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DESIGN REPORT
HALIFAX COUNTY ASH MONOFILL

HALIFAX COUNTY SOLID WASTE DEPARTMENT

HAZEN AND SAWYER
Environmental Engineers & Scientists
RALEIGH, NORTH CAROLINA

MARCH 1992

HAZEN AND SAWYER
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April 23, 1992

SOLID WASTE SECTION
APR 27 1992

North Carolina Department of Environment,
Health, and Natural Resources
Solid Waste Management Division
Solid Waste Section
401 Oberlin Road
Raleigh, NC 27611

Attention: Mr. Jim Coffee, P.E.

Re: Construction Permit Application
Halifax County Ash Monofill
Aurelian Springs, NC
H&S Job No. 3720

APPROVED
DIVISION OF SOLID WASTE MANAGEMENT
DATE 5/12/93 BY JCH

Dear Sir:

The construction permit for the above referenced project is enclosed for your review. Applicable portions of the project were prepared in accordance with the North Carolina Solid Waste Management Rules (15A NCAL 135 Sections .0503 and .0504). The application consists of five items; a Design Report, a Construction Quality Assurance Plan and Operations Manual; Contract Specifications and Contract Drawings. Five copies have been enclosed for your review.

If you have any questions or comments regarding this project, please contact us at (919) 833-7152.

Yours very truly,

HAZEN AND SAWYER, P.C.

John D. Barnard

John D. Barnard, E.I.T.
Staff Engineer

Gregory N. Richardson

Gregory N. Richardson, Ph.D., P.E.
Associate

JDB:er
Enclosures

TABLE OF CONTENTS

REPORT

Introduction 1
Project Description 1
Ash Characteristics 2
Design Requirements 2
Site Development 5
Monitoring Plan 9
Landfill Components 9
Closure and Post-Closure Plan 14
Post Closure Utilization 15
Engineering Analyses 15
Summary 16

APPENDICES

A. Figures
   1. Cell 4 Upper Stormwater System Schematic A.1
   2. Riser Detail A.2

B. Slope Stability Analysis
   1. Introduction B.1
   2. Input Data Summary B.2
   3. Output Summary B.3
   4. Critical Factor of Safety Sketches B.4
   5. Sample Runs B.5

C. Synthetic Liner Calculations

D. Internal Stormwater Collection and Removal System Calculations

E. Erosion and Sedimentation Control Calculations

F. Property Description

G. Project Drawings

DESIGN REPORT

Halifax County is developing a lined coal ash monofill adjacent to the existing county MSW landfill facility. The county acquired an additional 88 acres of land immediately east of the existing site for the construction of this facility. This complex is located approximately 2 miles northwest of Aurelian Springs, N.C. on State Road 1417, and is operated by Mr. Jerry Williams, Director, Halifax County Solid Waste Department.

The total expanded landfill property consists of a total of approximately 180 acres. An unnamed stream divides the site from east to west. To date, landfilling operations have occurred south of this stream. The county was preparing to cross the stream and continue operations early in 1992. However, a vertical expansion of the southern area was designed and permitted in 1991, gaining the county an additional 5 to 7 years of disposal capacity south of the creek. A lined MSW cell is currently being designed to replace the unlined cells previously permitted for the northern portion of the site. This lined cell will be placed in operation following the closure of the vertical expansion. Currently, the northern portion of the site contains a demolition debris landfill as well as the scale, office and maintenance shop. The newly acquired land underwent an extensive site investigation early in 1991 to determine its site suitability for the ash landfill. Based on the results of the investigation, the county received approval for use of this site early in June, 1991. Since that time the design of the ash landfill has been completed.

PROJECT DESCRIPTION

The proposed ash monofill will accept fly and bottom ash from a coal-fired cogeneration facility currently under construction in Weldon, North Carolina. Approximately 120,000 tons, 126,000 cubic yards, of ash will be generated and

disposed of annually. The monofill has sufficient capacity to accept this annual volume of ash for approximately 25 years.

WASTE CHARACTERISTICS

Two distinct ashes will be generated during the operation of the cogeneration facility; a granular bottom ash and a fine flue gas desulphurized (FGD) fly ash. Bottom ashes are typically very stable, high permeability type materials which make good drainage layers or daily covers. FGD ashes are typically low permeability, relatively stable, though highly erodible materials. Permeabilities range from 1.1×10^{-7} to 3.1×10^{-9} cm/sec in the FGD ash. The two ashes will normally come mixed together from the plant. Therefore, there will be no practical way to assure a uniform distribution of the granular material within the waste mass. Slope stability analyses performed on the facility indicate the ash to be stable both statically and under seismic loading. Placement will be controlled in order to keep the waste stable and to lower the amount of surface erosion.

DESIGN REQUIREMENTS

The design of the ash monofill addresses 3 separate sets of requirements; client requirements, general state regulation requirements, and state mandated site specific requirements.

The client for this project, Halifax County and Westmoreland Hadson Partners set forth their requirements at the outset of the project. They have five basic requirements; twenty five years disposal capacity, guaranteed permitted disposal capacity, cost effective disposal, ease of construction, operation and maintenance, and the ability to close at almost any point if other ash uses were found.

General regulation requirements are covered in section .0503 of the North Carolina Solid Waste Management Rules. Section .0503(1) was addressed during the site suitability phase of the project. Section .0503(2) is addressed by the design.

The physical nature of the ash makes the explosive gas and burning sections of these regulations irrelevant and requires modification of the leachate management plan. The ash will not burn, will not generate gas and unlike MSW, the ash has a very low permeability such that it does not create leachate. The main function of the 'leachate' removal system for this facility is to provide stormwater retention to separate the ash sediments from the runoff. Once the ash has settled out of the storm water, the water can be discharged as runoff, similar to sedimentation practices.

Access to the monofill will be controlled by the existing gate and scale house at the landfill. All access roads will come from the scale where the incoming trucks will be weighed. No other access will be allowed to the monofill.

The monofill is designed to meet or exceed the requirements of the National Pollutant Discharge Elimination System. The Erosion and Sedimentation Control System incorporates permanent measures, such as swales, drop inlets, pipes and sedimentation basins as well as temporary measures, such as silt fences, to control runoff from all phases of the landfill construction and operation. These measures are designed to eliminate discharge of pollutants into the small creek which borders the site to the south.

The ash monofill is the first in the state which incorporates a synthetic liner, 'leachate removal' system, capping system, and minimum 5' waste to groundwater separation. The design uses a 60 mil HDPE liner to separate the ash from the existing soil profile. A leachate removal system is incorporated which allows for the removal of ash sediment from surface water within the landfill. Due to the low permeability of the waste, a traditional leachate collection layer has not been incorporated because

surface water percolation through the ash will be negligible. For the same reason, a simple closure cap configuration of 12" of compacted soil and 12" of vegetative soil can be used. In this facility, the waste actually has a lower permeability than the cap.

A groundwater monitoring system has been proposed which incorporates 5 permanent monitor wells surrounding the largest footprint of the landfill. To augment these 5 permanent wells, 2 "floating" wells will be used. These two wells will be installed down gradient from the active intermediate berm. As the facility expands, the wells will be moved and the previous set will be abandoned. This type of system should allow for early detection of groundwater problems.

The closure and post closure of this facility will be much simpler than a MSW facility. This facility should experience no settlement, and will not generate gases. Therefore no gas vent or subsidence monitoring will be necessary. The annual inspection of the facility will concentrate on insuring the operation of the surface water system, inspection for surface erosion, and checking the vegetation on the cap. Due to the erodibility of the native soils as well as the ash, erosion must be kept in check through periodic maintenance of the cap vegetation and the surface water control system. Large trees should not be a problem on this cap because deep tap roots would enter the dry ash and tree could not survive. However certain types of shallow root system vegetation could grow readily on the facility. Regular mowing and seeding will be required.

Site specific requirements include MSW buffers and wetlands protection. Wetlands have been delineated along the stream in a band approximately 50′ wide. This, however, lies within the 50′ buffer requirement imposed on all streams. No development will occur within this zone. The remaining buffers are 500 feet from wells and residences and 300 feet from property boundaries. The site specific exception to the buffer regulations is a 100 foot buffer along the eastern property boundary. The waste boundary was delineated such that it meets or exceeds these requirements.

SITE DEVELOPMENT

The landfill footprint will encompass approximately 36 acres in plan area when fully developed. It will be constructed sequentially in four lined cells which keeps initial construction costs down, increases the reliability of the liner system and allows for design changes in the future as regulations and technology change. The total capacity of this facility will reach approximately 2.7 million cubic yards.

Working within state mandated buffer zones and the practical constraints of the terrain, the waste boundary, (defined as the interior crest of the perimeter berm) was developed. The perimeter berm will enclose the waste footprint with a berm which varies in height from 10 feet to 24 feet, has inside slopes of 2H:1V and outside slopes of 3H:1V. The perimeter berm crest is 10′ wide except along the western side of the facility, where it widens to 35′. This allows for an access road to be installed and maintained throughout the operational life of the facility. Inside the perimeter berms, three intermediate berms cross the facility from the west side to the east side parallel to the bottom contours.

The bottom of the facility was designed to maintain a minimum bottom slope of 1.5 percent and maintain a minimum waste to groundwater separation of 5 feet. The site naturally slopes from the northern ridge to the southern creek with an average slope of 6 percent. Grading the facility, while allowing for the minimum waste to groundwater separation and natural topography, yields simple, uniform bottom contours with slopes ranging from 1.5 to 4 percent.

The facility will be constructed from the highest portions of the site with subsequent cells added downgrade of the previous cell. Cell one is the northernmost cell and encompasses approximately one third of the total facility in plan area. It is bordered to the north and east by perimeter berms and to the south by the first intermediate berm. This berm begins approximately 75 feet south of the northwest corner and ends approximately one half of the distance from the northwest corner to

the intermediate berm at a slope of 1.5 percent. This cell will be filled to approximately elevation 350.

Cells two and three are roughly rectangular in shape and are similar in size. Together they encompass approximately one half the facility. Cell two is approximately 1450 feet by 200 feet with a bottom slope of 4 percent. It is bordered on the west and east by perimeter berms and to the north and south by intermediate berms. Cell three is approximately 1400 feet by 150 feet with a bottom slope of 3 percent. It is bordered to the east and west by perimeter berms and to the north and south by intermediate berms. Cells two and three will be filled to approximately elevations 360 and 370 feet respectively.

Cell four encompasses the remainder of the facility footprint and completes the perimeter berm system as well. It is bordered by an intermediate berm to the north and by perimeter berms on all remaining sides. The bottom has a slope of 2.5 percent with a minimum elevation of 286 feet. This cell is the final cell and is filled to a final elevation of 386 feet.

Each cell will be lined with a 60 mil HPDE liner above a prepared subgrade. The liner will be anchored in trenches on the crest of the perimeter and intermediate berms. An operational cover of a one foot layer of soil or select ash, will be placed above the liner on the bottom of the facility. No cover will be placed on the side slopes of the berms. This operational cover will be tracked in by a light dozer during placement, then smooth drum rolled to seal the surface.

The operational cover will consist of on-site soils in cell one and soil and ash in cells 2, 3, and 4. Cells two and three will have a 50′ wide strip of soil immediately upslope from their intermediate berm. Cell four will have a triangle of soil adjacent to the two southern perimeters berms and 50′ wide at the sump location. These soil strips are used as cover along the berms to facilitate cleanout of the toe stormwater impoundments. The soil is a distinctly different color than the ash sediments which

will accumulate in the impoundments. This color difference will signal to an equipment operator that the operational cover has been reached and that the impoundment is clean. Excavation past this point will lead to liner damage.

Each cell liner expansion is joined to the existing liner by seaming the new liner to the old liner along the intermediate berm. The new liner will be anchored in the berm in a new trench. A sheet of liner will then be extrusion welded to both the old and new liner sections. This sheet, called a "cap sheet", covers the crest of the intermediate berm between the two anchor trenches. This cap sheet also extends up the perimeter berm to the anchor trench where it is be anchored with the other liner. This will ensure a complete seal over the gap between the old and new liners.

The ash will be placed over the entire active area of the cell in 2 to 3 foot lifts. As each lift is placed, it will be compacted in place by the tracks of the dozer. A new lift will be initiated once the previous lift has been completely placed and compacted. Ash will not be placed within 30 feet of the intermediate berm to allow for stormwater retention in each cell. The interior or active face will be placed on a 3H:1V slope with benches located every 10 feet vertically. The exterior faces will be placed on a 4H:IV slope with benches located every 20 feet vertically. As the exterior faces and benches are completed to the lines and elevations shown on the Contract Drawings, the soil cap profile will be constructed and seeded. Newly constructed exterior faces and benches will be tied into existing faces and benches in order to complete the facility as depicted on the Contract Drawings.

Vehicle access for the landfill will be divided between the access road on the western perimeter berm and a ramp constructed on the north side of the landfill. The western access road will provide the initial access to each cell. Prior to filling operations, an ash ramp will be constructed to provide access from the top of the berm to the bottom of the cell. As filling progresses, this temporary ramp will be buried. At this stage, the ash will be placed to form a ramp from the perimeter berm up into the waste mass. Eventually, the ash will have been placed to an elevation

which makes this internal ramp usable. At this point, access will be moved to the permanent ramp on the north side of the facility. This ramp will be constructed sequentially beginning during filling operations in cell one. At the time when this ramp becomes active, a new ash ramp will be constructed from the top of the previous cell into the active cell. The previous internal ramp will be filled in from the top and filling operations will progress as before. The northern ramp will provide access to the facility cover for maintenance when the monofill closes.

External access roads and ramps will be surfaced with 12" layer of NCDOT spec aggregate base course. The temporary internal ash ramps will be surfaced with coarse bottom ash when possible. If this material is not available, the ramps will be kept open to traffic using aggregate base course where necessary.

The monofill will be closed sequentially. As a portion of the facility reaches final design elevation, the final soil cover will be placed and seeded. This continuous closure of finished areas is required to maintain the integrity of the facility. After the facility has been completely closed, monitoring and maintenance will continue for a period designated by State and Federal regulations.

TECHNICAL COMPONENTS

The ash monofill incorporates four distinct systems; the liner system, the leachate collection and removal system, the stormwater management system and the cap system. These four systems are designed to work together to minimize the impact of the monofill on the surrounding environment.

The liner system consists of three components; a prepared subgrade, a 60 mil HDPE synthetic liner and an operational soil or ash layer. The subgrade will be prepared by grading to the elevations shown in the plans, removing rocks greater than 1/2" in diameter and smooth drum rolling. The subgrade preparation will be monitored and tested to ensure compliance with all applicable specifications. Tests will include

proofrolling areas to determine weak zones and field density testing in fill areas to ensure proper compaction. Areas that are deemed acceptable will then be lined.

The liner will be 60 mil thick high density polyethylene (HDPE). It will be smooth sheet and will be seamed by either a double hot wedge seamer or an extrusion welder. The exact liner requirements are covered in detail in the contract specifications.

The last component of the liner system is the operational cover. It will be placed on the bottom of the facility only. Perimeter berm side slopes will not receive cover. The cover will be either soil or ash as indicated on the Contract Drawings. It will be placed by a low ground pressure dozer to a thickness of 1 foot. It will be compacted by the tracks of the dozer. The purpose of this cover is to protect the liner from damage which could be caused by equipment or wind.

Calculations were performed to evaluate the performance requirements of the liner system. Some of these include anchorage requirements, liner stresses due to self weight and waste placement, stresses due to wind lift and stresses due to subsidence of the subgrade or berms. These analyses all indicate the liner system is more than adequate for this facility.

The leachate collection and removal system is different for this facility than for a municipal solid waste facility. Most standard leachate collection systems consist of a drainage layer and system of pipes which collect leachate throughout the footprint of the cell. The pipe system then routes the leachate out of the facility and into the leachate basin where it is pretreated.

This facility is being developed to contain ash, a waste which cannot use a standard leachate collection system. A standard system will not work with the ash due to the extremely low permeability of the material; water cannot easily percolate through the waste. The majority of rainwater which falls on the ash will become

runoff. The inherit erodibility of the ash in conjunction with the large quantity of runoff will create sedimentation problems. Therefore, a leachate collection system for this facility needs no under waste collectors but rather a large, open area in which the runoff can be stored for a period of time to allow the ash particles to fall out of suspension.

The leachate collection system for this facility consists of sedimentation basins constructed within the cells. Runoff will collect in this basin and will be held there long enough for any sediment to settle out. A sump located in each cell will allow water to be removed fast enough to drain the basin in approximately twenty-four hours. The sump will be connected to a basin outside the facility which will act as a secondary settling basin. This second basin will allow any escaping sediment to settle out prior to discharging the water to the unnamed creek.

The interior sedimentation basins will be constructed in cells 1, 2 and 3 along the length of the intermediate berm by placing ash no closer than thirty feet from the toe of the intermediate berm. This will form a basin which has an intermediate berm as one side, perimeter berms as ends and a 3H:1V ash face as the fourth side. The sump for each cell will be placed at the toe of the intermediate berm half the distance from one perimeter berm to the other. This basin is capable of containing the twenty-five year storm with over 1 foot of freeboard, and the one hundred year storm with approximately six inches of freeboard.

The sumps for these basins are thirty inch diameter, four and one-half feet high, one-inch nominal thickness prefabricated HDPE. Each sump is fitted with a 12 inch diameter HDPE pipe. The pipe is perforated inside the sump, and has bolt-up flanges at either end. The sumps will be filled with number 57 (NCDOT) washed stone covered with a 16 ounce geotextile. A HDPE riser will be cast into an antiflotation concrete collar and placed above each sump. Each riser will be wrapped with a filter geotextile to reduce the possibility of sediment entering the system. The riser can be reused in each new basin as they are constructed.

Cell four differs from the first three because the basin can not be left open for the life of the cell. The previous basins could be left open because the waste was being placed on a 3H:1V slope away from the basin. Each basin was filled only after the succeeding cell was operational. Therefore, cell four uses a variation of this system.

The initial lift in cell four will be placed similarly to the lifts in the previous cells, creating a basin along the southern perimeter berms. A sump is located in the low spot formed at the intersection of the southern perimeter berms. The waste will be placed to within three feet of the top of the perimeter berm, or to elevation 307. The standard sump and riser has been operating identically to the previous cells up to this point. Now, the riser must be extended vertically approximately 14 feet, or to approximately elevation 308. Ash can now be placed in the basin itself, while the riser will continue to operate. Waste will be placed in this manner up to elevation 307. Simultaneously, a soil and ash expansion berm will be constructed around the perimeter berm, typing into cell three contours at each end. This berm is 10 feet tall with 4H:1V outside slopes and 2H:1V inside slopes. It has 2 feet of soil on the outer slopes and on top. The interior of the berm will be constructed of select fly ash. This configuration will help maximize ash volume while maintaining the containment system. A new riser will be placed at the toe of this new berm in approximately the same plan location as the previous sump which has been abandoned. The new riser will be connected to a lateral pipe which flows to an eighteen inch header pipe placed in the berm. This pipe directs the leachate to the secondary basin, which will continue to operate as before. A schematic of this system is included as Figure 1 in the Appendix.

These new risers must be replaced as every 10 feet of ash is placed. Ash will be placed to within three feet of the berm crest before the next soil ash berm is constructed. This three foot depression allows for more than enough in-cell storage to accommodate the twenty five year storm. The risers and pipes have been designed to drain each area in approximately twenty four hours.

As cumbersome as this system seems, it is the only way to control leachate runoff in cell four. It is very similar to the system designed in the new vertical expansion to remove stormwater, so the operators will be somewhat familiar with the logistics of the operation.

The stormwater system is designed to be installed segmentally as the facility expands. New components will be located and connected to existing components. This segmented approach allows for any completed cover section to be covered by the stormwater removal system.

The cap has benches set every 20 feet vertically. These benches provide a break in the slope which both slows and collects runoff from a given area of side slope. Swales located in the bench carry the runoff to drop inlets located at the corners of the cap. These drop inlets are connected to the sediment basins by pipes ranging from 18 to 24 inches in diameter. The drop inlets are prefabricated concrete units which allows for easy installation and maintenance.

The sediment basins are sized according to North Carolina Sedimentation and Erosion Control Planning and Design Manual guidelines. Each basin accepts approximately half of the cap runoff, holds it for a sufficient time to allow sediment to settle then discharges it towards the unnamed stream.

These permanent measures are augmented by temporary measures, mainly silt fences. Silt fences will be placed down slope of all active construction areas. Once these areas have established vegetative covers the silt fences can be removed. However, until that time, they will be cleaned and repaired to ensure continuous operation. The sequential construction of the facility combined with the permanent and temporary erosion control measures should adequately protect the creek from any sedimentation problems. Design calculations for all components of the stormwater system are included in the Appendix.

The cap system of the facility consists of 12 inches of compacted solid below 12 inches of agricultural soil. This simple cap profile is all that is needed to keep water from infiltrating the facility. Due to the low permeability of the waste, a more complex composite cap would not increase the long term performance of the facility.

ENGINEERING ANALYSES

The previously discussed components have been analyzed to confirm their hydraulic performance within the facility. More analyses were performed to model the performance of the facility with respect to slope stability. The results of all analyses show that the facility will perform satisfactory.

POST CLOSURE UTILIZATION

Upon completion of the ash monofill, the overall landfill complex will either be near closing or will have been expanded latedally. If the facility is closed, it will have to be monitored and maintained for thirty years. During this time, only county maintenance and monitoring personnel will be allowed access. If the MSW facility has been expanded, the ash monofill will still be part of the complex, and therefore will continue to be maintained and monitored.

SUMMARY

The Halifax County Ash Monofill will be the first lined ash facility in North Carolina. It will provide approximately twenty five years of permitted disposal for the Roanoke Valley Cogeneration Facility being developed in Weldon, North Carolina. The landfill incorporates best-available-technology liners, leachate collection systems, and stormwater collection and removal systems to provide a safe, cost effective, disposal alternative for coal ash.

APPENDICES

Halifax County Ash Monofill

Design Report

APPENDIX A: Figures

APPENDIX B: Slope Stability Analyses

APPENDIX C: Synthetic Liner Calculations

APPENDIX D: Internal Stormwater Collection and Removal System Calculations

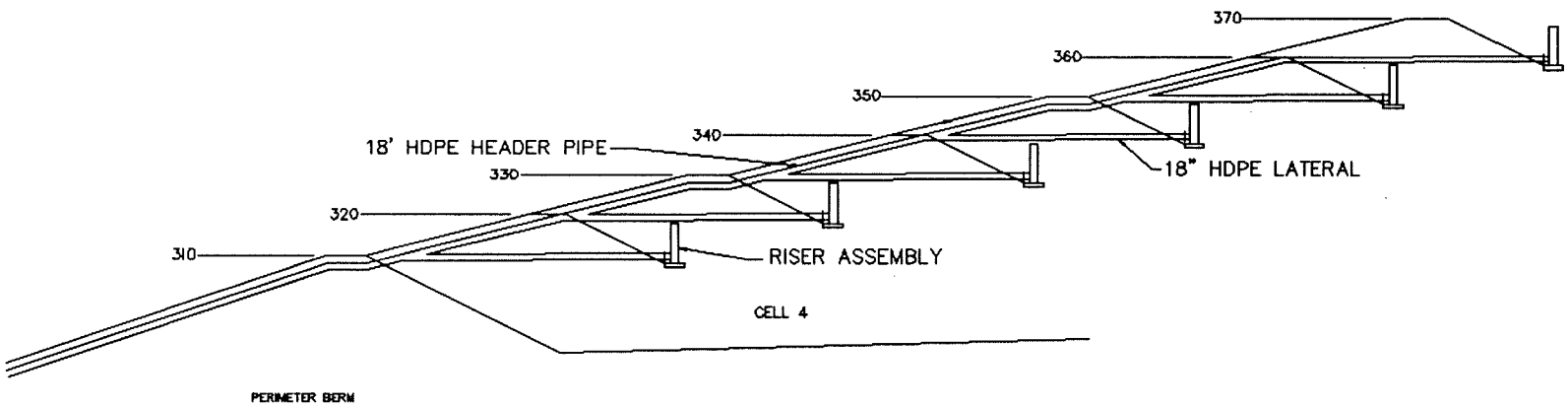
APPENDIX E: Erosion and Sedimentation Control Calculations

APPENDIX F: Property Description

APPENDIX G: Project Drawings

APPENDIX A:

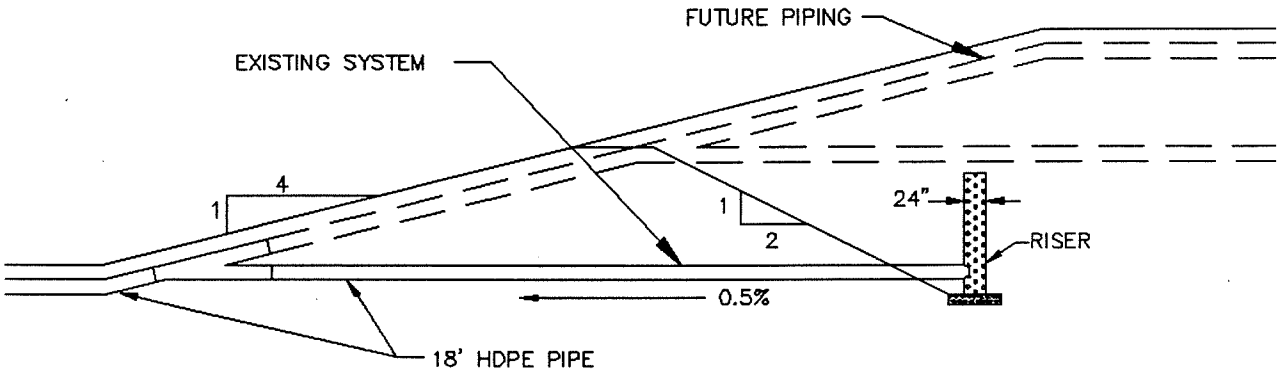
FIGURES



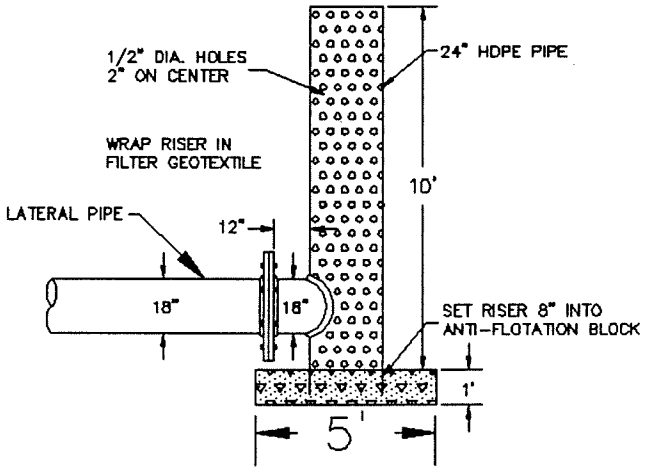
NOTE: ① SCHEMATIC SHOWS RELATIVE LOCATIONS OF EACH LIFT'S RISER, LATERAL HEADER. SEE CELL 4 FINAL CONTOURS (SHEET 16) FOR PLAN LOCATION OF HEATER PIPE

② RISERS SHALL BE BURIED AS NEXT STAGE OF FILLING PROGRESSES.

