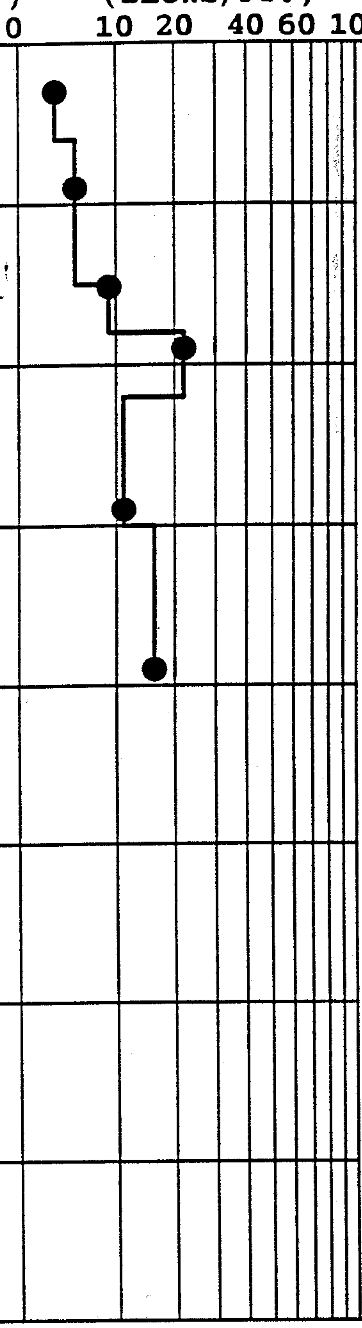
JOB NUMBER REW-A-130
BORING NUMBER B-42
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.	
0.0	Topsoil with Organics & Rootmat		203.9		
0.5	Very Loose Tan Silty Medium to Fine SAND	SM		2-2-1	
3.0	Loose Orange to Brown Clayey Medium to Fine SAND	SM	198.9	3-2-3	
				5-4-5	
7.5	Loose Orange to Brown Clayey Medium to Fine SAND with Quartz Fragments SM/SC				
9.0				5-11-11	
			193.9		
11.0	Medium Dense Orange to Brown Clayey Coarse to Medium SAND with Quartz Fragments SM/SC	SM		5-5-6	
15.0	Medium Dense Tan Slightly Clayey Coarse to Medium SAND with Quartz Fragments	SM	188.9		15.0
	Medium Dense Yellow Slightly Clayey Coarse to Medium SAND with Quartz Fragments			5-7-9	
20.0			183.9		
	Boring Terminated at 20.0' Caved Wet at 15.0'				

PENETRATION (BLOWS/FT.)



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

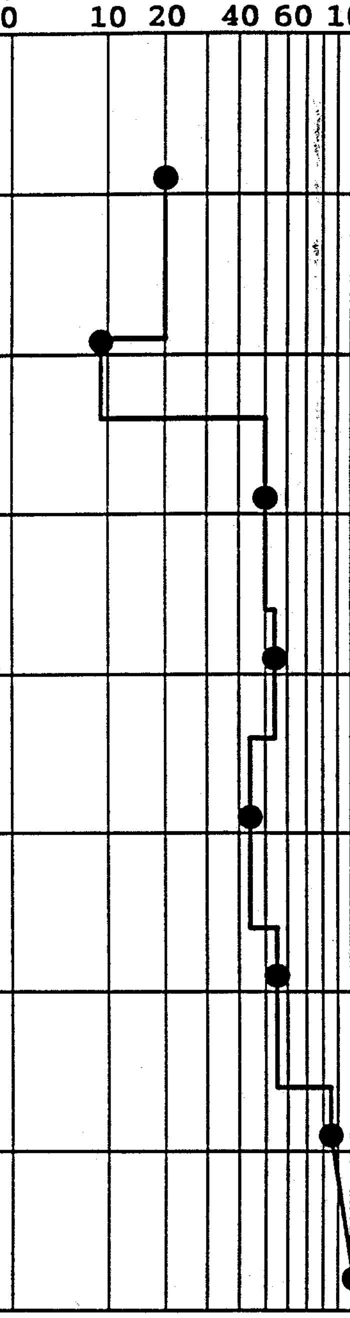
JOB NUMBER REEW-A-130
BORING NUMBER B-43
DATE 3-5-91

PAGE 1 OF 1

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.)	BLOWS PER SIX IN.	
0.0						
0.4	Topsoil with Organics and Rootmat	SC	182.2			
	Medium Dense Yellow-Orange Clayey Coarse to Medium SAND				8-9-11	
			177.2			
9.5					2-3-6	9.1
	Stiff Gray to Tan Slightly Coarse to Medium Sandy CLAY	CL	172.2			
12.0	Dense Gray to Tan Silty Clayey Coarse to Medium SAND to a Coarse to Medium Sandy CLAY	SC / CL			14-24-26	
			167.2			
18.0	Hard Brown to Tan Medium to Fine Sandy SILT	ML			13-24-30	
			162.2			
22.0	Hard Red to Gray Silty CLAY	CH			14-20-24	
			157.2			
28.0	Hard Gray Clayey SILT	MH			13-22-33	
			152.2			
33.0	Hard Red to Gray Medium to Fine Sandy SILT	ML			16-35-50	
			147.2			
39.0					36-50/4.2"	



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REEW-A-130
BORING NUMBER B-44
DATE 3-6-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
	Hard Gray Fine Sandy SILT	ML	142.2		36-50/4.8"
			137.2		
47.0	Dense Light Gray Silty Coarse to Medium SAND	SM			10-12-22
50.0	Boring Terminated at 50.0' No Ground Water Data at Termination of Boring. Ground Water Encountered at 9.1' after 7 days.		132.2		

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

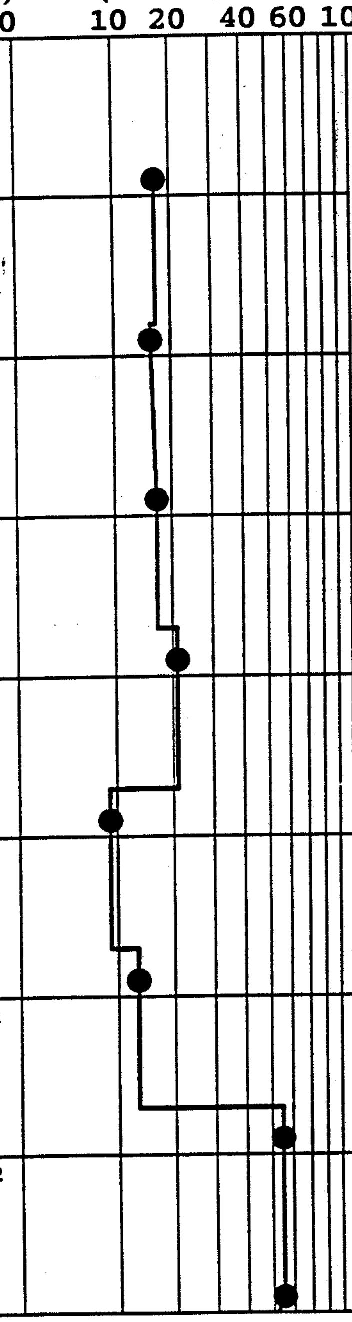
JOB NUMBER REW-A-130
BORING NUMBER B-44
DATE 3-6-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.	
0.0	Dark Brown Clayey Silty Fine to Medium SAND with Organics	SM/SC	200.2		
2.0	Medium Dense Red Clayey Silty Medium to Coarse SAND	SC		8-8-9	
			195.2		
9.0	Medium Dense White Clean Medium SAND	SP		10-8-8	
			190.2	5-8-9	
			185.2		
18.5	Medium Dense Brown Red Silty Sandy Gravel	GP		7-10-11	18.9
			180.2		
23.5	Loose Brown White and Pink Mottled Silty Coarse SAND with Gravel	SM		3-6-3	
			175.2		
28.5	Stiff Gray Silty CLAY	CH		4-6-7	
			170.2		
33.5	Very Dense Brown Gray Silty Medium to Coarse SAND	SM		20-25-30	
			165.2		
39.0				20-25-30	

PENETRATION (BLOWS/FT.)



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REEW-A-130
BORING NUMBER B-45
DATE 3-5-91

PAGE 1 OF 2

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
	Hard Brown Gray SILT CLAY Medium Plastic CH		160.2		11-14-16
			155.2		
48.5	Very Dense Gray with Pink Red Mottled Clayey Sandy SILT	ML			25-35-50/4.8"
50.0			150.2		

Boring Terminated at 50.0'
Ground water encountered at 18.8' at termination of boring. Ground water encountered at 18.9' after 7 days.

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-45
DATE 3-5-91

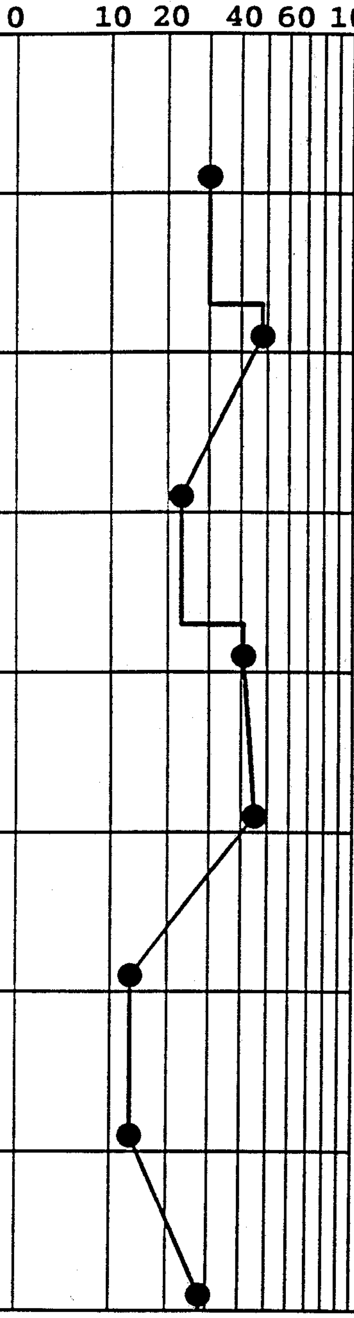
PAGE 2 OF 2

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Loose Brown Clayey Silty Fine SAND	SM SC	218.1	
3.5	Hard Brown Red Sandy Clayey SILT	ML	213.1	3-10-20
8.5	Very Stiff to Hard Red-Brown Silty Medium to Coarse Sandy CLAY	CL	208.1	16-24-24
			203.1	11-11-12
18.5	Dense to Medium Dense White with Pink Mottled Coarse SAND	SP	198.1	11-20-21
			193.1	17-21-24
			188.1	5-6-7
33.5	Stiff Gray Clayey Sandy SILT	ML	183.1	5-5-8
				11-11-17

PENETRATION (BLOWS/FT.)



28.1

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-46
DATE 3-5-91

PAGE 1 OF 2

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.	
			178.1			
43.5						43.7
44.0	Dense Medium to Light Brown Clayey Silty SAND SM	ML			23-22-23	
	Hard Red-Brown to Gray Sandy Clayey SILT		173.1			
					20-30-50	
50.0	Boring Terminated at 50.0' Ground Water Encountered at 43.7' at Termination of Boring. Ground Water Encountered at 28.1' after 7 days.		168.1			

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-46
DATE 3-5-91

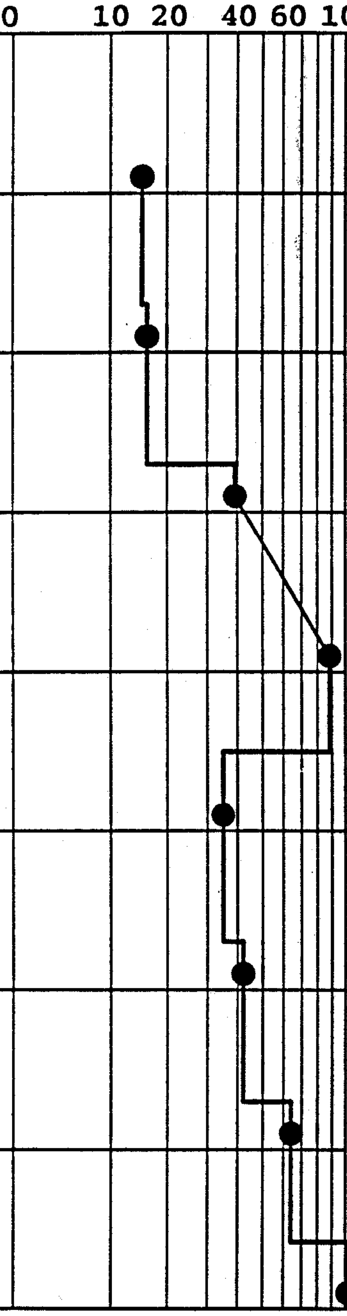
PAGE 2 OF 2

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Brown Clayey Silty SAND with Gravel	SM/SC	188.0	
4.0	Stiff Brown Sandy Clayey SILT	ML	183.0	7-7-8
8.5	Medium Dense Brown and Light Gray Silty Fine SAND	SM	178.0	3-6-10
13.5	Hard Gray Brown Sandy Clayey SILT	ML	173.0	5-15-24
			168.0	18-40-48
22.5	Dense Gray Brown Silty Fine to Coarse SAND	SM	163.0	4-16-19
28.5	Hard Dark Gray Brown Silty CLAY	CL	158.0	19-19-23
33.5	Hard Greenish Gray Clayey SILT	ML	153.0	16-26-38
37.9	Dense to Very Dense Gray Silty Medium SAND	SM		16-18-50/4.8"

PENETRATION (BLOWS/FT.)



24.6

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REEW-A-130
BORING NUMBER B-47
DATE 3-7-91

PAGE 1 OF 2

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
40.0	Hard Medium Gray Fine Sandy Clayey SILT	ML	148.0		50/6.0"
			143.0		35-50/4.8"
			138.0		
53.5	Very Dense Medium Gray Silty Medium to Coarse SAND	SM			13-36-37
55.0			133.0		

Boring Terminated at 55.0'
No Ground Water Data at Termination of Boring. Ground Water Encountered at 24.6' after 7 days.

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

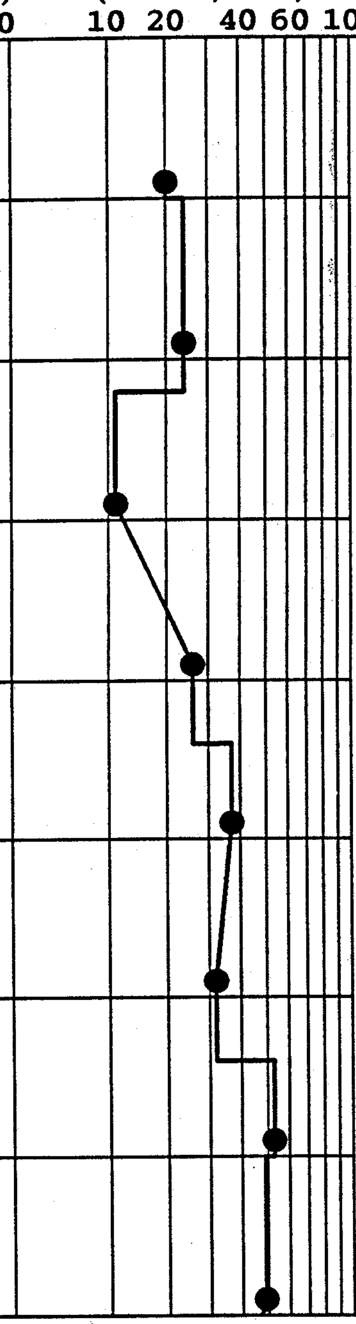
JOB NUMBER REW-A-130
BORING NUMBER B-47
DATE 3-7-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Medium Dense Gray to Tan Silty Medium to Fine SAND	SM	207.1	7-10-10
5.0	Medium Dense Orange to Yellow Slightly Clayey Coarse to Medium SAND with Quartz Fragments	SM	202.1	9-13-11
11.0	Stiff Gray to Orange Slightly Fine Sandy Silty CLAY	CH	197.1	2-3-8
			192.1	6-13-13
			187.1	
22.0	Dense Gray Slightly Clayey Silty Medium to Fine SAND	SM		11-16-21
			182.1	8-15-17
			177.1	
32.0	Hard Gray Silty Medium to Fine Sandy CLAY to a Silty Clayey Medium to Fine SAND	CH SC		8-22-31
35.0	Very Dense Silty Clayey Coarse SAND	SC	172.1	17-23-26

PENETRATION (BLOWS/FT.)



9.9

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-48
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	PENETRATION (BLOWS/FT.) 0 10 20 40 60 100	BLOWS PER SIX IN.
			167.1		10-13-20
			162.1		
47.0	Hard Gray Clayey SILT	MH			10-18-25
50.0	Boring Terminated at 50.0' No ground water encountered at termination of boring. Ground water encountered at 9.9' after 7 days.		157.1		

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

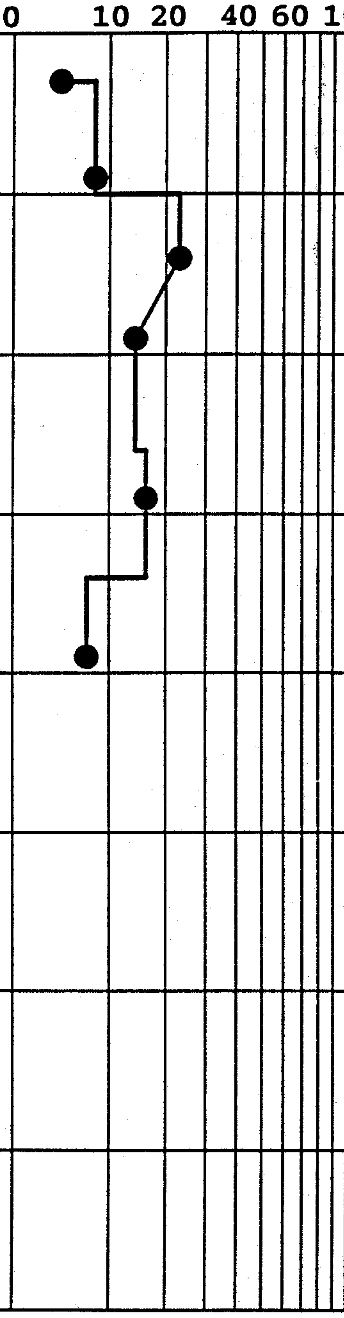
JOB NUMBER REW-A-130
BORING NUMBER B-48
DATE 3-5-91

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	Topsoil with Organics and Rootmat		204.4	2-2-2
0.5	Loose Tan to Gray Medium to Fine SAND SM	SM		
1.5	Loose Orange to Brown Clayey Coarse to Medium SAND	SC		4-4-4
5.0	Medium Dense Orange to Yellow Slightly Clayey Silty Coarse to Medium SAND	SM	199.4	9-11-12
				7-7-7
			194.4	
13.0	Medium Dense Orange to Yellow Slightly Silty Coarse to Medium SAND	SP		5-7-9
			189.4	
17.0	Medium Stiff Light Gray to Tan Silty CLAY	CH		2-3-4
20.0	Boring Terminated at 20.0' Ground Water Encountered at 16.2' at Termination of Boring		184.4	

PENETRATION (BLOWS/FT.)



16.2

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REEW-A-130
BORING NUMBER B-51
DATE 3-5-91

PAGE 1 OF 1

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.
0.0	TOPSOIL	CL	207.1	3-4-7
0.3	Stiff Orange to Brown Silty Medium to Fine Sandy CLAY	CL		4-6-8
2.0	Stiff Orange Red to Yellow Fine Sandy Silty CLAY		202.1	4-4-6
				5-5-8
9.5	Stiff Tan to Gray Silty CLAY	CH	197.1	11-11-14
			192.1	
17.0	Very Dense Gray to Brown Silty Clayey Medium to Fine SAND	SC		11-25-32
20.0	Boring Terminated at 20.0' Ground Water Encountered at 17.0 at Termination of Boring		187.1	

PENETRATION (BLOWS/FT.): 0 10 20 40 60 100

17.0

REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-53
DATE 3-4-91

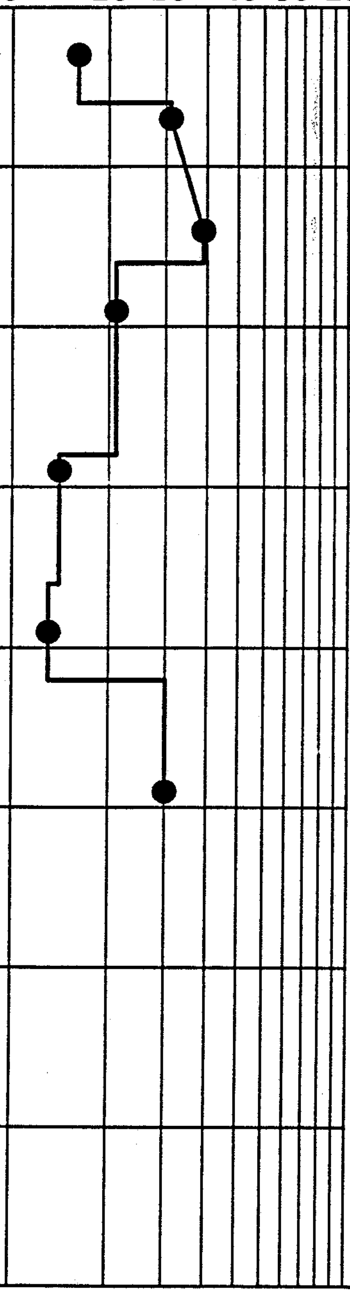
PAGE 1 OF 1

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.	
0.0	Loose Orange to Tan Clayey Medium to Fine SAND	SC	222.5	3-3-3	
3.0	Very Stiff Orange to Red Fine Sandy Silty CLAY	CL	217.5	6-8-13 8-13-16	
8.0	Medium Dense Orange to Brown Clayey Fine SAND	SC	212.5	3-4-7	
14.0	Soft Red to Orange Silty CLAY	CH	207.5	2-1-3	17.0
18.0	Soft Red to Orange Clayey SILT	MH	202.5	1-1-2	
21.0	Very Stiff Gray to Black Silty CLAY	CH		4-8-12	
25.0	Boring Terminated at 25.0' Ground Water Encountered at 17.0' at Termination of Boring.		197.5		

PENETRATION (BLOWS/FT.)



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-55
DATE 3-4-91

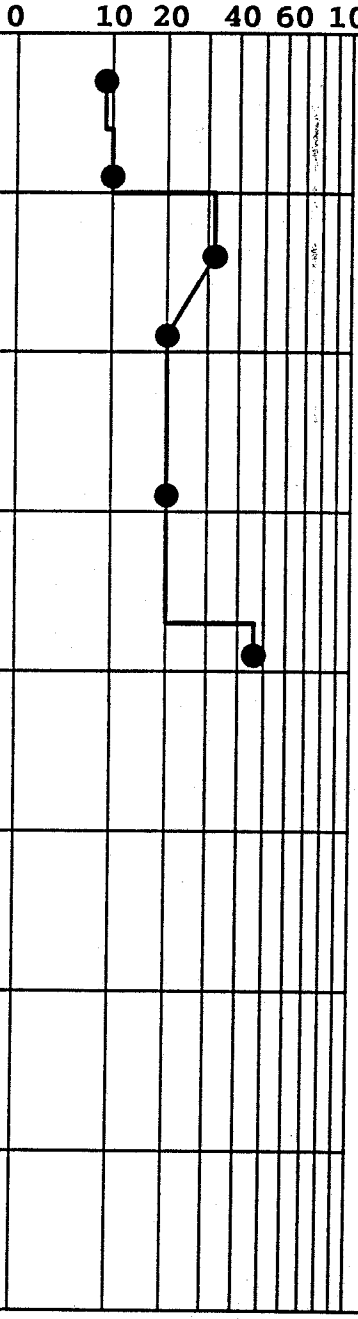
PAGE 1 OF 1

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.	
0.0 – 0.3	TOPSOIL				
0.3 – 3.0	Stiff Red Silty CLAY	CH	202.0	3-4-5	
3.0 – 5.0	Stiff Red Fine Sandy Clayey SILT	ML		3-4-6	3.7
5.0 – 11.0	Dense Red Brown Clayey Coarse to Medium SAND with Numerous Quartz Fragments	SM/SC	197.0	15-18-14	
				5-10-10	
11.0 – 18.5	Very Stiff Light Gray Silty CLAY	CH	192.0	4-9-11	
			187.0		15.5
18.5 – 20.0	Hard Light Gray to Tan Medium to Fine Sandy Silty CLAY	CH		6-17-29	
	Boring Terminated at 20.0' Ground Water Encountered at 15.5' at Termination of Boring. Ground Water Encountered at 3.75' after 7 days.		182.0		

PENETRATION (BLOWS/FT.)



REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-57
DATE 3-5-91

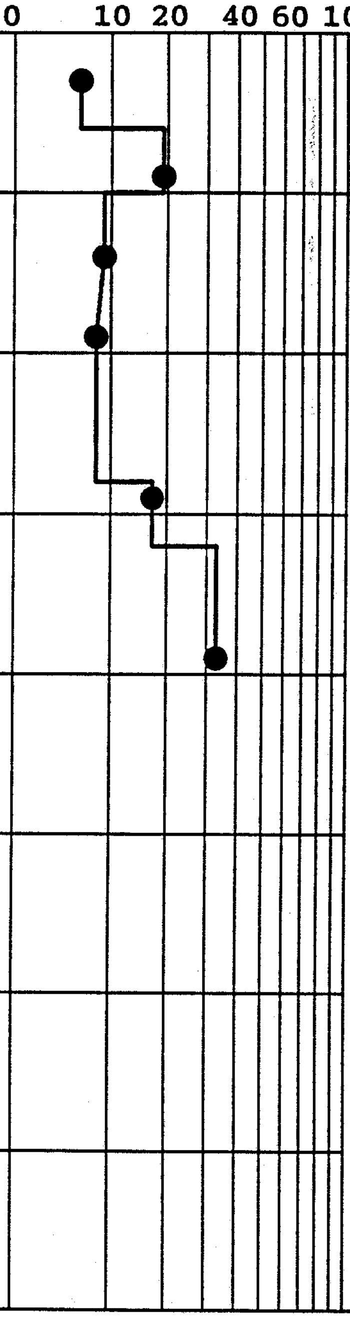
PAGE 1 OF 1

Westinghouse Environmental and Geotechnical Services, Inc.

TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION		ELEVATION (FT.)	BLOWS PER SIX IN.	
0.0	TOPSOIL		212.0		
0.3	Loose Tan Clayey Medium to Fine SAND with Quartz Pebbles	SC		2-2-4	
3.0	Medium Dense Yellow to Orange Clayey Coarse to Medium SAND	SC		7-7-12	
5.0	Stiff Yellow Gray to Red Fine Sandy Clayey SILT	MH	207.0	2-4-5	
				3-3-5	8.0
			202.0		
14.0	Very Stiff Gray Fine Sandy Silty CLAY	CH		3-7-10	15.0
16.0	Hard Gray Silty Medium to Fine Sandy CLAY	CL	197.0	10-14-19	
20.0	Boring Terminated at 20.0' Ground Water Encountered at 15.0' at Termination of Boring. Ground Water Encountered at 8.0' after 7 days.		192.0		

PENETRATION (BLOWS/FT.)



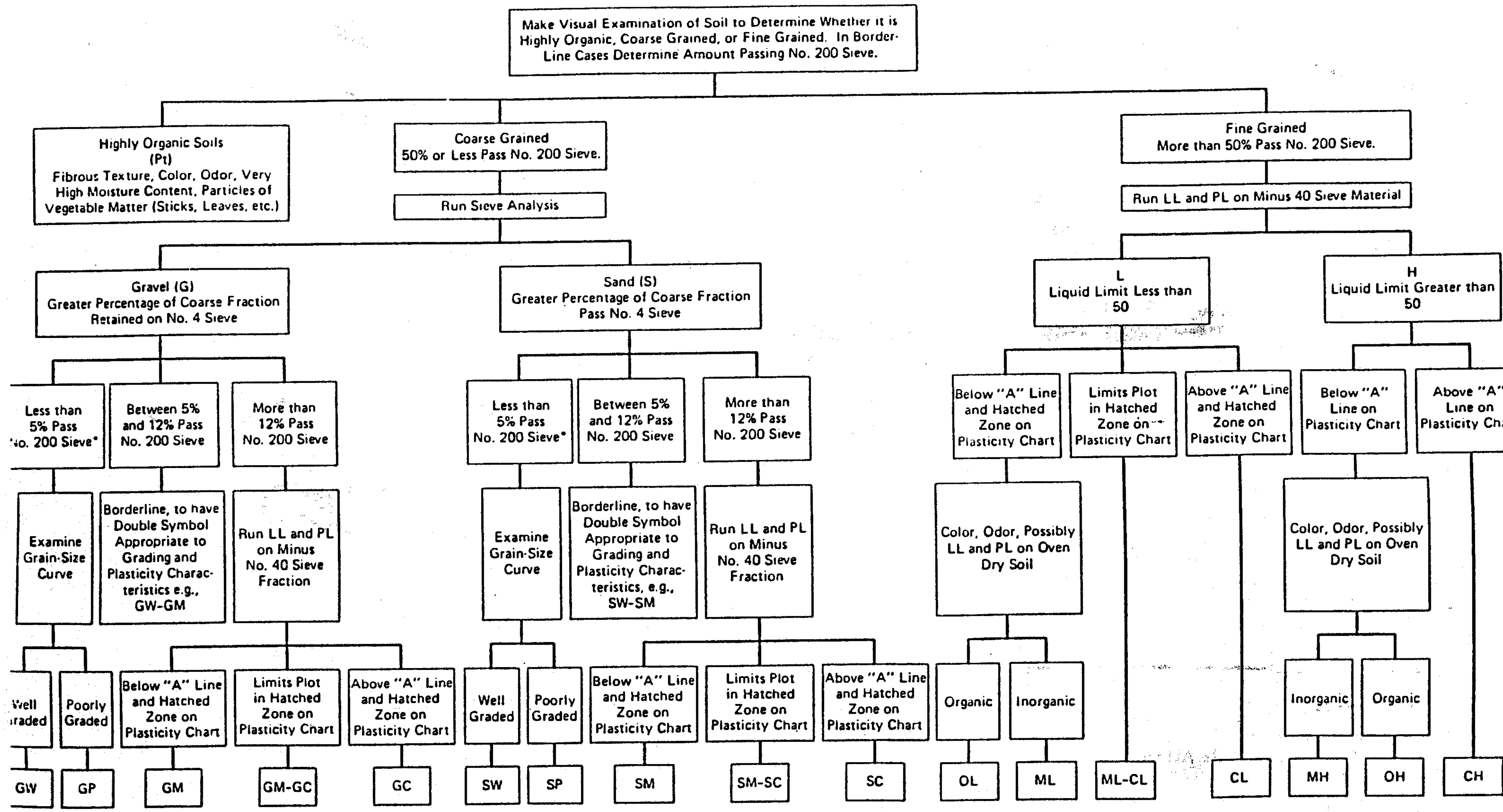
REFER TO ATTACHED SHEET FOR EXPLANATIONS AND SYMBOLS

JOB NUMBER REW-A-130
BORING NUMBER B-58
DATE 3-5-91

PAGE 1 OF 1

Westinghouse Environmental and Geotechnical Services, Inc.

APPENDIX D



Note: Sieve Sizes are U.S. Standard.
*If Fines Interfere with Free-Draining Properties use Double Symbol such as GW-GM, etc.

UNIFIED SOIL CLASSIFICATION SYSTEM

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: W42 DEPTH: 4 - 6 FT.

SOIL DESCRIPTION: MOTTLED SLIGHTLY SANDY SILTY CLAY

NOTES: LL = 60 / PL = 29 / PI = 31 / CH

---

sample from top of tube

UNDISTURBED (x) REMOLDED ( )

MAX DRY DENSITY lbs./cu.ft.
OPTIMUM MOISTURE %
% COMPACTION %

SAMPLE DATA

HEIGHT	7.75 cm.	MOISTURE CONTENT	32.5 %	
DIAMETER	7.31 cm.	WET DENSITY	113.2	lbs/cu.ft
AREA	41.97 sq.cm.	DRY DENSITY	85.4	lbs/cu.ft
VOLUME	325.26 cu.cm.	INITIAL SATURATION	89.6 %	
WET WEIGHT	589.97 grams	FINAL SATURATION	100.0 %	
DRY WEIGHT	445.26 grams	INITIAL VOID RATIO	0.987	
		POROSITY	0.497	
		SPECIFIC GRAVITY	2.720	apparent

1. K = 4.15E-06
2. K = 3.64E-06
3. k = 3.41E-06

AVERAGE K = 3.73E-06

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: W42 DEPTH: 4 - 6 FT.

SOIL DESCRIPTION: MOTTLED SANDY SILTY CLAY

NOTES: LL =53 / PL = 26 / PI = 27 / CH

---

sample from bottom of tube

UNDISTURBED (x) REMOLDED ( )

MAX DRY DENSITY		lbs./cu.ft.
OPTIMUM MOISTURE		%
% COMPACTION		%

SAMPLE DATA

HEIGHT	8.10	cm.	MOISTURE CONTENT	30.1	%
DIAMETER	7.31	cm.	WET DENSITY	113.6	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	87.3	lbs/cu.ft
VOLUME	339.95	cu.cm.	INITIAL SATURATION	87.4	%
WET WEIGHT	618.90	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	475.71	grams	INITIAL VOID RATIO	0.929	
			POROSITY	0.482	
			SPECIFIC GRAVITY	2.700	apparent

1. K = 1.41E-06
2. K = 1.31E-06
3. k = 1.37E-06

AVERAGE K = 1.36E-06

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP49 DEPTH: 2 - 8 FT.

SOIL DESCRIPTION: GRAYISH BROWN SANDY CLAYEY SILT w/ MICA

NOTES: LL = 33 / PL = 15 / PI = 18

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY 117.8 lbs./cu.ft.
OPTIMUM MOISTURE 12.8 %
% COMPACTION 96.6 %

SAMPLE DATA

HEIGHT	7.80	cm.	MOISTURE CONTENT	14.8	%
DIAMETER	7.31	cm.	WET DENSITY	130.6	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	113.8	lbs/cu.ft
VOLUME	327.36	cu.cm.	INITIAL SATURATION	88.7	%
WET WEIGHT	685.12	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	596.79	grams	INITIAL VOID RATIO	0.437	
			POROSITY	0.304	
			SPECIFIC GRAVITY	2.620	apparent

1. K = 1.60E-06
2. K = 1.29E-06
3. k = 1.40E-06

AVERAGE K = 1.43E-06

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: APRIL 91 SAMPLE #: TP49 DEPTH: 2 - 3 FT.

SOIL DESCRIPTION: GRAYISH BROWN SANDY CLAYEY SILT w/ MICA

NOTES: LL = 33 / PL = 15 / PI = 18

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	117.8	lbs./cu.ft.
OPTIMUM MOISTURE	12.8	%
% COMPACTION	98.1	%

SAMPLE DATA

HEIGHT	7.80	cm.	MOISTURE CONTENT	14.7	%
DIAMETER	7.31	cm.	WET DENSITY	132.5	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	115.6	lbs/cu.ft
VOLUME	327.36	cu.cm.	INITIAL SATURATION	92.8	%
WET WEIGHT	695.15	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	606.06	grams	INITIAL VOID RATIO	0.415	
			POROSITY	0.293	
			SPECIFIC GRAVITY	2.620	apparent

1. K = 2.18E-07
2. K = 2.40E-07
3. k = 3.22E-07

AVERAGE K = 2.60E-07

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP50 DEPTH: 2 - 6 FT.

SOIL DESCRIPTION: OLIVE YELLOW SILTY CLAYEY SAND w/ MICA

NOTES: LL = 54 / PL = 25 / PI = 29 / SC

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	107.8 lbs./cu.ft.
OPTIMUM MOISTURE	16.6 %
% COMPACTION	95.4 %

SAMPLE DATA

HEIGHT	7.59 cm.	MOISTURE CONTENT	19 %
DIAMETER	7.30 cm.	WET DENSITY	122.4 lbs/cu.ft
AREA	41.89 sq.cm.	DRY DENSITY	102.9 lbs/cu.ft
VOLUME	318.02 cu.cm.	INITIAL SATURATION	84.4 %
WET WEIGHT	623.65 grams	FINAL SATURATION	100.0 %
DRY WEIGHT	524.08 grams	INITIAL VOID RATIO	0.590
		POROSITY	0.371
		SPECIFIC GRAVITY	2.620 apparent

1. K = 7.33E-06
2. K = 6.77E-06
3. k = 6.55E-06

AVERAGE K = 6.88E-06

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: APRIL 91 SAMPLE #: TP50 DEPTH: 2 - 6 FT.

SOIL DESCRIPTION: OLIVE YELLOW SILTY CLAYEY SAND w/ MICA

NOTES: LL = 54 / PL = 25 / PI = 29 / SC

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	107.8	lbs./cu.ft.
OPTIMUM MOISTURE	16.6	%
% COMPACTION	99	%

SAMPLE DATA

HEIGHT	7.80	cm.	MOISTURE CONTENT	18.5	%
DIAMETER	7.31	cm.	WET DENSITY	126.5	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	106.8	lbs/cu.ft
VOLUME	327.36	cu.cm.	INITIAL SATURATION	91.1	%
WET WEIGHT	663.47	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	559.89	grams	INITIAL VOID RATIO	0.532	
			POROSITY	0.347	
			SPECIFIC GRAVITY	2.620	apparent

1. K = 9.11E-07
2. K = 7.22E-07
3. k = 6.95E-07

AVERAGE K = 7.76E-07

WESTINGHOUSE ENVIRONMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP52 DEPTH: 7 - 10.5 FT.

SOIL DESCRIPTION: OLIVE YELLOW SILTY CLAYEY SAND w/ MICA

NOTES: LL = 43 / PL = 18 / PI = 25 / SC

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	112.6	lbs./cu.ft.
OPTIMUM MOISTURE	14.5	%
% COMPACTION	95.3	%

SAMPLE DATA

HEIGHT	7.65	cm.	MOISTURE CONTENT	16.6	%
DIAMETER	7.31	cm.	WET DENSITY	125.1	lbs/cu.ft
AREA	41.97	sq.cm.	DRY DENSITY	107.3	lbs/cu.ft
VOLUME	321.06	cu.cm.	INITIAL SATURATION	81.3	%
WET WEIGHT	643.65	grams	FINAL SATURATION	100.0	%
DRY WEIGHT	552.02	grams	INITIAL VOID RATIO	0.541	
			POROSITY	0.351	
			SPECIFIC GRAVITY	2.650	apparent

1. K = 2.17E-06
2. K = 2.00E-06
3. k = 2.04E-06

AVERAGE K = 2.07E-06

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP52 DEPTH: 7 - 10.5 FT.

SOIL DESCRIPTION: OLIVE YELLOW SILTY CLAYEY SAND w/ MICA

NOTES: LL = 43 / PL = 18 / PI = 25 / SC

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

MAX DRY DENSITY	112.6 lbs./cu.ft.
OPTIMUM MOISTURE	14.5 %
% COMPACTION	97.9 %

SAMPLE DATA

HEIGHT	7.80 cm.	MOISTURE CONTENT	16.6 %
DIAMETER	7.31 cm.	WET DENSITY	128.5 lbs/cu.ft
AREA	41.97 sq.cm.	DRY DENSITY	110.2 lbs/cu.ft
VOLUME	327.36 cu.cm.	INITIAL SATURATION	87.8 %
WET WEIGHT	673.86 grams	FINAL SATURATION	100.0 %
DRY WEIGHT	577.92 grams	INITIAL VOID RATIO	0.501
		POROSITY	0.334
		SPECIFIC GRAVITY	2.650 apparent

1. K = 9.03E-07
2. K = 7.15E-07
3. k = 7.22E-07

AVERAGE K = 7.80E-07

WESTINGHOUSE ENVIORNMENTAL & GEOTECHNICAL SERVICES

FALLING HEAD PERMEABILITY TEST

JOB #: REW130 JOB NAME: HARNETT COUNTY LANDFILL

DATE: MARCH 91 SAMPLE #: TP54 DEPTH: 4 - 10 FT.