FIGURE 1. CELL 4 RISER/HEADER SCHEMATIC



CELL 4 RISER/LATERAL DETAIL



CELL 4 UPPER RISER

FIGURE 2. RISER AND LATERAL DETAILS

APPENDIX B:

SLOPE STABILITY ANALYSIS

SLOPE STABILITY ANALYSIS

Slope Stability Analyses were performed on this facility using Purdue University's STABL4. A critical section was determined and an analysis of each phase of landfilling was performed. Each phase was analyzed both statically and dynamically using a lateral acceleration of 0.05g. Failure surfaces were generated using block surfaces or circular surfaces depending upon which was more appropriate. Minimum factors of safety for similar facilities are 1.3 for nonseismic and 1.0 for seismic analyses. Every landfilling phase performed adequately under both scenarios. A summary of input data, sketches of minimum factor of safety failure planes, and a summary of results are included in this section.

INPUT DATA SUMMARY

Soil Types

Soil 1: Compacted On-Site Material

Soil 2: Loosely Compacted On-Site Material

Soil 3: Ash

Soil Data

Soil No.	1	2	3
Total Unit Weight (pcf)	105	90	85
Saturated Unit Weight (pcf)	120	110	100
Cohesion (psf)	400	0	0
Friction Angle (deg.)	20	12.5	28.5

SOIL DATA FROM TESTING PERFORMED DURING SITE SUITABILITY STUDY SUBMITTED BY ENSCI CORPORATION, MARCH, 1991.
ASH DATA ASSUMPTIONS BASED ON STUDIES OF SIMILAR ASH TYPES

HALIFAX COUNTY ASH MONOFILL
SLOPE STABLITY SUMMARY

MINIMUM FACTOR OF SAFETY	1.3	1.0

	MINIMUM F.S.	
PROFILE	CASE 1	CASE 2
1A	2.444	1.669
1B	2.211	1.573
1C	1.457	1.166
1D	1.519	1.204
2A	2.033	1.626
2B	2.242	1.591
2C	1.584	1.244
2D	1.463	1.171
2E	1.563	1.260
2F	1.563	1.260
3A	1.761	1.341
3B	1.372	1.106
3C	1.322	1.108
3D	1.374	1.108
3E	1.374	1.108
3F	1.374	1.108
3G	1.373	1.108
4A	2.183	1.797
4B	2.177	1.792
4C	2.346	1.914
4D	2.292	1.887
4E	2.467	1.991
4F	2.472	2.000
4G	2.407	1.949

CASE 1: NO SEISMIC LOADING
CASE 2: HORIZONTAL SEISMIC LOADING = 0.05g

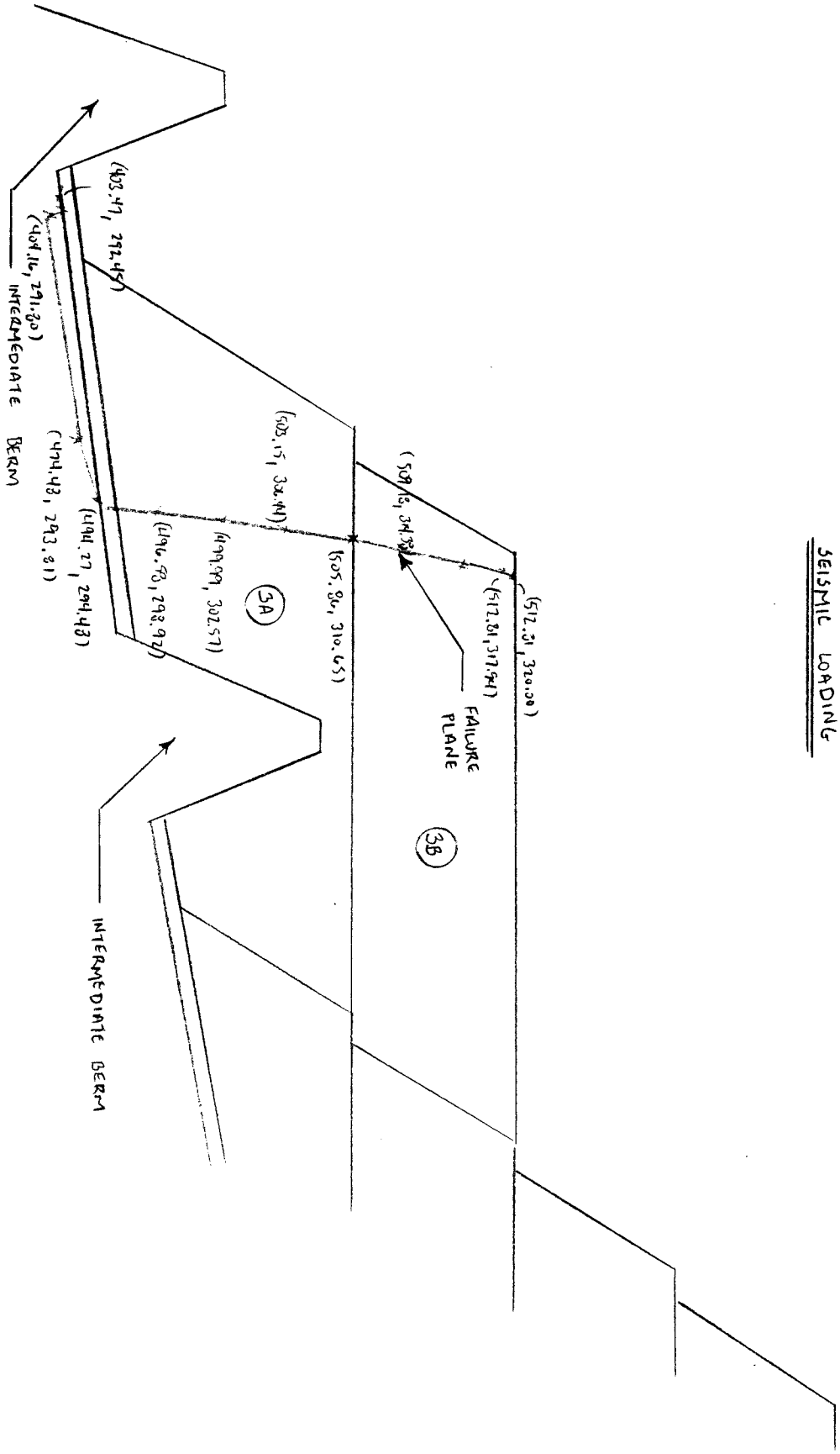
NOTES:
1. PROFILE DESIGNATIONS DENOTE INCREMENTAL FILLING PHASES
2. STABILITY ANALYSES PERFORMED USING STABL4
3. PROFILES 1D, 2F, 3G AND 4I DENOTE EACH CELL'S FINAL CONTOURS

HAZEN AND SAWYER
Environmental Engineers & Scientists

HALIFAX COUNTY ASH MONOFILL
SLOPE STABILITY
MINIMUM FACTOR OF SAFETY FAILURE PLANE

Date 2-27-92 4 of 5
By SAS Chkd. JDB
Job 3720

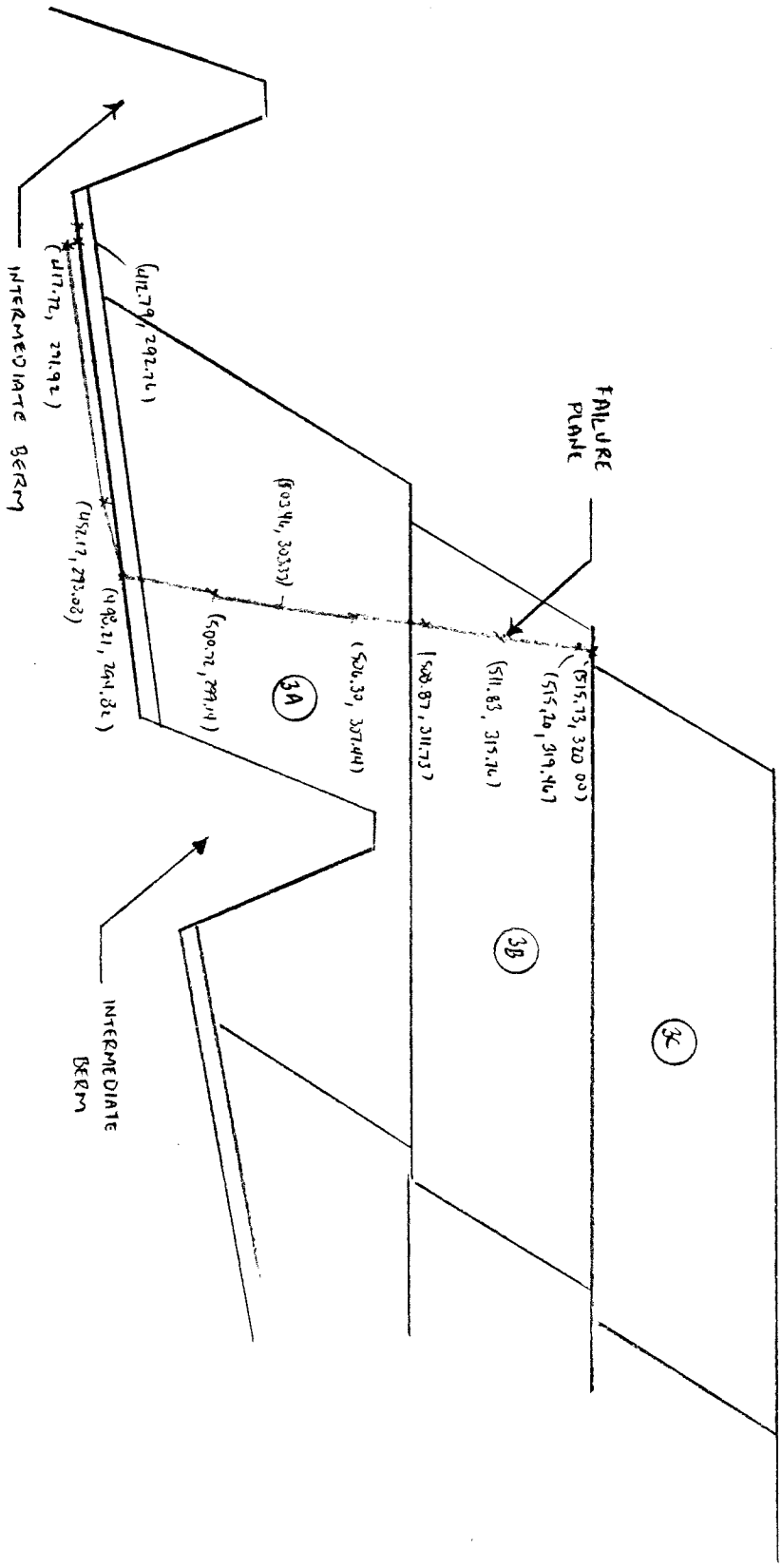
CELL 3B
SEISMIC LOADING



HAZEN AND SAWYER
Environmental Engineers & Scientists

HALIFAX COUNTY ASH MONOFILL
SLOPE STABILITY
MINIMUM FACTOR OF SAFETY FAILURE PLANE

Date 2-27-92 5 of 5
By SAJ Chkd. JDB
Job 3720



** PCSTABL4 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu Method of Slices
or Simplified Bishop Method

Run Date:	1-28-92
Time of Run:	13:44
Run By:	JDB
Input Data Filename:	CELL1D1.IN
Output Filename:	CELL1D1.OUT

PROBLEM DESCRIPTION HALIFAX COUNTY ASH CELL 1D

BOUNDARY COORDINATES

19 Top Boundaries
24 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	592.00	297.00	796.00	305.00	1
2	796.00	305.00	820.00	316.00	1
3	820.00	316.00	830.00	316.00	1
4	830.00	316.00	848.00	306.00	1
5	848.00	306.00	877.00	307.00	2
6	877.00	307.00	920.00	320.00	3
7	920.00	320.00	930.00	320.00	3
8	930.00	320.00	960.00	330.00	3
9	960.00	330.00	970.00	330.00	3
10	970.00	330.00	1000.00	340.00	3
11	1000.00	340.00	1010.00	340.00	3
12	1010.00	340.00	1040.00	350.00	3
13	1040.00	350.00	1250.00	350.00	3
14	1250.00	350.00	1330.00	330.00	3
15	1330.00	330.00	1340.00	330.00	3
16	1340.00	330.00	1380.00	320.00	3
17	1380.00	320.00	1385.00	320.00	1

18	1385.00	320.00	1410.00	312.00	1
19	1410.00	312.00	1425.00	310.00	1
20	877.00	307.00	1350.00	314.00	2
21	852.00	305.00	1347.00	313.00	1
22	1347.00	313.00	1350.00	314.00	1
23	1350.00	314.00	1365.00	320.00	1
24	1365.00	320.00	1380.00	320.00	1

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	105.0	120.0	400.0	20.0	.00	.0	1
2	90.0	110.0	.0	12.5	.00	.0	1
3	85.0	100.0	.0	28.5	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	276.00
2	175.00	280.00
3	800.00	300.00
4	1425.00	305.00

A Horizontal Earthquake Loading Coefficient
Of .050 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

25 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 5.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	850.00	305.50	877.00	306.50	1.00
2	950.00	308.00	1150.00	310.50	1.00

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method *

*

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	855.79	306.27
2	856.64	305.48
3	988.12	308.60
4	991.29	312.47
5	993.99	316.68
6	997.32	320.41
7	1000.83	323.97
8	1001.10	328.96
9	1003.29	333.46

10	1004.81	338.22
11	1005.67	340.00

*** 1.204 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	871.66	306.82
2	872.21	306.63
3	985.49	308.60
4	986.39	313.52
5	989.92	317.06
6	992.48	321.35
7	995.84	325.06
8	998.42	329.34
9	1001.63	333.18
10	1004.55	337.23
11	1007.32	340.00

*** 1.218 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	862.08	306.49
2	863.44	305.57
3	1029.14	308.84
4	1031.54	313.22
5	1035.08	316.76
6	1037.24	321.27
7	1037.91	326.22
8	1041.41	329.80
9	1042.03	334.76
10	1045.28	338.57
11	1048.06	342.72
12	1051.21	346.60
13	1051.85	350.00

*** 1.254 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	873.25	306.87
2	873.71	306.44
3	1029.43	309.29
4	1032.84	312.94
5	1036.15	316.69
6	1039.21	320.65
7	1042.41	324.48
8	1044.28	329.12
9	1045.42	333.99
10	1048.79	337.69
11	1052.32	341.22
12	1053.52	346.08
13	1054.55	350.00

*** 1.325 ***

1

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	850.02	306.07
2	852.49	305.10
3	969.52	308.37
4	972.95	312.01
5	976.47	315.55
6	977.03	320.52
7	977.30	325.52
8	978.72	330.31
9	982.25	333.85
10	982.44	334.15

*** 1.380 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	864.88	306.58
2	866.26	306.12
3	1048.47	309.18
4	1049.95	313.96
5	1053.42	317.56
6	1054.39	322.47
7	1057.89	326.03
8	1059.37	330.81
9	1060.40	335.70
10	1063.49	339.63
11	1066.63	343.53
12	1069.96	347.26
13	1072.19	350.00

*** 1.383 ***

1

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	867.52	306.67
2	869.06	306.46
3	996.18	308.83
4	998.58	313.21
5	1002.10	316.76
6	1003.64	321.52
7	1004.75	326.40
8	1007.55	330.54
9	1011.08	334.08
10	1012.90	338.74
11	1015.75	341.92

*** 1.523 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	860.54	306.43
2	861.47	305.52

3	1089.93	310.09
4	1092.88	314.13
5	1096.40	317.67
6	1099.54	321.57
7	1102.09	325.87
8	1103.25	330.73
9	1106.00	334.91
10	1107.28	339.74
11	1110.11	343.87
12	1113.64	347.40
13	1114.29	350.00

*** 1.542 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	865.45	306.60
2	865.66	306.42
3	1075.67	309.46
4	1078.52	313.57
5	1081.72	317.41
6	1085.24	320.96
7	1088.20	324.99
8	1088.81	329.95
9	1089.50	334.90
10	1092.42	338.96
11	1093.55	343.83
12	1094.25	348.78
13	1095.45	350.00

*** 1.545 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	859.06	306.38
2	859.21	306.23
3	1100.13	309.58
4	1101.40	314.42
5	1104.69	318.18

6	1107.89	322.03
7	1111.39	325.60
8	1114.89	329.16
9	1118.43	332.70
10	1121.83	336.36
11	1125.26	340.00
12	1128.02	344.17
13	1130.24	348.65
14	1131.03	350.00

*** 1.611 ***

1

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                Y            A     X     I     S            F     T

                .00    178.13    356.25    534.38    712.50    890.63

X          .00 +----------+----W----+---------+---------+---------+
               -
               -
               -
               -
               -
       178.13 +               W
               -
               -
               -
               -
               -
A      356.25 +
               -
               -
               -
               -
               -
X      534.38 +
               -
               -                *
               -
               -
               -
I      712.50 +
               -
               -
               -                *
               -                 *
               -                *
S      890.63 +                 *
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                 -                  *
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                 -                 11*
                 -                 71*
                 -                 333*
       1068.75 +                   9664
                 -                 8889
                 -                 .008
                 -                 ....
                 -                    .
                 -
   F   1246.88 +                     *
                 -
                 -
                 -                  **
                 -                  *
                 -                  *
   T   1425.00 +                   *
^Z
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** PCSTABL4 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu Method of Slices
or Simplified Bishop Method

Run Date:	1-28-92
Time of Run:	14:03
Run By:	JDB
Input Data Filename:	CELL2F1.IN
Output Filename:	CELL2F1.OUT

PROBLEM DESCRIPTION HALIFAX COUNTY ASH CELL 2F

BOUNDARY COORDINATES

25 Top Boundaries
38 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	392.00	290.00	535.00	295.00	1
2	535.00	295.00	560.00	308.00	1
3	560.00	308.00	570.00	308.00	1
4	570.00	308.00	590.00	298.00	1
5	590.00	298.00	617.00	299.00	1
6	617.00	299.00	650.00	310.00	3
7	650.00	310.00	660.00	310.00	3
8	660.00	310.00	690.00	320.00	3
9	690.00	320.00	700.00	320.00	3
10	700.00	320.00	730.00	330.00	3
11	730.00	330.00	740.00	330.00	3
12	740.00	330.00	770.00	340.00	3
13	770.00	340.00	780.00	340.00	3
14	780.00	340.00	810.00	350.00	3
15	810.00	350.00	820.00	350.00	3
16	820.00	350.00	850.00	360.00	3
17	850.00	360.00	1200.00	360.00	3

18	1200.00	360.00	1240.00	350.00	3
19	1240.00	350.00	1250.00	350.00	3
20	1250.00	350.00	1330.00	330.00	3
21	1330.00	330.00	1340.00	330.00	3
22	1340.00	330.00	1380.00	320.00	3
23	1380.00	320.00	1385.00	320.00	1
24	1385.00	320.00	1410.00	312.00	1
25	1410.00	312.00	1425.00	310.00	1
26	820.00	316.00	830.00	316.00	1
27	800.00	306.00	820.00	316.00	1
28	617.00	299.00	800.00	306.00	2
29	590.00	298.00	592.00	297.00	1
30	592.00	297.00	796.00	305.00	1
31	796.00	305.00	800.00	306.00	1
32	830.00	316.00	848.00	306.00	1
33	848.00	306.00	1350.00	314.00	2
34	848.00	306.00	852.00	305.00	1
35	852.00	305.00	1347.00	313.00	1
36	1347.00	313.00	1350.00	314.00	1
37	1350.00	314.00	1365.00	320.00	1
38	1365.00	320.00	1380.00	320.00	1

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	105.0	120.0	400.0	20.0	.00	.0	1
2	90.0	110.0	.0	12.5	.00	.0	1
3	85.0	100.0	.0	28.5	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	276.00
2	175.00	280.00
3	800.00	300.00
4	1425.00	305.00

A Horizontal Earthquake Loading Coefficient
Of .050 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

25 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 5.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	591.00	297.50	617.00	298.50	1.00
2	618.00	298.50	715.00	302.00	1.00
3	716.00	302.00	800.00	305.50	1.00

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method *

*

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	601.59	298.43
2	603.22	298.16
3	694.23	301.53
4	738.66	302.88
5	742.03	306.57
6	745.18	310.45
7	747.84	314.69
8	751.29	318.30
9	754.30	322.29
10	757.05	326.47
11	758.76	331.17
12	761.91	335.06
13	765.21	338.40

*** 1.260 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	606.46	298.61
2	606.52	298.58
3	713.57	302.27
4	783.79	304.50
5	785.41	309.24
6	786.31	314.15
7	789.84	317.69
8	792.40	321.99
9	795.76	325.69
10	798.34	329.97
11	801.55	333.81
12	804.47	337.87
13	808.01	341.41
14	810.44	345.77
15	811.65	350.00

*** 1.270 ***

1

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	614.19	298.90
2	615.30	298.47
3	712.58	302.15
4	782.60	305.19
5	785.23	309.44
6	786.07	314.37
7	787.22	319.24
8	790.73	322.80
9	792.28	327.55
10	792.57	332.55
11	796.09	336.09
12	797.34	340.93
13	800.79	344.55
14	801.66	347.22

*** 1.292 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	599.58	298.35
2	600.13	298.26
3	680.61	300.79
4	768.37	304.60
5	769.87	309.37
6	771.53	314.09
7	773.94	318.46
8	777.13	322.32
9	779.61	326.66
10	782.40	330.81
11	784.33	335.42
12	785.74	340.22
13	786.64	342.21

*** 1.296 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	601.01	298.41
2	603.59	297.51
3	698.46	301.84
4	769.73	304.50
5	772.57	308.62
6	774.08	313.38
7	775.48	318.18
8	779.01	321.73
9	782.44	325.36
10	784.61	329.87
11	785.49	334.79
12	788.44	338.83
13	789.52	343.17

*** 1.303 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	593.91	298.14
2	595.32	297.44
3	644.30	299.82
4	766.96	304.47
5	770.27	308.22
6	772.70	312.58
7	776.24	316.12
8	779.21	320.14
9	781.31	324.68
10	782.21	329.59
11	784.76	333.89
12	787.84	337.84
13	789.27	342.63
14	789.90	343.30

*** 1.313 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	594.74	298.18
2	594.94	298.02
3	628.49	299.16
4	788.04	304.89
5	791.37	308.62
6	794.52	312.50
7	796.09	317.25
8	799.36	321.03
9	799.46	326.03
10	802.50	330.00
11	804.12	334.73
12	806.28	339.24
13	808.29	343.82
14	809.93	348.54
15	811.36	350.00

*** 1.320 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	599.43	298.35
2	600.82	298.29
3	681.86	300.73
4	795.87	305.29
5	799.01	309.18
6	802.44	312.82
7	805.81	316.51
8	806.98	321.38
9	807.57	326.34
10	808.56	331.24
11	812.10	334.78
12	812.13	339.78
13	813.31	344.64
14	815.25	349.24
15	815.75	350.00

*** 1.323 ***

1

Failure Surface Specified By 13 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	612.77	298.84
2	613.70	297.97
3	618.92	298.13
4	768.60	304.42
5	772.12	307.96
6	772.68	312.93
7	772.95	317.92
8	774.36	322.72
9	777.90	326.26
10	780.60	330.46
11	783.14	334.77
12	785.66	339.09
13	787.02	342.34