SOIL DESCRIPTION: YELLOW BROWN SILTY CLAYEY SAND w/ MICA

NOTES: LL = 33 / PL = 24 / PI = 9 / SC-SM

UNDISTURBED ( ) REMOLDED (X) STANDARD PROCTOR

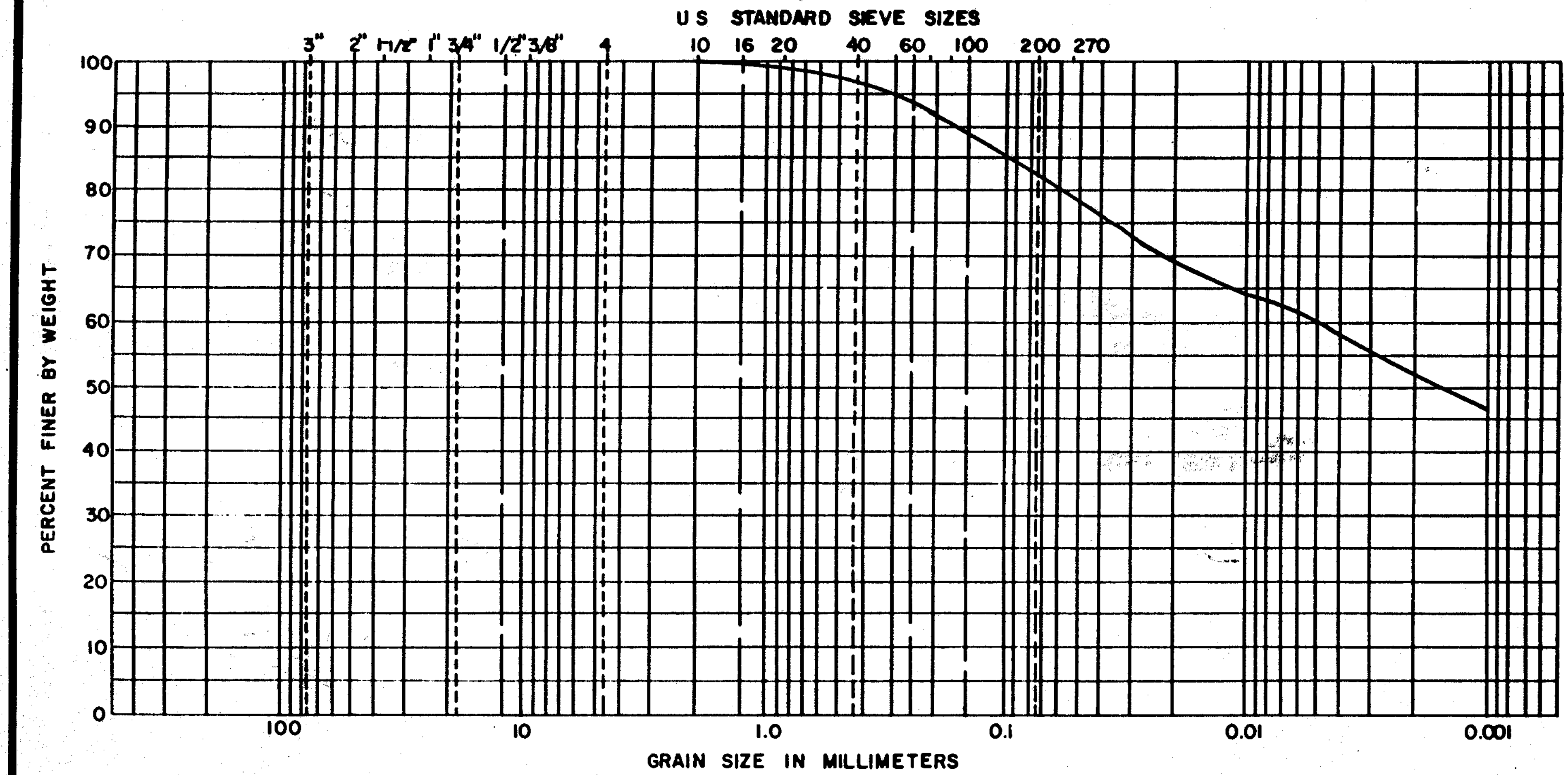
MAX DRY DENSITY	113.5 lbs./cu.ft.
OPTIMUM MOISTURE	14.8 %
% COMPACTION	94.6 %

SAMPLE DATA

HEIGHT	7.60 cm.	MOISTURE CONTENT	17.3 %
DIAMETER	7.31 cm.	WET DENSITY	126.0 lbs/cu.ft
AREA	41.97 sq.cm.	DRY DENSITY	107.4 lbs/cu.ft
VOLUME	327.36 cu.cm.	INITIAL SATURATION	85.5 %
WET WEIGHT	660.76 grams	FINAL SATURATION	100.0 %
DRY WEIGHT	563.31 grams	INITIAL VOID RATIO	0.534
		POROSITY	0.348
		SPECIFIC GRAVITY	2.640 apparent

1. K = 7.15E-05
2. K = 6.57E-05
3. k = 6.46E-05

AVERAGE K = 6.73E-05



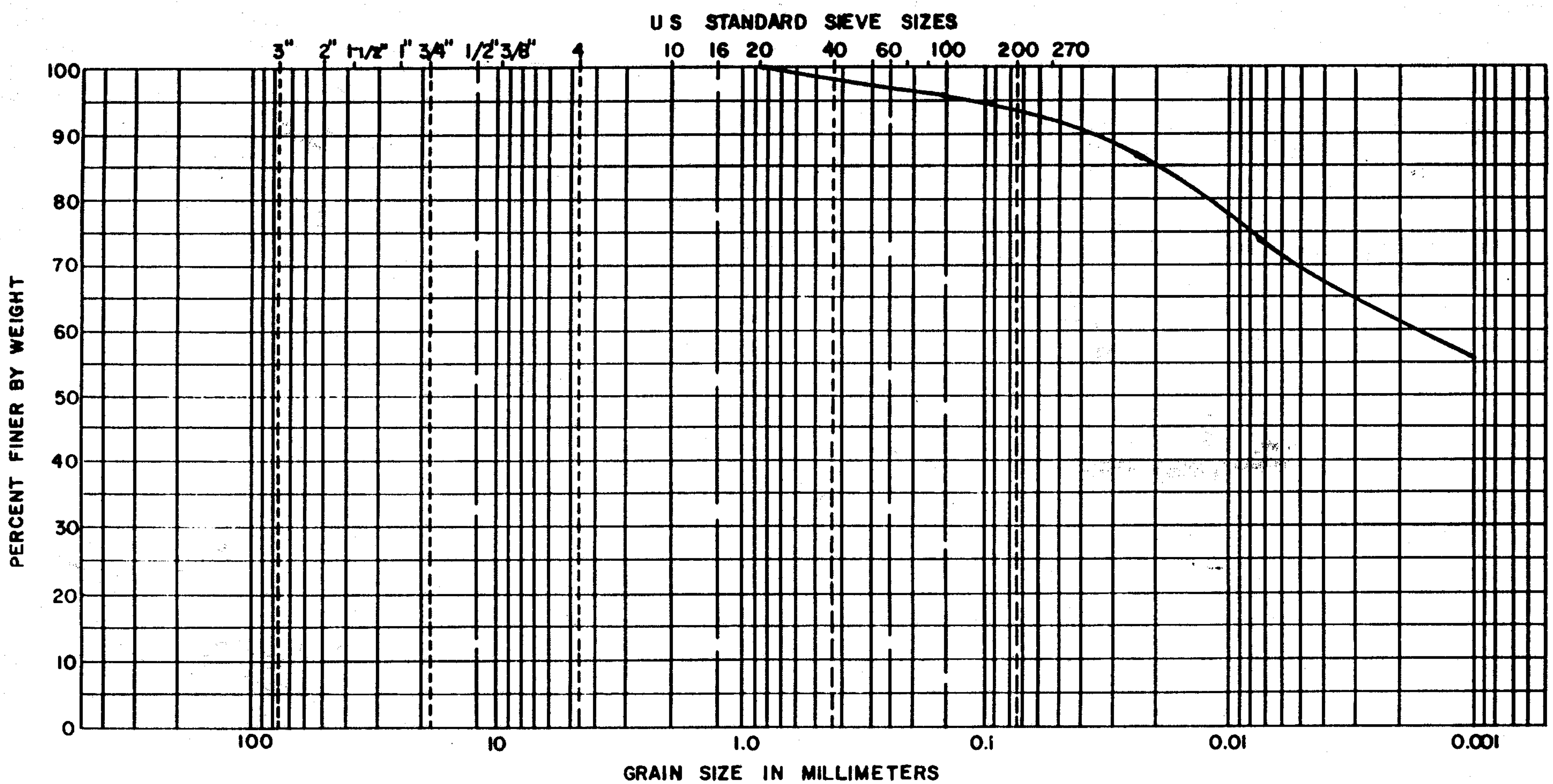
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-42	5.0 - 6.0 BOTTOM OF TUBE	30.1	53	26	27	Light Gray Fine Sandy Silty CLAY (CH)

JOB NO. REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

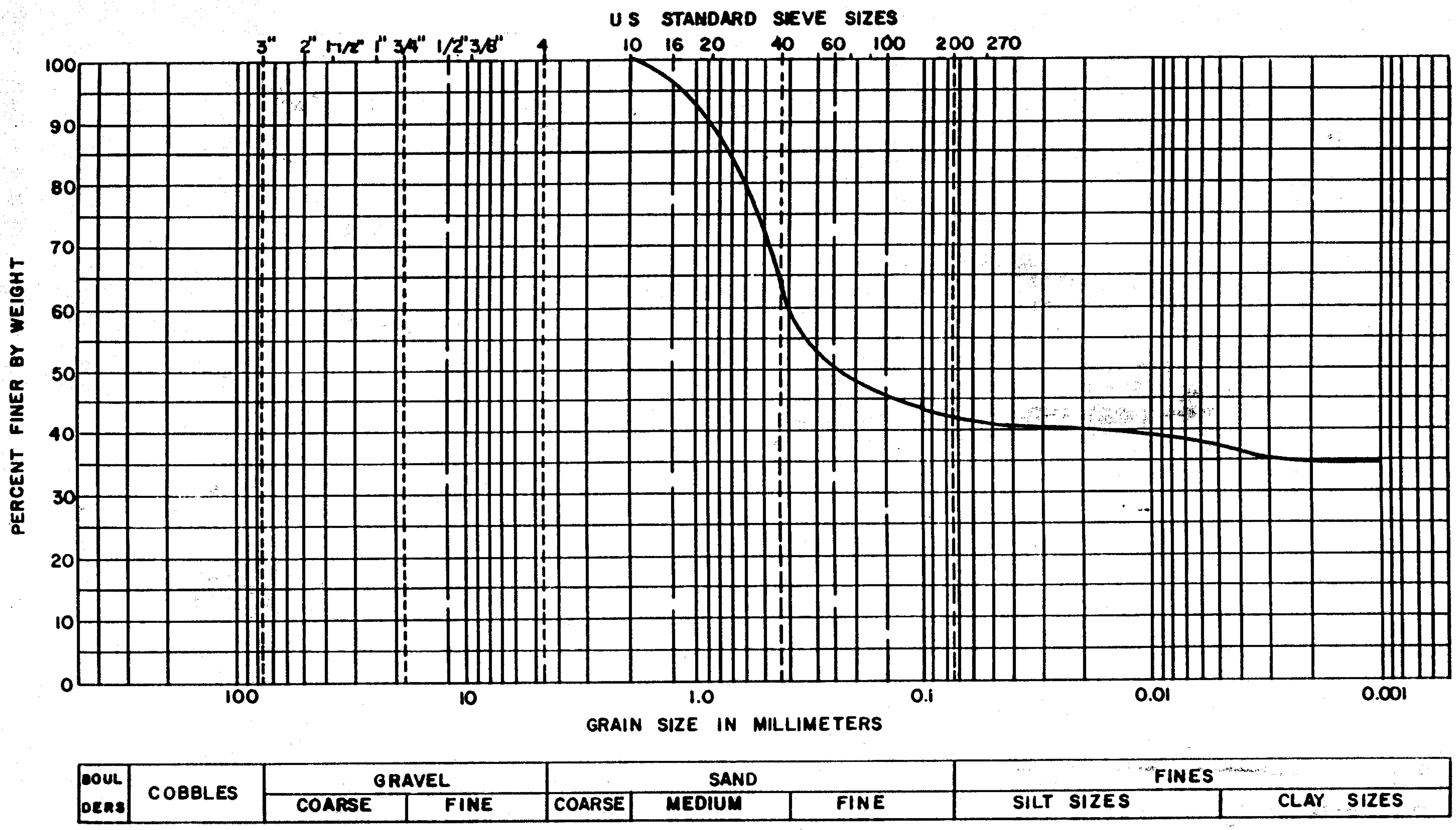
BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-42	4.0 - 5.0 TOP OF TUBE	32.5	60	29	31	Light Gray Fine Sandy Silty CLAY (CH)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.

172A

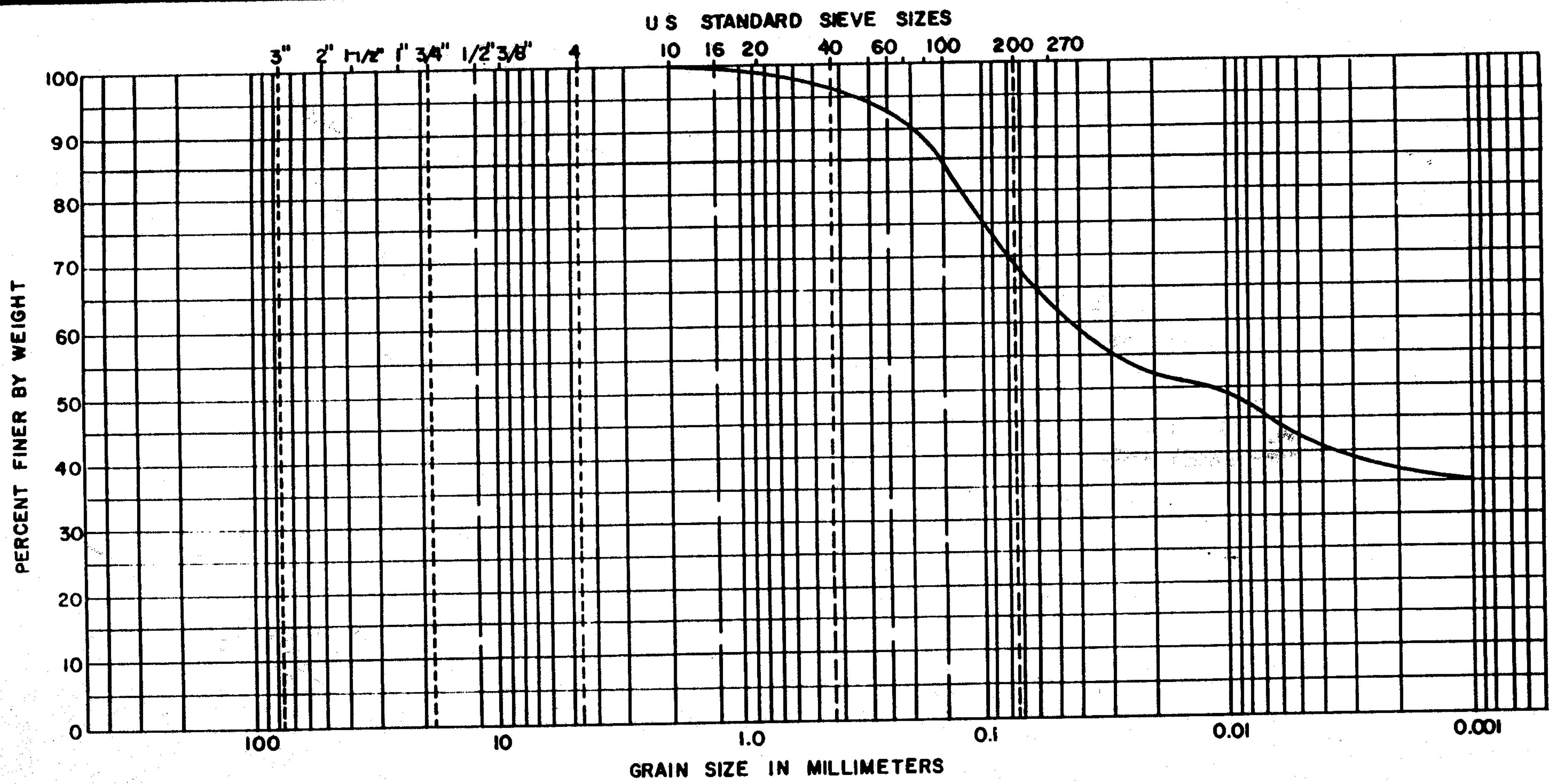


BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-44	8.5-10.0	21.4	64	18	46	Yellow-Orange Clayey Course to Medium SAND (SC)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



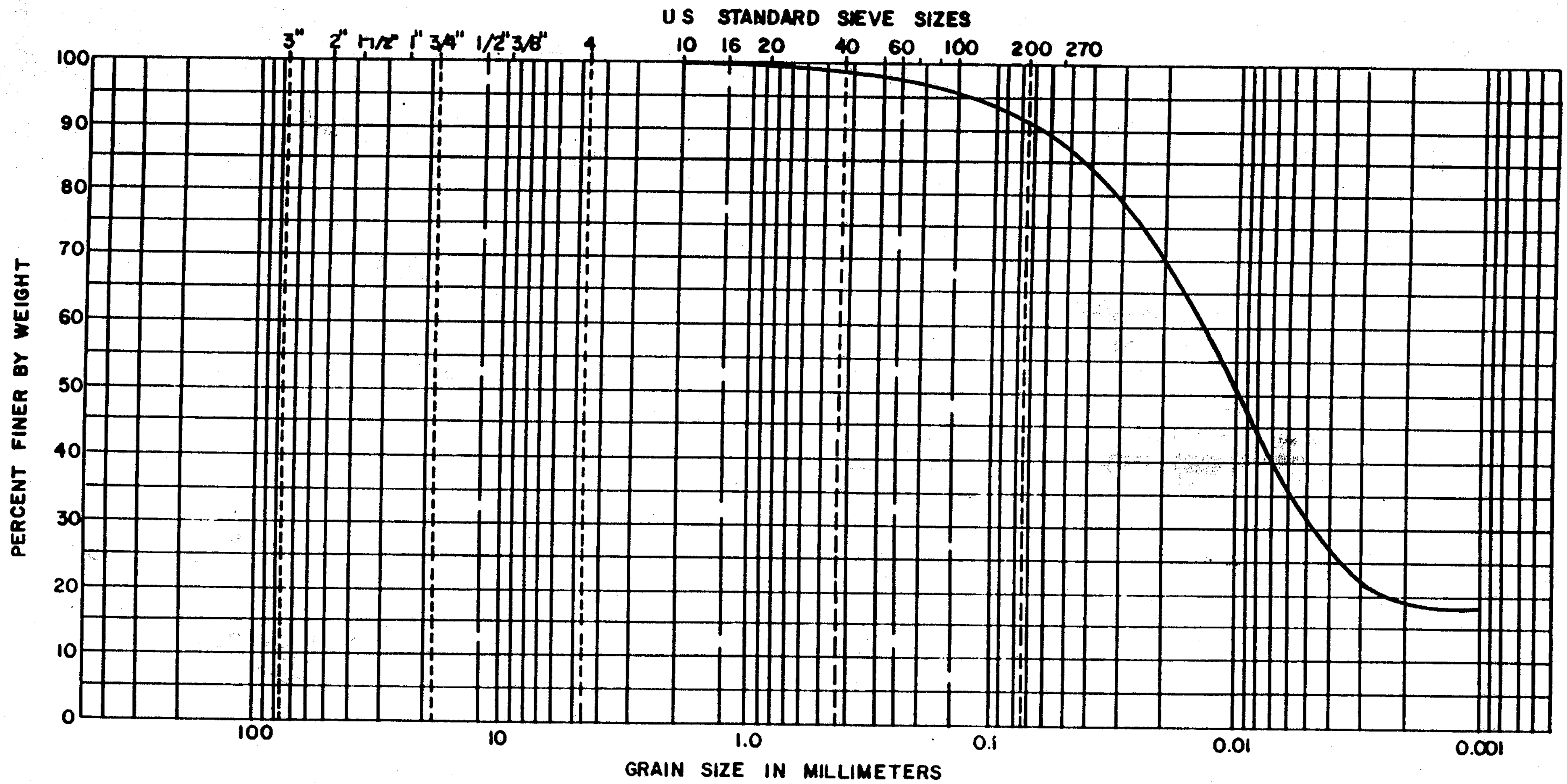
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-46	13.5-15.0'	20.5	46	16	30	Red-Brown Silty Medium to Course Sandy CLAY (CL)

JOB NO. REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



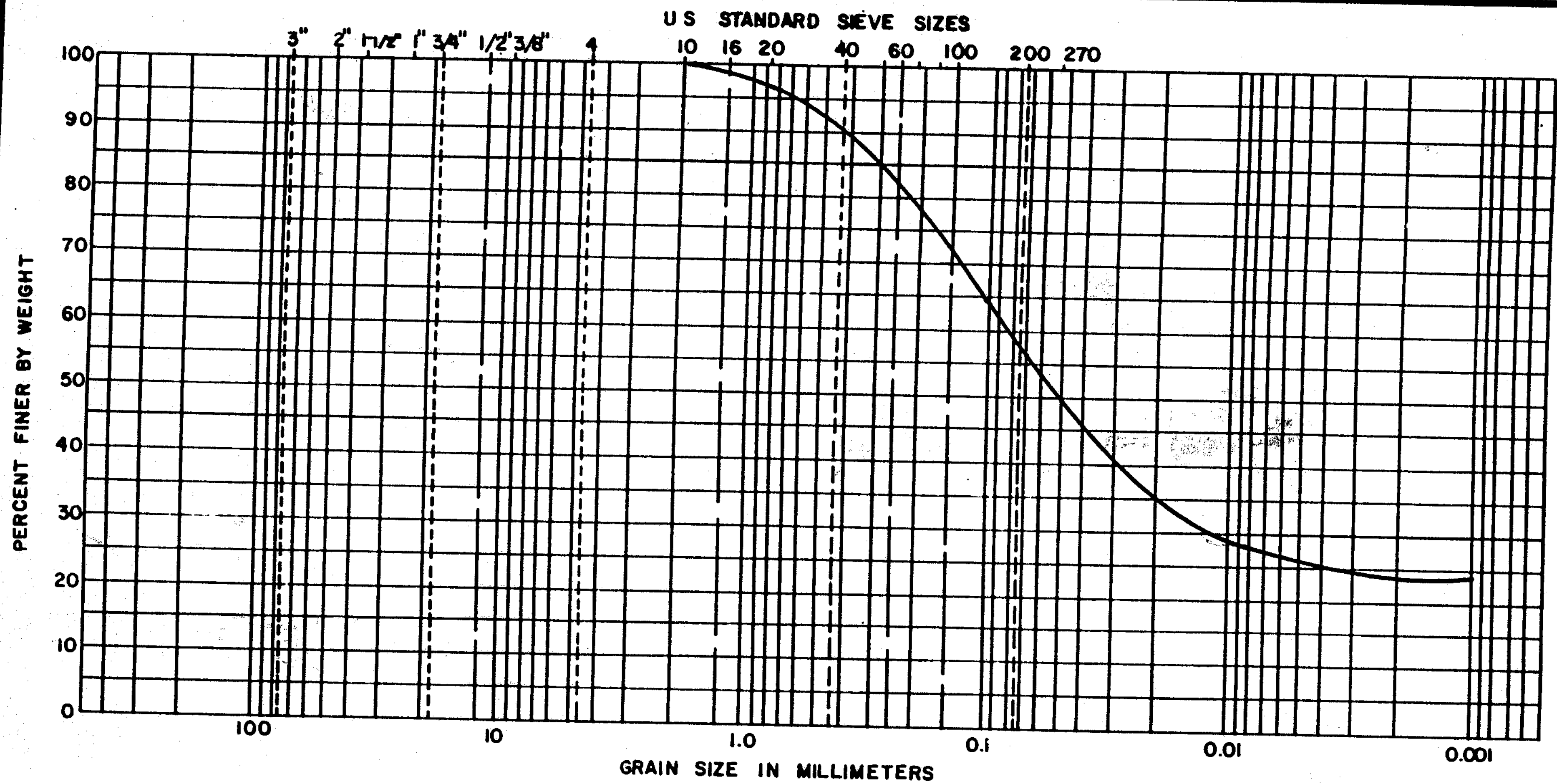
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
B-48	13.5-15.0'	29.2	55	29	26	Gray to Orange Slightly Fine Sandy Silty CLAY (CH)

JOB NO. REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-49	7.0 - 8.0	19.0	33	15	18	Light Gray Fine Sandy Silty CLAY (CL)

JOB NO. REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.

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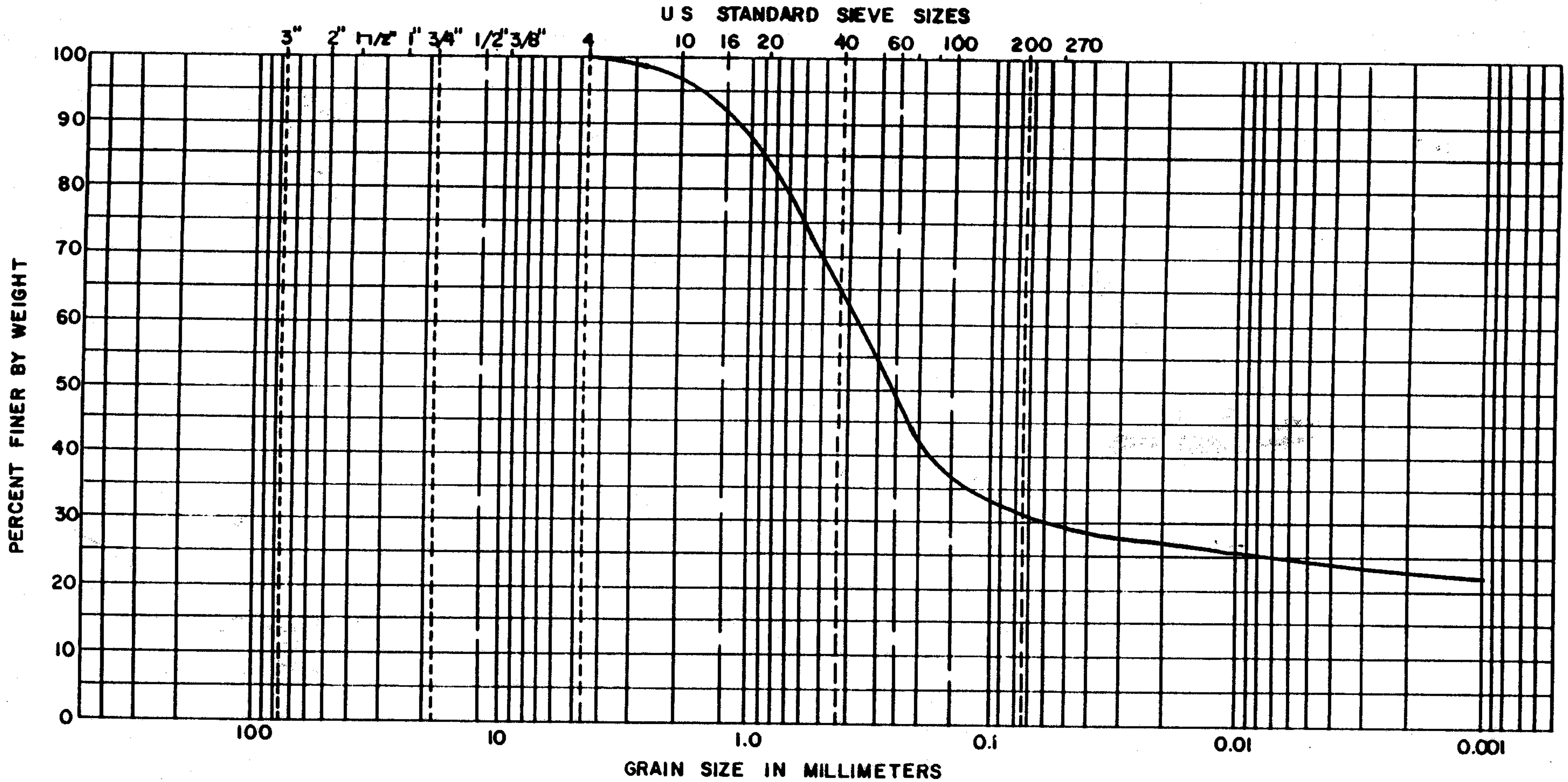
GRAIN SIZE DISTRIBUTION

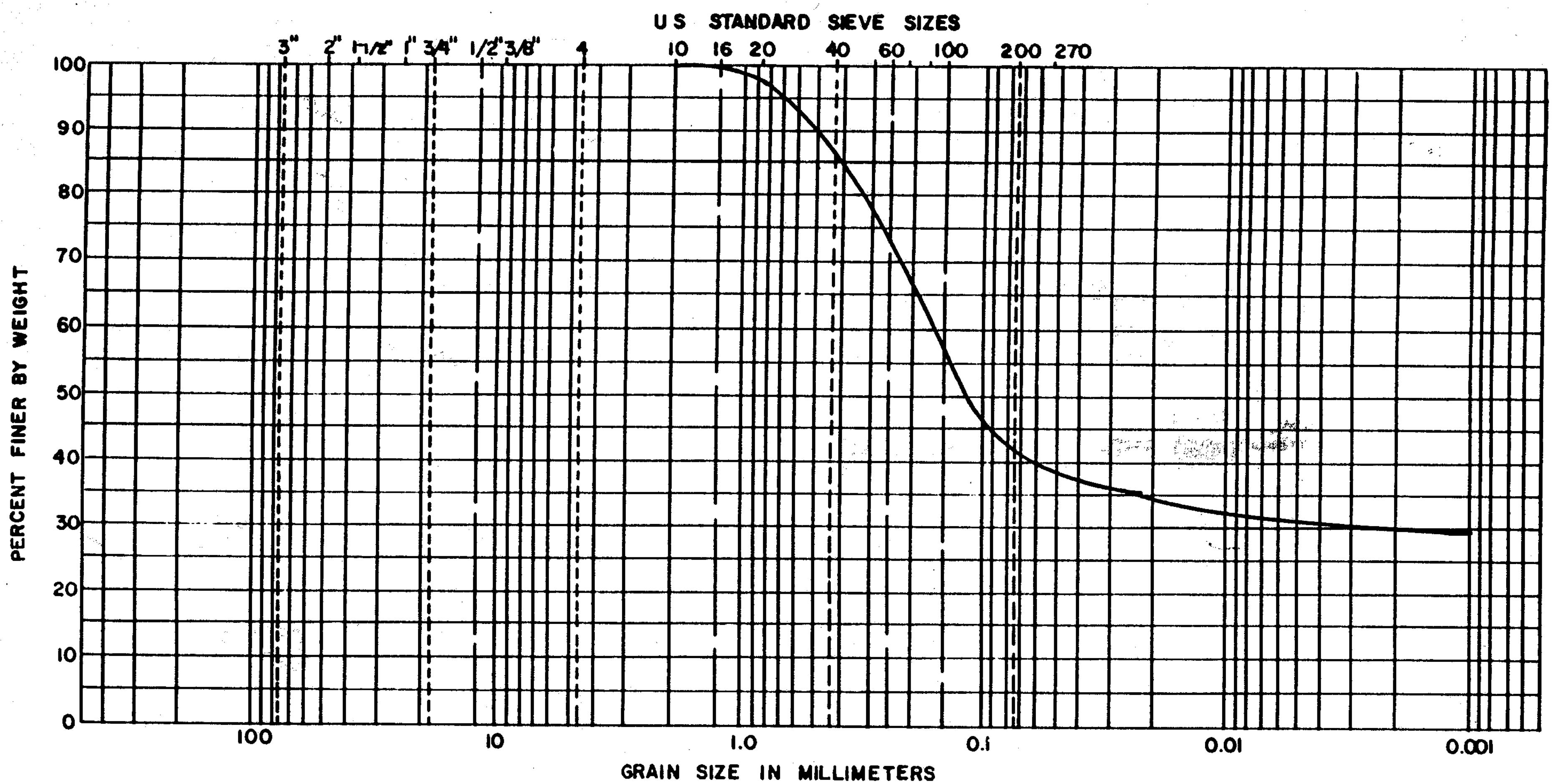


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-50	2.0 - 6.0	19.5	54	25	29	Gray -Tan Mottled Slightly Silty Clayey Fine SAND (SC)

JOB NO REW-A-130

Westinghouse Environmental and Geotechnical Services, Inc.



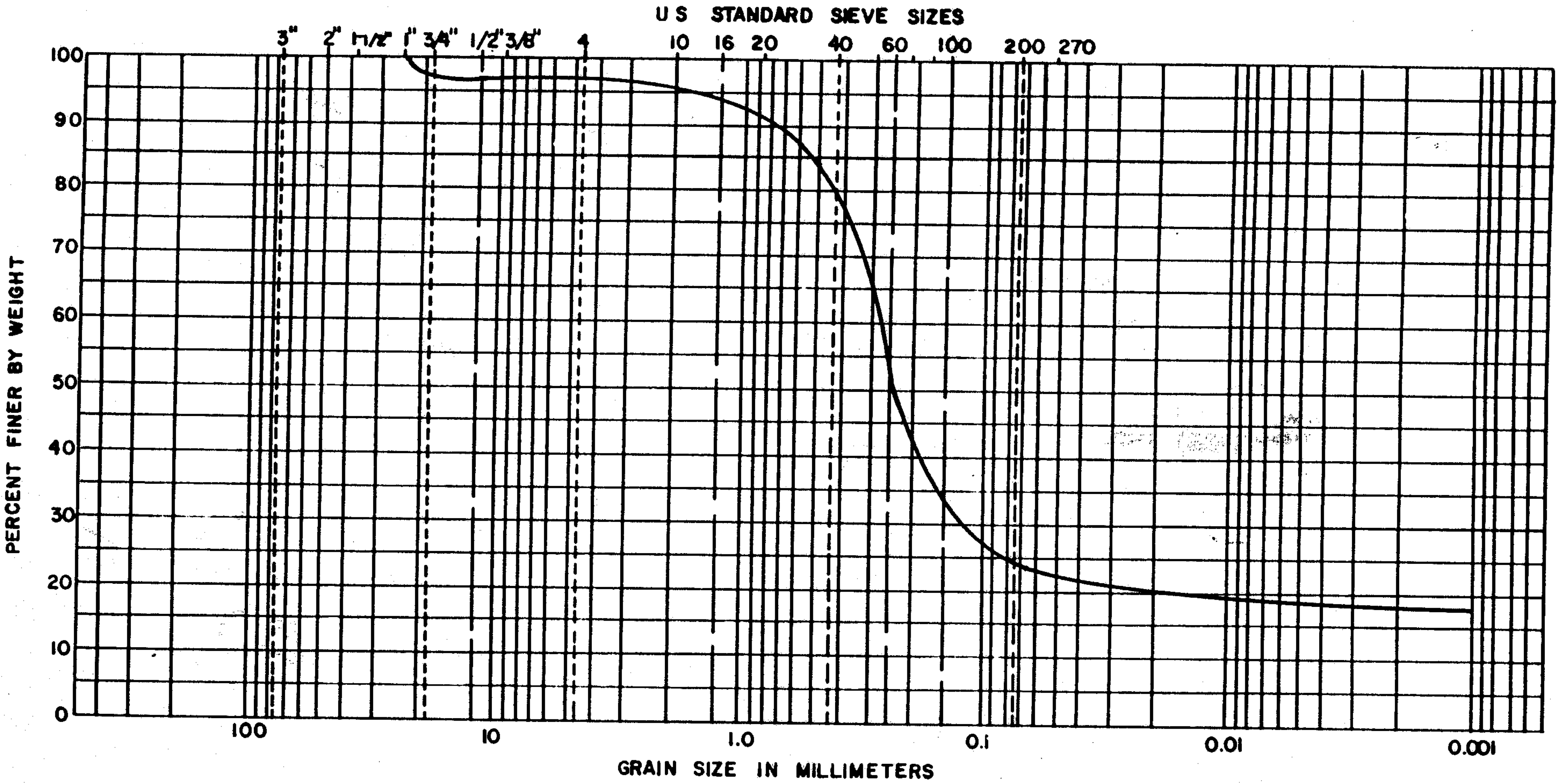
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-52	7.0 - 10.5	19.0	43	18	25	Gray -Tan Mottled Silty Clayey Fine SAND (SC)

JOB NO. REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



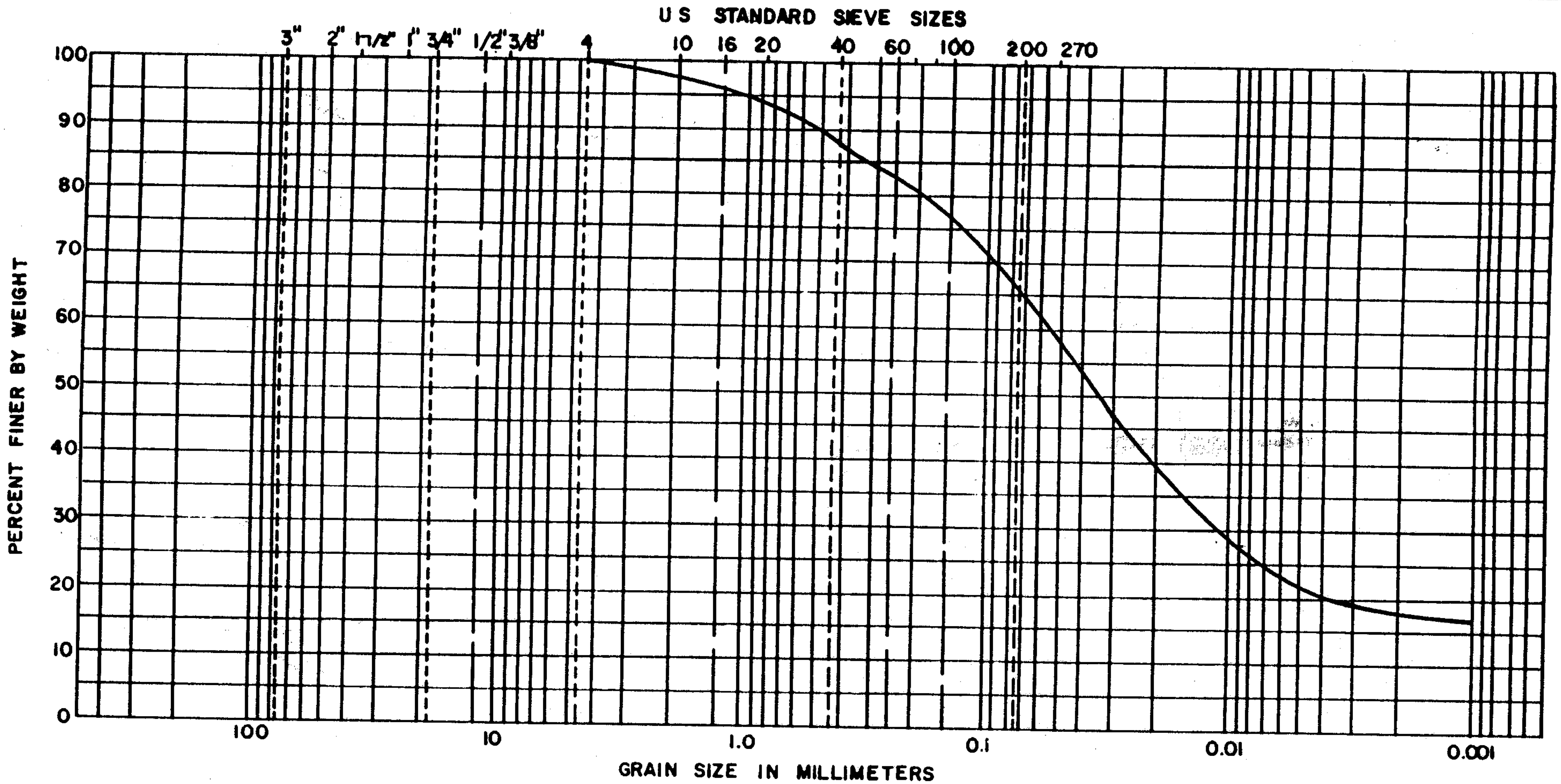
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-54	3.5 - 10.0	25.8	33	24	9	Yellow-Tan and Light Gray Mottled Slightly Silty Clayey Fine SAND (SC-SM)

JOB NO REW-A-130

GRAIN SIZE DISTRIBUTION

Westinghouse Environmental and Geotechnical Services, Inc.



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV./ DEPTH	NAT. WC	L.L.	PL	PI	DESCRIPTION OR CLASSIFICATION
TP-56	8.0 - 10.5	22.6	35	22	13	Gray Brown and Red Mottled Fine Sandy Silty CLAY (CL)

JOB NO. REW-A-130

GRAIN SIZE DISTRIBUTION

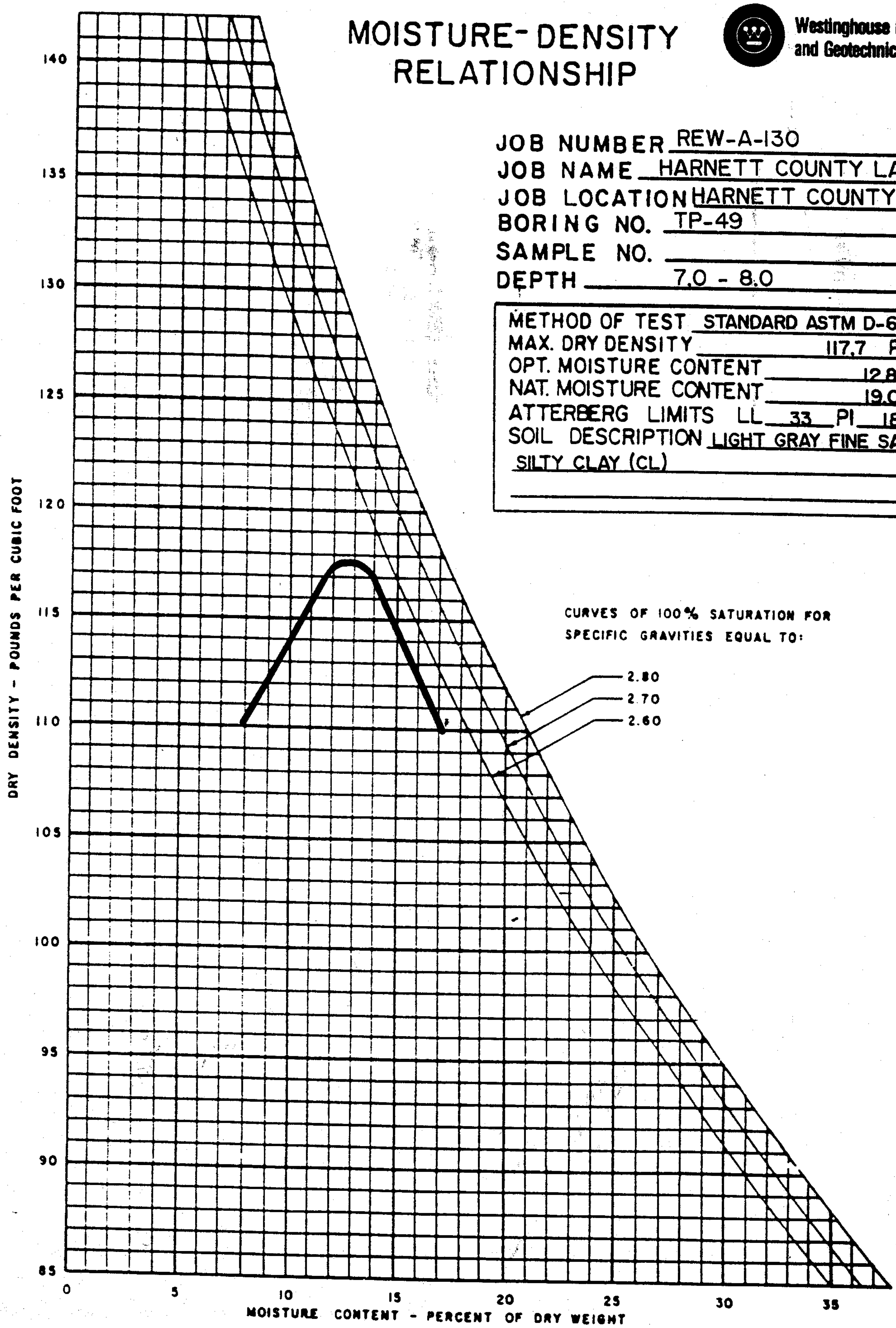
Westinghouse Environmental and Geotechnical Services, Inc.