*** 1.344 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	607.02	298.63
2	607.45	298.27
3	646.72	299.41
4	781.85	304.44
5	782.19	309.43
6	783.22	314.32
7	786.59	318.01
8	790.08	321.60
9	793.14	325.55
10	795.54	329.93
11	798.25	334.14
12	801.05	338.28
13	803.97	342.34
14	805.55	347.08
15	806.04	348.68

*** 1.349 ***

1

Y A X I S F T

.00 178.13 356.25 534.38 712.50 890.63

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X        .00 +---------+----W----+---------+---------+---------+
             -
             -
             -
             -
             -
     178.13 +                W
             -
             -
             -
             -
             -
A    356.25 +
             -                *
             -
             -
             -
             -
X    534.38 +                  *
             -                 *
             -                 *
             -                 *
             -                 *
             -                 1*
I    712.50 +                  2*
             -                 11*
             -                 21*
             -                 *22*
             -                  * *
             -                 *  *
S    890.63 +
             -
             -
             -
             -
             -
    1068.75 +
             -
             -
             -
             -                    *
             -
F   1246.88 +                    *
             -
             -
             -                  **
             -                  *
             -                  *
T   1425.00 +                 *
^Z
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** PCSTABL4 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu Method of Slices
or Simplified Bishop Method

Run Date:	1-28-92
Time of Run:	14:16
Run By:	JDB
Input Data Filename:	CELL3G1.IN
Output Filename:	CELL3G1.OUT

PROBLEM DESCRIPTION HALIFAX COUNTY ASH CELL 3G

BOUNDARY COORDINATES

24 Top Boundaries
46 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	190.00	286.00	340.00	290.00	1
2	340.00	290.00	360.00	302.00	1
3	360.00	302.00	370.00	302.00	1
4	370.00	302.00	390.00	292.00	1
5	390.00	292.00	420.00	293.00	2
6	420.00	293.00	470.00	310.00	3
7	470.00	310.00	490.00	310.00	3
8	490.00	310.00	510.00	320.00	3
9	510.00	320.00	520.00	320.00	3
10	520.00	320.00	550.00	330.00	3
11	550.00	330.00	560.00	330.00	3
12	560.00	330.00	590.00	340.00	3
13	590.00	340.00	600.00	340.00	3
14	600.00	340.00	630.00	350.00	3
15	630.00	350.00	640.00	350.00	3
16	640.00	350.00	670.00	360.00	3
17	670.00	360.00	680.00	360.00	3

18	680.00	360.00	710.00	370.00	3
19	710.00	370.00	1160.00	370.00	3
20	1160.00	370.00	1240.00	350.00	3
21	1240.00	350.00	1250.00	350.00	3
22	1250.00	350.00	1330.00	330.00	3
23	1330.00	330.00	1340.00	330.00	3
24	1340.00	330.00	1385.00	320.00	3
25	1385.00	320.00	1410.00	312.00	1
26	1410.00	312.00	1425.00	310.00	1
27	420.00	293.00	537.00	296.00	2
28	390.00	292.00	392.00	290.00	1
29	392.00	290.00	535.00	295.00	1
30	535.00	295.00	537.00	296.00	1
31	537.00	296.00	560.00	308.00	1
32	560.00	308.00	570.00	308.00	1
33	570.00	308.00	590.00	298.00	1
34	590.00	298.00	800.00	306.00	2
35	590.00	298.00	592.00	297.00	1
36	592.00	297.00	796.00	305.00	1
37	796.00	305.00	800.00	306.00	1
38	800.00	306.00	820.00	316.00	1
39	820.00	316.00	830.00	316.00	1
40	830.00	316.00	848.00	306.00	1
41	848.00	306.00	1350.00	314.00	2
42	848.00	306.00	852.00	305.00	1
43	852.00	305.00	1347.00	313.00	1
44	1347.00	313.00	1350.00	314.00	1
45	1350.00	314.00	1365.00	320.00	1
46	1365.00	320.00	1385.00	320.00	1

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	105.0	120.0	400.0	20.0	.00	.0	1
2	90.0	110.0	.0	12.5	.00	.0	1
3	85.0	100.0	.0	28.5	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	276.00
2	175.00	280.00
3	800.00	300.00
4	1425.00	305.00

A Horizontal Earthquake Loading Coefficient
Of .050 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

25 Trial Surfaces Have Been Generated.

3 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 5.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	391.00	291.00	420.00	292.00	1.00
2	421.00	291.50	480.00	294.50	1.00
3	481.00	294.50	535.00	295.50	1.00

1

Following Are Displayed The Ten Most Critical Of The Trial

Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method *
*

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	414.41	292.81
2	416.68	292.23
3	426.79	292.07
4	532.99	295.02
5	536.44	298.64
6	537.99	303.40
7	541.21	307.22
8	543.36	311.74
9	546.15	315.89
10	549.67	319.44
11	552.74	323.38
12	555.92	327.25
13	557.78	330.00

*** 1.108 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	406.76	292.56
2	409.16	291.85
3	432.33	291.64
4	531.00	295.89
5	534.54	299.43
6	537.24	303.63
7	539.78	307.94
8	542.30	312.26
9	544.23	316.87
10	547.69	320.48
11	551.01	324.22
12	554.33	327.96
13	554.71	330.00

*** 1.122 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	396.10	292.20
2	397.92	290.77
3	456.94	293.41
4	526.10	295.46
5	529.43	299.19
6	532.28	303.30
7	535.48	307.14
8	539.00	310.70
9	541.96	314.72
10	542.57	319.68
11	543.26	324.64
12	546.18	328.69
13	546.19	328.73

*** 1.137 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	415.82	292.86
2	417.29	291.49
3	435.50	291.97
4	491.29	294.82
5	494.46	298.69
6	497.16	302.89
7	500.49	306.62
8	504.00	310.19
9	504.27	315.18
10	505.53	317.77

*** 1.142 ***

L

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	412.00	292.73
2	413.58	291.93
3	468.65	293.75
4	529.33	295.53
5	532.61	299.30
6	535.75	303.19
7	537.24	307.97
8	540.66	311.61
9	543.91	315.41
10	544.26	320.39
11	545.29	325.29
12	548.66	328.98
13	549.48	329.83

*** 1.158 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	405.05	292.50
2	408.42	291.18
3	466.79	294.17
4	507.69	294.54
5	511.03	298.26
6	514.47	301.89
7	515.48	306.79
8	518.67	310.64
9	519.26	315.60
10	522.27	319.60
11	523.71	321.24

*** 1.182 ***

1

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	395.10	292.17
2	396.32	291.18
3	465.10	293.49
4	509.42	295.19
5	511.23	299.85
6	512.29	304.74
7	515.77	308.33
8	518.98	312.17
9	522.09	316.08
10	522.71	320.90

*** 1.182 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	407.73	292.59
2	408.59	291.95
3	458.84	293.20
4	513.07	294.62
5	515.17	299.16
6	516.06	304.08
7	518.62	308.37
8	521.70	312.32
9	523.13	317.11
10	526.54	320.76
11	528.46	322.82

*** 1.216 ***

1

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	399.91	292.33
2	402.60	291.50
3	451.82	293.06
4	505.49	295.22
5	508.96	298.82
6	509.93	303.73
7	513.44	307.29
8	514.92	312.07

9	515.95	316.96
10	518.34	320.00

*** 1.216 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	402.39	292.41
2	405.64	291.21
3	471.61	294.04
4	507.36	294.69
5	508.14	299.63
6	510.06	304.25
7	511.72	308.96
8	515.11	312.65
9	516.79	317.35
10	517.16	320.00

*** 1.229 ***

1

```
            Y            A     X     I     S            F     T

            .00    178.13    356.25    534.38    712.50    890.63

X        .00 +---------+----W----+---------+---------+---------+
             -
             -
             -
             -
             -
     178.13 +               *
             -
             -
             -
             -
             -               *
A    356.25 +                *
             -               *.
             -               *
             -               2
```

```
                -                  5*
                -                   **
X     534.38    +                   **.
                -                   *1*
                -                   * *
                -                      *
                -                      *
                -                      *
I     712.50    +                       *
                -
                -
                -                   *
                -                    *
                -                   *
S     890.63    +
                -
                -
                -
                -
                -
    1068.75     +
                -
                -
                -                       *
                -
                -
F    1246.88    +                      *
                -
                -
                -                    **
                -                    *
                -                    *
T    1425.00    +                   *
^Z
```

** PCSTABL4 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu Method of Slices
or Simplified Bishop Method

Run Date:
Time of Run:
Run By:
Input Data Filename: CELL4I.IN
Output Filename: CELL4I.OUT

PROBLEM DESCRIPTION HALIFAX COUNTY ASH CELL 4I

BOUNDARY COORDINATES

18 Top Boundaries
46 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	280.00	45.00	290.00	1
2	45.00	290.00	55.00	290.00	1
3	55.00	290.00	115.00	310.00	1
4	115.00	310.00	125.00	310.00	1
5	125.00	310.00	205.00	330.00	3
6	205.00	330.00	215.00	330.00	3
7	215.00	330.00	295.00	350.00	3
8	295.00	350.00	305.00	350.00	3
9	305.00	350.00	385.00	370.00	3
10	385.00	370.00	765.00	386.00	3
11	765.00	386.00	1160.00	370.00	3
12	1160.00	370.00	1240.00	350.00	3
13	1240.00	350.00	1250.00	350.00	3
14	1250.00	350.00	1330.00	330.00	3
15	1330.00	330.00	1340.00	330.00	3
16	1340.00	330.00	1385.00	320.00	3
17	1385.00	320.00	1410.00	312.00	1
18	1410.00	312.00	1425.00	310.00	1
19	125.00	310.00	175.00	286.00	1

20	175.00	286.00	342.00	291.00	2
21	175.00	286.00	176.00	285.00	1
22	176.00	285.00	340.00	290.00	1
23	340.00	290.00	342.00	291.00	1
24	342.00	291.00	360.00	302.00	1
25	360.00	302.00	370.00	302.00	1
26	370.00	302.00	390.00	292.00	1
27	390.00	292.00	537.00	296.00	2
28	390.00	292.00	392.00	290.00	1
29	392.00	290.00	535.00	295.00	1
30	535.00	295.00	537.00	296.00	1
31	537.00	296.00	560.00	308.00	1
32	560.00	308.00	570.00	308.00	1
33	570.00	308.00	590.00	298.00	1
34	590.00	298.00	800.00	306.00	2
35	590.00	298.00	592.00	297.00	1
36	592.00	297.00	796.00	305.00	1
37	796.00	305.00	800.00	306.00	1
38	800.00	306.00	820.00	316.00	1
39	820.00	316.00	830.00	316.00	1
40	830.00	316.00	848.00	306.00	1
41	848.00	306.00	1350.00	314.00	2
42	848.00	306.00	852.00	305.00	1
43	852.00	305.00	1347.00	313.00	1
44	1347.00	313.00	1350.00	314.00	1
45	1350.00	314.00	1365.00	320.00	1
46	1365.00	320.00	1385.00	320.00	1

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	105.0	120.0	400.0	20.0	.00	.0	1
2	90.0	110.0	.0	12.5	.00	.0	1
3	85.0	100.0	.0	28.5	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 4 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	276.00
2	175.00	280.00
3	800.00	300.00
4	1425.00	305.00

A Horizontal Earthquake Loading Coefficient
Of .050 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

1

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

200 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 115.00 ft.
and X = 165.00 ft.

Each Surface Terminates Between X = 280.00 ft.
and X = 760.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y =270.00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Examined. They Are Ordered - Most Critical
First.

* * Safety Factors Are Calculated By The Modified Janbu Method *

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	128.16	310.79
2	138.09	311.98
3	148.00	313.31
4	157.89	314.78
5	167.76	316.41
6	177.60	318.17
7	187.41	320.09
8	197.20	322.14
9	206.96	324.34
10	216.68	326.68
11	226.36	329.17
12	236.01	331.80
13	245.62	334.57
14	255.19	337.48
15	264.71	340.53
16	274.19	343.72
17	283.62	347.05
18	284.51	347.38

*** 1.949 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	162.37	319.34
2	172.25	320.88
3	182.12	322.47
4	191.99	324.12
5	201.84	325.82
6	211.68	327.59
7	221.51	329.41
8	231.34	331.29
9	241.15	333.23
10	250.94	335.23
11	260.73	337.29
12	270.51	339.40
13	280.27	341.57
14	290.02	343.80

15	299.75	346.08
16	309.47	348.42
17	319.18	350.82
18	328.87	353.28
19	338.55	355.79
20	348.22	358.36
21	357.87	360.99
22	367.50	363.68
23	377.12	366.42
24	386.72	369.22
25	390.06	370.21

*** 1.968 ***

1

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	159.74	318.68
2	169.72	319.20
3	179.69	319.97
4	189.64	320.98
5	199.57	322.23
6	209.45	323.72
7	219.30	325.45
8	229.11	327.42
9	238.86	329.63
10	248.55	332.08
11	258.19	334.76
12	267.75	337.68
13	277.24	340.83
14	286.65	344.22
15	295.98	347.83
16	301.21	350.00

*** 1.972 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	159.74	318.68
2	169.73	318.91

3	179.72	319.43
4	189.69	320.23
5	199.63	321.32
6	209.53	322.69
7	219.40	324.35
8	229.21	326.30
9	238.96	328.52
10	248.64	331.02
11	258.24	333.80
12	267.76	336.86
13	277.19	340.19
14	286.52	343.78
15	295.75	347.65
16	300.94	350.00

*** 1.977 ***

1

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	130.79	311.45
2	140.79	311.62
3	150.78	312.01
4	160.76	312.63
5	170.73	313.48
6	180.67	314.56
7	190.58	315.86
8	200.47	317.38
9	210.31	319.13
10	220.12	321.10
11	229.87	323.29
12	239.58	325.71
13	249.22	328.34
14	258.81	331.20
15	268.32	334.27
16	277.77	337.55
17	287.14	341.05
18	296.42	344.76
19	305.62	348.68
20	312.90	351.98

*** 1.979 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	141.32	314.08
2	151.27	315.01
3	161.22	316.07
4	171.14	317.27
5	181.06	318.59
6	190.95	320.04
7	200.82	321.63
8	210.68	323.34
9	220.51	325.18
10	230.31	327.15
11	240.09	329.25
12	249.84	331.47
13	259.56	333.83
14	269.24	336.31
15	278.90	338.92
16	288.52	341.65
17	298.10	344.51
18	307.64	347.50
19	317.14	350.61
20	326.61	353.85
21	336.03	357.21
22	340.55	358.89

*** 1.989 ***

1

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	136.05	312.76
2	146.05	312.81
3	156.05	313.04
4	166.04	313.47
5	176.02	314.08
6	185.99	314.88
7	195.94	315.87
8	205.87	317.05
9	215.78	318.42
10	225.66	319.97
11	235.50	321.71
12	245.32	323.63
13	255.09	325.74
14	264.83	328.04

15	274.51	330.52
16	284.15	333.18
17	293.74	336.02
18	303.27	339.04
19	312.74	342.25
20	322.16	345.63
21	331.50	349.19
22	340.78	352.93
23	349.98	356.84
24	359.11	360.92
25	368.16	365.18
26	370.67	366.42

*** 1.990 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	149.21	316.05
2	159.20	316.50
3	169.18	317.08
4	179.16	317.79
5	189.12	318.63
6	199.08	319.61
7	209.01	320.72
8	218.94	321.96
9	228.84	323.33
10	238.73	324.83
11	248.59	326.46
12	258.44	328.23
13	268.26	330.12
14	278.05	332.15
15	287.81	334.30
16	297.55	336.59
17	307.26	339.00
18	316.93	341.54
19	326.56	344.21
20	336.17	347.01
21	345.73	349.93
22	355.25	352.98
23	364.73	356.16
24	374.17	359.46
25	383.57	362.88
26	392.92	366.44
27	402.22	370.11
28	403.88	370.80

*** 1.997 ***

1

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	125.53	310.13
2	135.51	309.56
3	145.51	309.25
4	155.51	309.18
5	165.50	309.38
6	175.49	309.82
7	185.47	310.52
8	195.42	311.47
9	205.35	312.68
10	215.24	314.13
11	225.10	315.84
12	234.91	317.79
13	244.66	320.00
14	254.35	322.45
15	263.98	325.14
16	273.54	328.08
17	283.02	331.26
18	292.42	334.68
19	301.73	338.34
20	310.94	342.23
21	320.05	346.36
22	329.05	350.71
23	337.94	355.29
24	346.71	360.10
25	347.69	360.67

*** 2.005 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	162.37	319.34
2	172.37	319.33
3	182.37	319.54
4	192.36	319.96
5	202.34	320.60
6	212.30	321.46

7	222.24	322.54
8	232.16	323.84
9	242.04	325.36
10	251.89	327.09
11	261.70	329.03
12	271.46	331.19
13	281.18	333.56
14	290.84	336.15
15	300.44	338.94
16	309.98	341.95
17	319.45	345.16
18	328.84	348.58
19	338.16	352.21
20	347.40	356.03
21	356.55	360.06
22	365.62	364.29
23	369.15	366.04

*** 2.005 ***

1

```
                Y            A     X     I     S            F     T

                .00    178.13    356.25    534.38    712.50    890.63

X          .00 +---------+----W*---+---------+---------+---------+
               -
               -               *
               -
               -                *.
               -               .51
       178.13 +               .*91
               -              ..91*
               -              ...11
               -              ...71
               -              ....1*
               -              .*..72
A      356.25 +               .**..27
               -              .*...8*
               -               .....8
               -               ......
               -               ......
               -               ......
X      534.38 +               .*....
               -               *....
               -               *....
               -                ....
               -                 ...
               -                 ...
```

```
I     712.50 +                    ...
             -                     ..
             -                      *
             -                 *
             -                  *
             -                 *
S     890.63 +
             -
             -
             -
             -
             -
    1068.75 +
             -
             -
             -                     *
             -
             -
F    1246.88 +                    *
             -
             -
             -                  **
             -                  *
             -                  *
T    1425.00 +                 *
^Z
```

APPENDIX C:

SYNTHETIC LINER CALCULATIONS

(I) LINER TENSILE STRESS DUE TO SELF WEIGHT

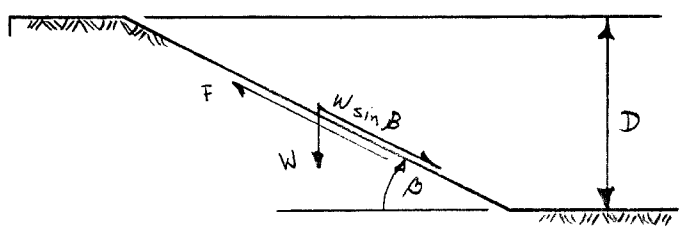
GIVEN: 60 MIL HDPE

SPECIFIC GRAVITY $G = 0.941$

FRICTION ANGLE $\delta_1 = 10°$

SLOPE HEIGHT $D = 24'$

SLOPE ANGLE $\beta = 26.6°$ (2:1)



(1) CALCULATE FML TENSILE FORCE, T

$T = W \sin\beta - F$

SLOPE LENGTH

W = LINER WEIGHT $= [G\,\gamma_w\,t][1 \times D/\sin\beta]$

$F = W \cos\beta \tan\delta_L$

$W = [0.941(62.4)(\frac{.060}{12})][1(24/\sin 26.6)]$

$W = [0.294][53.6]$

$W = 15.8$ lb/FT

$F = 15.8 \cos 26.6 \tan 10$

$F = 2.5$ lb/FT

MIN T

$T = 15.8 \sin 26.6 - 2.5$

$T = 4.6$ lb/FT

(2) CALCULATE FML TENSILE STRESS, σ (MAX & MIN)

MIN $\sigma = T/A$ $\sigma = 4.6/(.060/12) = 920$ lb/FT^2 = 6.4 psi

MAX $\sigma = 15.8/(.060/12) = 3160$ lb/FT^2 = 22 psi

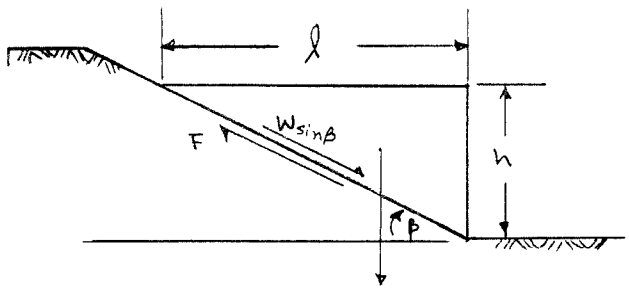
(3) CALCULATE DESIGN RATIO

FML YIELD STRESS = 2000 lb/in²

D.R. MIN = 2000/6.4 = 312.5 OK

D.R. MAX = 2000/22 = 91 OK

(II) LINER TENSILE STRESS DUE TO ASH PLACEMENT



NO GEOTEXTILE OVER GEOMEMBRANE

GIVEN:

LIFT THICKNESS, h = 10' WORST CASE
UNIT WT ASH γ = 80 PCF
SLOPE ANGLE β = 26.6
FRICTION ANGLE δ = 10°
60 MIL HDPE

(1) CALCULATE DOWN-DRAG FORCE ON FML, T

$T = W \cos\beta \tan\delta$

W = WEIGHT ASH = $\frac{1}{2}(h)(\gamma)(h/\tan 26.6)$

ASSUME WORST CASE: 10' LIFT ON FACE.

$W = \frac{1}{2}(10)(80)(10/\tan 26.6)$

$W = 7{,}988$ lb/FT

$T = 7{,}988 (\cos 26.6°) \tan 10°$

$T = 1{,}259.4$ lb/FT

$\sigma = T/t$ $\quad$ t = thickness = .060/12 = .005 FT

$\sigma = 1259.4 / .005 = 251{,}880 \text{ lb/FT}^2 \Rightarrow 1{,}749 \text{ lb/in}^2$

CALCULATE DESIGN RATIO

D.R. = YIELD/σ = 2000/1749 = 1.14 ⇒ MARGINAL

TRY H = 5'

$W = \frac{1}{2}(5)(80)(5/\tan 26.6)$

$W = 1{,}997$ lb/FT

LOWER BOUND: $T = 1997(\cos 26.6)(\tan 10)$

$T = 314.9$ lb/FT

$\sigma = 314.9/.005$

$\sigma = 437.3 \text{ lb/in}^2$

UPPER BOUND: $\delta = 15^\circ$

$T = 1997(\cos 26.6^\circ)(\tan 15^\circ)$

$T = 478$ lb/FT

$\sigma = 478/.005$

$\sigma = 665$ psi

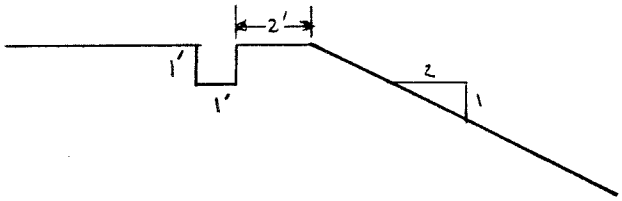
CALCULATE DESIGN RATIO (LOWER AND UPPER BOUNDS)

D.R. (LOWER) $= \frac{2000}{437} = 4.6$ OK

D.R. (UPPER) $= \frac{200}{665} = 3$ OK

ASH WILL BE PLACED IN 2-3 FOOT LIFTS, THESE CALCULATIONS SHOW THAT A FIVE FOOT LIFT IS OKAY. THEY ALSO SHOW THAT A 10 FOOT LIFT IS POSSIBLE BUT NOT ADVISABLE.

(III) ANCHOR TRENCH REQUIREMENTS



FROM "GEOSYNTHETIC DESIGN GUIDANCE" Pg EPA III - 48

$$T = \frac{q\,L \tan\delta + (K_p + K_A)\tan\delta\left[0.5\,\gamma d^2 + q_b d\right]}{(F.S._{MIN})\cos\beta - \sin\beta \tan\gamma}$$

d = DEPTH OF TRENCH = 1'

L = SETBACK OF TRENCH = 2'

β = SLOPE ANGLE = 26.6°

$F.S._{MIN}$ = MINIMUM FACTOR OF SAFETY = 1.5

$q_b = d(\gamma_{SOIL})$

δ = FRICTION ANGLE LINER = 10°-15°

ϕ = BACKFILL FRICTION ANGLE = 25°

γ = BACKFILL UNIT WEIGHT = 110 pcf

K_A = ACTIVE EARTH PRESSURE = $\frac{1-\sin\phi}{1+\sin\phi}$

= .41

K_p = 2 (MOBILIZED)

LOWER BOUND $\delta = 10°$:

$$T = \frac{1(110)(2)(\tan 10°) + (.41+2)\tan 10°\left[0.5(110)(1)^2 + 1(110)1\right]}{1.5(\cos 26.6) - \sin 26.6 \tan 10}$$

$$T = \frac{38.79 + 70.12}{1.26} = 86.43 \text{ lb/FT}$$

$$\sigma = \frac{T}{\ell t} = \frac{86.43}{1\left(\frac{.06}{12}\right)} = 17{,}286 \text{ lb/FT}^2 = 120 \text{ lb/in}^2$$

D.R. = 2000/120 = $\underline{16.7}$ OK

UPPER BOUND $\delta = 15°$

$$T = \frac{1(110)(2)(\tan 15°) + (.41+2)\tan 15°\left[0.5(110)(1)^2 + 1(110)1\right]}{.5\cos 26.6 - \sin 26.6 \tan 10}$$

$$T = \frac{165.5}{1.22} = 136 \text{ lb/FT}$$

$$\sigma = \frac{136}{1(.06/12)} = 27{,}216 \text{ psf} = 189 \text{ psi}$$

$$D.R. = \frac{2000}{189} = 10.6 \quad \underline{\underline{OK}}$$

σ_L AND σ_u < DOWNDRAG FORCE FROM Pg 3 (237 psi) AND ARE LESS THAN YIELD STRESS. THEREFORE SHEET WILL PULL OUT BEFORE IT RIPS.