MOISTURE-DENSITY RELATIONSHIP

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NUMBER REW-A-130
JOB NAME HARNETT COUNTY LANDFILL
JOB LOCATION HARNETT COUNTY, N.C.
BORING NO. TP-49
SAMPLE NO.
DEPTH 7.0 - 8.0

METHOD OF TEST	STANDARD ASTM D-698
MAX. DRY DENSITY	117.7 PCF
OPT. MOISTURE CONTENT	12.8 %
NAT. MOISTURE CONTENT	19.0 %
ATTERBERG LIMITS	LL 33 PI 18
SOIL DESCRIPTION	LIGHT GRAY FINE SANDY SILTY CLAY (CL)

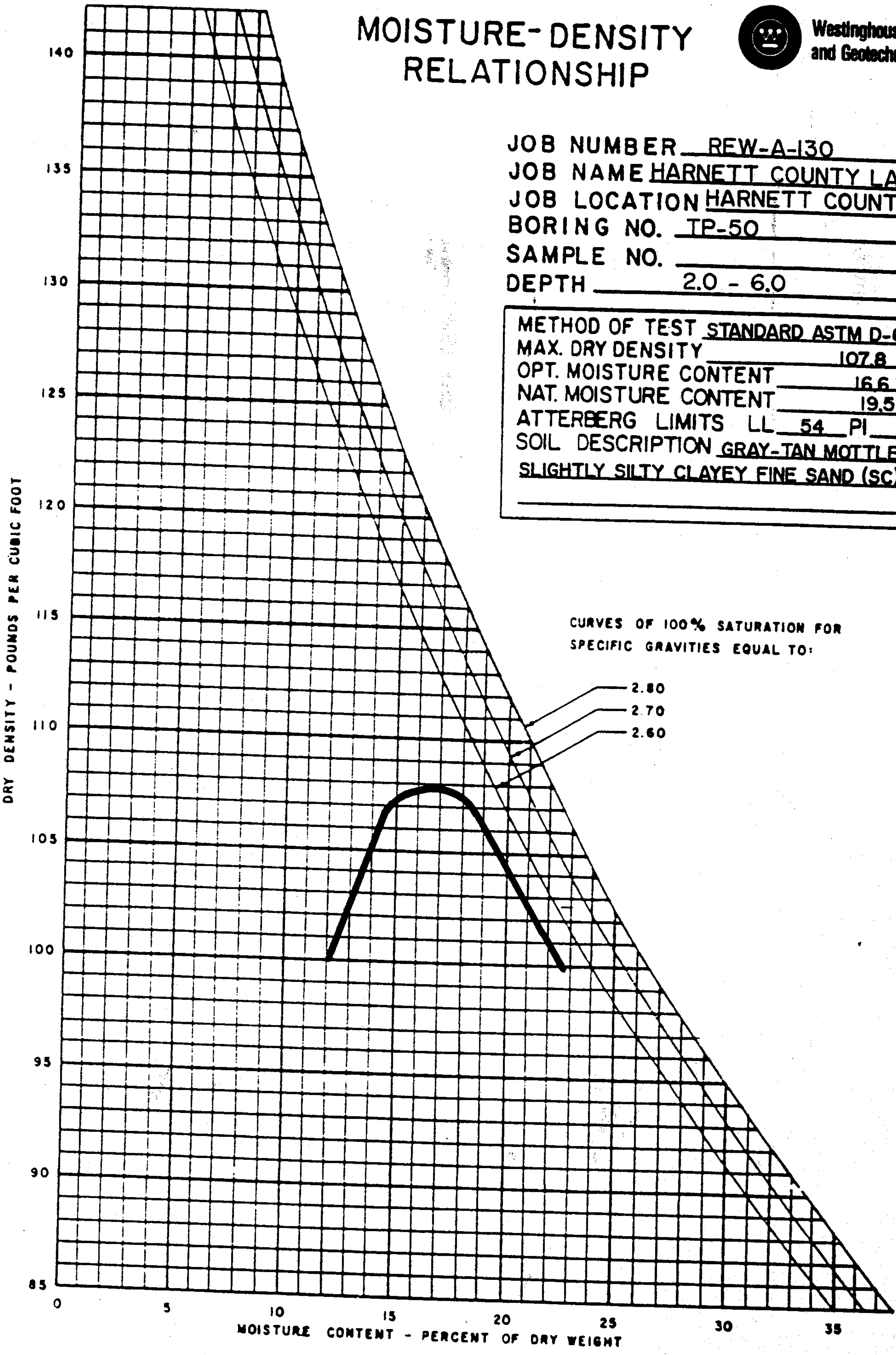


MOISTURE-DENSITY RELATIONSHIP

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NUMBER REW-A-130
JOB NAME HARNETT COUNTY LANDFILL
JOB LOCATION HARNETT COUNTY, N.C.
BORING NO. TP-50
SAMPLE NO.
DEPTH 2.0 - 6.0

METHOD OF TEST STANDARD ASTM D-698
MAX. DRY DENSITY 107.8 PCF
OPT. MOISTURE CONTENT 16.6 %
NAT. MOISTURE CONTENT 19.5 %
ATTERBERG LIMITS LL 54 PI 29
SOIL DESCRIPTION GRAY-TAN MOTTLED SLIGHTLY SILTY CLAYEY FINE SAND (SC)



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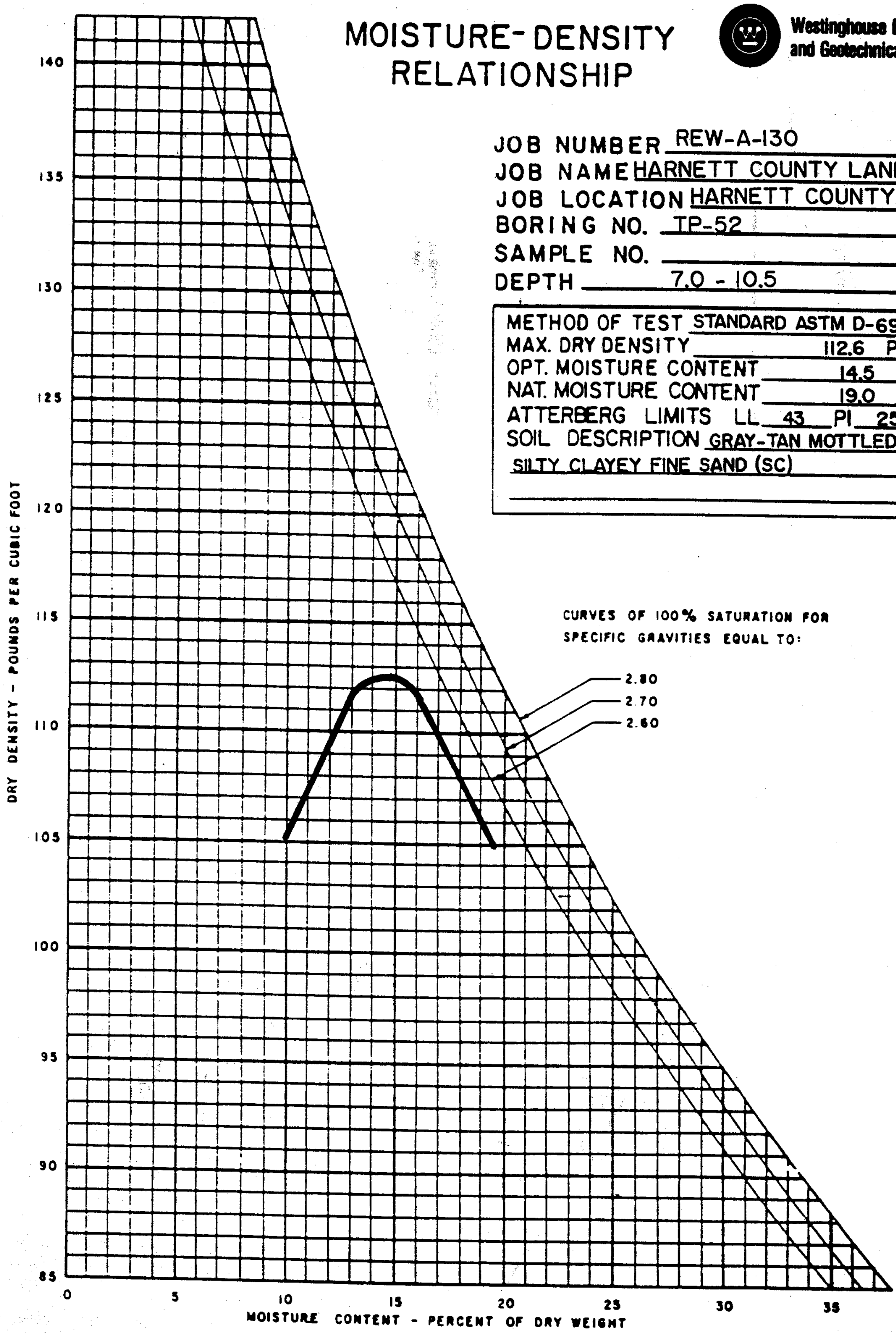
MOISTURE-DENSITY RELATIONSHIP

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NUMBER REW-A-130
JOB NAME HARNETT COUNTY LANDFILL
JOB LOCATION HARNETT COUNTY, N.C.
BORING NO. TP-52
SAMPLE NO.
DEPTH 7.0 - 10.5

METHOD OF TEST	STANDARD ASTM D-698
MAX. DRY DENSITY	112.6 PCF
OPT. MOISTURE CONTENT	14.5 %
NAT. MOISTURE CONTENT	19.0 %
ATTERBERG LIMITS	LL 43 PI 25
SOIL DESCRIPTION	GRAY-TAN MOTTLED SILTY CLAYEY FINE SAND (SC)

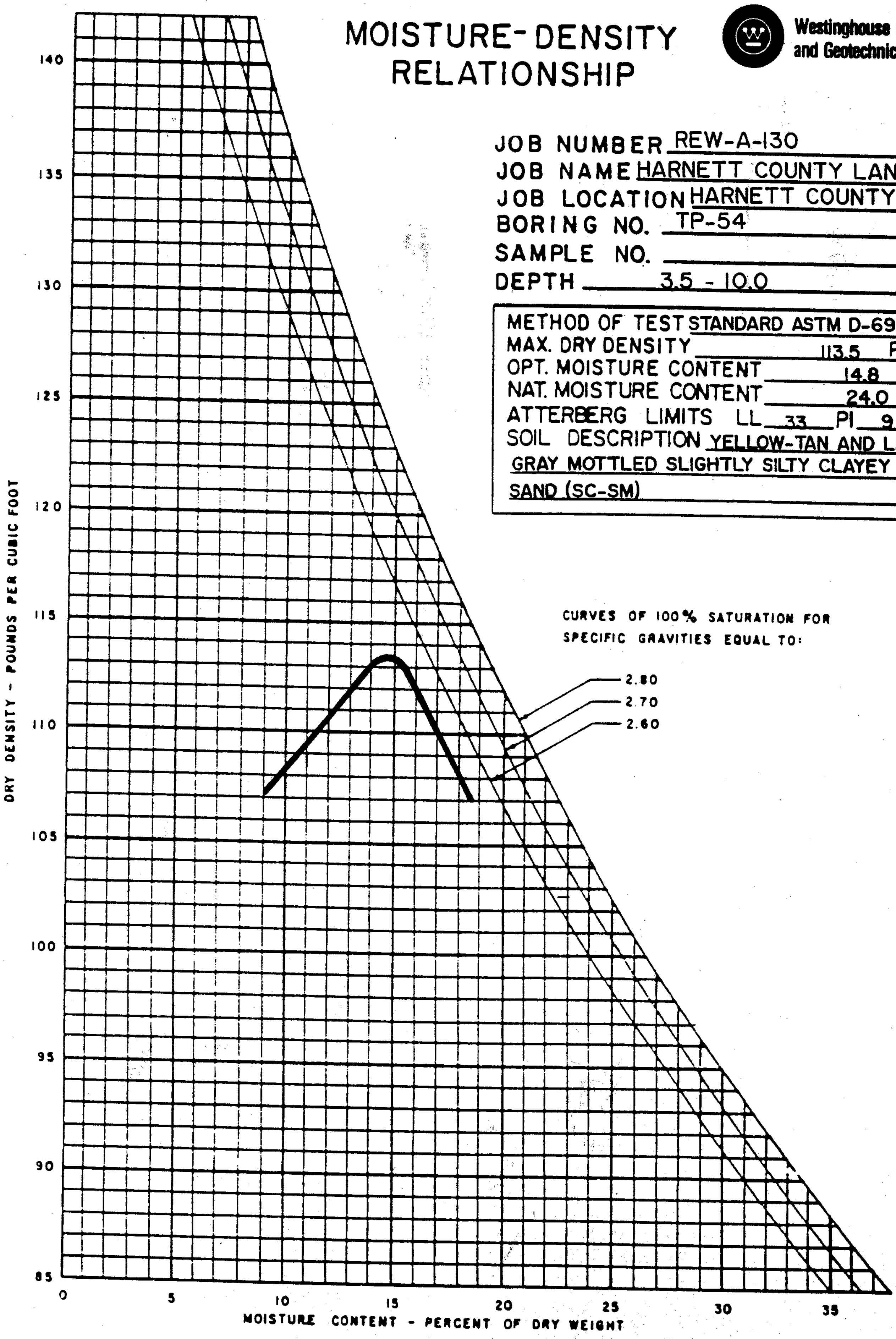


MOISTURE-DENSITY RELATIONSHIP

Westinghouse Environmental and Geotechnical Services, Inc.

JOB NUMBER REW-A-130
JOB NAME HARNETT COUNTY LANDFILL
JOB LOCATION HARNETT COUNTY, N.C.
BORING NO. TP-54
SAMPLE NO.
DEPTH 3.5 - 10.0

METHOD OF TEST STANDARD ASTM D-698
MAX. DRY DENSITY 113.5 PCF
OPT. MOISTURE CONTENT 14.8 %
NAT. MOISTURE CONTENT 24.0 %
ATTERBERG LIMITS LL 33 PI 9
SOIL DESCRIPTION YELLOW-TAN AND LIGHT GRAY MOTTLED SLIGHTLY SILTY CLAYEY FINE SAND (SC-SM)



169A

APPENDIX D

EARTHWORK CALCULATIONS

McKIM&CREED

Plus III Software
One Dunwoody Park, Ste. 250
Atlanta, GA 30338 Phone:404-396-0700
Fri Jan 11 09:56:59 1980

HAUL ROAD DESIGN PROJECT: H:394ROAD.pro

DTM TO DTM VOLUME

Cut and Fill Volumes

Shrinkage/swell factors: Cut 1.0000 Fill 1.0000

Original DTM Layer Name	# of Points	Final DTM Layer Name	# of Points
POINTS	6347	COROADS	429

Cut Volume (yd3)	Cumulative Cut Volume	Fill Volume (yd3)	Cumulative Fill Volume
570605.6	570605.6	1.9	1.9

CALCULATION

PROJECT Dunn Erwin Landfill

CLIENT Harnett County

SUBJECT Vertical Expansions

PROJ. NO. 6L0099E

DATE 12/14/92

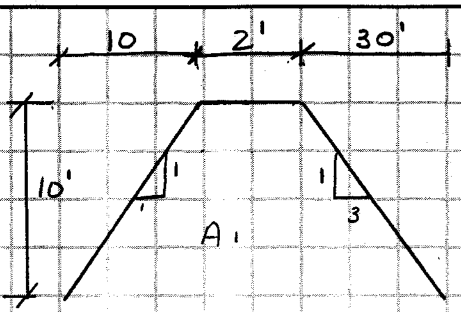
DES. BY EHK

CHK. BY

1/5

REMARKS

Lift 1 - 3900 L.F.



$A_1 = \frac{1}{2}(10)(10) + (2)(10) + \frac{1}{2}(10)(30) = 220$ SF. $\times$ 3900 LF $= V_1$

$V_1 =$ 858,000 CF = 31,777.78 = 32000 CY

Lift 2 - 3500 LF.

$V_1 =$ 220 SF $\times$ 3500 L.F. = 770,000 CF = 28,500 CY

Lift 3 - 3300 LF

$V_1 =$ 220 SF $\times$ 3300 LF = 726,000 CF = 26,889 CY
= 27,000 CY

Lift 4 - 2800 LF

$V_1 =$ 220 SF $\times$ 2800 LF = 616,000 CF
= 23,000 CY

Lift 5 - 2600 LF.

$V_1 =$ 220 SF $\times$ 2600 LF = 572,000 CF
= 22,000 CY

CALCULATION

PROJECT Dunn Erwin Landfill PROJ. NO. 6L009.9E

CLIENT Harnett County DATE 12/14/92

SUBJECT Vertical Expansion DES. BY EHK

CHK. BY

2/5

REMARKS

Lift 6 - 2200 LF

V_1 = 220 SF × 2200 LF = 484,000 CF
= 18,000 CY

Lift 7 - 1600 LF

V_1 = 1600 LF × 220 SF = 352,000 CF
= 13000 CY

Lift 8 - 1200 LF

V_1 = 1200 LF × 220 SF = 264,000 CF
= 10,000 CY

Lift 9 - 800 LF

V_1 = 800 LF × 220 SF = 176,000 CF
= 6500 CY

Total Volume of Soil (In Place) For Berms Only:
180,000 CY

McKIM&CREED

CALCULATION

PROJECT Dunn Erwin Landfill
CLIENT Hernett County
SUBJECT Vertical Expansion

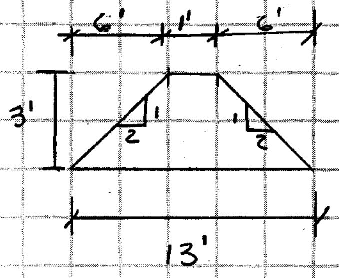
PROJ. NO. 6L009.9E
DATE 12/14/92
DES. BY EHK
CHK. BY

3/5

REMARKS

Diversion Berm Volumes

Total Length = 3300 + 2200 + 800 = 6300 L.F.