CHECK WITH K_o (AT REST EARTH PRESSURE)

$$K_o = 1 - \sin\phi = 1 - \sin 25^\circ = .5774$$

LOWER BOUND $\delta = 10^\circ$

$$T_{K_o} = \frac{220(\tan 10) + (2.5774)(\tan 10^\circ)[165]}{1.5(\cos 26.6) - \sin 26.6 \tan 10} = 90.27 \text{ lb/FT}$$

$$\sigma = 90.27/(.06/12)/144 = 125.4 \text{ psi} \qquad D.R. = \frac{2000}{125.4} = 16 \quad \underline{\underline{OK}}$$

UPPER BOUND

$$T_{K_o} = \frac{220(\tan 15) + 425.3(\tan 15)}{1.22} = 141.7 \text{ lb/FT}$$

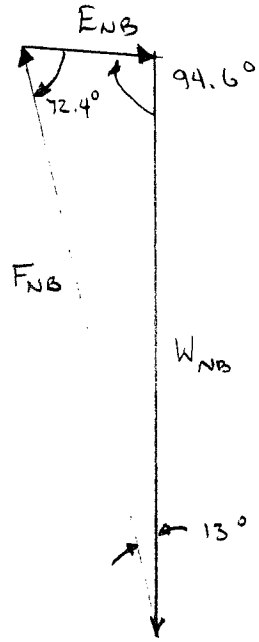
$$\sigma = \left(\frac{141.7}{(.06/12)}\right)/144 = 196.8 \text{ lb/FT} \qquad D.R. = \frac{2000}{196.8} = 10.2 \quad \underline{\underline{OK}}$$

NEUTRAL BLOCK FORCE DIAGRAM

$W_{NB} = 230{,}560$ lb/FT

$F_{NB} = ?$

$E_{NB} = ?$



USE LAW OF SINES:

$$\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$$

TO SOLVE FOR F_{NB} AND E_{NB}

$$\frac{\sin 72.4^\circ}{W_{NB}} = \frac{\sin 94.6^\circ}{F_{NB}} = \frac{\sin 13^\circ}{E_{NB}}$$

$$F_{NB} = \frac{\sin 94.6\,(230{,}560)}{\sin 72.4}$$

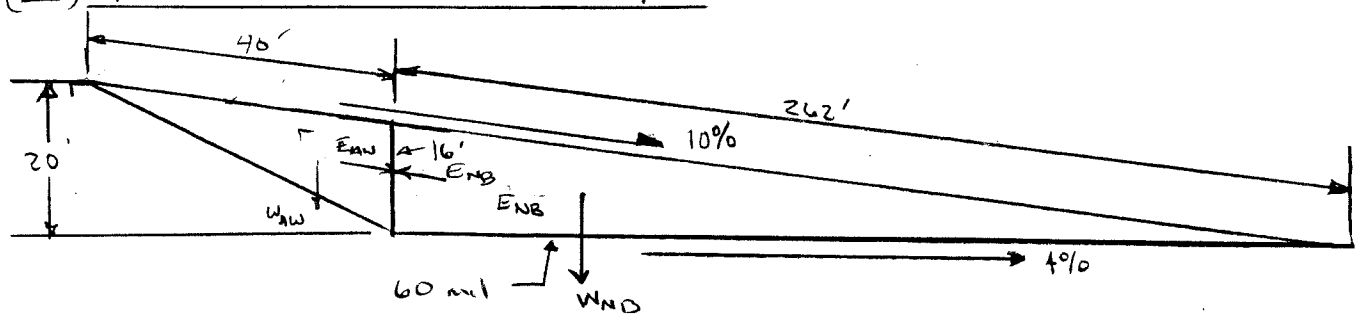
$F_{NB} = 241{,}103.22$ lb/FT

$$E_{NB} = \frac{\sin 13\,(230{,}560)}{\sin 72.4}$$

$E_{NB} = 54{,}411.7$ lb/FT

NOW SOLVE FORCE POLYGON FOR ACTIVE WEDGE. OBTAIN E_{AW}. E_{NB} DIVIDED BY E_{AW} = FACTOR OF SAFETY OF RAMP.

(IV) ACCESS RAMP STABILITY



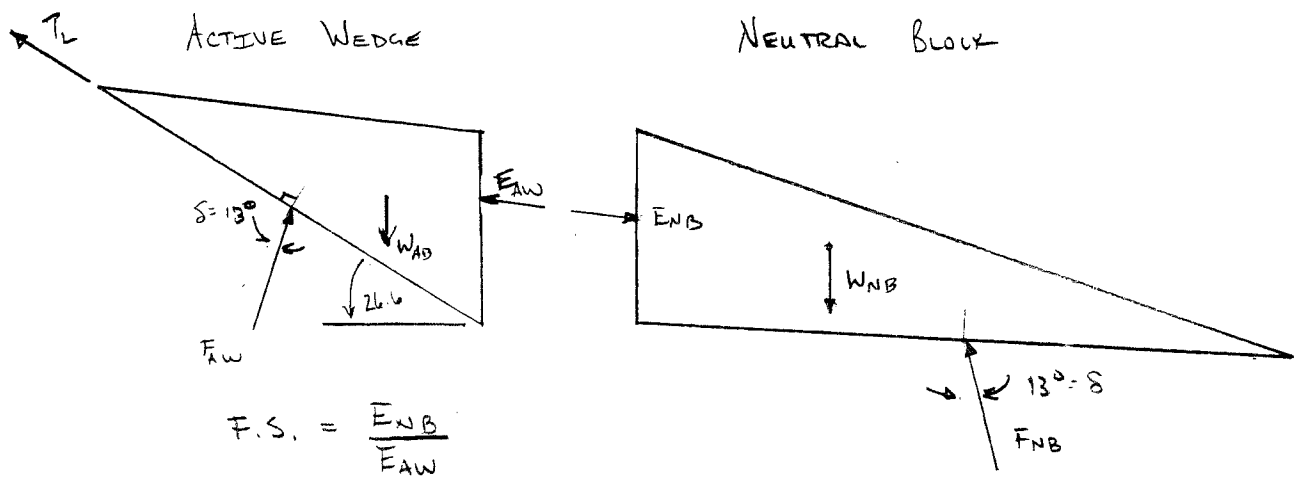
GIVEN:

60 mil HDPE LINER $\sigma_y = 2000\ lb/in^2$
SIDE SLOPE FRICTION ANGLE = 13°
BOTTOM FRICTION ANGLE = 13°
SOIL UNIT WEIGHT = 110 pcf
SIDE SLOPE HEIGHT = 20 FEET
SLOPE ANGLE = 26.6°

(1) CALCULATE WEIGHTS OF BLOCK

$$W_{NB} = A_{NB} \times \gamma = \tfrac{1}{2}(h)(l)\gamma = \tfrac{1}{2}(16)(262')(110) = 230{,}560\ lb/FT$$

$$W_{AW} = A_{AW} \times \gamma = \tfrac{1}{2}(h)(l)\gamma = \tfrac{1}{2}(16)(40)(110) = 35{,}200\ lb/FT$$



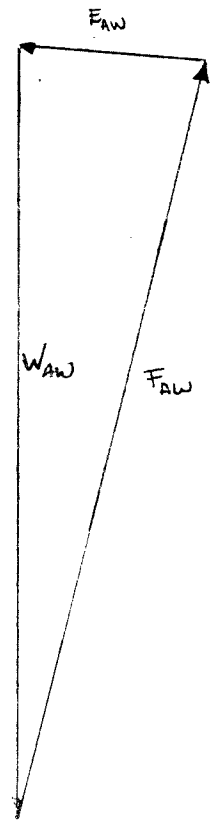
$$F.S. = \frac{E_{NB}}{E_{AW}}$$

T_L = TENSION IN LINER ⇒ SET = 0

KNOW T_L, W_{AW}, W_{NB}
NEED F_{AW}, F_{NB}, E_{AW}, E_{NB} → USE FORCE POLYGONS TO SOLVE FOR UNKNOWNS

ACTIVE WEDGE FORCE DIAGRAM

DRAW TO SCALE



FORCE SUMMARY

W_{AW} = 35,200 lb/FT

T_L = 0

F_{AW} = 35,904 lb/FT
E_{AW} = 8,448 lb/FT
} SCALED

SCALE 1" = 8,800 lb/FT

FACTOR OF SAFETY = E_{NB} / E_{AW}

FROM Pg 7 OF 8 E_{NB} = 54,412 lb/FT

E_{AW} = 8448 lb/FT

F.S. = 54,412 / 8,448 = 6.4 OK

APPENDIX D:

INTERNAL STORMWATER COLLECTION AND REMOVAL SYSTEM CALCULATIONS

ASSUMPTIONS

1. MAIN STORAGE TO BE IN TOE BERM BASIN IN CELLS 1-3 AND IN CELL 4.

2. TOE BASIN TO HANDLE MAIN SETTLEMENT. THEREFORE ALLOW APPROXIMATELY 24 HOURS TO DRAIN BASIN.

3. DRAIN BASIN TO SECONDARY BASIN. SET PEAK OUTFLOW FROM SECONDARY BASIN EQUAL TO OR LESS THAN OUTFLOW FROM TOE BASINS.

4. ASSUME MAXIMUM OF 20 ACRES OPEN TO COLLECTION OF LEACHATE AT ANY GIVEN TIME. (FROM CONTRACT DRAWINGS)

5. DESIGN STORM = 25 YR 24 HR STORM (CONSERVATIVE)

CALCULATE TOTAL VOLUME OF WATER COLLECTED DURING THE 25 YEAR STORM:

25 YR. 24 HR. STORM → 6.5 IN.

$$\frac{6.5 \text{ IN.}}{12 \text{ IN./FT.}} \times 20 \text{ AC.} \times 43560 \text{ FT}^2/\text{AC} = 471{,}900 \text{ FT}^3$$

USE 475,000 FT^3 FOR STORAGE IN BASINS

CALCULATE REQUIRED OUTFLOW TO DRAIN BASIN IN 24 HRS.

$$24 \text{ HRS.} \times \frac{60 \text{ MIN}}{1 \text{ HR.}} \times \frac{60 \text{ SEC}}{1 \text{ MIN.}} = 86{,}400 \text{ SEC/DAY}$$

$$\frac{475{,}000 \text{ FT}^3}{86{,}400 \text{ SEC}} = \boxed{5.5 \text{ CFS}}$$

NEED A PIPE WHICH WILL SUPPLY APPROXIMATELY 5.5 CFS AT A MINIMUM BOTTOM SLOPE OF 2%. (MINIMUM DESIGN SLOPE)

FROM ADS TECHNICAL NOTE NO. 2.109 (88)
"FLOW CAPACITY"

ADS N-12 (MANNING # n = .012)

A 12" PIPE (ADS N12) Q = 5.46 OK

SIZE A RISER TO BE SET ABOVE THE SUMP.

USE A 48" RISER. 8' FROM TOP OF ANTI-FLOTATION BLOCK TO TOP (9' OVERALL)

PERFORATE PIPE RISER WITH 1/2" DIA. HOLES SPACED 2" APART

ANTIFLOTATION REQUIREMENTS

$V_{RISER} = \pi r^2 h$ $\quad r = 2'$, $h = 8'$

$V = \pi (2)^2 (8)$

$V = 100.5 \text{ FT}^3$

BOUYANT WEIGHT = $100.5 \text{ FT}^3 \times 62.4 \text{ pcf} = 6{,}273$ lbs.

ANCHOR WEIGHT REQUIRED = $1.1 \times \text{WT } H_2O = 1.1 \times 6{,}273$ lbs. = 6900 lbs.

USING # 57 STONE (NCDOT) $\gamma = 120$ pcf (CONSERVATIVE)

$\frac{6900}{120} = 57.5 \text{ cf} = 2.1$ cy # 57 STONE AROUND RISER ON ATTACHED FLANGE.

DEPTH → $A_{FLANGE} = \pi r^2_{TOTAL} - \pi r^2_{PIPE} \quad \pi (10)^2 - \pi (4)^2 = 264 \text{ FT}^2$

1' THICK YIELDS $264 \text{ FT}^3 > 57.5 \text{ FT}^3$ REQUIRED

USE MINIMUM 1' # 57 STONE OVER FLANGE

AT THE OUTLET TO SUMP 4, THE PIPE SLOPE FLATTENS OUT TO 0.5%. RESIZE THIS SECTION PIPE.

USE AN 12" PIPE (Q = 8.05 CFS)

CELL 4 PIPING ABOVE PERIMETER BERM

MINIMUM PIPE SLOPE = 0.5%

PEAK Q = 5.5 CFS

∴ USE 18" ADS N-12 Q = 8.05 CFS OK

RISER ASSEMBLY

USE 10' 24" DIA. RISER PERFORATE W/ 1/2" DIA. HOLES SPACED 2" APART

ANTIFLOTATION BLOCK

$V_{RISER} = \pi r^2 h = \pi (1)^2 (10) = 31.46 \text{ FT}^3$

$W_{RISER} = 31.42 (62.4) = 1{,}960$ lbs.

1.1 (1960) = REQUIRED WEIGHT OF CONCRETE

2,156 lbs.

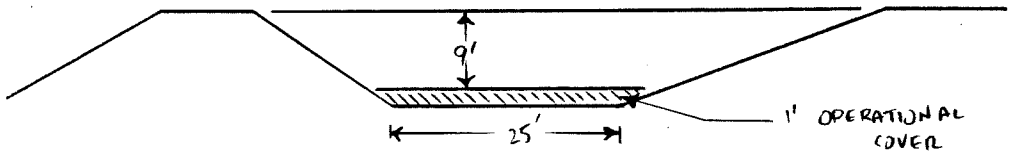
REQUIRED VOLUME OF CONCRETE = 2156/87.6 = 24.6 FT^3

USE A BLOCK 5' x 5' x 1' (L x W x D)

18" PIPE OUT TO BASIN

CELL 1,2,3 TOE BASIN VOLUMES

TYPICAL CROSS SECTION



BASIN - CELL 1

STAGE (FT)	AREA (FT^2)	THICKNESS (FT)	Δ VOLUME (FT^3)	TOT. VOL (FT^3)
0	42,000			
		1'	45,500	45,500
1	49,000			
		1'	52,500	98,000
2	56,000			
		1'	59,500	157,500
3	63,000			
		1'	66,500	224,000
4	70,000			
		1'	73,500	297,500
5	77,000			
		1'	80,500	378,000
6	84,000			
		1'	87,500	465,500
7	91,000			
		1'	94,500	560,000
8	98,000			
		1'	101,500	661,500
9	105,000			

AT STAGE 7.1 THE 25 YR. STORM IS CONTAINED WITH 1.9' FREE BOARD.

OK

CELL 2 BASIN

STAGE (FT)	AREA (FT^2)	THICKNESS (FT)	Δ VOL (FT^3)	TOTAL VOL. (FT^3)
0	41,100			
		1'	44,525	44,525
1	47,950			
		1'	51,375	95,900
2	54,800			
		1'	58,225	154,125
3	61,650			
		1'	65,075	219,200
4	68,500			
		1'	71,925	291,125
5	75,350			
		1'	78,775	369,900
6	82,200			
		1'	85,625	455,525
7	89,050			
		1'	92,475	548,000
8	95,900			
		1'	99,325	647,325
9	102,750			

AT STAGE 7.2, THE 25 YR. STORM IS CONTAINED WITH 1.8' FREEBOARD

OK

CELL 3 BASIN

STAGE (FT)	AREA (FT²)	THICKNESS (FT)	Δ VOL (FT³)	TOT. VOL. (FT³)
0	40,200			
		1'	43,550	43,550
1	46,900			
		1'	50,250	93,800
2	53,600			
		1'	56,950	150,750
3	60,300			
		1'	63,650	214,400
4	67,000			
		1'	70,350	284,750
5	73,700			
		1'	77,050	361,800
6	80,400			
		1'	83,750	445,550
7	87,100			
		1'	90,450	536,000
8	93,800			
		1'	97,150	633,150
9	100,500			

AT STAGE 7.3 THE 25 YR. STORM IS CONTAINED WITH 1.9' FREEBOARD,

OK

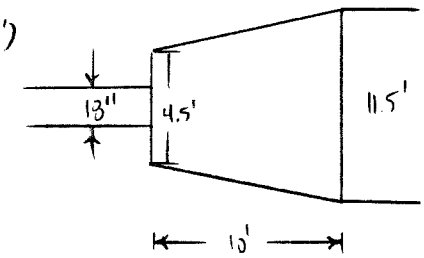
OUTLET PROTECTION FOR COLLECTOR PIPES

PIPE 1 (FROM SUMP A) & PIPE 2 FROM CELL 4 UPPERS

Q = 8.05 CFS

ASSUME MINIMUM TAILWATER CONDITION

d_{50} = .3' (4")
d_0 = 18"
L_a = 10'
W = 11.5'



SECONDARY BASIN CALCULATIONS

DIMENSIONS 180' x 115' x 9'

VOLUME = HLW x SH²L − SH²W + 2S² H³ → FROM "DESIGNING WITH GEOSYNTHETICS" KOERNER, 1990.

= (9)(180)(115) − (2.5)(9)²(180) − (2.5)(9)²(115) + (2)(2.5)²(9)³

= 186,300 − 36,450 − 23,287.5 + 9,112.5

V = 135,675 FT³

RISER / BARREL

BARREL 8% SLOPE TO EXIT USE 15" BARREL

Q = 10.44 MAX Q_{IN} = 8.05 CFS

RISER USE A 21" RISER PERFORATED WITH 1/2" DIAMETER HOLES SPACED 3" APART

BLOCK

$V_{RISER} = \pi r^2 h$ r = .875' h = 9'

= 21.65 FT³

21.65 (62.4) = 1351 lbs.

x 1.1 = 1486 lbs.

1486/87.6 = 17 FT³ CONCRETE

USE A 4' x 4' x 1.5' BLOCK

ANTI SEEP COLLARS

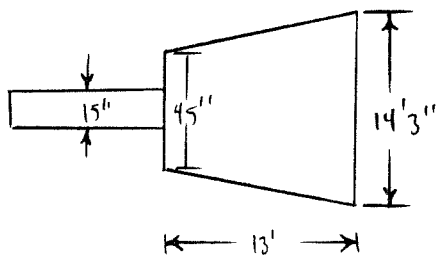
5' x 5' SQUARE 3' DOWNSTREAM FROM ALL PIPE JOINTS

DISCHARGE VELOCITY $\frac{10.44 \text{ CFS}}{1.22 \text{ FT}^2}$ $\frac{Q}{A} = V$

= 8.6 FT/SEC

OUTLET PROTECTION

ASSUME MINIMUM TAILWATER CONDITION



RIP-RAP d_{50} = 6"

APRON THICKNESS = 12"

d_{50} = .45'
L_a = 13'
W = 14.25'

A.D.S. TECHNICAL NOTE NO. 2.109 (88)

FLOW CAPACITY

June 1, 1988

ADVANCED DRAINAGE SYSTEMS, INC.

TABLE 1

Manning's "n" Value For Design

(Storm & Sanitary Sewer and Culverts)

Pipe Type	"n"
A.D.S. Corrugated Polyethylene Pipe	
3 - 6" Diameter	0.015
8" Diameter	0.016
10" Diameter	0.017
12 - 15" Diameter	0.018
18 - 36" Diameter	0.020
A.D.S. N-12	0.012
Concrete Pipe	0.013
Corrugated Metal Pipe (2 2/3" x 1/2" corrugation)	
Annular	
Plain	0.024
Paved Invert	0.020
Fully Paved (smooth lined)	0.013
Helical	
Plain 15" Diameter	0.013
18" Diameter	0.015
24" Diameter	0.018
36" Diameter	0.021
Spiral-Rib	0.012
Plastic Pipe (SDR, S&D, Etc.)	0.011
Vitrified Clay	0.013

TABLE 4

CIRCULAR PIPE FLOW CAPACITY
Full Flow (cubic feet per second)

Mannings "n"= 0.012

Dia. (in.)	*Conv. Factor	% Slope (feet per 100 feet) 0.02	0.05	0.10	0.20	0.35	0.50	0.75	1.00	1.25	1.50	1.75	2.0	2.5	5.0	10.0	20.0
		(c.f.s.)															
3	0.957	0.014	0.021	0.030	0.043	0.057	0.068	0.083	0.096	0.107	0.12	0.13	0.14	0.15	0.21	0.30	0.43
4	2.062	0.029	0.046	0.065	0.092	0.122	0.146	0.179	0.206	0.231	0.25	0.27	0.29	0.33	0.46	0.65	0.92
5	3.738	0.053	0.084	0.118	0.167	0.221	0.264	0.324	0.374	0.418	0.46	0.49	0.53	0.59	0.84	1.18	1.67
6	6.079	0.086	0.136	0.192	0.272	0.360	0.430	0.526	0.608	0.680	0.74	0.80	0.86	0.96	1.36	1.92	2.72
8	13.091	0.185	0.293	0.414	0.585	0.774	0.926	1.134	1.309	1.464	1.60	1.73	1.85	2.07	2.93	4.14	5.85
10	23.74	0.34	0.53	0.75	1.06	1.40	1.68	2.06	2.37	2.65	2.91	3.14	3.36	3.75	5.31	7.51	10.61
12	38.60	0.55	0.86	1.22	1.73	2.28	2.73	3.34	3.86	4.32	4.73	5.11	5.46	6.10	8.63	12.21	17.26
15	69.98	0.99	1.56	2.21	3.13	4.14	4.95	6.06	7.00	7.82	8.57	9.26	9.90	11.06	15.65	22.13	31.30
18	113.80	1.61	2.54	3.60	5.09	6.73	8.05	9.86	11.38	12.72	13.94	15.05	16.09	17.99	25.45	35.99	50.89
21	171.65	2.43	3.84	5.43	7.68	10.16	12.14	14.87	17.17	19.19	21.02	22.71	24.28	27.14	38.38	54.28	76.77
24	245.08	3.47	5.48	7.75	10.96	14.50	17.33	21.22	24.51	27.40	30.02	32.42	34.66	38.75	54.80	77.50	109.60
27	335.51	4.74	7.50	10.61	15.00	19.85	23.72	29.06	33.55	37.51	41.09	44.38	47.45	53.05	75.0	106.1	150.0
30	444.35	6.28	9.94	14.05	19.87	26.29	31.42	38.48	44.44	49.68	54.42	58.78	62.84	70.26	99.4	140.5	198.7
36	722.57	10.22	16.16	22.85	32.31	42.75	51.09	62.58	72.26	80.79	88.50	95.59	102.19	114.25	161.6	228.5	323.1
42	1089.9	15.41	24.37	34.47	48.74	64.5	77.1	94.4	109.0	121.9	133.5	144.2	154.1	172.3	243.7	344.7	487.4
48	1556.1	22.01	34.80	49.21	69.59	92.1	110.0	134.8	155.6	174.0	190.6	205.9	220.1	246.0	348.0	492.1	695.9

* Conveyance Factor = (1.486 x R2/3 x A) / n

APPENDIX E:

EROSION AND SEDIMENTATION CONTROL CALCULATIONS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DISCHARGE

USE RATIONAL METHOD TO CALCULATE RUNOFF FROM EACH SWALE LOCATED ON THE PROJECT.

$Q = CIA$

Q = DISCHARGE (CFS)
C = RUNOFF COEFFICIENT
I = INTENSITY (in/HR)
A = AREA (ACRES)

TIME OF CONCENTRATION

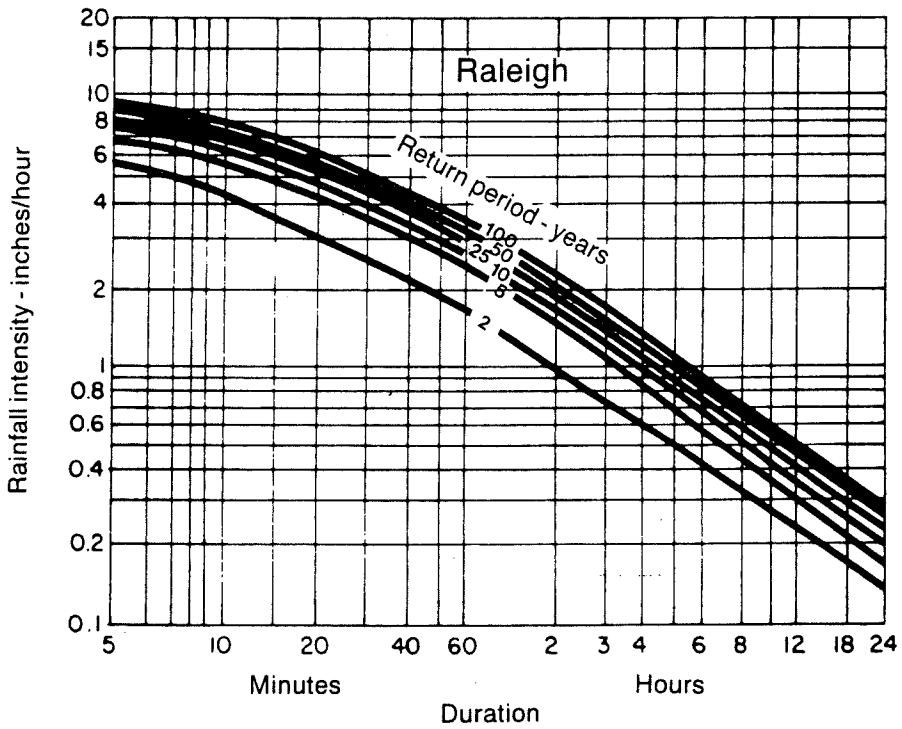
$$t_c = \frac{\left[\frac{L^3}{H}\right]^{0.385}}{128}$$

REF: H. ROCHET MALLOLM "ELEMENTS OF URBAN STORMWATER DESIGN" MANUAL P I-3

FOR $t_c < 5$ min USE $t_c = 5$ min

INTENSITY

USE INTENSITY-DURATION CURVES FOR RALEIGH. RALEIGH IS CLOSEST LOCATION TO SITE WITH A I-D CURVE.