$A_1 = \frac{1}{2}(3)(6)(2) + (1)(3)$
$= 21$ SF

Vol. = 6300 L.F. × 21 = 132,300 CF
= 4900 CY

Final Cover Volumes

1 Ac × 43560 SF/Ac × 2 FT. = 87,120 CF
= 3200 CY

Daily Cover Volumes

Use 3:1 Ratio for Soils to Waste

731,042 × .25 = 182760 CY

SAY 185,000 CY

McKIM & CREED

CALCULATION

PROJECT DUNN-ERWIN LANDFILL PROJ. NO. 6L009.9E

CLIENT HARNETT COUNTY DATE 1

SUBJECT VERTICAL EXPANSION DES. BY ARK

CHK. BY EHK

4/5

VOLUME – FINAL GRADING – Volume Calcs. – Based On Cross-Section

STA.	AREA SF	AVE. AREA SF	DIST. FT	VOLUME CF	REMARKS
0+00	-0-				
		11,495	280	3,218,600	
2+80	22,990				
		35685	280	9,991,800	
5+60	48,380				
		45,910	280	12,854,800	
8+40	43,440				
		30,640	280	8,579,200	
11+20	17,840				
		8740	280	2,447,200	
14+00	-0-				
				37,091,600 CF	
				1,373,760 CY	

MCKIM & CREED

CALCULATION

PROJECT Dunn-Erwin Landfill PROJ. NO. 61009.9E

CLIENT Harnett County DATE 12/14/92

SUBJECT Vertical Expansion DES. BY EHK

CHK. BY

5/5

REMARKS

1. Estimated Solid Waste Volumes Needed

- 1992 Quantity - 60,000 Tons / Yr
- Use In-Place Density = 1000 #/CY
- 5% Increase / Yr

Yr	Tons / Yr	Accumulated Tonnage
1992	60,000	60,000
1993	63,000	123,000
1994	66,150	189,150
1995	69,458	258,607
1996	72,931	331,538
1997	76,577	408,115
1998	80,406	488,521

2. Estimated Solid Waste Volumes Available

Total Available Air Space = 1,373,760 CY (From X-Section)

A. Volume For Berms = 185,000 CY
B. Volume For Final Cover = 3,200 CY
C. Volume For Daily Cover = 185,000 CY

Subtotal 373,200 CY

Total Volume For Waste = Air Space - (A+B+C)

Total Volume For Waste = 1,000,560.00 CY

Total Volume Required =

$$\frac{365{,}521 \times 2000\ \#/TN}{(1000\ \#/CY)} = 731{,}042.00$$

Total Available > Total Required ∴ Ok

McKIM & CREED

APPENDIX E

SOLID WASTE ANALYSIS

McKIM&CREED

Harnett County
Solid Waste Stream
Analysis
Dec-23-92

Item	Anderson Creek tons	Dunn-Erwin tons	Total tons
Demolition	2820	9262	12082
Yard Waste	156	1850	2006
Commercial	780	7428	8208
Industrial	1661	14627	16288
Residential	7688	27890	35578
Total	**13105**	**61057**	**74162**

1. Based upon weight data gathered for the month of August, 1992.

Harnett County
5-Year Solid Waste Generation
Dec-23-92

Year	Tons/Year	Accumulative Tons/Year	Tons/Day	Vol/Yr cy	Accumulative Vol/Yr	Vol/Day cy	Total Vol/Day cy
1992	60000	60000	240	120000	120000	480	600
1993	**63000**	**123000**	**252**	**126000**	**246000**	**504**	**630**
1994	66150	189150	265	132300	378300	529	662
1995	69458	258608	278	138915	517215	556	695
1996	72930	331538	292	145861	663076	583	729
1997	76577	408115	306	153154	816230	613	766
1998	80406	488521	322	160811	977041	643	804

1. Begin 5 year volume generation in 1993 based upon 1992 data.

Estimated
Cell Quantity and Life of Landfill
Dec-23-92

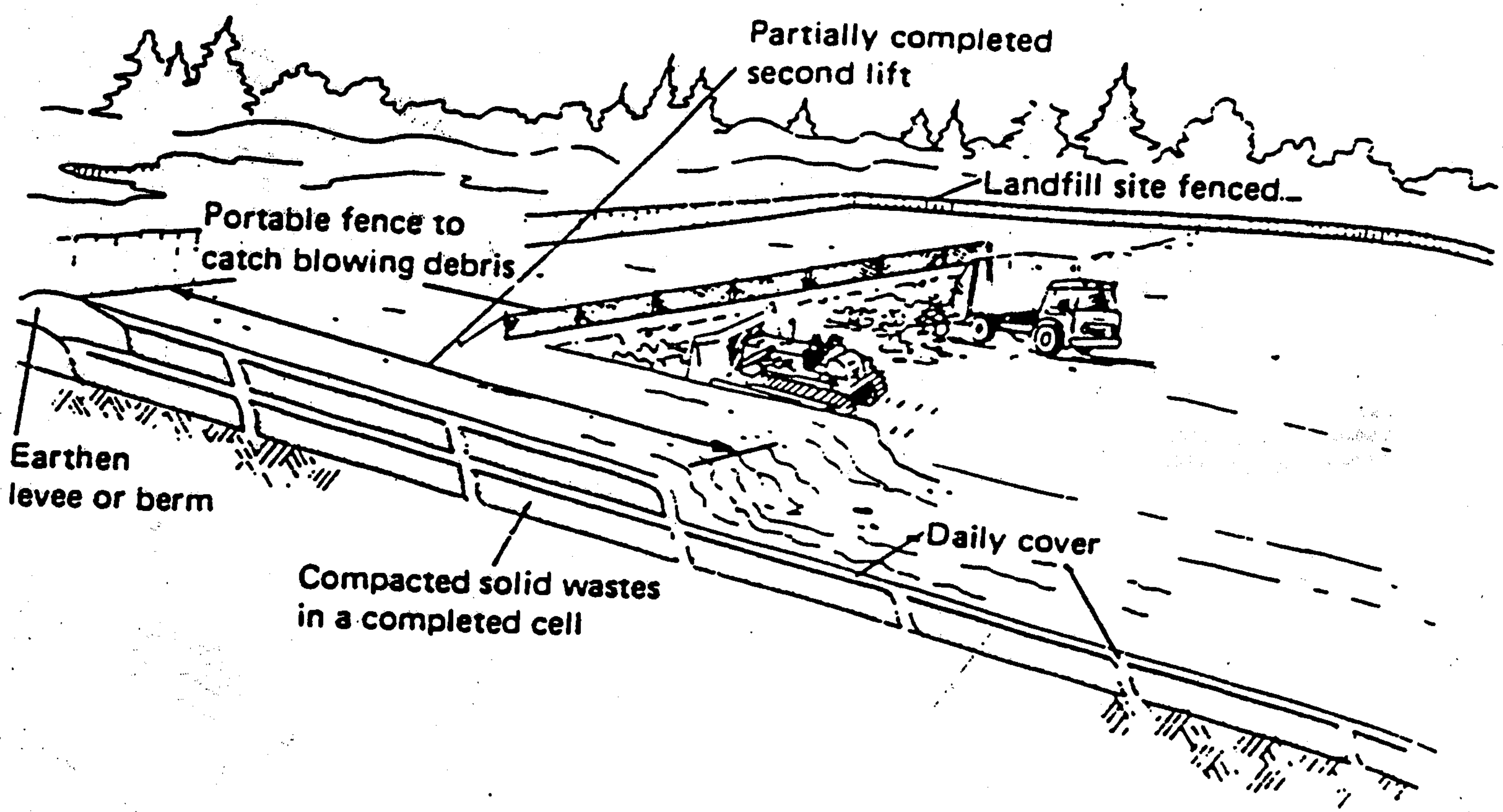
Cell Size = 25' (wide) x 100' (long) x 10' (deep)
Each cell is in excess of volume required for 1 operational day

Lift #	Avg. Width	Avg. Length	# Cells/Width	#Cells/Length	Total #Cells Per 10' Lift	Months	Total Months Per Layer	Summary of Vertical Exp Life Months
1	800	900	32	9	288	14		
2	770	870	31	9	268	13		
3	740	840	30	8	249	12	**39**	
4	710	810	28	8	230	11		
5	680	780	27	8	212	10		
6	650	750	26	8	195	9	**30**	**69**
7	620	720	25	7	179	9		
8	590	690	24	7	163	8		
9	560	660	22	7	148	7	**24**	**93**

APPENDIX F

OPERATIONAL SCHEMATICS

McKIM & CREED



Area Method Of Operation For A Sanitary Landfill

APPENDIX G

CONSTRUCTION & DEMOLITION PERMIT

McKIM&CREED

North Carolina Department of Human Resources
Division of Health Services
P.O. Box 2091 • Raleigh, North Carolina 27602-2091

James G. Martin, Governor
David T. Flaherty, Secretary

Ronald H. Levine, M.D., M.P.H.
State Health Director

November 15, 1988

Mr. Dallas H. Pope, County Manager
Harnett County
P.O. Box 759
Lillington, N.C. 27546

RE: Harnett County Sanitary Landfill, Amendment to Permit #43-02

Dear Mr. Pope:

The enclosed Amendment to Permit for the referenced facility is issued in accordance with G.S. 130A-294, subject to the revised conditions of the permit.

Please note that this is a phased construction plan with only specified phases approved for a period not to exceed five years from the date of issuance.

Also, please note the other conditions, expanded ground water monitoring, and specific closure and post-closure requirements.

In addition, since this is leased land, it must be recorded in the manner previously used to record the existing landfill.

If there are any questions, please contact me at (919) 733-0692.

Sincerely,

James C. Coffey

James C. Coffey
Environmental Engineer
Solid Waste Branch
Solid Waste Management Section

JCC/mj

cc: Terry F. Dover
Dexter Matthews

401 Ob[illegible] Rd.

AMENDMENT TO PERMIT NO. 43-02
DATE ISSUED 11/15/88

STATE OF NORTH CAROLINA

DEPARTMENT OF HUMAN RESOURCES

DIVISION OF HEALTH SERVICES

P.O. BOX 2091 RALEIGH, NC 27602

S O L I D W A S T E P E R M I T

HARNETT COUNTY

is hereby issued a permit to operate a

SANITARY LANDFILL

located

off Highway 1724, near Dunn-Erwin,

in accordance with Article 9, Chapter 130A, of the General Statutes of North Carolina and all rules promulgated thereunder and subject to the conditions set forth in this permit. The facility is located and described by the legal description of the site on the attached sheet.

J. Gordon Layton

J. Gordon Layton, Supervisor
Solid Waste Branch
Solid Waste Management Section

Being all the certain tract or parcel of land containing 219.09 acres, more or less, situated on both sides of Secondary Road No. 1724 South of termination point of said secondary road in Grove Township, Harnett County, North Carolina, and more fully described upon a map of survey by Artis P. Spence, RLS, and of record in Plat Cabinet 2, Slide 399, Harnett County Registry, to which reference is hereby made and incorporated herein as a part of this description, said lands are more fully described by metes and bounds as follows:

BEGINNING at an existing concrete monument being the northeast corner of the County of Harnett Landfill Site which is described in a lease dated April 14, 1976 and of record in Book 637, Page 920, Harnett County Registry and runs thence as the northern line of the County of Harnett landfill site North 66 degrees 12 minutes 29 seconds West 2765.73 feet to an existing concrete monument in the edge of an old field near a swamp; thence North 44 degrees 59 minutes 06 seconds East 992.54 feet to an existing iron stake on a hill; thence North 9 degrees 41 minutes 48 seconds West 774.76 feet to a new iron stake in the edge of a swamp; thence North 4 degrees 35 minutes 41 seconds West 600 feet to an existing iron stake on a ridge; thence North 27 degrees 38 minutes 19 seconds East 698.24 feet to an existing iron stake; thence North 27 degrees 38 minutes 19 seconds East 729 feet to an existing iron stake in the edge of a small marsh area; thence South 52 degrees 48 minutes 39 seconds East 1513.41 feet to a new iron stake in or near the center line of Secondary Road No. 1724, being a corner with a 2.22 acre tract which is not a portion of the area herein described; thence in and as the center line of said Secondary Road No. 1724 South 3 degrees 47 minutes 31 seconds West 232.84 feet to a new iron stake, another corner for the 2.22 acre tract; thence South 53 degrees 18 minutes 35 seconds East 440.32 feet to a new iron stake, being another corner of said 2.22 acre tract; thence North 36 degrees 41 minutes 25 seconds East 190.04 feet to a new iron stake in the original line, another corner with said 2.22 acre tract; thence with a fence and as the original line South 52 degrees 48 minutes 39 seconds East 572.71 feet to an existing iron stake; thence continuing South 52 degrees 48 minutes 39 seconds East 467.81 feet to an existing iron stake in a small branch area; thence South 34 degrees 32 minutes 26 seconds West 297.10 feet to an existing iron stake in a branch; thence South 16 degrees 06 minutes 06 seconds East 93.60 feet to an existing iron stake on the point of a small ridge; thence South 37 degrees 22 minutes 09 seconds East 637.49 feet to a existing concrete monument on the edge of a hill; thence South 38 degrees 54 minutes 40 seconds West 1980.71 feet to an existing concrete monument; thence South 38 degrees West 223.70 feet to the point of beginning and containing 219.09 acres, more or less.

There is excepted from the sale hereof the dwelling house and all appurtenant outbuildings situated on that certain 2.1 acre tract, described in deed dated August 19, 1974, and recorded in Book 633, Page 487, Harnett County Registry, said tract of land being contained within the aforesaid described lands and the grantors Jeanette D. Johnson and husband, P. J. Johnson, Jr. shall be entitled to remove said items of property which are hereby deemed to be personal property and specifically not a part of the realty herein being conveyed.

The aforesaid properties are subject to an easement to Carolina Power and Light Company for a high rise transmission line which passes across said property and located as shown on the aforementioned recorded plat, said right of way easement is dated August 30, 1983 and recorded Book 754, Page 41, Harnett County Registry.

The aforesaid tract of land is subject to a timber deed to Boise Cascade Corporation dated June 28, 1985, and recorded Book 785, Page 776, Harnett County Registry.

TO HAVE AND TO HOLD said easement right, hereinafter more fully set forth, unto the grantee and its successors and assigns pursuant to the terms hereinafter set forth.

905

AMENDMENT TO PERMIT NO. 43-02
DATE ISSUED 11/15/88

S O L I D W A S T E P E R M I T

CONDITIONS OF PERMIT:

1. This permit shall not be effective unless the certified copy is filed in the Register of Deeds Office, in the grantor index under the name of the owner of the land in the county or counties in which the land is located. After recordation, the certified copy shall be returned to the Solid Waste Branch and shall have indicated on it the page and book number, date of recordation, and Register's seal.

2. When this property is sold, leased, conveyed or transferred, the deed or other instrument of transfer shall contain in the description section in no smaller type than that used in the body of the deed or instrument a statement that the property has been used as a sanitary landfill.

3. The following requirements shall be met prior to receiving solid waste at the site:

   a. Site preparation shall be in accordance with the construction plan.
   b. Site inspection shall be made by a representative of the Division of Health Services.
   c. The permit number and the words "NO HAZARDOUS OR LIQUID WASTE ACCEPTED" shall be posted on an entrance sign.

4. This solid waste disposal site is permitted to receive solid waste as defined in 10 NCAC 10G, .0101(36), except that hazardous waste, liquid waste and any other wastes that may pose a threat to the environment or public health are prohibited from disposal at this site.

5. This permit is for construction according to the attached plans with the following revisions:

   a. The construction plan is a phased construction plan with only the specified phases (I, II and III) approved for a period not to exceed five years from the date of issuance.
   b. The remaining phases within the site will be reviewed when the approved capacity is fully utilized.
   c. A 200 foot buffer between the waste boundary and the property boundary must be maintained on the northern boundary of Phase III.

   Additional conditions and revisions of the approved plans shall be approved by the North Carolina Solid and Hazardous Waste Management Branch.

6. Ground water monitoring wells and monitoring requirements:

   a. Three wells shall be installed at locations as shown on construction plans.
   b. Installation shall conform to DHS well standard (Attachment 1).
   c. A well completion record shall be submitted to DHS for each monitoring well constructed (Attachment 2) within 30 days upon completion.
   d. The location of the monitoring wells shall be physically located in the field and approved by DHS prior to the well being constructed.
   e. For new site locations, ground water monitoring wells shall be constructed and sampled prior to the acceptance of any waste at the landfill and confirm to specifications outlined in the N.C. Water Quality Monitoring Guidance Document for Solid Waste Facilities. Complete specifications are delineated in this document which is available from DHS.
   f. Surface water sampling shall be performed at the locations specified on the construction plans as per methods outlined in the above-referenced Guidance Document.
   g. Harnett County shall sample monitoring wells and surface waters, semi-annually, for the first year and annually thereafter as per the above-referenced Guidance Document.
   h. A readily accessible unobstructed path shall be initially cleared and maintained so that four-wheel drive vehicles may access the monitoring wells at all times.

7. This facility shall conform to operating procedures in Rule .0505 of the Solid Waste Management Rules.

8. Ground water quality at this facility is subject to the classification and remedial action provisions of 15 NCAC 2L (Attachment 3).

9. All future necessary maintenance shall be the responsibility of Harnett County. Necessary maintenance will be specified in the closure letter and will include, at a minimum, the following:

   a. Maintenance of the integrity and effectiveness of the final cover including settling, subsidence, erosion and prevention of run-on and run-off problems.
   b. Maintenance of ground water monitoring system and water quality sampling in accordance with N.C. Water Quality Monitoring Guidance Document.
   c. Post-closure use must not be allowed to disturb the integrity of the final cover, unless approved by the Branch.

CERTIFIED COPY OF SOLID WASTE PERMIT

I do hereby certify that the attached PERMIT is an exact and true copy of Permit No. 43-02.

J. Gordon Layton

J. Gordon Layton, Supervisor
Solid Waste Branch

North Carolina

Wake County

I, Gail B. Faucette, a Notary Public for said County and State, do hereby certify that J. Gordon Layton, Supervisor, Solid Waste Branch personally appeared before me this day and acknowledged the due execution of the foregoing instrument.

Witness my hand and official seal, this the 16th day of November, 1988.

OFFICIAL SEAL

Gail B. Faucette

NOTARY PUBLIC

My commission expires My Commission Expires 10-13-93, 19____.

APPENDIX H

YARD WASTE REPORT

McKIM&CREED

HARNETT COUNTY LANDFILL

YARD WASTE FACILITIES

ASBESTOS MONOFILL

TIRE MONOFILL

DALLAS H. POPE, COUNTY MANAGER

TABLE OF CONTENTS

YARD WASTE MANAGEMENT

A. General Description

The Yard Waste Management Facility is located within the existing landfill facilities and includes a staging area, mechanical processing, composting and stockpiling.

B. The receiving area and processing area is approximately 1.1 acres in size. The compost area is approximately 2.5 acres in size.

C. Regulatory Requirements

1. Plan and Permit Requirements

a. Construction plans have been prepared in accordance to N.C. Solid Waste Management Rules as amended January 9, 1992.

b. Copy of permit, plans and report will be available at all times at the landfill.

c. Material received at the yard waste facility shall be limited to separated construction and demolition debris, organic wood, leaves and grass. MSW will not be allowed to be dumped at the yard waste facility. Woody organic material will be stockpiled temporarily, processed and then placed in stockpile within 7 days. Grass clippings and leaves will be placed in windrows within 48 hours.

d. The design storage capacity of the staging area is one week at the rate of 200 tons/week. The design storage capacity of the composting facility is <u>one year</u> based on the rate of 5,000 tons/year. The capacity of the mulch storage area is six months based on the rate of 625 tons/month.

e. As stated above, only demolition debris, organic wood, leaves and grass will be received at the yard waste facility.

f. Woody organic material will be stockpiled temporarily, processed and then placed in windrows within 7 days.

g. A Norkot Slabgrinder or similar will be used to reduce waste material size to a uniform size. Screen sizes of 1" to 4" will be utilized. Woody waste will be stockpiled as shown on the plans and utilized as a mulch. Leaves and grass clippings will be placed in windrows for composting within 48 hours.

h. Material dumped at the yard waste facility will be loose and outside of any containers. If delivered in bags, the customer must empty the bags. Empty plastic bags and other containers will not be accepted at the yard waste facility.

i. Windrows consisting of the leaves and grass clippings will be located as shown on the plans. The windrows will be turned utilizing a clam shell front end loader to maintain proper aeration and temperature control.

j. The windrows will be carefully managed with detailed attention to temperature, oxygen, moisture and C/N ratio. <u>Temperatures</u> will be maintained between 70 degrees and 132 degrees Fahrenheit. <u>Carbon to nitrogen ratios (C/N)</u> between 20:1 to 30:1 will be maintained. <u>Oxygen</u> will be such that the windrow will be squishy and comparatively light. <u>Moisture</u> will be maintained such that water can be squeezed out.

k. Windrow will be constructed with a bottom width of 16 feet, and approximately 8' in height. A temperature probe will be utilized to insure proper temperature control. All other parameters will be controlled based upon visual inspection and experience. Turning frequency will be as necessary to maintain conditions described in item J above.

l. Compost will receive final aeration upon completion of stabilization cycle to ensure stability before distribution.

m. The compost areas will be located on a silty clay material of low permeability.

n. Aerobic conditions will be maintained as much as possible. Thus odor will be minimized.

o. All static piles will be turned at least once every 6 months.

p. Compost process will be managed as discussed in item J above.

q. Nitrogen bearing waste (grass clippings) will be incorporated into piles within 48 hours of on-site arrival.

2. Drainage Control Requirements

a. Surface water at the staging area will drain toward the east side of the facility as shown on the plans. Surface water will drain into side ditches and collect in the sediment control basin before discharging into surface waters that eventually lead offsite.

b. Windrows run east to west and parallel to grade with drainage such that the windrows do not obstruct or collect surface water flow.

c. See above.

3. Water Protection Requirements

a. Leachate will be properly managed on site by best management practices.

Leachate will be minimized and restricted to specific areas to the extent possible. Within the staging area, material will be processed as rapidly as possible and transported to either the mulch stockpile, windrows, or the monofill. Stockpiles will consist of organic woods or leaves and grass clippings. As such, the quality of the leachate is not anticipated to be detrimental to the environment.

4. Access and Security Requirements

   a. The yard waste facility is located within the landfill compound. As such, the site will be secured by the access gates and fencing for the landfill.

   b. The access will be a 22' wide gravel road and maintained in a manner that will allow for access at all times by the general public. Slopes along the access road are mild such that even during wet conditions ingress and egress can be accomplished by cars and light duty trucks.

5. Sign Requirements

   a. A sign located at the entrance to the landfill facility will provide information regarding the owner and operator. Telephone numbers and also operating hours of both the landfill and the yard waste facilities will be posted.

   b. Within the landfill facility there will be traffic signs and markers which identify an orderly traffic pattern to the yard waste facility.

   c. A sign at the yard waste site will be posted stating the type of waste which may be received at the facility.

6. a. Burning will be prohibited at the facility.

b. Equipment on site includes loaders and other related earth moving equipment which may be utilized to control accidental fires. In addition, there will be water available at the yard waste facility as an additional source of fire protection. (Note: Water supply will be limited to a single yard hydrant). The local fire department will be contacted and arrangements will be made to inform them of the location of the facility in case of an emergency as well.

c. A 25' access to <u>each</u> windrow pile shall be provided in the windrow storage facility for access by vehicles including the fire department.

7. Monitoring and Reporting Requirements

a. Ground water and surface water monitoring are currently in place. In accordance to state regulations and permit requirements, ground water and surface water are being monitored annually. Beginning January 1, 1993, ground water and surface water will be monitored in May and November of each year thereafter. Yard waste is the only component currently being processed and composted. As such, additional monitoring of soil and plant tissue is not anticipated.

b. An annual report will be submitted to the Division which includes the following information:

(i) Sources type quality by weight or volume) of waste received at the facility

(ii) Turning frequencies, timing and amount of water addition (if applicable).

(iii) Sampling of temperature, duration, and changes during composting.

(iv) The quantity, by weight or volume, of compost or mulch produced.

(v) The quantity, by weight or volume, of compost and mulch removed from the facility.

(vi) A description of the end product and distribution or method of disposal.

In accordance to Memorandum Number 14 (Original date January 23, 1991, revised August 5, 1991), please note the following:

1. The referenced plans show the facility location, boundary and surrounding land use. Appendix I includes a letter from the county regarding zoning.

2. The enclosed plans demonstrate receiving, processing and production areas within the facility as well as location of curing and storage piles, access controls and drainage structures, existing and proposed contours.

3. Report Item A - Waste to be received at the yard waste facility includes yard waste,land clearing debris, inert debris, and construction or demolition debris as defined by Policy Memorandum No. 16 dated August 1, 1991. In addition, the staging area will also receive tires and asbestos. The source of the waste will be residential and commercial businesses from Harnett County and municipalities within Harnett County. The yard waste facility will be operated by 2 people at all times when open to the public.

   The composition of the waste will vary, but will be segregated immediately upon receipt to insure that the material is directed either to the correct monofill or is positioned so that it can be processed by the yard waste equipment or stockpiled in the windrows for composting.

   Report Item B - The currently suggested management process for the Harnett County Yard Waste Facility is as follows:

   a. Material enters the Dunn-Erwin landfill site and is measured by scales similar to any other waste entering the facility.

   b. Construction debris, demolition debris, inert material, yard waste, and tires, will be directed to the yard waste and asbestos facility, specifically the staging area.

   c. Loads of construction debris will be directed to the construction and demolition landfill by the yard waste crew.

   d. At the staging area, yard waste is unloaded and segregated into leaves and grass clippings; limbs and stumps less than 6" in diameter, and the remaining yard waste that does not fall into either of the first two categories.

e. Tires will be accepted at an area adjacent to the staging area for stockpiling. Asbestos, if properly packaged in accordance to state regulations will be directed to the asbestos monofill.

f. Unauthorized dumping of construction or demolition debris in the staging area will be managed by fines.

g. Grass and leaves will be hauled from the staging area to the storage pile by the crew. The leaves and grass will initially be run through the process equipment to reduce particle size and provide a more uniform mixture. Following this the processed material will be wetted and placed in windrows to begin the composting process. The windrows will be turned by a clamshell bucket (front end loader). Once the composting process has stabilized (anticipate 4-6 months) then the material will be moved to a curing pile. The compost will be distributed from the curing pile.

h. The limbs and stumps, less than 6" in diameter will be picked up by the front end loader and dumped into the process equipment . The mulch from the equipment will be stockpiled near the staging area convenient for pickup by the public.

Signage for the facility will include an operational sign located at the entrance of the landfill which describes hours of operation, personnel, telephone numbers, and directions to the staging area. Currently, traffic at the Dunn-Erwin landfill is not such that litter control cannot be maintained by the staff on site. However, should this matter become a nuisance or a problem the facility will consider that all customers enter the landfill with their MSW as well as yard waste covered until they dump the material. Fire protection and safety will be maintained and monitored at all times. Adequate access as to the staging area as well as proper separation between windrow piles will be maintained such that access by equipment can be achieved at all times. A 25 foot wide access to each windrow is provided within the composting area. Other stockpile areas also have access to all sides of the pile. There will also be a water source at the staging area which will serve as an additional fire protection measure. The staging area of the yard waste facility will not be receiving any municipal solid waste. Furthermore, material that is received and stockpiled on site for processing will be processed within 24 hours of receipt and placed either in windrows or stockpiled for public distribution as previously described. Careful monitoring by the crew will be provided to ensure that anaerobic conditions are minimized. Unauthorized dumping will be closely supervised and not tolerated. If this becomes a problem then penalties in the form of fines will be established to discourage unauthorized dumping. Should dust become a problem, then the area will be lightly sprayed.

C. The current design capacity for both process and storage of the yard waste facility is 12,500 tons per year.

D. As indicated by sheet 5 of 9 of the plans, the facility process consists of staging area, an active compost area, a compost curing area, an area for debagging and plastic storage, wood and brush storage, wood and brush processing, a building for tool and supply storage, and water supply.

The staging area is 1.1 acres in size. The active compost area located at the northwest corner of the project is 2.5 acres and is capable of storing 12 months of material. It is important to note that only grass clippings and leaves will be composted. Woody waste will not be incorporated into the compost material. The compost curing pile will be located as shown on the plans at the Northwest Borrow Site. This storage area is approximately 2.0 acres in size capable of storing approximately 300 tons of material or approximately 8 months at the rate of 5000 tons/year. Compost debagging and plastic storage will occur at the staging area. Material that arrives at the facility in bags will be debagged immediately as it is unloaded from the customer. Bags will be collected and delivered to the landfill for burial at the end of each day. Leaves, grass, woody and brush material will be segregated as they arrive from the customer. Leaves and grass will be mixed and delivered to the windrow site to begin the composting process immediately. Woody material will be processed by a grinder and then stockpiled in the designated location on the site plan for distribution as mulch to the customers.

The wood and brush processing equipment will be a Maxi-grind Model No. 9100 Slab Grinder as manufactured by Norco Manufacturing Co. in Bottineau, North Dakota or similar. The exact throughput of this equipment will vary depending on material type. However, it is anticipated that the equipment can process an excess of 50 tons per hour of yard waste.

Windrows will be monitored for moisture, oxygen, carbon nitrogen ratio and temperature. Temperature will be the primary indicator for pile turning and will be monitored by a temperature probe. At a reading of a 132 degrees F, it is anticipated that the windrows will be turned. Windrows will be turned utilizing a clamshell front end loader located on existing tractors that the County currently owns. The windrows are 20' in width at the bottom with 2:1 side slopes and 10' in height. Final slope of the top of the windrow will be dependent upon moisture conditions and if necessary, moisture will be added by mechanical means. Oxygen will be controlled by routine inspection. If undesirable odors are detected during inspection, the windrows will be turned and aerated such that the process remains aerobic. The proper carbon to nitrogen ratio will be maintained between 21 and 31. Currently, the anticipated compost process length is anticipated to be between 4 and 6 months.

ASBESTOS MANAGEMENT

A. General Description

1. The referenced landfill will receive properly packaged asbestos and dispose of the asbestos in the monofill as shown on the plans.

2. The design storage capacity of the asbestos monofill is 27,400 cubic yards an expected life of 20 years.

B. Regulatory Requirements

The disposal site for asbestos waste will be owned and operated in accordance to N.C. Regulations. Material delivered to the sanitary landfill must be sealed in a leak-proof container with an OSHA specified label that includes the name of the waste generator. Upon delivery and prior to disposal of the asbestos into the landfill, the following information must be provided to the operator:

1. Name, address and telephone number of the generator

2. Name, address, and telephone number of the transporter

3. Name, address and telephone number of the North Carolina Asbestos Branch.

4. Quantity of waste

5. Date material was transported to disposal facility

The above will be provided on Form-1 as shown in Appendix II of this report and herein referred to as a Waste Shipment Record.

Upon provision of the above, the operator of the yard waste facility will insure that the form has been properly executed and certify by signature that the waste is properly described, labeled and packaged.

Within 30 days of execution of the waste shipment record, the disposal operator must return one copy of the shipment record fully executed and signed by the generator, unless a discrepancy is noted. If a discrepancy is noted, the disposal operator will inform the generator within 15 days and then the Asbestos Branch of North Carolina.

All records will be maintained by the County for a period of two years.

SCRAP TIRE MANAGEMENT

A. General Description

The scrap tire management process will consist of a collection facility, storage area and a scrap tire monofill. All facilities will be located as shown on the plans.

B. Regulatory Requirement

.1106 Scrap Tire Collection Site Permit Requirement

(a) Noted

(b) 5,040 tires per month will be collected on site. The total number of collected tires will not exceed 6,500 before the tires are processed. Tires will be processed off site.

(c) Siting and Design Requirements

(1) Noted and compiled
(2) Noted and compiled
(3) Noted and compiled
(4) Noted and compiled
(5) Noted and compiled
(6) Noted and compiled
(7) Noted and compiled
(8) Access will be limited by the gate to the landfill facility
(9) The existing drained pond will serve as protection and a buffer to offsite surface waters
(10) Fire protection will be provided by the Erwin Volunteer Fire Department

(d) Application - Upon review approval of the plans the following

(1) Facility
Name: Harnett County Landfill
Address: Mr. Jerry Blanchard, Director
103 East Ive St.
P.O. Box 940
Lillington, NC 27546

(2) Operator
Name:
Address:
Telephone:

(3) Property Owner

Name: Harnett County
Address: Mr. Jerry Blanchard, Director
103 East Ive St
PO Box 940
Lillington, NC 27546
Telephone: 893-7536

(4) See plans prepared by McKim & Creed Engineers, P.A. dated June, 1992.

(5) Tires will enter the facility as any other material. The operator of the scales will get the name and address of the generator, transporter and quantity of tires delivered. The transporter will be directed to the tire collection area where the tires will be unloaded by the facility attendants and the transporter.

The collection and storage facility is designed for a two month capacity. Arrangements with an independent contractor will be made to process and shred the tires such that they may be disposed of in the tire monofill. Tentative contractual agreements are once a month or upon accumulation of approximately 6,500 tires whichever occurs first.

(6) The source of the tires will be commercial businesses and residents of Harnett County and municipalities located within Harnett County. Approximately 63 tons of tires per month are expected.

(7) See item 5 above.

(8) Within 30 days of state approval of permit

(9) Scrap tire waste from processing will be placed in the monofill

(10) See above

(11) See Appendix IV

(12) Will comply

(13) See below

(14) Noted

C- .1107 Scrap Tire Collection Site Operational Requirements

(1) N/A
(2)
(a) Complied
(b) Complied
(c) Shredded material is to be placed in the monofill immediately
(d) Noted, will comply
(e) will comply
(f) Will comply
(g) Telephone facilities exist at landfill maintenance building
(h) Will comply
(i) Will Comply
(j) Any emergencies that have potential off site effects will be called to the attention of the Division
(k) A copy of the permit will be maintained on site at all times. In addition, the following records will be kept by the Operator:

(a) Name, address and telephone number of generator

(b) Name, address and telephone number of transporter

(c) Quantity of tires received from each generator

(d) All certification forms applicable to any tires shipped to the site.

(e) Not applicable

(3)

(a) N/A

(b) Residual from scrap tire processing will be placed in the monofill

(4) Noted

E- .1111 Financial Responsibility Requirements

(a) Based upon a telephone conference with Mr. Bill Sessoms of the Solid Waste Section of North Carolina, Harnett County is exempt from financial responsibility.

APPENDIX I

HARNETT COUNTY PLANNING BOARD

27 E. Harnett Street P. O. Box 65
LILLINGTON, NORTH CAROLINA 27546

Phone: (919) 893-3077
893-3078

March 14, 1985

Mr. C. T. Clayton, P.E.
Ragsdale Consultants
P. O. Box 760
1210 S. Main Street
Lillington, NC 27546

Dear Mr. Clayton:

I am writing to inform you that the proposed site for the sanitary landfill located off S. R. 1723 between Coats and Erwin poses no problems in terms of county planning regulations.

Since the county imposes no zoning regulations, the site is not in conflict with zoning law. Also, the site seems comparatively compatible to the subdivision activity and various land uses in the vicinity.

If I can be of further assistance, please let me know.

Sincerely yours,

Ervin G. Dobson

Ervin G. Dobson, Director
Harnett County Planning

EGD:waj

APPENDIX II

Form - 1
Asbestos Waste Shipment Record

Date collected and shipped from generator

Date delivered to disposal site

Generator
Name:
Address:
Telephone:

Transporter
Name:
Address:
Telephone:

Government Agency
Name:
Address:
Telephone:

Disposal Site
Name:
Address:
Telephone:

Operator
Name
Telephone: (If different from above)

Quantity of Waste

_______ lbs.

I, ____________________ (Operator Name) of the Harnett County Landfill do hereby certify that the asbestos delivered on this day is of approximately the quantity noted above and is properly packaged in a leakproof container in accordance to N.C. Regulations.

____
Operator Signature

APPENDIX I

LEGAL DESCRIPTION

McKIM&CREED

BOUNDARY DESCRIPTION

Beginning at a nail over a culvert in the centerline of State Road No. 1725, approximately one mile north of Hodges Cross Roads; Control Corner as shown on map entitled "County of Harnett Landfill Site", prepared by Piedmont Surveying Company dated September 6, 1976; thence as center line of road N 25° 24' W 355.55 feet to a point in the center line of road; thence N 25° 30' W 239.92 feet to a point in the center line of road; thence leaving the road as the line of C.P. Johnson, (Plat Book 7, Page 111; Deed Book 356, Page 402) referenced by an iron pipe on the right of way of the road N 35° 14' E, crossing the Durham and Southern Railroad 1271.02 feet to a found iron stake, Johnson's corner, thence as Johnson's line N 50° 02' W 534.14 feet to a found iron stake, corner of Johnson and Cora Stewart (Deed Book 170, Page 546); thence, as the line of Stewart, N 50° 00' W 947.76 feet to a set concrete monument, Stewart's corner, thence N 47° 01' E 450.98 feet to a set concrete monument, corner of the Melvin Daniel Estate, (Deed Book 324, Page 379, second tract) in the Stewart line; thence as the Daniel Estate line S 67° 49' E 2816.29 feet to a set concrete monument, Daniel Estate corner in the line of John Sorrell, Sr. (Plat Book 16, Page 11); thence as Sorrell's line S 38° 39' W 223.53 feet to a found concrete monument, Corner of Sorrell and Cora S. Bennett (Plat Book 9, Page 108), thence S 40° 00' W 1076.12 feet to a found iron stake by a Hickory tree, corner of Harold S. Turlington (Book 398, Page 554) in the line of Bennett; thence as Turlington's line N 50° 25' W 239.00 feet to a set iron pipe, new corner of Turlington;

thence as a new line with Turlington S 32° 41' W 817.00 feet to a set iron pipe; Turlington's new corner, thence as another of Turlington's new lines S 54° 25' W, Crossing the Durham and Southern Railroad 859.42 feet to a point in the center line of State Road 1725, Turlington's new corner; thence as the center line of road N 25° 24' W 290.00 feet to the Point of Beginning, containing approximately 85 acres.

I certify that I am holder of a partial fee interest in the land described in the foregoing Order of Approval for a sanitary landfill issued to Harnett County.

Rebecca M. Turlington
Edward S. Turlington
Paula R. Turlington
Frank W. Turlington

Owner(s), Herein described land
(Grantor)

North Carolina

Harnett County

I, Carolyn H. Stone, a Notary Public for said County and State, do hereby certify that Rebecca M. Turlington, Edward S. Turlington, Paula R. Turlington & Frank W. Turlington personally appeared before me this day and acknowledged the due execution of the foregoing instrument.

Witness my hand and official seal, this the 4th day of October, 1988.

OFFICIAL SEAL

Carolyn H. Stone
NOTARY PUBLIC

My commission expires December 30, 1991.

NORTH CAROLINA

HARNETT COUNTY

LEASE

THIS LEASE, Made and entered into this 24 day of February, 1976, by and between REBECCA M. TURLINGTON, Widow; EDWARD S. TURLINGTON and wife, PAULA R. TURLINGTON; and FRANK TURLINGTON and wife, BRENDA S. TURLINGTON, all of Harnett County, North Carolina, hereinafter called TURLINGTON, and the COUNTY OF HARNETT, a body politic, hereinafter called COUNTY;

W I T N E S S E T H:

That for Ten Dollars and other good and valuable consideration and subject to the terms and conditions herein set out, said Turlington does hereby let and lease unto the County that certain property situate in Grove Township, Harnett County, North Carolina, and more fully described as follows:

> BEGINNING at a corner in the center of the road, it being a new dividing corner between Carl F. Turlington and Harold S. Turlington, said corner being a pin 8 feet West of culvert and runs thence as a new dividing line between Carl F. Turlington and Harold S. Turlington South 50 degrees 50 minutes West 990.5 feet to an iron stake; thence North 32 degrees West 273.6 feet to a concrete corner; thence North 35 degrees East 2,435 feet to an iron stake; thence South 51 degrees East 1,028 feet to an iron stake, a new corner between Carl F. and Harold S. Turlington; thence as a dividing line between the said parties South 32 degrees 7 minutes West 817 feet to an iron stake; thence another dividing line between said parties South 54 degrees 40 minutes West 859.5 feet to a corner in the center of the road; thence along the center of the road North 25 degrees 24 minutes West 290 feet to the BEGINNING, containing 41 acres more or less, not including that part in the right-of-way of Durham and Southern Railroad.

THE TERMS AND CONDITIONS OF THIS LEASE ARE AS FOLLOWS:

1. TERM: This lease shall commence upon execution and shall continue for a term of Twenty-five (25) years from the above date, as herein provided and shall be binding upon the successors, heirs and assigns of the Lessors and Lessee.

2. USE OF PROPERTY: The above described property shall be used only for a solid waste disposal site.

3. SPECIAL CONDITIONS: The County shall exercise reasonable care in maintaining the premises, including access roads, and in controlling fire, insects, rodents, and other hazards associated with garbage disposal sites. The County

4. BREACH OF CONDITIONS: In the event that Turlington or their successors in title should be of the opinion that the County has breached the terms of this agreement, the County shall be given written notice thereof, setting forth the allegations as to the specific breach or breaches which are deemed to have occurred, and thereafter the County shall have 60 days within which to make an investigation and remedy any condition which in their opinion is found to constitute a possible breach; however, any such action on their part shall not constitute an admission of a breach. Following the expiration of said 60 day period, Turlington or their successors in title, shall have the right to apply to the Courts for an Order or Judgment requiring specific performance by the County of the terms of the Lease, and such action on the part of Turlington shall be the exclusive remedy of Turlington in connection with any allegation of breach by the County, it being specifically agreed that no monetary damages shall be payable to or claimed by Turlington in connection with any breach alleged or determined to have been made and neither shall any breach or breaches by County constitute or effect a termination of the Lease.

5. COST OF THE LEASE:

(a) The County shall pay to Turlington the sum of $1,500.00 per acre for 41 acres of land or $61,500.00. This sum shall be paid in three (3) equal payments as follows:

$20,500.00 upon execution of this lease;
$20,500.00 on January 10, 1977 and
$20,500.00 on January 10, 1978.

(b) The County agrees to pay an additional sum annually as rent which sum shall be equal to the amount by which County property taxes exceed $75.00. (Taxes for 1975 on the premises were about $50.00.)

6. ADDITIONAL COUNTY OBLIGATIONS:

(a) The County shall leave and not use a 25 foot border inside all property lines and not use the area within such border for solid waste disposal purposes.

7. ADDITIONAL LESSOR RIGHTS: Lessor shall retain timber rights but will remove any timber upon request by the County within a 30 day period following such request. If such timber is not removed, the County shall have the right to remove such timber.

8. WARRANTY: The Lessors covenant to and with the Lessee that they are seized and possessed of said premises in fee and have a right to convey the same in fee simple; that the same are free and clear of all encumbrances; that the Lessee is entitled to immediate possession of said premises; that they will warrant and defend the title to the same against the lawful claims of all persons whomsoever.

IN TESTIMONY WHEREOF, said Turlington and County have executed this Lease in duplicate, the original of which is retained by the County and a copy of which is retained by Turlington.

Rebecca M. Turlington (SEAL)
Rebecca M. Turlington

Edward S. Turlington (SEAL)
Edward S. Turlington

Paula R. Turlington (SEAL)
Paula R. Turlington

Frank Turlington (SEAL)
Frank Turlington

Brenda Turlington (SEAL)
Brenda S. Turlington

COUNTY OF HARNETT

By: M. H. Brock
M. H. Brock, County Manager

ATTEST:

H. D. Carson, Jr., Clerk

NORTH CAROLINA

HARNETT COUNTY

ACKNOWLEDGMENT

I, Judith Ann Breeden, a Notary Public in and for said State and County do hereby certify that REBECCA M. TURLINGTON, Widow; EDWARD S. TURLINGTON and wife, PAULA R. TURLINGTON; and FRANK TURLINGTON and wife, BRENDA S. TURLINGTON, each personally appeared before me this day and acknowledged the due execution of the foregoing instrument.

Witness my hand and notarial seal, this 24 day of February, 1976.

Judith Ann Breeden
Notary Public

My Commission Expires: 4-14-80

* * * * * * * * * * * * * *

NORTH CAROLINA

HARNETT COUNTY

ACKNOWLEDGMENT

I, Rachel W. Blanchard, a Notary Public in and for said State and County, do hereby certify that H. D. CARSON, JR. personally appeared before me who being by me duly sworn, says that he knows the common seal of said County of Harnett, and is acquainted with M. H. Brock, who is the County Manager of said County; that he, the said H. D. Carson, Jr., is the Clerk of the Board of Commissioners of said County, and saw the said County Manager sign the foregoing instrument, and that the said Clerk as aforesaid, affixed said seal to said instrument, and that the said Clerk signed his name in attestation of the execution of said instrument in the presence of the said County Manager of said County.

Witness my hand and notarial seal, this 23rd day of April, 1976.