RUNOFF COEFFICIENT

CHOOSE C BASED ON SITE SPECIFIC CONDITIONS

Table of Rational runoff coefficients

Description	C	Source
Roof, inclined	1.00	Malcom
Street, driveway, sidewalk	0.95	Chow, 1964
Parking lot	0.90	Malcom
Roof, flat	0.90	Malcom
Commercial, generalized	0.85	Malcom
Apartments, schools, churches	0.60	WSSC, c.1968
Residences, 10 dwellings/acre	0.60	Malcom
Residences, 6 dwellings/acre	0.55	Malcom
Residences, 4 dwellings/acre	0.50	Malcom
Residences, 2 dwellings/acre	0.40	Malcom
Unimproved cleared area * INITIAL	0.35	Malcom
Lawn, dense soil, steep >7% * FINAL	0.35	Chow, 1964
Playground	0.35	Chow, 1964
Park, cemetery	0.25	Chow, 1964
Lawn, dense soil, avg 2-7%	0.22	Chow, 1964
Wooded, sparse ground litter	0.20	Malcom
Lawn, dense soil, flat 2%	0.17	Chow, 1964
Lawn, sandy, avg 2-7%	0.15	Chow, 1964
Lawn, sandy, flat <2%	0.10	Chow, 1964
Wooded, deep ground litter	0.10	Malcom

CHART IS FROM HRM MANUAL

SITE HAS 4:1 SLOPES (25%)
INITIALLY CLEARED C=.35
SEEDED IMMEDIATELY C=.35

∴ C = .35

USE TABULAR APPROACH TO CALCULATE Q FOR EACH DRAINAGE AREA.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DISCHARGE TABLE

AREA	DRAINAGE AREA (FT^2)	AREA (AC)	H (FT)	L (FT)	T_c min	I in/hr	C	Q (CFS)
1	90,680	2.08	13	345	2.48	8	.35	5.8
2	46,415	1.07	20	90	.45	8	.35	3.0
3	53,765	1.23	20	90	.45	8	.35	3.4
4	89,500	2.05	13	315	2.24	8	.35	5.7
5	46,415	1.07	20	90	.45	8	.35	3.0
6	53,765	1.23	20	90	.45	8	.35	3.4
7	16,625	0.38	6	170	1.48	8	.35	1.1
8	19,892	0.46	20	90	.45	8	.35	1.3
9	26,955	0.62	20	90	.45	8	.35	1.7
10	30,366	0.70	10	200	1.81	8	.35	2.0
11	19,892	0.46	20	90	.45	8	.35	1.3
12	26,955	0.62	20	90	.45	8	.35	1.7
13	62,559	1.44	20	90	.45	8	.35	4.0
14	49,625	1.14	12	300	2.18	8	.35	3.2
15	22,174	0.51	20	90	.45	8	.35	1.4
16	24,360	0.56	20	90	.45	8	.35	1.6
17	26,691	0.61	20	90	.45	8	.35	1.7
18	23,207	0.53	20	70	.33	8	.35	1.5
19	62,952	~~1.54~~ 1.45	13	345	2.43	8	.35	~~4.3~~ 4.1
20	22,174	0.51	20	90	.45	8	.35	1.4
21	24,360	0.56	20	90	.45	8	.35	1.6
22	26,691	0.61	20	90	.45	8	.35	1.7

AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

DISCHARGE TABLE

AREA	DRAINAGE AREA (FT²)	AREA (AC)	H (FT)	L (FT)	T_c (MIN)	I (IN/HR)	C	Q (CFS)
23	23,207	0.53	20	70	.33	3	.35	1.5
24	41,128	0.94	13	360	2.61	8	.35	2.6
25	22,487	0.52	20	90	.45	3	.35	1.5
26	28,973	0.67	20	90	.45	3	.35	1.9
27	33,585	0.77	20	90	.45	3	.35	2.2
28	26,378	0.61	20	70	.33	3	.35	1.7
29	30,800	0.71	—	200	1.68	3	.35	2.0
30	22,487	0.52	20	90	.45	3	.35	1.5
31	28,973	0.67	20	90	.45	3	.35	1.9
32	33,586	0.77	20	90	.45	3	.35	2.2
33	26,379	0.61	20	70	.33	3	.35	1.7
34	73,466	1.69	13	345	2.48	8	.35	4.7
35	42,307	0.97	20	90	.45	3	.35	2.7
36	53,045	1.22	20	90	.45	3	.35	3.4
37	73,467	1.69	13	345	2.48	8	.35	4.7
38	42,307	0.97	20	90	.45	3	.35	2.7
39	53,045	1.22	20	90	.45	3	.35	3.4
40	56,937	1.31	20	90	.45	3	.35	3.7
41	29,261	0.67	20	90	.45	3	.35	1.9
42	10,378	0.24	[illegible]	25	.16	3	.35	0.7
43	17,500	0.40	20	70	.33	3	.35	1.1
44	52,266	1.20	22	70	.32	3	.35	3.4
45	60,000	1.38	20	70	.33	8	.35	3.9

AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

SWALE SIZING

TWO SWALES ARE TO BE USED ON THIS FACILITY.
1. A MAIN SWALE LOCATED ON BENCHES.
2. A ROADWAY SWALE LOCATED ALONG ALL ACCESS ROADS

MAIN SWALE

FROM AREA SUMMARY CHART, MAX Q = 5.8 cfs.

DESIGN SWALE FOR Q = 6 cfs
4:1 SIDES
.5% BOTTOM SLOPE
1.5' MAX DEPTH
n = .03 (GRASS)

NORMAL DEPTH PROCEDURE
FROM HRM MANUAL Pg II-7

$$Z_{REQ} = \frac{Qn}{1.49\sqrt{S}}$$ => DESIGN REQUIRED QUANTITY

$$Z_{AV} = AR^{2/3}$$ => DESIGN AVG. QUANTITY (FOR A GIVEN CROSS SECTION)

$$A = By + My^2 \; ; \; B = 0 \; \therefore \; A = My^2$$

$$R = \frac{A}{P} = \frac{My^2}{2y\sqrt{1+M^2}} = \frac{My}{2\sqrt{1+M^2}}$$

$$P = B + 2y\sqrt{1+M^2} \; ; \; B = 0 \; \therefore \; P = 2y\sqrt{1+M^2}$$

$$Z_{REQ} = \frac{6(.03)}{1.49\sqrt{.005}} = 1.71$$

$$Z_{AV} = My^2\left[\frac{My}{2\sqrt{1+M^2}}\right]^{2/3} = Z_{REQ}$$

$$1.71 = 4(y^2)\left[\frac{4(y)}{2\sqrt{17}}\right]^{2/3}$$

$$= 4y^2\left[.485\,y\right]^{2/3}$$

$$= 2.47\,y^{8/3}$$

$$.693 = y^{8/3}$$

$$.87 = y$$

CK: $A = My^2 = 4(.87)^2 = 3.03$

$V = Q/A = \frac{6}{3.03} = 2.0$ fps

OK

CHANNEL DIMENSIONS
DEPTH = 1.0'
SIDE SLOPE = 4:1
TOP WIDTH = 8.0'

SWALE SIZING CONT.

ROADWAY SWALE

SIDE SLOPES 1:1
MIN BOTTOM .5%
MAX BOTTOM 2.5%
MAX Q = 7.3 CFS (AREAS 44 & 45)
n = .03 (GRASS)

BEST HYDRAULIC SECTION

$C_m = .817$
$k = .828$

$$Y = C_m \left[\frac{Qn}{\sqrt{S}} \right]^{.375}$$

$B = kY$

MIN BOTTOM SLOPE

$S = .005$

$$Y = .817 \left[\frac{7.3(.03)}{\sqrt{.005}} \right]^{.375}$$

$Y = 1.25$

$B = K(1.25$
$B = .828(1.25)$
$B = 1.03$

CK $V = \frac{Q}{A}$

$V = \frac{7.3}{2.85}$

$A = By + My^2$
$A = 1.03(1.25) + 1(1.25)^2$
$A = 2.85$

$V = 2.56$ FPS < 4.0 OKAY FOR GRASS.

A SECTION 1.25' deep with a BOTTOM WIDTH OF 1.03' WORKS.

MAX BOTTOM SLOPE

$S = .025$

$$Y = .817 \left[\frac{7.3(.03)}{\sqrt{.025}} \right]^{.375}$$

$Y = .92'$

$B = Ky$
$B = .828(.92)$

$B = .76'$

CK CHANNEL:
$A = By + My^2 = .76(.92) + 1(.92)^2 = 1.546$

$V = Q/A = \frac{7.3}{1.546} = 4.72$ FPS > 4.0 TOO FAST

TRY CHANNEL WITH

$Y = 1.5$
$B = 1.5$
$M = 1$

$A = By + My^2$
$P = B + 2y\sqrt{1+M^2}$
$R = A/P$
$Z_{AV} = AR^{2/3}$

CK CHANNEL TO FIND
1. NORMAL DEPTH
2. FLOW VELOCITY

$$Z_{REQ} = \frac{Qn}{1.49\sqrt{S}} = \frac{7.3\,(.03)}{1.49\sqrt{.025}} = .93$$

1	2	3	4	5	6	7
B	Y	A	P	R	Z_{AV}	REM
1.5	1	2.5	4.9	.51	1.59	
1.5	.75	1.69	3.62	.47	1.02	
1.5	.65	1.40	3.34	.42	.78	
1.5	.7	1.54	3.48	.44	.89	
1.5	.72	1.60	3.54	.45	.91	OK
		$V = \frac{7.3}{1.6}$	$= 4.56$	TOO FAST		

USE VELOCITY LIMITED PROCEDURE TO CHECK CHANNEL DIMENSIONS WHICH LIMIT V TO LESS THAN 4.0 FPS (PROCEDURE FROM HRM MANUAL PGS II-5, II-6)

$A_x = \frac{Q}{V_a}$ A_x = REQUIRED CROSS SECTIONAL AREA
Q = DISCHARGE
V_a = ALLOWABLE VELOCITY

$V_a = 4.0$
$Q = 7.3$ CFS $A_x = \frac{7.3}{4.0} = 1.83\ FT^2$

COMPUTE WORKING CONSTRAINTS W_1 & W_2

$$W_1 = M - 2\sqrt{1+M^2}$$

$$W_2 = \frac{A_x}{\left[\frac{V_a n}{1.49\sqrt{S}}\right]^{3/2}}$$

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

VELOCITY LIMITED PROCEDURE (CONT.)

$A_x = 1.83$
$n = .03$
$S = .025$
$V_a = 4.0$

$$W_1 = 1 - 2\sqrt{1+(1)^2}$$

$$W_1 = -1.83$$

$$W_2 = \frac{1.83}{\left[\frac{4(.03)}{1.49\sqrt{.025}}\right]^{1.5}}$$

$$W_2 = 5.03$$

COMPUTE DEPTH OF FLOW

$$Y = \frac{-W_2 + \sqrt{W_2^2 + 4(W_1)(A_x)}}{2(W_1)}$$

$$Y = \frac{-5.03 + \sqrt{(5.03)^2 + 4(-1.83)(1.83)}}{2(-1.83)}$$

$$Y = .43'$$

COMPUTE BOTTOM WIDTH

$$B = \frac{A_x}{Y} - MY$$

$$B = \frac{1.83}{.43} - 1(.43)$$

$$B = 3.83'$$

CHECK DISCHARGE

$n = .03$
$A = 1.83$
$S = .025$

$$R = A/P = \frac{1.83}{5.04} = .36$$

$$P = B + 2Y\sqrt{1+M^2}$$

$$P = 3.83 + 2(.43)\sqrt{2}$$

$$P = 5.04$$

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.486}{.03}(1.83)(.36)^{2/3}(.025)^{.5}$$

$$Q = 7.23 \text{ CFS}$$

THIS CHANNEL WOULD BE 6' WIDE AT THE TOP. THIS IS TOO WIDE FOR THE AREAS WHERE IT WILL BE USED. THEREFORE USE THE ORIGINAL CHANNEL WITH EROSION CONTROL MAT SUCH AS ENKA MAT 7010.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

EROSION CONTROL MAT.

DETERMINE MAX. SHEAR STRESS IN CHANNEL

$= \gamma_{H_2O}(s)(Y)$ (REF. ENKAMAT [illegible] DATA)

$= 62.4(.025)(.72)$

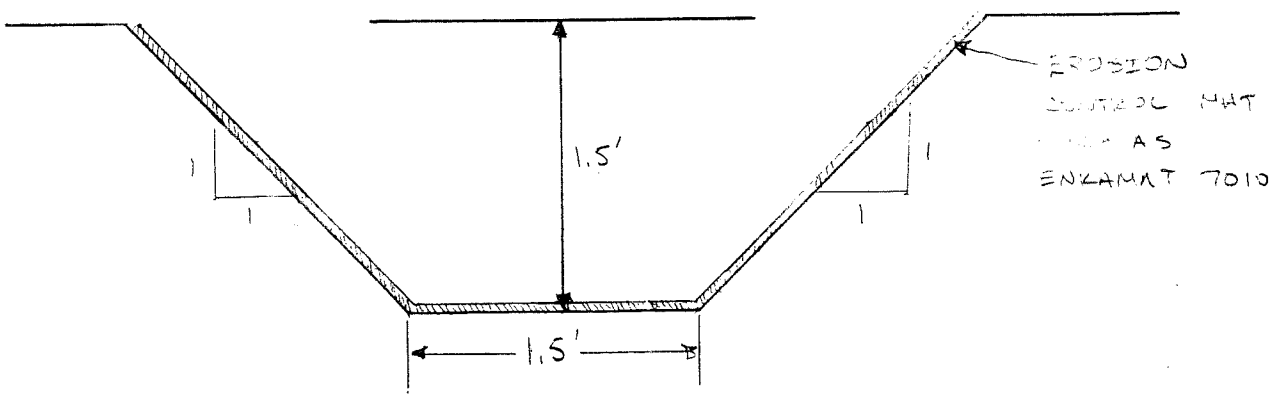
$= 1.12$ PSF

ALLOWABLE SHEAR STRESS ENKAMAT 7010

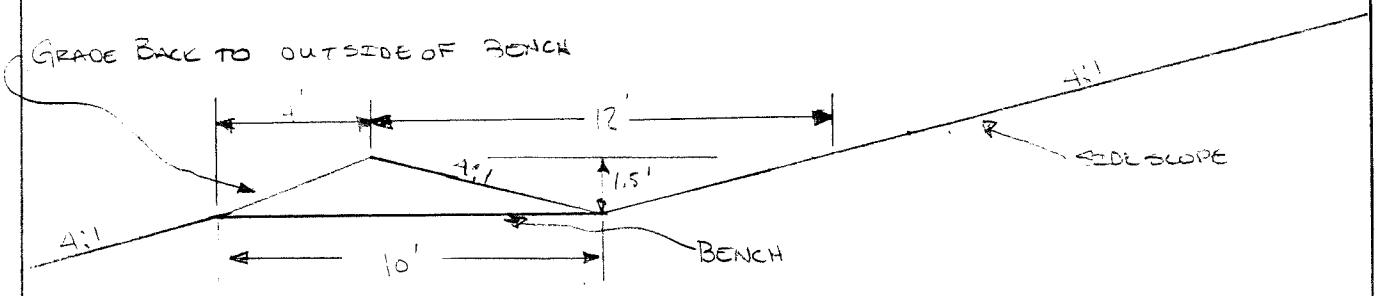
$= 8$ PSF (FROM AKZO INDUSTRIAL SYSTEMS CO. TECHNICAL DOCUMENT)

∴ CHANNEL WITH MAT WILL WORK

ROADWAY CHANNEL CROSS-SECTION



SWALE CROSS-SECTION



HAZEN AND SAWYER
Environmental Engineers & Scientists

HALIFAX COUNTY ASH MONOFILL
DESIGN CALCULATIONS
STORMWATER SYSTEM CALCS

Date ..... 1 of 1
By VDB Chkd. .....
Job 3720

SWALE	DROP INLET	LENGTH	BEGINNING SWALE ELEVATION	DROP INLET TOP ELEV.	DROP INLET BOTTOM ELEV
1A	SWALE 42	280'	372.25	—	—
1B	D1	50'	370.25	370.0	366.0
2A	SWALE 42	70'	352.75	—	—
2B	D2	400'	352.00	350.0	346.0
3	D3	600'	333.00	330.0	326.0
4	D4	450'	372.25	370.0	366.0
5	D5	550'	352.75	350.0	346.0
6	D6	650'	333.25	330.0	326.0
7	D4	190'	370.95	370.0	366.0
8	D5	250'	351.25	350.0	346.0
9	D6	350'	331.75	330.0	326.0
10	D7	180'	370.90	370.0	366.0
11	D8	250'	351.25	350.0	346.0
12	D9	320'	331.60	330.0	326.0
13	D10	750'	321.50	310.0	306.0
14	D7	230'	371.15	370.0	366.0
15	D8	260'	351.30	350.0	346.0
16	D9	290'	331.45	330.0	326.0
17	D10	310'	311.55	310.0	306.0
18	D11	340'	291.70	290.0	286.0
19	D12	230'	371.15	370.0	366.0
20	D13	260'	351.30	350.0	346.0
21	D14	275'	331.38	330.0	326.0
22	D15	310'	311.55	310.0	306.0
23	D16	330'	291.65	290.0	286.0
24	D12	220'	371.10	370.0	366.0
25	D13	290'	351.45	350.0	346.0
26	D14	350'	331.75	330.0	326.0
27	D15	400'	312.00	310.0	306.0
28	D16	310'	291.55	290.0	286.0
29	D17	230'	371.15	370.0	366.0
30	D18	290'	351.45	350.0	346.0
31	D19	360'	331.80	330.0	326.0
32	D20	420'	312.10	310.0	306.0
33	D21	300'	291.50	290.0	286.0
34	D17	410'	372.05	370.0	366.0
35	D18	530'	352.65	350.0	346.0
36	D19	630'	333.15	330.0	326.0
37	D1	400'	372.00	370.0	366.0
38	D2	510'	352.55	350.0	346.0
39	D3	600'	333.00	330.0	326.0
40	D23, D24, D25	1440'	320.00	23) 315.7 24) 309.3 25) 306.0	23) 311.7 24) 305.3 25) 302.0
41	D11	235'	291.18	290.0	286.0
42	D26	1000'	370.00	311.5	307.5

HALIFAX COUNTY

ASH MONOFILL

SURFACE WATER CALCULATIONS

INLETS

INLET	SWALES DRAINED	AREA (AC) DRAINED	Q
1	1, 37	3.77	10.5
2	2, 38	2.04	5.7
3	3, 39	2.45	6.8
4	4, 7	2.43	6.8
5	5, 8	1.53	4.3
6	6, 9	1.85	5.1
7	10, 14	1.84	5.2
8	11, 15	.97	2.7
9	12, 16	1.18	3.3
10	13, 17	2.05	5.7
11	43, 18	.93	2.6
12	19, 24	2.48	6.9
13	20, 25	1.03	2.9
14	21, 26	1.23	3.5
15	22, 27	1.38	3.9
16	23, 28	1.14	3.2
17	29, 34	2.40	6.7
18	30, 35	1.49	4.2
19	31, 36	1.89	5.3
20	32, 41	1.44	4.1
21	33	.61	1.7
22	1/2 [42]	.12	.35
23	1/3 [40]	.44	1.2
24	1/3 [40]	.44	1.2
25	1/3 [40] 1/2 [42]	.44 + .12 = .56	1.7

INLET FLOW CHART

∴ MAX Q INTO ANY INLET = 10.5 CFS

CHART (CONT)

INLET	SWALE	AREA	Q
26	45	1.38	3.9

AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

INLET SIZING

USE A WEIR TYPE INLET 24" SQUARE

CK FLOW.

$Q = C_w L H^{3/2}$ $L = 2(4) = 8$

$Q = 3(8)(1.5)^{1.5}$ $C_w = 3.0$ (Free Overfall)

$Q = 44.09$ cfs $H = 1.5'$ (Full Channel)

IF TWO SIDES ARE BLOCKED, Q = ?

$Q = C_w L H^{3/2}$

$= 3(4)(1.5)^{1.5}$

$= 22$ cfs > 10.5 cfs OK

INLET SPACING

CK TO SEE IF ALLOWABLE DRAINAGE AREA IS GREATER THAN ACTUAL.

$A_{ALL} = \frac{Q}{CI}$

$= \frac{22}{.35(8)}$

$A = 7.85$ Ac > 3.77 Ac OK

INLET SPACING OK.

HALIFAX COUNTY
ASH MONOFILL

SURFACE WATER CALCULATIONS

PIPES : PIPE SIZING

1/2

PIPE SECTION	FROM	TO	Q	MIN S	n	D_{THEO}	D_{ACT}	V
1	D1	D2	10.5	.02	.01	14.3	18	9.4
2	D2	D3	16.2	.02	.01	16.8	18	10.5
3	D4	D5	6.8	.02	.01	9.8	18	7.3
4	D5	D6	11.1	.02	.01	14.6	18	9.6
5	D7	D8	5.2	.02	.01	11.0	18	7.9
6	D8	D9	7.9	.02	.01	12.9	18	8.8
7	D9	D10	11.2	.02	.01	14.7	18	9.6
8	D10	D11	16.9	.02	.0	17.1	18	10.6
9	D12	D13	6.9	.02	.01	12.2	18	8.5
10	D13	D14	9.8	.02	.01	13.9	18	9.3
11	D14	D15	13.3	.02	.01	15.6	18	10.0
12	D15	D16	17.2	.02	.01	17.2	18	10.7
13	D17	D18	6.7	.02	.01	12.1	18	8.4
14	D18	D19	10.9	.02	.01	14.5	18	9.5
15	D19	D20	16.2	.02	.01	16.8	18	10.5
16	D3	D27	23.0	.2	.01	12.5	18	27.3
17	D27	D23	23.0	.01	.01	21.8	24	8.8
18	D23	D24	24.2	.016	.01	20.4	24	10.7
19	D24	D25	25.4	.011	.01	22.3	24	9.4
20	D25	POND1	27.1	.011	.01	22.8	24	9.6
21	D22	D21	20.7	.05	.01	15.5	18	15.8
22	D20	D22	20.3	.05	.01	15.4	18	15.7
23	D21	POND1	22.4	.035	.01	17.0	18	16.1

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

PIPE SECTION	FROM	TO	Q	MIN S	n	D_{THEO}	D_{ALT}	V
24	DZ6	POND 2	20.1	.005	.01	23.7	24	6.6
25	D6	DZ6	16.2	.02	.01	16.8	18	10.5
26	D16	POND 1	20.4	.005	.01	23.8	24	6.6
27	D11	POND 2	19.5	.02	.01	18.1	24	11.1

EQUATIONS

$$D_{THEO} = 16 \left[\frac{Qn}{\sqrt{S}} \right]^{3/8}$$

$$V = \frac{\sqrt{S}\ D^{2/3}}{8.9n}$$

NOTE: ① ALL CALCULATIONS ASSUME USE OF ADVANCED DRAINAGE SYSTEMS INC. N-12 POLYETHELENE PIPE.

② ALL VELOCITIES EXCEED ALLOWABLE VELOCITIES ON BARE SOIL. THERFORE PIPES SHOULD BE SELF-SCOURING.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

HALIFAX COUNTY
ASH MONOFILL

SURFACE WATER CALCULATIONS

PIPES : INVERTS

1/2

PIPE SECTION	FROM	TO	UPSTREAM INVERT	DOWNSTREAM INVERT	LENGTH	PIPE ø (in)
1	D1	D2	367.0	347.0	140'	18
2	D2	D3	346.8	327.0	110'	18
3	D4	D5	367.0	347.0	140'	18
4	D5	D6	346.8	327.0	120'	18
5	D7	D8	367.0	347.0	90'	18
6	D8	D9	346.8	327.0	100'	18
7	D9	D10	326.8	307.0	90'	18
8	D10	D11	306.8	287.0	30'	18
9	D12	D13	367.0	347.0	90'	18
10	D13	D14	346.8	327.0	90'	18
11	D14	D15	326.8	307.0	90	18
12	D15	D16	306.8	287.0	75'	18
13	D17	D18	367.0	347.0	150'	18
14	D18	D19	346.8	327.0	150'	18
15	D19	D20	326.8	307.0	90'	18
16	D23	MH1	326.8	317.0	50'	18
17	MH1	D23	316.5	312.5	400'	24
18	D23	D24	312.3	305.9	400'	24
19	D24	D25	305.7	299.6	400'	24
20	D25	POND1	299.0	286.0	450'	24
21	D22	D21	300.8	287.0	230'	18
22	D20	D22	306.8	301.0	30'	18
23	D21	POND1	286.8	285	50'	18

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

HALIFAX COUNTY

ASH MONOFILL | SURFACE WATER CALCULATIONS | PIPES: INVERTS

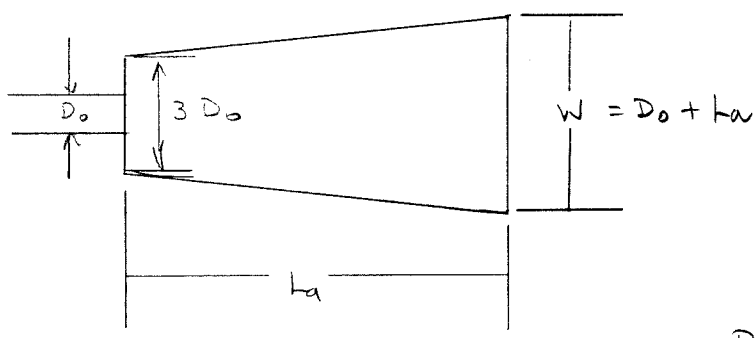
PIPE SECTION	FROM	TO	UPSTREAM INVERT	DOWNSTREAM INVERT	LENGTH	PIPE Ø in
24	D26	POND 2	307.5	285	650'	24
25	D6	D26	326.8	308	110'	18
26	D16	POND 1	286.5	284	440'	24
27	D11	POND 2	286.5	285	90'	24

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SYSTEM CONTAINS 5 OUTLETS. 1 FROM EACH OF THE FOLLOWING PIPES:

PIPE	Q (cfs)	V (ft/s)	ϕ (in)
20	27.1	9.6	24
23	22.4	16.1	18
24	20.1	6.6	24
26	20.4	6.6	24
27	19.5	11.1	24

ASSUME MINIMUM TAILWATER CONDITIONS FOR EACH OUTLET.



PIPE	D_o	Q	L_a	W	Riprap d_{50}	APRON THICKNESS
20	24	27.1	17'	19'	.55' (7")	12"
23	18	22.4	14'	16'	.4' (5")	12"
24	24	20.1	13'	15'	.4' (5")	12"
26	24	20.4	13'	15'	.4' (5")	12"
27	24	19.5	13'	15'	.4' (5")	12"

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

BASIN 1

DRAINAGE AREA : 25 ACRES
RUNOFF COEFFICIENT : .35

$Q = CIA$

I

$$t_c = \frac{\left[\frac{L^3}{H}\right]^{0.385}}{128} \qquad L = 1950' \quad H = 85.0'$$

$$t_c = \frac{\left[\frac{1950^3}{85}\right]^{.385}}{128}$$

$t_c = 8.9$ min

FROM I-D-F CURVES FOR AREA.

$I = 7$ in/hr

$Q = CIA = .35(7)(25)$
$= 61.25$ cfs

MINIMUM VOLUME = 1800 FT³/AC (N.C. Guidelines)

$\therefore 1800(25) = 45{,}000$ FT³

USE RECTANGULAR BASIN WITH THE FOLLOWING DIMENSIONS :

$V = 45{,}000$ FT³
$S = 2.5$ (2.5:1)
$H = 5'$
$L = 3W$
$W = W$

$V = HLW - SH^2L - SH^2W + 2S^2H^3$

$45000 = 5(3W)W - 2.5(25)(3W) - 25(25)W + 2(2.5)^2(125)$

$45000 = 15W^2 - 250W + 1{,}562.50$

$0 = W^2 - 16.7W - 2895.0$

BASIN 1 (CONT.)

$$w = \frac{16.7 \pm \sqrt{(16.7)^2 - 4(1)(-2895.8)}}{2(1)}$$

$w = 62.8 \Rightarrow 63$ FT

$L = 189$ FT

ADD 2' FREEBOARD ; ADDS 10' TO EACH DIMENSION

$W = 73$
$L = 199$

USE 75' X 200' X 5'

TOP ELEVATION	:	289.0'
PRINCIPAL SPILLWAY ELEVATION	:	282.0'
EMERGENCY SPILLWAY ELEVATION	:	283.0'
BOTTOM ELEVATION	:	277.0'

PRINCIPAL SPILLWAY

BARREL

$Q_{min} = .2$ cfs/ACRE
$= .2(25) = 5$ CFS

$H = 5'$
$L = 65'$

FROM TABLE 8.07a Pg 8.07.6

USE 18" BARREL

$Q_{BARREL} = 12.23$ cfs > 5.0 o.k

RISER

FROM INLET PROPORTIONS CHART, 18" BARREL USES A 24" RISER.

ANTIFLOTATION BLOCK

VOLUME RISER $= L(A_c)$
$= 5'(\pi)(1)^2$
$= 15.71$ FT^3

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

BASIN 1

Weight H_2O displaced

$15.7\ FT^3\ (62.4\ lbs/FT^3)$

$= 980\ lbs$

Concrete [illegible] 150 pcf

$980/150 = 6.5\ FT^3$

24" side = $36''^2$ Block

$V = 3 \times 3 \times d \geq 6.5\ FT^3$

Use a block $3' \times 3' \times 1' = 9\ FT^3 = 1350\ lbs$

$1350\ lbs > 980\ lbs(1.1)$

ANTI-SEEP COLLARS

PLACE COLLARS (60" x 60" x 1/2") 3' DOWNSTREAM OF ALL PIPE JOINTS.

OUTLET PROTECTION

BARREL DISCHARGE VELOCITY

$$V = \frac{\sqrt{s}\, D^{2/3}}{8.9n}$$

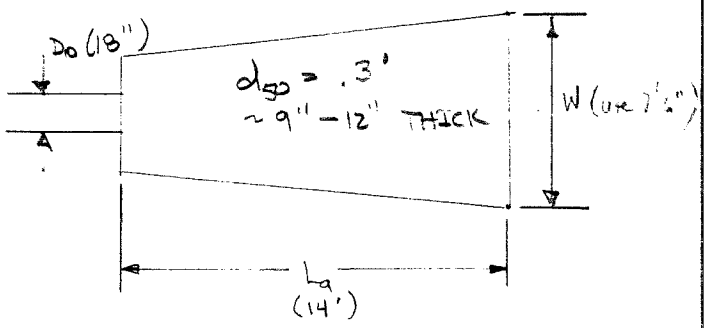
$D = 18''$
$s = 1\%$
$n = .024$ (CMP)

$$= \frac{\sqrt{.01}\,(18)^{2/3}}{8.9(.024)}$$

$V = 3.24\ Fps$ $\quad Q = 12.23\ cfs$

ASSUME TAILWATER > 0.5 D_o

$D_o = 18''$
$L_a = 14'$
$W = 7.1' \rightarrow (7'6")$
$d_{50} = .3'$
$d_{max} = .45'$
Apron thickness = .68' (8.1")



BASIN 1

EMERGENCY SPILLWAY

Required Capacity

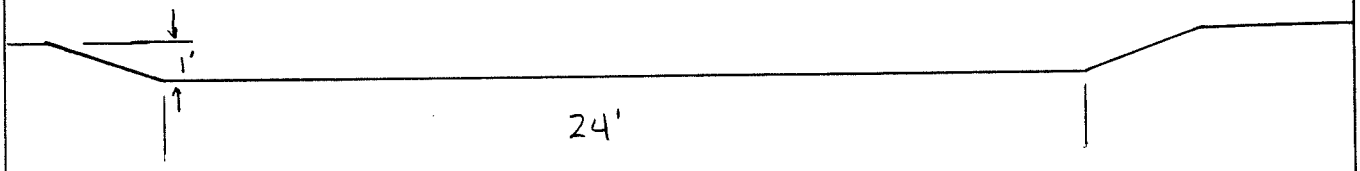
$$Q_e = Q - Q_p$$

$$Q_e = 61.25 - 12.23$$
$$Q_e = 49.02$$

FROM TABLE 8.07c (ASSUME USE OF EROSION CONTROL MAT)

SLOPE 3.1 - 9.0%
Q = 50 CFS
BOTTOM WIDTH 24'
STAGE .94'

CROSS - SECTION



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

BASIN 2

DRAINAGE AREA: 15.5 AC
RUNOFF COEFFICIENT: .35

$$Q = CIA$$

$$I \qquad t_c = \frac{\left[\frac{L^3}{H}\right]^{0.385}}{128} \qquad L = 1{,}020' \quad H = 85'$$

$$t_c = \frac{\left[\frac{1020^3}{85}\right]^{.385}}{128}$$

$$= 4.21 \Rightarrow t_c = 5\,min$$

$$I = 8''/hr$$

$$Q = CIA$$
$$= .35(8)(15.5)$$
$$Q = 43.4\ cfs$$

MINIMUM VOLUME = 1800 FT^3/AC

$$1800(15.5) = 27{,}900 \Rightarrow 28{,}000$$

$V = 28{,}000$
$S = 2.5$
$H = 5'$
$L = 3w$
$w = w$

$$V = HLw - SH^2L - SH^2w + 2S^2H^3$$

$$28{,}000 = 5(3w)(w) - 2.5(25)(3w) - 2.5(25)w + 2(25)^2(125)$$

$$28{,}000 = 15w^2 - 250w + 1562.5$$

$$0 = w^2 - 16.7w - 1762.5$$

$$w = \frac{16.7 \pm \sqrt{(16.7)^2 - 4(1)(-1762.5)}}{2}$$

$$w = 51.15 \Rightarrow 52'$$

$$L = 156'$$

ADD FREEBOARD $L = 170$
$w = 65$
$H = 5'$

TOP ELEVATION : 284
PRINCIPAL SPILLWAY ELEVATION : 282
EMERGENCY SPILLWAY ELEVATION : 283
BOTTOM ELEVATION : 277.0

PRINCIPAL SPILLWAY

BARREL $H = 5'$ $L = 65'$

$Q_{min} = .2 CFS/ACRE$
$.2(15.5)$
$= 3.1 CFS$

FROM TABLE 8.07a

USE 12" BARREL

$Q_{12''} = 4.49 CFS > 3.1 CFS$ OK

RISER

USE 18" RISER (Pg. 8.07.9)

ANTI-SEEP COLLAR

PLACE COLLARS (30" x 30" x 1/2") 3' DOWNSTREAM OF ALL PIPE JOINTS.

ANTI-FLOTATION BLOCK

$V_{RISER} = \frac{\pi}{4}(1.5)^2(L) = \pi(.75)^2(5)$
$= 8.84 FT^3$

$WT_{H2O} = 8.84(62.4) = 551.3 lbs$

BLOCK MIN TOP DIMENSION

30" x 30" $A = 6.25 FT^2$

$V_{CONCRETE} = 551.3/150 = 3.67 FT^3$

USE BLOCK 30" x 30" x 12"

$V = 6.25 FT^3 > 3.67 FT^3$

$WT = 937.5 lbs > 551.3(1.1)$ OK

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

BASIN 2

OUTLET PROTECTION

BARREL DISCHARGE VELOCITY

$$V = \frac{\sqrt{s}\, D^{2/3}}{8.9\, n}$$

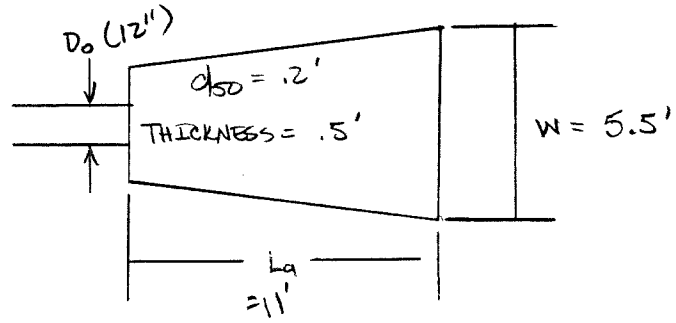
$D = 12''$
$s = 1\%$
$n = .024$

$V = 2.5$ fps $Q = 4.5$ cfs

ASSUME TAILWATER $> 0.5\, D_o$

FROM FIGURE 8.06 b

$D_o = 12''$
$L_a = 11'$
$w = 5.5'$
$d_{50} = .2'$
$d_{max} = .3'$
Thickness $= .45'$



EMERGENCY SPILLWAY

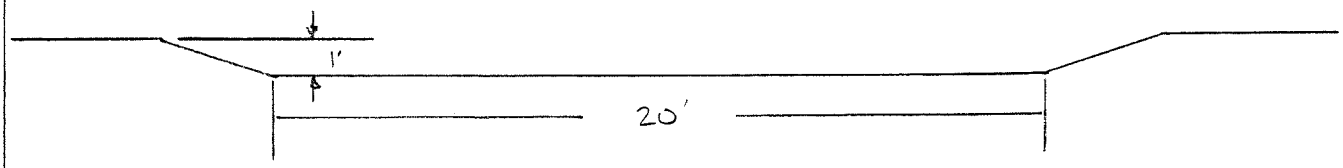
REQUIRED CAPACITY

$$Q_e = Q - Q_p$$
$$= 43.4 - 4.5$$
$$= 38.9$$

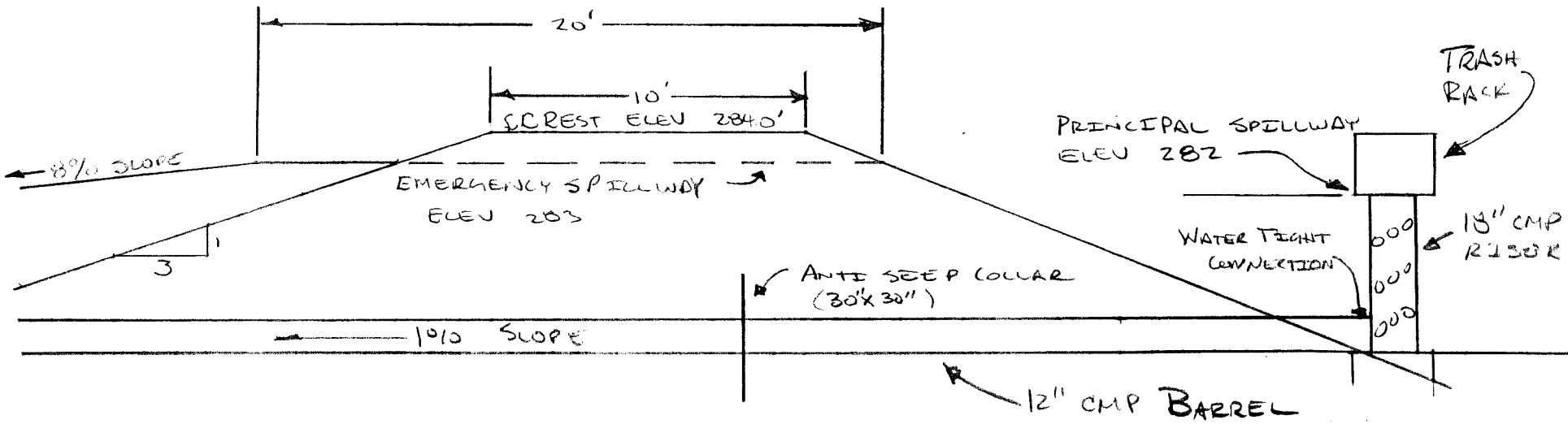
USE EROSION CONTROL MAT ON SPILLWAY

SLOPE 3.1 - 9.0%
Q = 40 cfs
BOTTOM WIDTH = 20'
STAGE = .91'

CROSS - SECTION



AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS



BASIN 2 CROSS - SECTION

APPENDIX F:

PROPERTY DESCRIPTION

GODWIN & STEPHENSON
ATTORNEYS AT LAW
938 ROANOKE AVENUE
P. O. BOX 429
ROANOKE RAPIDS, N. C. 27870

A. S. GODWIN, JR.
W. TURNER STEPHENSON, III

TELEPHONE: (919) 537-9148
FAX: (919) 537-2637

April 14, 1992

Mr. John Barnard
Hazen & Sawyer
4011 Westchase Blvd.
Raleigh, NC 27607

Dear John:

I have enclosed the recently completed map showing the entire landfill property owned by Halifax County. Also, please find enclosed a metes and bounds description of this same property.

It is my understanding that you needed both of these items to complete a stage of your permitting process.

If you have any questions, please advise.

Yours very truly,

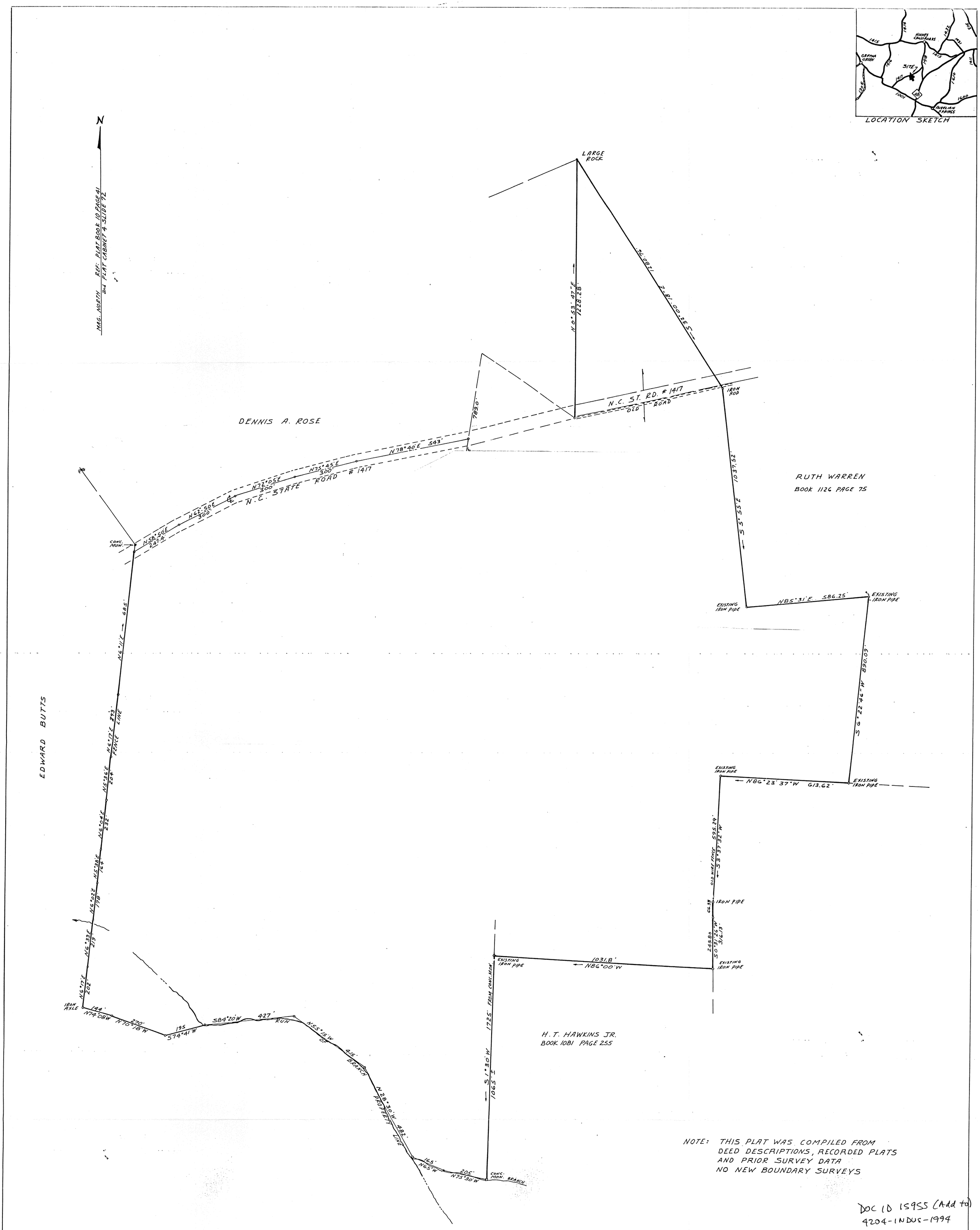
Turner

W. Turner Stephenson, III

WTS:wch

Copy to: Neal Phillips
Dave Stoner

That certain tract or parcel of land lying and being situate in Butterwood Township, Halifax County, North Carolina, more particularly described as follows: Beginning at an iron rod located in the Southern right-of-way of N.C. State Road 1417: thence along the Ruth Warren property line S. 5° 55' E. 1037.52 feet to an existing iron pipe; thence N. 85° 31' E. 586.25 feet to an existing iron pipe; thence S. 6° 22' 46" W. 890.09 feet to an existing iron pipe; thence N. 86° 23' 37" W. 613.62 feet to an existing iron pipe; thence along an old wire fence S. 3° 37' 32" W. 595.29 feet to an iron pipe; thence S. 0° 31' 26" W. 316.13 feet to an existing iron pipe; thence N. 86° 00' W. 1031.8 feet to an existing iron pipe; thence S. 1° 30' W. 1725 feet to a concrete monument on the North side of a branch; thence running generally up the branch N. 75° 30' W. 205 feet to a point; thence N. 65° W. 165 feet to a point; thence N. 28° 30' W. 482 feet to a point; thence N. 55° 15' W. 415 feet to a point; thence S. 84° 20' W. 427 feet to a point; thence leaving said branch and running S. 74° 41' W. 195 feet to a point; thence N. 70° 18' W. 270 feet to a point; thence N. 74° 08' W. 144 feet to an iron axle; thence running along the Edward Butts property N. 6° 17' E. 202 feet to a point; thence N. 6° 33' E. 219 feet to a point; thence N. 6° 02' E. 178 feet to a point; thence N. 5° 38' E. 164 feet to a point; thence N. 6° 04' E. 232 feet to a point; thence N. 5° 36' E. 204 feet to a point; thence along a fence line N. 6° 17' E. 293 feet to a point; thence N. 6° 11' E. 685 feet to the centerline of N.C. State Road 1417; thence along said centerline the following courses and distances, N. 58° 50' E. 247.4 feet; N. 62° 50' E. 300 feet; N. 72° 05' E. 300 feet; N. 75° 45' E. 300 feet; N. 78° 40' E. 543 feet; thence S. 8° 38' W. approximately 30 feet to the Southern right-of-way of said State Road 1417; thence along said right-of-way in a Easterly direction approximately 510 feet to a point on an old road; thence N. 0° 53' 47" E. 1228.28 feet to a large rock; thence S. 32° 00' 18" E. 1280.76 feet to the point of beginning. This property is shown on that certain map entitled "Plat Showing Property Belonging to Halifax County 'Landfill Area'", prepared by Cyril C. Waters, Registered Surveyor, under date of April 11, 1992; reference to said map being hereby made for greater certainty of description.