Rachel W. Blanchard
Notary Public

My Commission Expires: July 24, 1976

* * * * * * * * * * * * * *

Judith Ann Breeden

BOOK 790 PAGE 904-910

FILED

OCT 11 3 22 PM '85

GAYLE P. HOLDER
REGISTER OF DEEDS
HARNETT COUNTY, NC

HARNETT COUNTY 05847

STATE OF NORTH CAROLINA Real Estate Excise Tax OCT 14 '85 203.00 P.B. 10737

10-14-85 203.00

Excise Tax | Recording Time, Book and Page

Tax Lot No. ______ Parcel Identifier No. ______

Verified by ______ County on the ______ day of ______, 1985

by ______

Mail after recording to John Phelps

This instrument was prepared by E. Marshall Woodall

Brief description for the Index

219.09 acres; Grove Township

DEED OF EASEMENT

THIS DEED OF EASEMENT, made this 7th day of October, 1985, by and between

GRANTORS	GRANTEE
THESSIE D. DANIEL, widow; JEANETTE D. JOHNSON and husband, P. J. JOHNSON, JR.	COUNTY OF HARNETT

W I T N E S S E T H :

THAT WHEREAS, the grantors are the owners of certain premises lying on both sides of Secondary Road Number 1724 and adjoining the present sanitary solid waste disposal landfill site being operated by the grantee; and

WHEREAS, the grantee desires to acquire an easement right in and to said lands to use said lands as a sanitary solid waste disposal landfill, specifically to deposit for thirty (30) years from and after the date hereof, garbage and other refuse which shall permanently remain buried within the soil thereof; and the grantors have agreed to convey said easement right in and to said land to the grantee for said purpose as hereinafter more fully set forth.

NOW, THEREFORE, the grantors, in consideration of $10.00 and other good and valuable considerations, the receipt of which is hereby acknowledged, have bargained and sold and by these presents do bargain, sell and convey unto the grantee and its successors and assigns, an easement right, hereinafter more fully described, in and to those lands more particularly described as follows:

Being all the certain tract or parcel of land containing 219.09 acres, more or less, situated on both sides of Secondary Road No. 1724 South of termination point of said secondary road in Grove Township, Harnett County, North Carolina, and more fully described upon a map of survey by Artis P. Spence, RLS, and of record in Plat Cabinet 2, Slide 399, Harnett County Registry, to which reference is hereby made and incorporated herein as a part of this description, said lands are more fully described by metes and bounds as follows:

BEGINNING at an existing concrete monument being the northeast corner of the County of Harnett Landfill Site which is described in a lease dated April 14, 1976 and of record in Book 637, Page 920, Harnett County Registry and runs thence as the northern line of the County of Harnett landfill site North 66 degrees 12 minutes 29 seconds West 2765.73 feet to an existing concrete monument in the edge of an old field near a swamp; thence North 44 degrees 59 minutes 06 seconds East 992.54 feet to an existing iron stake on a hill; thence North 9 degrees 41 minutes 48 seconds West 774.76 feet to a new iron stake in the edge of a swamp; thence North 4 degrees 35 minutes 41 seconds West 600 feet to an existing iron stake on a ridge; thence North 27 degrees 38 minutes 19 seconds East 698.24 feet to an existing iron stake; thence North 27 degrees 38 minutes 19 seconds East 729 feet to an existing iron stake in the edge of a small marsh area; thence South 52 degrees 48 minutes 39 seconds East 1513.41 feet to a new iron stake in or near the center line of Secondary Road No. 1724, being a corner with a 2.22 acre tract which is not a portion of the area herein described; thence in and as the center line of said Secondary Road No. 1724 South 3 degrees 47 minutes 31 seconds West 232.84 feet to a new iron stake, another corner for the 2.22 acre tract; thence South 53 degrees 18 minutes 35 seconds East 440.32 feet to a new iron stake, being another corner of said 2.22 acre tract; thence North 36 degrees 41 minutes 25 seconds East 190.04 feet to a new iron stake in the original line, another corner with said 2.22 acre tract; thence with a fence and as the original line South 52 degrees 48 minutes 39 seconds East 572.71 feet to an existing iron stake; thence continuing South 52 degrees 48 minutes 39 seconds East 467.81 feet to an existing iron stake in a small branch area; thence South 34 degrees 32 minutes 26 seconds West 297.10 feet to an existing iron stake in a branch; thence South 16 degrees 06 minutes 06 seconds East 93.60 feet to an existing iron stake on the point of a small ridge; thence South 37 degrees 22 minutes 09 seconds East 637.49 feet to a existing concrete monument on the edge of a hill; thence South 38 degrees 54 minutes 40 seconds West 1980.71 feet to an existing concrete monument; thence South 38 degrees West 223.70 feet to the point of beginning and containing 219.09 acres, more or less.

There is excepted from the sale hereof the dwelling house and all appurtenant outbuildings situated on that certain 2.1 acre tract, described in deed dated August 19, 1974, and recorded in Book 633, Page 487, Harnett County Registry, said tract of land being contained within the aforesaid described lands and the grantors Jeanette D. Johnson and husband, P. J. Johnson, Jr. shall be entitled to remove said items of property which are hereby deemed to be personal property and specifically not a part of the realty herein being conveyed.

The aforesaid properties are subject to an easement to Carolina Power and Light Company for a high rise transmission line which passes across said property and located as shown on the aforementioned recorded plat, said right of way easement is dated August 30, 1983 and recorded Book 754, Page 41, Harnett County Registry.

The aforesaid tract of land is subject to a timber deed to Boise Cascade Corporation dated June 28, 1985, and recorded Book 785, Page 776, Harnett County Registry.

TO HAVE AND TO HOLD said easement right, hereinafter more fully set forth, unto the grantee and its successors and assigns pursuant to the terms hereinafter set forth.

And the grantors covenant with the grantee that the grantors are seized of the premises in fee simple, have the right to convey the easement right herein granted, that title to said premises is marketable and free and clear of all encumbrances, with the exception as stated above, and that the grantors will warrant and defend the title against the lawful claims of all persons whomsoever except for the provisions herein stated.

THE TERMS OF THIS DEED OF EASEMENT ARE AS FOLLOWS:

1. EASEMENT RIGHT GRANTED: The easement granted unto the grantee is the easement right to use the premises hereinabove described as a sanitary solid waste disposal landfill, specifically the right to deposit within the soil of said premises for a period of thirty (30) years from and after the date hereof (being October 7, 1985), garbage and other refuse which shall permanently remain buried therein. Said use shall be in accordance with the regulation of such use thereof by the state and federal governments and specifically in accordance with solid waste management rules promulgated by the Department of Human Resources, Division of Health Services, Environmental Health Section, Solid and Hazardous Waste Management Branch and as specifically authorized pursuant to N.C.G.S. 138-294, etc. In accordance with the right herein granted, the grantee shall be entitled to disturb with heavy equipment the soil on said premises to such depth as it deems necessary to cause garbage and other refuse to be buried in accordance with the provisions herein, to go upon the lands to test soils and make appropriate plans for the use of the right herein granted, to remove, relocate, and otherwise disturb soils thereon to make use of the right herein granted, to locate, build, maintain and otherwise use portions of the premises to house, store, repair, maintain and otherwise use the grantee's equipment and related property relative to the operation by the grantee of the use of the easement right herein granted and to otherwise conduct and perform all acts and things necessary for the grantee to make use of the right herein granted. The grantee covenants that it shall not operate the landfill as a depository of hazardous waste.

2. Roadway; Agreement to Give Easement: The grantee shall be entitled to extend its present roadway existing into the Harnett County landfill site existing on the south hereof, across the lands herein described and to connect with Secondary Road No. 1724 at or near that point where said Secondary Road now terminates. It is anticipated that the

grantee shall lend its assistance and influence in causing said roadway to be taken over and accepted by the North Carolina Department of Transportation or such other state agencies as may hereafter exists and the grantors shall execute, if necessary, such easement rights of way with the North Carolina Department of Transportation or other agency or agencies as may be necessary for said roadway.

3. POSSESSION OF PREMISES:

(a) General Provision: The grantee shall be entitled to possession of the premises herein described to use the easement right herein granted; except for possession needed to use said easement right, the grantors and their heirs and assigns shall be in possession of said premises. Grantors covenant that they shall make no use of said premises as shall interfere with or unreasonably restrict the grantee's right herein granted. The grantee anticipates the use of said premises in stages or increments of areas, commencing in the southern areas of said lands and extending in a northerly direction until the entire premises are subjected to the use of the right herein granted. In accordance therewith, the grantee covenants to give grantors written notice of its need of the various areas of said premises as the same shall materialize.

(b) Resident dwelling house and buildings: The parties hereto acknowledge that the residence dwelling home of Jeanette D. Johnson and P. J. Johnson, Jr. is located on the 2.1 acre tract of the land described in that deed dated August 19, 1974 and recorded in Book 633, Page 487, Harnett County Registry (said 2.1 acre tract being a portion of the 219.09 acre tract). It is expressly understood and agreed by the parties hereto that grantors Jeanette D. Johnson and husband, P. J. Johnson, Jr. shall continue to use the dwelling house located on said parcel of land together with appurtenant buildings and property thereof for residential purposes until grantee give written notice of its need for said premises; whereupon and within six (6) months thereafter, said grantors shall move the dwelling house and other such appurtenant buildings and property from said premises; in the event grantors fail to so move said improvements within six (6) months after said notice, the grantee shall be entitled to make such use of said improvements as it desires, including the assignment, destruction and/or other means of use or disposition thereof.

(c) Croplands: Until the grantee uses the cropland located on said premises pursuant to the right herein granted, the grantors shall be entitled to farm and otherwise use the cropland located on said premises, including row-crop cultivation, pasturing and other general agricultural purposes. The grantors, upon receiving written notice from the grantee of its need for such area or areas, shall, upon the completion of the harvesting of the then growing crops, deliver possession to the grantee.

(d) Pasturelands: Grantors shall be entitled to possession of pasturelands until needed by the grantee; provided that the grantors shall deliver possession not later than thirty (30) days after written notice of need by the grantee is delivered to the grantors.

(e) Certain woodlands excepted until timber harvested: It is understood and agreed that this conveyance is subject to the sale of timber as referred to above to Boise Cascade Corporation; as soon as said timber has been cut and removed, the grantee shall be entitled to possession of the premises upon which the timber now stands in accordance with this deed of easement.

(f) Woodland and other premises: Upon the commencement by the grantee of use of the right herein granted within those areas of woodland and other premises not otherwise mentioned above, the grantors shall deliver possession of such premises to the grantee.

(g) Possession of premise after grantee's use: After grantee has completed its use of specific areas of said premises, grantors shall be entitled to possess and use such areas, provided that grantors' use and possession will not interfere with or unreasonably restrict grantee's use of other portions of said premises. It is specifically anticipated that grantors may pasture or re-forest such areas. Upon request by the grantors, the grantee agrees to execute such written document (that may be necessary for grantors' needs) to certify its completion of use of specific areas.

4. Restrictions on Prospective Use of Land Recognized: It is understood and recognized that the above authorized use of said lands herein will involve the disturbance of the soil for several feet deep and the deposit therein of garbage and other refuse and that said use shall effectively destroy many prospective uses of said lands, to wit: (1) effective use of said lands for row-crop agricultural purposes;

(2) use as residential building or subdivision; (3) use as commercial building or subdivision; and (4) other possible prospective uses not herein mentioned.

5. Miscellaneous Provisions:

(a) It is anticipated that the premises mentioned herein shall be fully used (garbage and refuse deposited to the extent permitted by rules and regulations governing said activity) for the easement right purpose herein granted, within the period of thirty (30) years from and after the date hereof; and for the purpose of removing any cloud upon title to land herein mentioned, the grant of easement herein to deposit garbage and other refuse within or upon the soil of said lands, shall terminate after a term of thirty (30) years from and after the date hereof.

(b) The grantee shall hold the grantors harmless from any liability from the grantee's possession and use of said lands herein described and the use of its easement right herein granted.

IN WITNESS WHEREOF, the grantors have hereunto set their hands and seals the day and year first above written.

Thessie D. Daniel (SEAL)
Thessie D. Daniel, widow

Jeanette D. Johnson (SEAL)
Jeanette D. Johnson

P. J. Johnson Jr. (SEAL)
P. J. Johnson, Jr.

NORTH CAROLINA

HARNETT COUNTY

ACKNOWLEDGMENT

I, a Notary Public of said County and State, do hereby certify that THESSIE D. DANIEL personally appeared before me this day and acknowledged the execution of the foregoing Deed. Witness by hand and official stamp or seal, this 7th day of October, 1985.

Gail L. McDonald
Notary Public

My Commission Expires: November 11, 1986.

GAIL L. McDONALD NOTARY PUBLIC HARNETT COUNTY, N.C.

NORTH CAROLINA

ACKNOWLEDGMENT

HARNETT COUNTY

I, a Notary Public of said County and State, do hereby certify that JEANETTE D. JOHNSON and husband, P. J. JOHNSON, JR. personally appeared before me this day and acknowledged the execution of the foregoing Deed. Witness my hand and official stamp or seal, this 7th day of October, 1985.

NOTARY PUBLIC

Gail L. McDonald
Notary Public

My Commission Expires: November 11, 1986.

The foregoing Certificates of Gail L. McDonald

are certified to be correct. This instrument and this certificate are duly registered at the date and time and in the Book and Page shown on the first page hereof.

GAYLE P. HOLDER, REGISTER OF DEEDS OF HARNETT COUNTY

By Shirley Pope Deputy/Assistant - Register of Deeds

HARNETT COUNTY, N. C.
FILED DATE 10-11-85 TIME 3:22 PM
BOOK 790 PAGE 904-910
REGISTER OF DEEDS
GAYLE P. HOLDER

910

I certify that I am holder of a partial fee interest in the land described in the foregoing Order of Approval for a sanitary landfill issued to Harnett County.

Paul Johnson Jr.

Jeanett Daniels Johnson

Owner(s), herein described land
(Grantor)

North Carolina

Harnett County

I, Geralding T. Cooke, a Notary Public for said County and State, do hereby certify that Paul Johnson Jr. and Jeanett Daniels Johnson personally appeared before me this day and acknowledged the due execution of the foregoing instrument.

Witness my hand and official seal, this the 11 day of August, 1988.

OFFICIAL SEAL

Geraldine T. Cooke

NOTARY PUBLIC

GERALDINE T. COOKE NOTARY *** PUBLIC HARNETT COUNTY, NC

My commission expires August 10, 19

NORTH CAROLINA

HARNETT COUNTY

LEASE

THIS LEASE, Made and entered into this 14 day of ~~February~~ April, 1976 by and between PAUL JOHNSON, JR. and wife, JEANETTE DANIELS JOHNSON of Harnett County, North Carolina, hereinafter called JOHNSON, and the COUNTY OF HARNETT, a body politic, hereinafter called COUNTY;

W I T N E S S E T H:

That for Ten Dollars and other good and valuable consideration and subject to the terms and conditions herein set out, said Johnson does hereby let and lease unto the County that certain property situate in Grove Township, Harnett County, North Carolina, and more fully described as follows:

BEGINNING at a stake on the West side of Stewart's Creek and runs North 45 degrees East 6.70 chains to a stake; thence South 71 degrees East 41.70 chains to a stake in Sorrell's line; thence South 20 degrees West 1.57 chains to a stake corner; thence South 38¼ degrees West 18 chains to a small red oak; thence North 54 3/4 degrees West 15.50 chains; thence North 51 degrees 45 minutes 25 chains to the BEGINNING, containing 50 acres, more or less.

THE TERMS AND CONDITIONS OF THIS LEASE ARE AS FOLLOWS:

1. TERM: This lease shall commence upon execution and shall continue for a term of twenty-five (25) years from the above date, as herein provided and shall be binding upon the successors, heirs and assigns of the Lessors and Lessee.

2. USE OF PROPERTY: The above described property shall be used only for a solid waste disposal site.

3. SPECIAL CONDITIONS: The County shall exercise reasonable care in maintaining the premises, including access roads, and in controlling fire, insects, rodents, and other hazards associated with garbage disposal sites. The County shall implement a Rodent Control Program in keeping with the State regulations and in all respects operate said site in accordance with State Law.

4. BREACH OF CONDITIONS: In the event that Johnson or their successors in title should be of the opinion that the County has breached the terms of this agreement, the County shall be given written notice thereof, setting forth the allegations as to the specific breach or breaches which are deemed to have

admission of a breach. Following the expiration of said 60 day period, Johnson or their successors in title, shall have the right to apply to the Courts for an Order or Judgment requiring specific performance by the County of the terms of the Lease, and such action on the part of Johnson shall be the exclusive remedy of Johnson in connection with any allegation of breach by the County, it being specifically agreed that no monetary damages shall be payable to or claimed by Johnson in connection with any breach alleged or determined to have been made and neither shall any breach or breaches by County constitute or effect a termination of the Lease.

5. COST OF THE LEASE:

(a) The County shall pay to Johnson the sum of $1,500.00 per acre for 50 acres of land or $75,000.00. This sum shall be paid in three (3) equal payments as follows:

$25,000.00 upon execution of this lease;

$25,000.00 on January 10, 1977 and

$25,000.00 on January 10, 1978.

(b) The County agrees to pay an additional sum annually as rent which sum shall be equal to the amount by which County property taxes exceed $125.00. (Taxes for 1975 on the premises were about $80.75.)

6. ADDITIONAL COUNTY OBLIGATIONS:

(a) The County shall leave and not use a 25 foot border inside all property lines and not use the area within such border for solid waste disposal purposes.

(b) Harnett County agrees to keep all access roads and SR #1725 clear of debris and waste athat might be caused by the operation of the sanitary landfill.

(c) If this lease is terminated as hereinabove provided, the County agrees to provide cover material to the solid waste disposal site and seed the site in accordance with State Health Regulations governing solid waste disposal.

7. ADDITIONAL LESSOR RIGHTS AND OBLIGATIONS:

8. WARRANTY: The Lessors covenant to and with the Lessee that they are seized and possessed of said premises in fee and have a right to convey the same in fee simple; that the same are free and clear of all encumbrances; that the Lessee is entitled to immediate possession of said premises; that they will warrant and defend the title to the same against the lawful claims of all persons whomsoever.

IN TESTIMONY WHEREOF, said Johnson and County have executed this Lease in duplicate, the original of which is retained by the County and a copy of which is retained by Johnson.

Paul Johnson Jr. (SEAL)
Paul Johnson, Jr.

Jeanette Daniel Johnson (SEAL)
Jeanette Daniels Johnson

COUNTY OF HARNETT

By: M H Brock
M. H. Brock, County Manager

ATTEST:

H. D. Carson, Jr., Clerk

* * * * * * * * * * * * *

NORTH CAROLINA

ACKNOWLEDGMENT

HARNETT COUNTY

I, Judith Ann Brock, a Notary Public in and for said State and County do hereby certify that PAUL JOHNSON, JR. and wife, JEANETTE DANIELS JOHNSON each personally appeared before me this day and acknowledged the due execution of the foregoing instrument.

Witness my hand and notarial seal, this 14 day of ~~February~~ April, 1976.

Judith Ann Brock

NORTH CAROLINA

HARNETT COUNTY

ACKNOWLEDGMENT

I, Rachel W. Blanchard, a Notary Public in and for said State and County, do hereby certify that H. D. CARSON, JR. personally appeared before me this day and who being by me duly sworn, says that he knows the common seal of said County of Harnett, and is acquainted with M. H. Brock, who is the County Manager of said County; that he, the said H. D. Carson, Jr. is the Clerk of the Board of Commissioners of said County, and saw the said County Manager sign the foregoing instrument, and that the said Clerk as aforesaid, affixed said seal to said instrument, and that said Clerk signed his name in attestation of the execution of said instrument in the presence of the said County Manager of said County.

Witness my hand and notarial seal, this 23rd day of April, 1976.

Rachel W. Blanchard
Notary Public

My Commission Expires: July 24, 1976

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FILED
BOOK 637 PAGE 920-923
APR 23 2 36 PM '76
FLORA J. HILTON
REGISTER OF DEEDS
HARNETT COUNTY, N.C.

North Carolina-Harnett County
The foregoing certificate of Rachel W. Blanchard
Notary Public of Harnett County is certified to be correct.
This 23 day of April, 1976
Flora J. Hilton
Register of Deeds
Harnett County, N. C.

APPENDIX J

ZONING LETTER FROM HARNETT COUNTY FOR DUNN ERWIN FACILITY

McKIM & CREED

HARNETT COUNTY PLANNING BOARD

27 E. Harnett Street P. O. Box 65
LILLINGTON, NORTH CAROLINA 27546

Phone: (919) 893-3077
893-3078

March 14, 1985

Mr. C. T. Clayton, P.E.
Ragsdale Consultants
P. O. Box 760
1210 S. Main Street
Lillington, NC 27546

Dear Mr. Clayton:

I am writing to inform you that the proposed site for the sanitary landfill located off S. R. 1723 between Coats and Erwin poses no problems in terms of county planning regulations.

Since the county imposes no zoning regulations, the site is not in conflict with zoning law. Also, the site seems comparatively compatible to the subdivision activity and various land uses in the vicinity.

If I can be of further assistance, please let me know.

Sincerely yours,

Ervin G. Dobson

Ervin G. Dobson, Director
Harnett County Planning

EGD:waj

McKIM & CREED ENGINEERS, PA

243 NORTH FRONT ST.
WILMINGTON, NC 28401
919/343-1048 FAX 919/251-8282

SUITE 117, BUILDING I
5625 DILLARD ROAD
CARY, NC 27511
919/233-8091 FAX 919/233-8031

310 E. JOHNSTON STREET
P.O. BOX 1749
SMITHFIELD, NC 27577
919/934-7154 FAX 919/828-0501

ENGINEERS
SURVEYORS
ARCHITECTS
PLANNERS

McKIM & CREED