NOTE: THIS PLAT WAS COMPILED FROM DEED DESCRIPTIONS, RECORDED PLATS AND PRIOR SURVEY DATA NO NEW BOUNDARY SURVEYS

DOC ID 15955 (Add to)
4204-INDUS-1994
1-24-12 DW
Cell 1 Construction Plan
Application (App. F)

PLAT SHOWING PROPERTY
BELONGING TO

HALIFAX COUNTY

"LANDFILL AREA"

DATE: APRIL 11, 1992	DRAWN BY: C.C.W.
SCALE 1" = 200'	

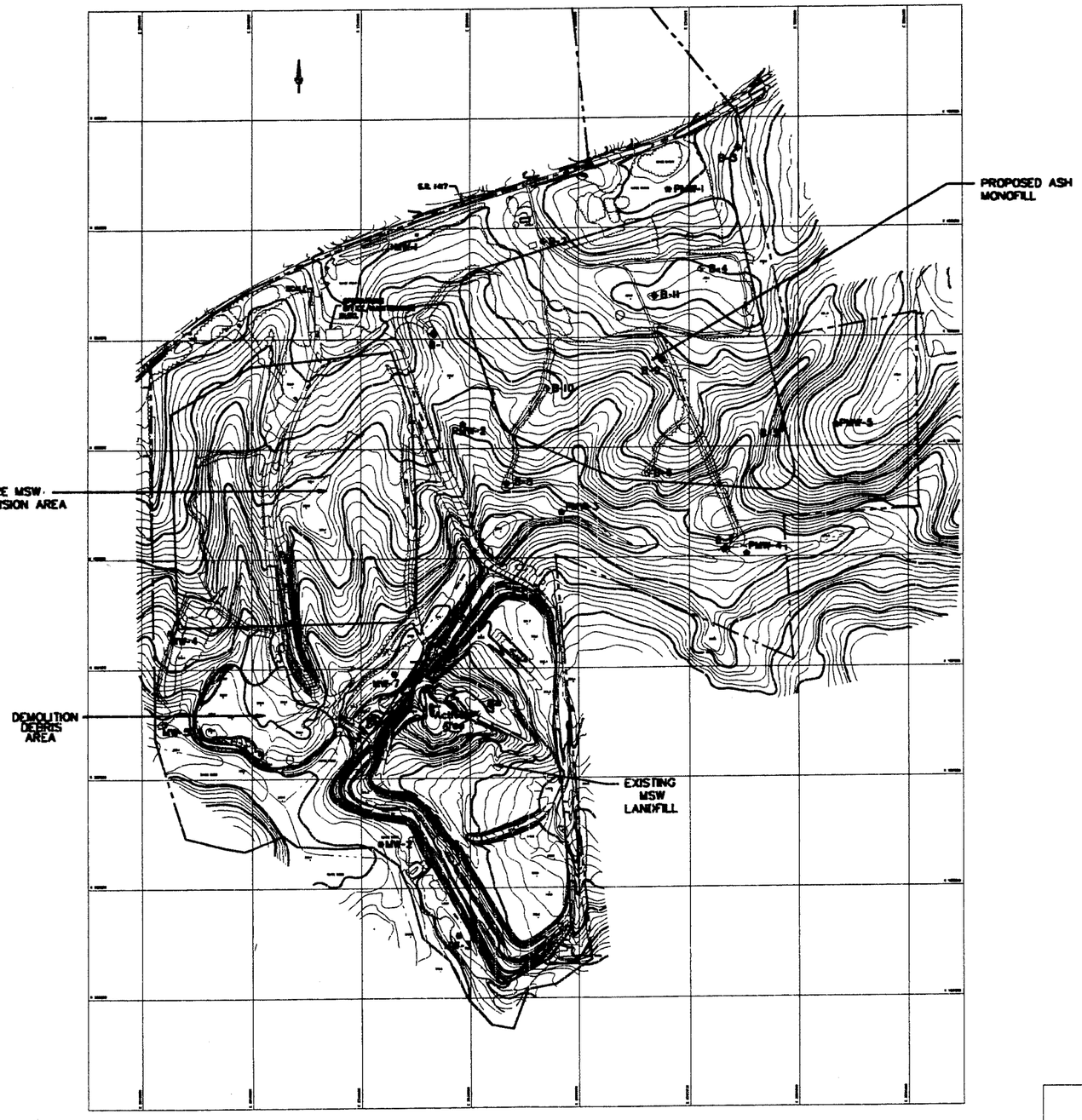
CYRIL C. WATERS
REGISTERED SURVEYOR

P.O. BOX 585
ROANOKE RAPIDS, N.C.

919 586 3409

APPENDIX G:

PROJECT DRAWINGS



LEGEND

- PROPERTY LINE
- STREAM
- APPROXIMATE DISPOSAL AREA LIMIT
- FACILITY FENCE
- ▲ BENCHMARK
- MW-1 ● EXISTING MONITOR WELL
- PMW-1 ● PROPOSED MONITOR WELL
- B-10 ⊕ SOIL BORINGS PERFORMED 1991 (BY ENSCI CORP.)
- B-9 ● PIEZOMETER INSTALLED 1991

SCALE: 1"=200'

TOPOGRAPHIC SURVEY BY

PHOTO SCIENCE INC.
GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

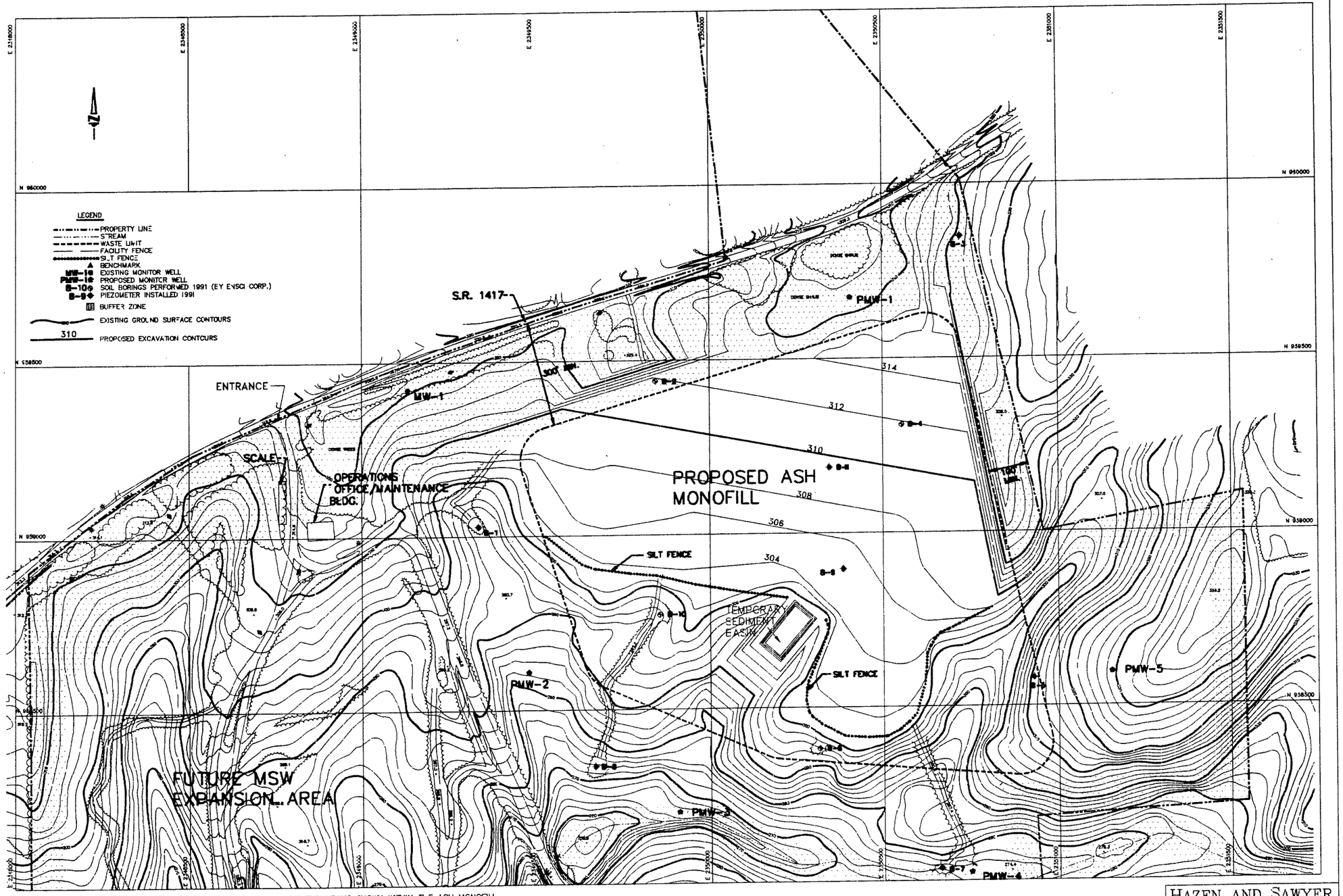
NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

EXISTING SITE CONDITIONS

HALIFAX COUNTY ASH MONOFILL

SCALE 1" = 200'	DRAWN BY JDB	CHECKED BY GNR	
JOB NO. 3720	DATE 2-92	PAGE 1 OF 29	



TOPOGRAPHIC SURVEY BY

PHOTO SCIENCE INC.
GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

NOTES: 1. EXCAVATION TO THE ELEVATIONS SHOWN WITHIN THE ASH MONOFILL BOUNDARY TO BE COMPLETED PRIOR TO START OF ASH MONOFILL CONSTRUCTION.

2. DRAWING DEPICTS PROPOSED BORROW EXCAVATION ELEVATIONS. ACTUAL ELEVATIONS WILL BE DETERMINED IMMEDIATELY PRIOR TO CONSTRUCTION OF CELL 1.

0 50 100 200 300 400 500
25 75

SCALE: 1"=100'

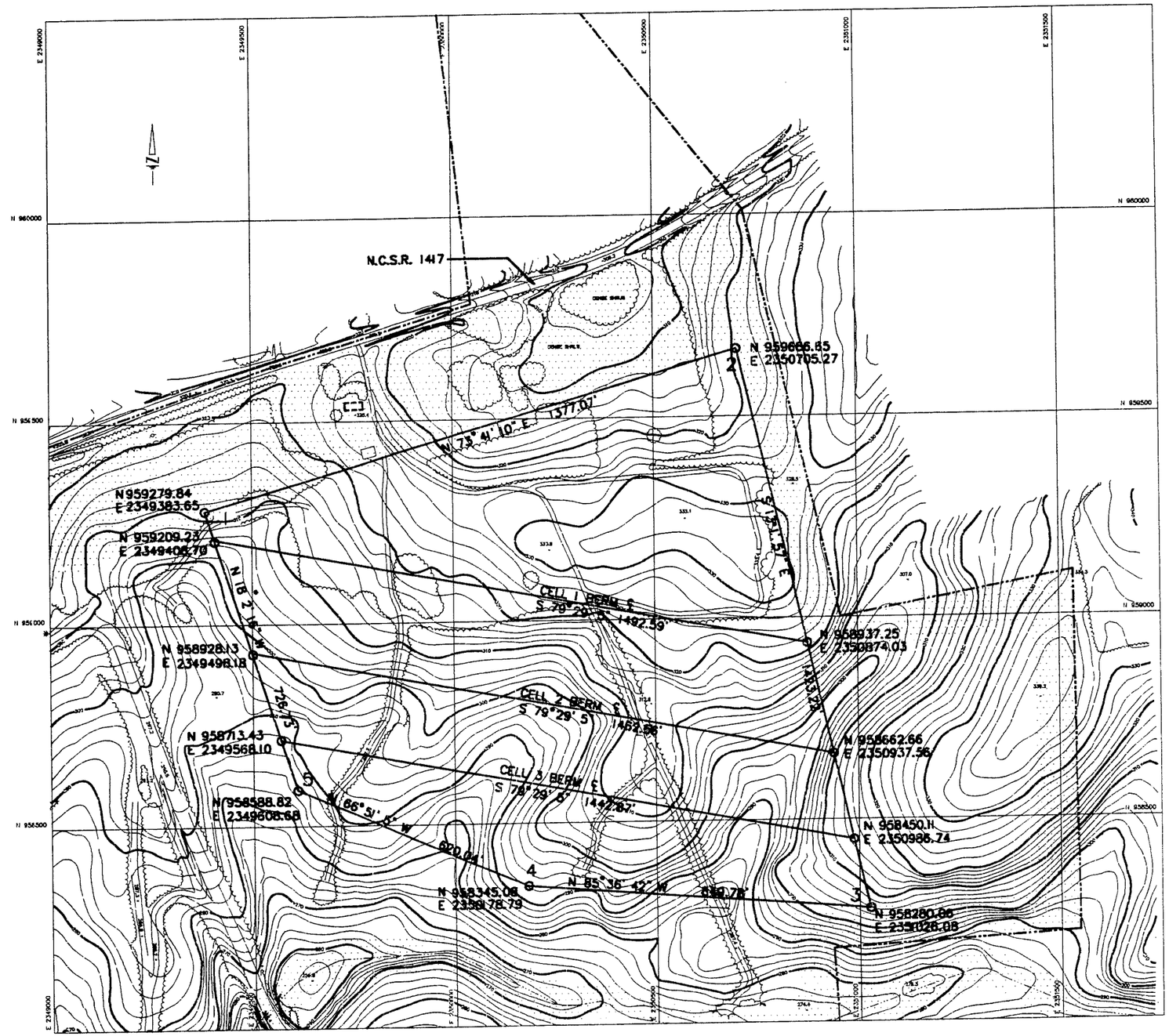
NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

SITE CONDITIONS AFTER BORROW EXCAVATION

HALIFAX COUNTY ASH MONFILL

SCALE 1"=100'	DRAWN BY JDB	CHECKED BY CNR
JOB NO. 372K	DATE 2-92	PAGE 2 OF 29



CENTERLINE OF BERM
BUFFER ZONE

CURVE DATA TABLE

CURVE	R	Δ	T	PI N	PI E
1	[illegible]	9.72	[illegible]	[illegible]	[illegible]
2	[illegible]	94.00	92.85	[illegible]	[illegible]
3	[illegible]	33.33	70.10	[illegible]	[illegible]
4	[illegible]	16.76	17.35	[illegible]	[illegible]
5	[illegible]	49.61	47.04	[illegible]	[illegible]

0 50 100 200 300 400 500
25 75
SCALE: 1"=100'

TOPOGRAPHIC SURVEY BY

PHOTO SCIENCE INC.
GREENSBORO, N.C.

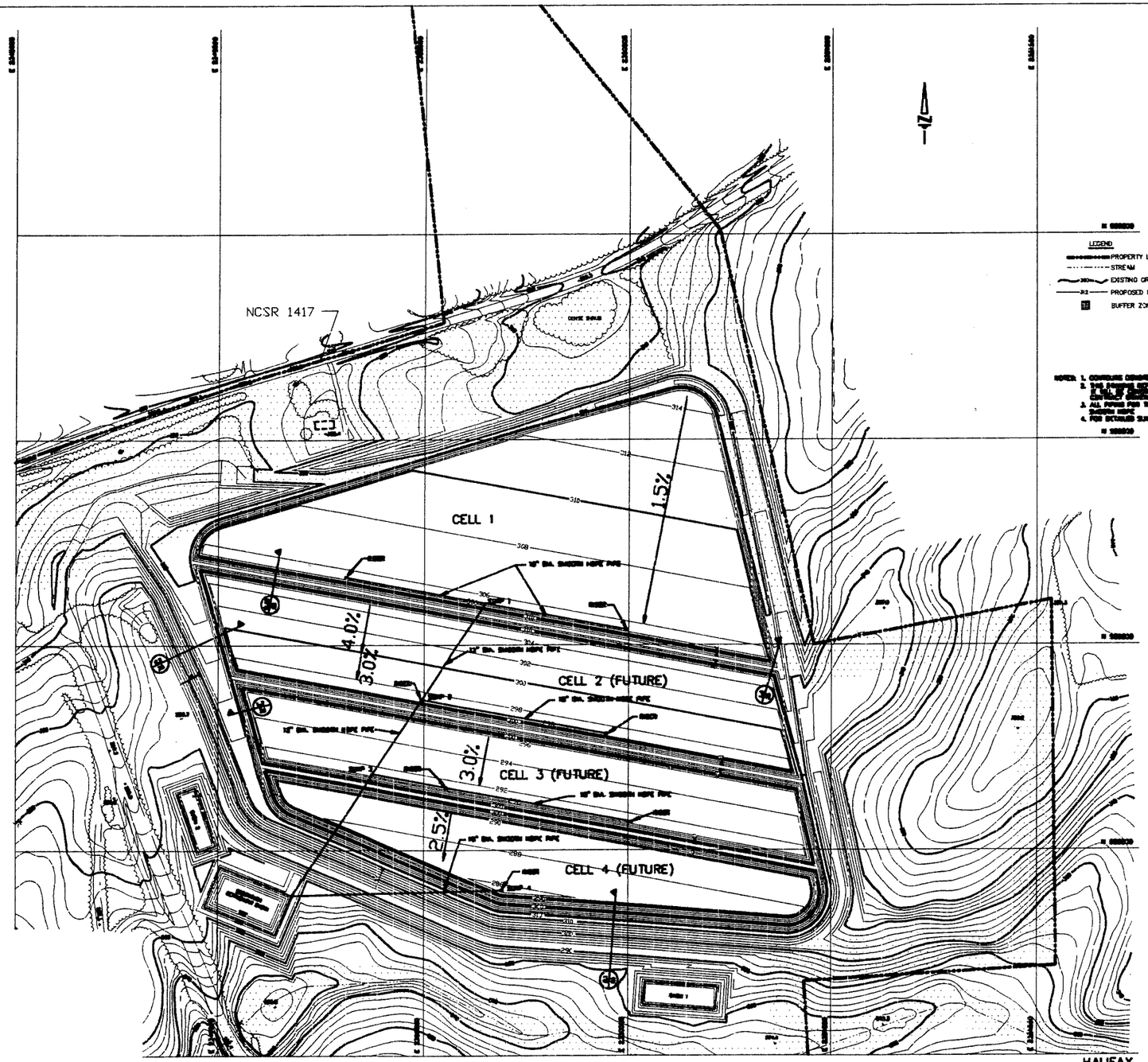
SURVEY FLOWN 2-1-91

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

BERM LAYOUT INFORMATION
HALIFAX COUNTY ASH MONOFILL

SCALE 1"=100'	DRAWN BY JGB	CHECKED BY CNR
JOB NO. 3720	DATE 2-92	PAGE 3 OF 29



NOTE: FOR BASIN DETAILS SEE SHEETS 28 AND 29

LEGEND

PROPERTY LINE
STREAM
EXISTING GROUND SURFACE CONTOURS
PROPOSED EARTHWORK CONTOURS
BUFFER ZONE

NOTES:
1. [illegible]
2. [illegible]
3. ALL PIPING FOR THE MATERIAL TERMINATED EVENTS WILL BE 24-INCH HDPE
4. FOR DETAILED SUMP LOCATIONS, SEE DETAIL SHEET 34

TOPOGRAPHIC SURVEY BY
PHOTO SCIENCE INC.
GREENSBORO, N.C.
SURVEY FLOWN 2-1-91

0 50 100 200 300 400 500
25 75
SCALE: 1"=100'

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

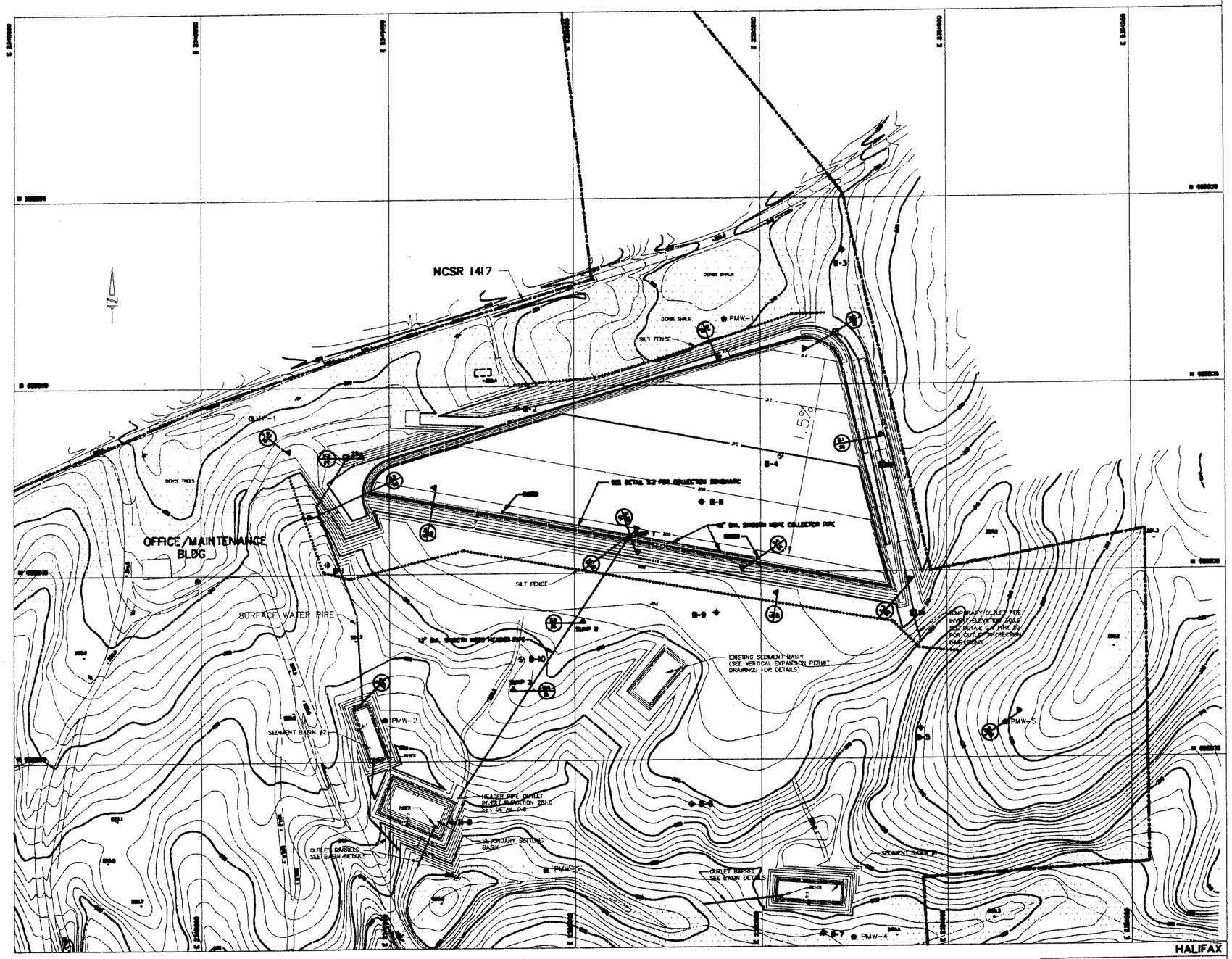
OVERALL EXCAVATION PLAN
HALIFAX COUNTY ASH MONOFILL

SCALE 1"=100'	DRAWN BY: JDB	CHECKED BY: GNR
JOB NO. 3720	DATE 2-92	PAGE 4 OF 29

LEGEND

- PROPERTY LINE
- STREAM
- DRAINAGE SWALE
- SILT FENCE
- DRAINAGE PIPE
- DRAINAGE DIRECTION ARROW
- DROP INLET
- INTERNAL STORMWATER COLLECTION SUMP
- BENCHMARK
- MW-1 EXISTING MONITOR WELL
- PMW-4 PROPOSED MONITOR WELL
- B-10 SOIL BORINGS PERFORMED 1991 (BY ENSCI CORP.)
- B-9 PIEZOMETER INSTALLED 1991
- 280 EXISTING GROUND SURFACE CONTOURS
- 312 PROPOSED EARTH-WORK CONTOURS
- BUFFER ZONE

NOTES:
1. CONTOURS DENOTE SYNTHETIC LINER SUBGRADE ELEVATIONS
2. SEE OPERATIONAL COVER PLAN FOR TOP OF OPERATIONAL COVER ELEVATIONS
3. INSTALL SUMPS 1, 2, 3 AND HEADER PIPE DURING CONSTRUCTION OF CELL 1. INSTALL PROTECTIVE COVERS ON SUMPS 2 AND 3 AS DETAILED IMMEDIATELY AFTER INSTALLATION.
4. SEE DETAIL SHEETS 25 AND 29 FOR BASIN LAYOUT INFORMATION



SCALE: 1"=100'

TOPOGRAPHIC SURVEY BY

PHOTO SCIENCE INC.
GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

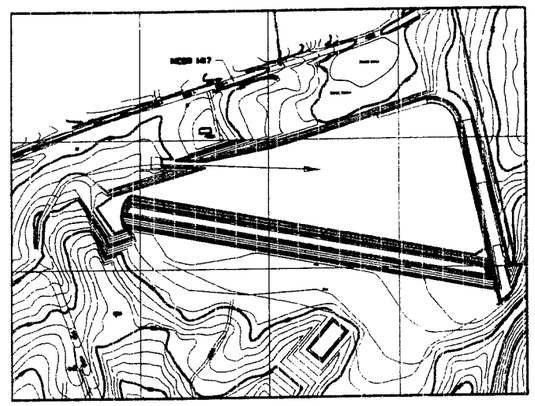
NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

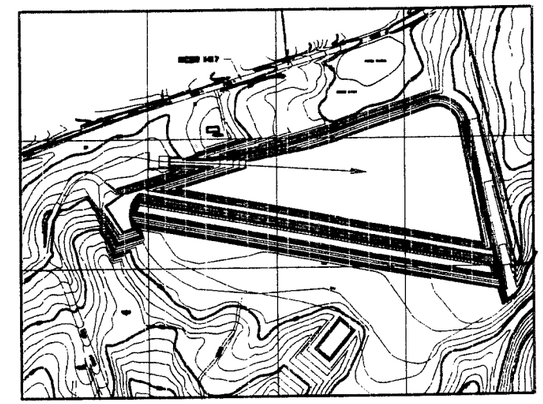
EXCAVATION PLAN CELL 1

HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY	CHECKED BY
1"=100'	JDB	GHR
JOB NO. J720	DATE 2-92	PAGE 6 OF 29

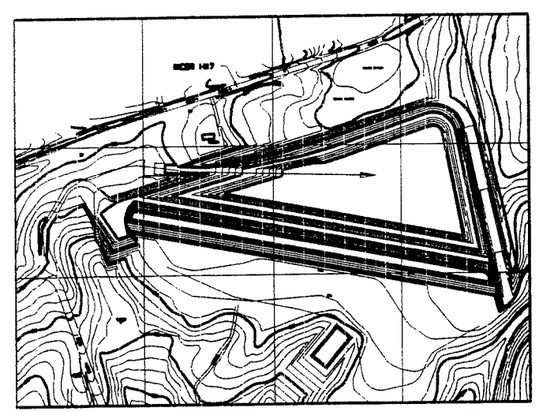


PHASE 1A: FILLED TO ELEVATION 320



PHASE 1B: FILLED TO ELEVATION 330

NOTES:
1. THESE DRAWINGS DEPICT THE SEQUENTIAL FILLING OF CELL 1
   EACH PHASE DENOTES AN APPROXIMATE 10 FOOT LIFT OF ASH.
2. THE ACCESS ARROWS INDICATE ACCESS FOR THAT PHASE
3. THE CELL INTERIM COVER ELEVATIONS ARE SHOWN ON THE FOLLOWING SHEET
4. CONTOURS DENOTE TOP OF ASH ELEVATIONS



PHASE 1C: FILLED TO ELEVATION 340

→ ACCESS TO ACTIVE FACE

NO	DATE	DESCRIPTION	BY

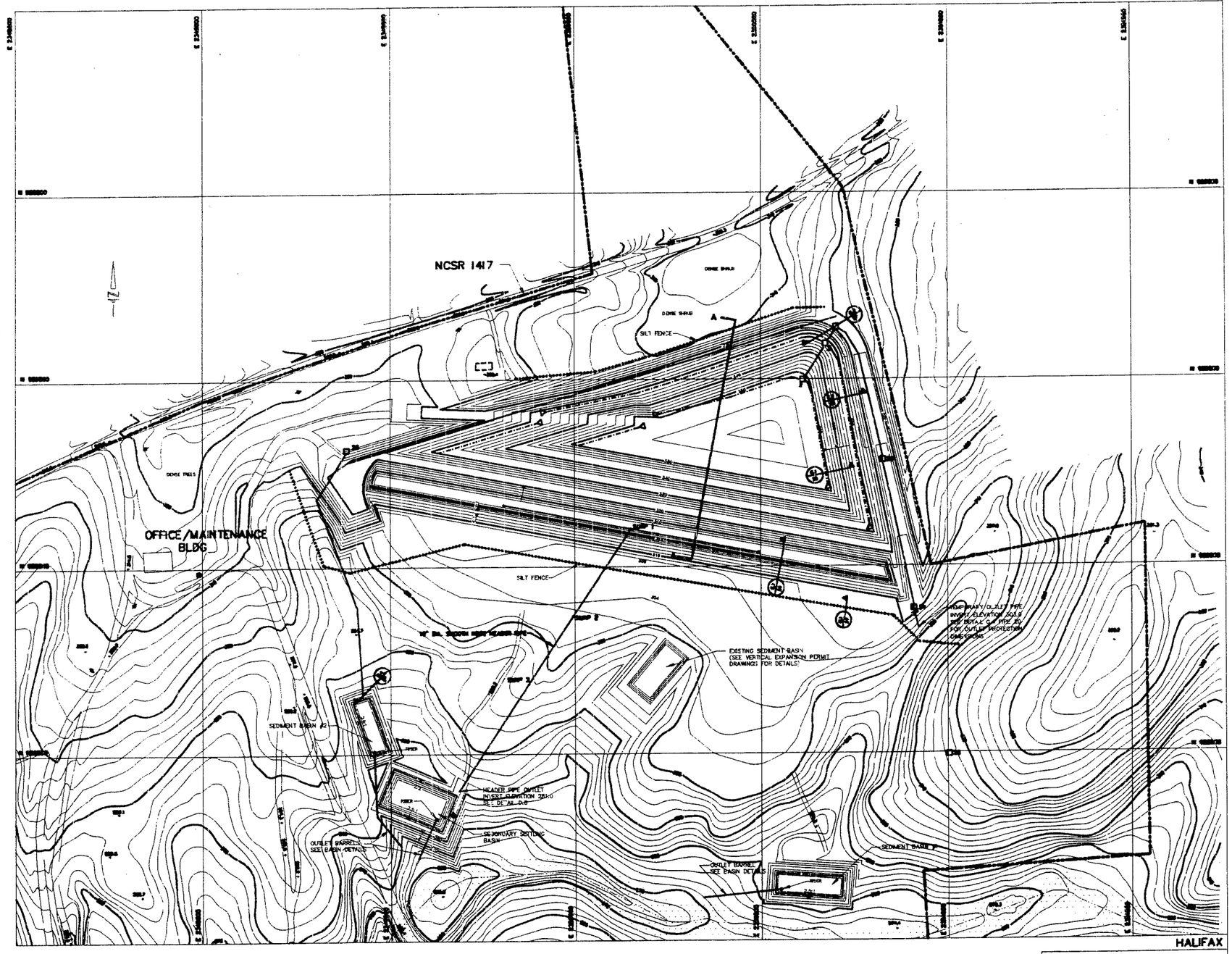
HAZEN AND SAWYER
Environmental Engineers & Scientists

PHASING PLAN
CELL 1
HALIFAX COUNTY ASH MONCFILL

SCALE NTS	DRAWN BY JDB	CHECKED BY CNR	
JOB NO 3720	DATE 2-92	PLATE 7 OF 23	

LEGEND

- PROPERTY LINE
- STREAM
- DRAINAGE SWALE
- SILT FENCE
- DRAINAGE PIPE
- DRAINAGE DIRECTION ARROW
- DROP INLET
- INTERNAL STORMWATER COLLECTION SUMP
- BENCHMARK
- MW-1 EXISTING MONITOR WELL
- PMW-4 PROPOSED MONITOR WELL
- B-10 SOIL BORINGS PERFORMED 1991 (BY ENSCI CORP.)
- B-9 PIEZOMETER INSTALLED 1991
- 280 EXISTING GROUND SURFACE CONTOURS
- 312 PROPOSED EARTHWORK CONTOURS
- BUFFER ZONE



NOTES:
1. DRAWING DEPICTS CELL 1, PHASE D, FILLED TO ELEVATION 354
2. CELL 2 WILL BE OPERATIONAL PRIOR TO REACHING THIS PHASE
3. FOR CELL 2 EXCAVATION PLAN SEE SHEET 9
4. FOR EROSION AND SEDIMENTATION CONTROL SEE SHEET 18

0 50 100 200 300 400 500
25 75

SCALE: 1"=100'

TOPOGRAPHIC SURVEY BY

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GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

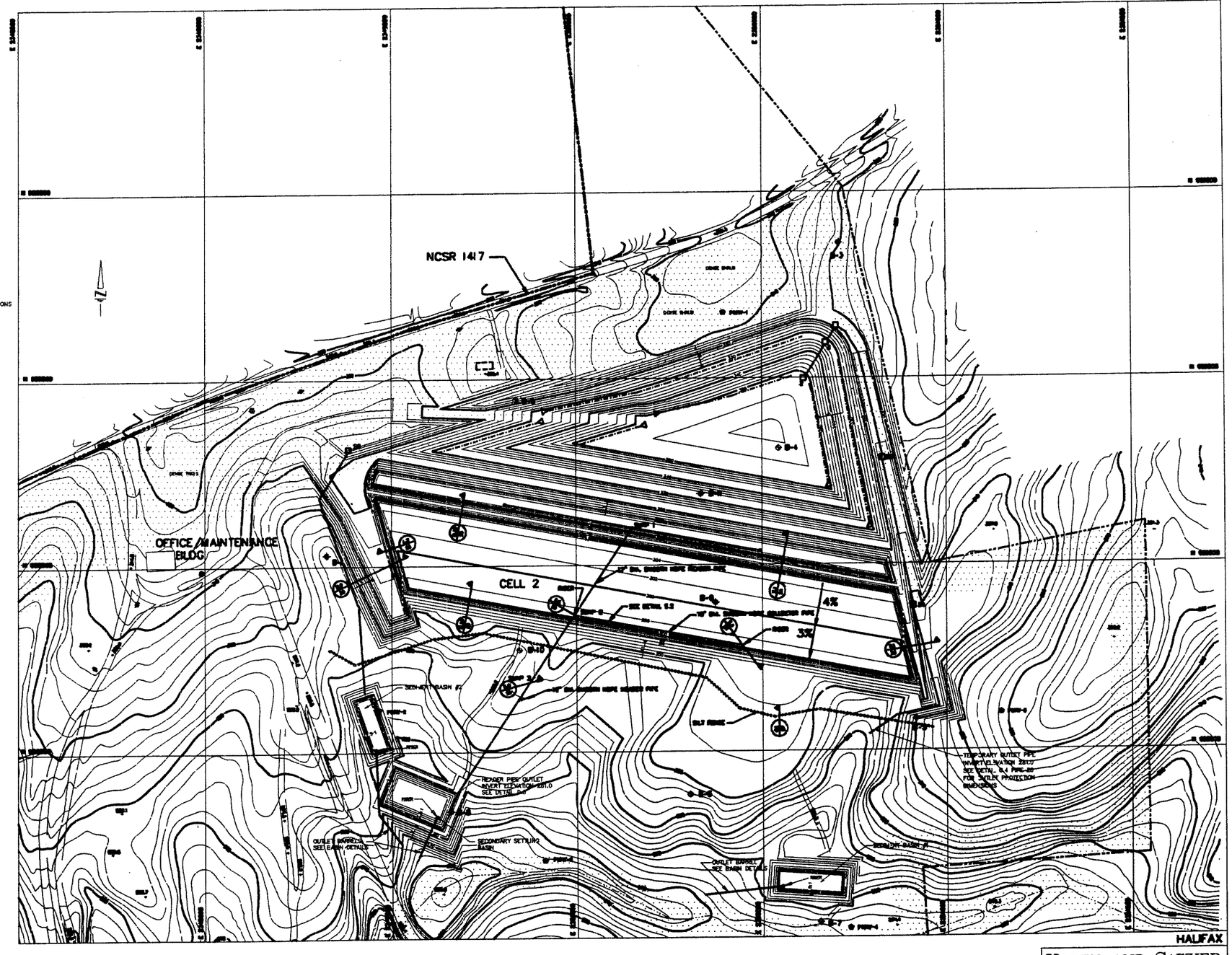
INTERIM COVER CELL 1

SCALE 1"=100'	DRAWN BY: JDB	CHECKED BY: GNR
JOB NO 3720	DATE 2-92	PAGE 8 OF 23

LEGEND

- PROPERTY LINE
- STREAM
- DRAINAGE SWALE
- SILT FENCE
- DRAINAGE PIPE
- DRAINAGE DIRECTION ARROW
- DROP INLET
- INTERNAL STORMWATER COLLECTION SUMP
- BENCHMARK
- MW-1 EXISTING MONITOR WELL
- PMW-4 PROPOSED MONITOR WELL
- B-10 SOIL BORINGS PERFORMED 1991 (BY ENSCI CORP.)
- B-9 PIEZOMETER INSTALLED 1991
- 280 EXISTING GROUND SURFACE CONTOURS
- 312 PROPOSED EARTHWORK CONTOURS
- BUFFER ZONE

NOTES:
1. CONTOURS IN CELL 2 DENOTE SYNTHETIC LINER SUBGRADE ELEVATIONS
2. SEE OPERATIONAL COVER PLAN FOR TOP OF OPERATIONAL COVER ELEVATIONS
3. LEAVE SUMP 3 PROTECTIVE COVER IN PLACE DURING THIS PHASE
4. SUMPS AND HEADER PIPES WERE INSTALLED DURING CONSTRUCTION OF CELL 1
5. SEE SHEETS 28 AND 29 FOR BASIN DETAILS



TOPOGRAPHIC SURVEY BY

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GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

0 50 100 200 300 400 500
25 75
SCALE: 1"=100'

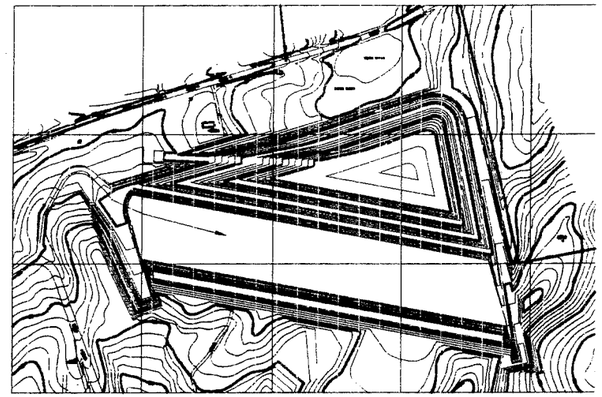
NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

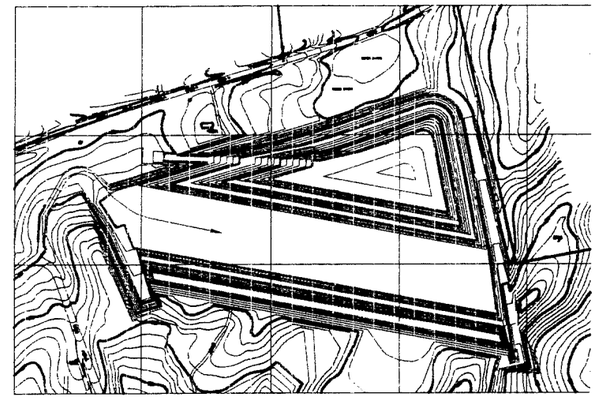
EXCAVATION PLAN CELL 2

HALIFAX COUNTY ASH MONOFILL

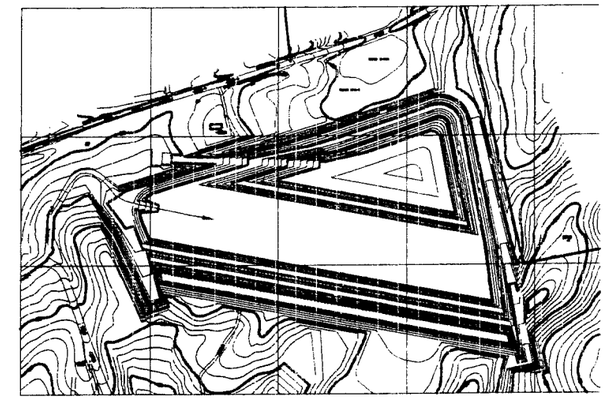
SCALE 1"=100'	DESIGNED BY JDS	CHECKED BY GNR
JOB NO. 3720	DATE 2-92	PAGE 8 OF 29



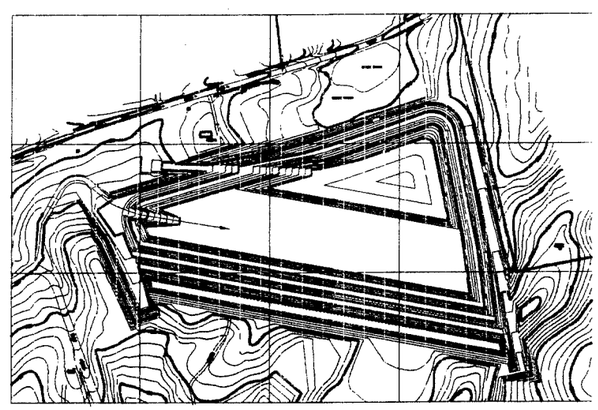
PHASE 2A: FILLED TO ELEVATION 310



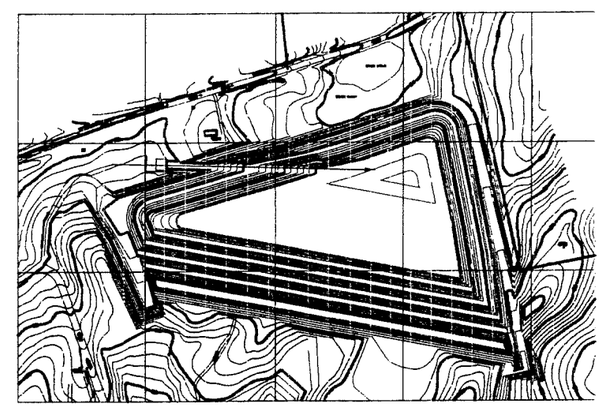
PHASE 2B: FILLED TO ELEVATION 320



PHASE 2C: FILLED TO ELEVATION 330



PHASE 2D: FILLED TO ELEVATION 340



PHASE 2E: FILLED TO ELEVATION 360

NOTES:
1. THESE DRAWINGS DEPICT THE SEQUENTIAL FILLING OF CELL 2 EACH PHASE DENOTES AN APPROXIMATE 10 FOOT LIFT OF ASH.
2. THE ACCESS ARROWS INDICATE ACCESS FOR THAT PHASE
3. THE CELL 2 INTERIM COVER ELEVATIONS ARE SHOWN ON THE FOLLOWING SHEET
4. CONTOURS DENOTE TOP OF ASH ELEVATIONS

→ ACCESS TO ACTIVE FACE

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

PHASING PLAN
CELL 2
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY	CHECKED BY
NTS	JDB	GNR
JOB NO. 3720	DATE 2-92	PAGE 10 OF 29

LEGEND

- PROPERTY LINE
- STREAM
- DRAINAGE SWALE
- SILT FENCE
- DRAINAGE PIPE
- DRAINAGE DIRECTION ARROW
- DROP INLET
- INTERNAL STORMWATER COLLECTION SUMP
- BENCHMARK
- MW- EXISTING MONITOR WELL
- PMW-4 PROPOSED MONITOR WELL
- B-10 SOIL BORINGS PERFORMED 1991 (BY ENSCI CORP.)
- B-9 PIEZOMETER INSTALLED 1991
- 280 EXISTING GROUND SURFACE CONTOURS
- 312 PROPOSED EARTHWORK CONTOURS
- BUFFER ZONE

NOTES:
1. DRAWING DEPICTS CELL 2, PHASE F, FILLED TO ELEVATION 364
2. CELL 3 WILL BE OPERATIONAL PRIOR TO REACHING THIS PHASE
3. FOR CELL 3 EXCAVATION PLAN SEE SHEET 12
4. FOR EROSION AND SEDIMENTATION CONTROL SEE SHEET 18

0 50 100 200 300 400 500
25 75

SCALE: 1"=100'

TOPOGRAPHIC SURVEY BY

PHOTO SCIENCE INC.
GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

INTERIM COVER CELL 2

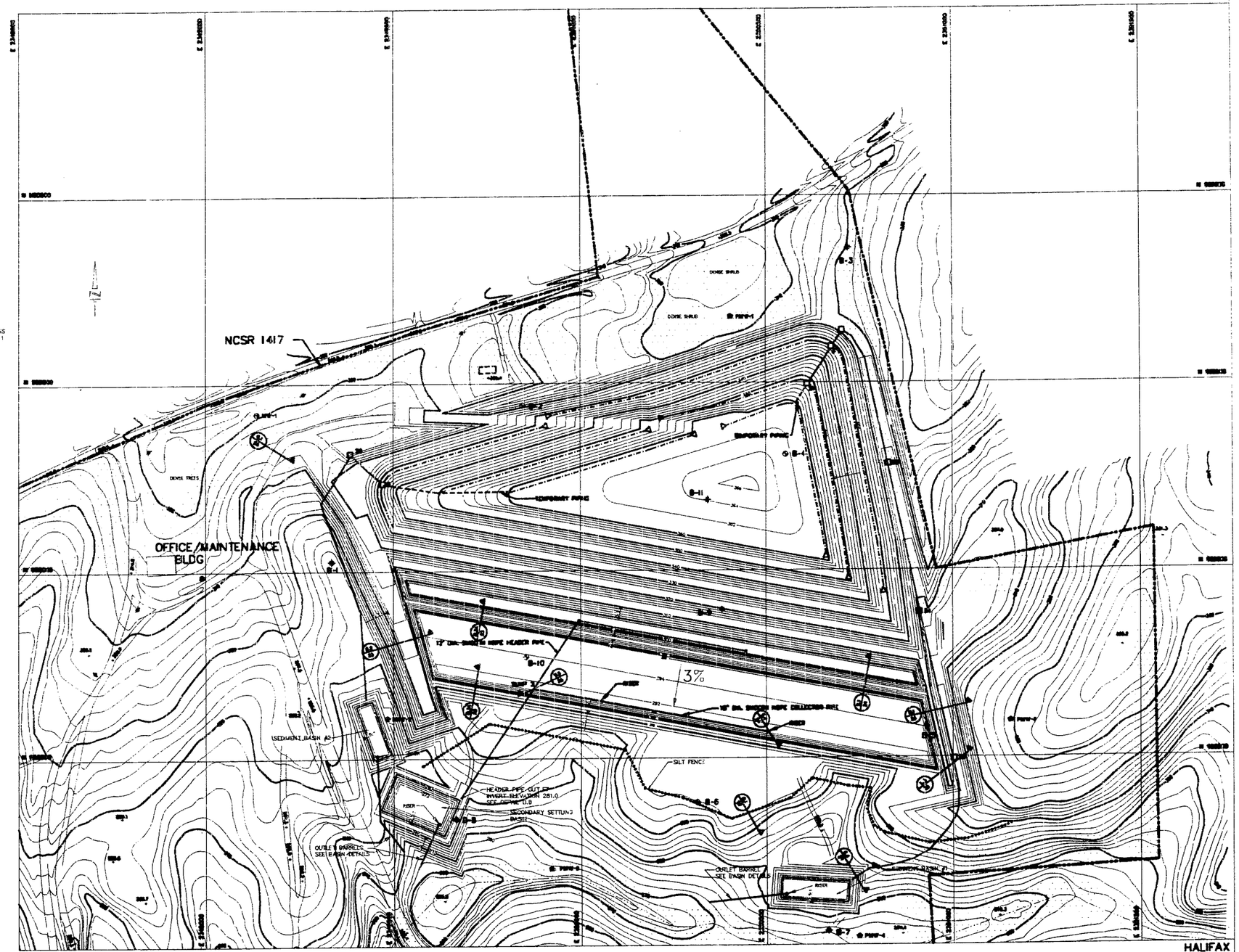
HALIFAX COUNTY ASH MONOFILL

SCALE 1"=100'	DRAWN BY: JDB	CHECKED BY: GNR	
JOB NO 3720	DATE: 2-92	PAGE 11 OF 29	

LEGEND

- PROPERTY LINE
- STREAM
- DRAINAGE SWALE
- SILT FENCE
- DRAINAGE PIPE
- DRAINAGE DIRECTION ARROW
- DROP INLET
- INTERNAL STORMWATER COLLECTION SUMP
- BENCHMARK
- MW-1 EXISTING MONITOR WELL
- PMW-4 PROPOSED MONITOR WELL
- B-10 SOIL BORINGS PERFORMED 1991 (BY ENSCI CORP.)
- B-9 PIEZOMETER INSTALLED 1989
- 280 EXISTING GROUND SURFACE CONTOURS
- 312 PROPOSED EARTHWORK CONTOURS
- BUFFER ZONE

NOTES
1. CONTOURS IN CELL 3 DENOTE SYNTHETIC LINER SUBGRADE ELEVATIONS
2. SEE OPERATIONAL COVER PLAN FOR TOP OF OPERATIONAL COVER ELEVATIONS
3. SUMPS AND HEADER PIPE WERE INSTALLED DURING CONSTRUCTION OF CELL 1



TOPOGRAPHIC SURVEY BY

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GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

0 50 100 200 300 400 500
25 75

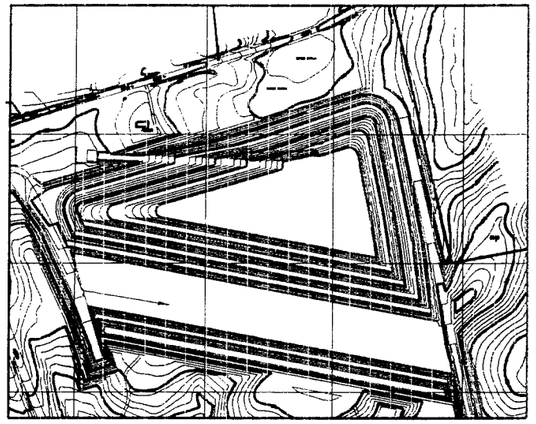
SCALE: 1"=100'

NO.	DATE	DESCRIPTION	BY

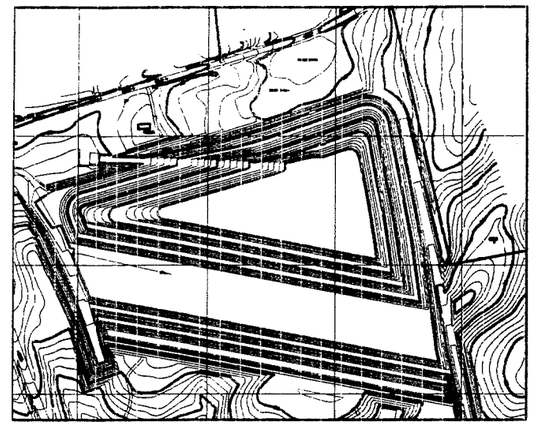
HAZEN AND SAWYER
Environmental Engineers & Scientists

EXCAVATION PLAN
CELL 3
HALIFAX COUNTY ASH MONOFILL

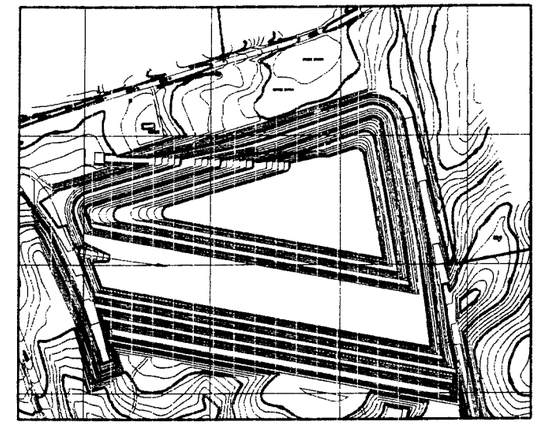
SCALE	DRAWN BY	CHECKED BY
1"=100'	JCB	GNR
JOB NO. 3720	DATE 2-92	PAGE 12 OF 29



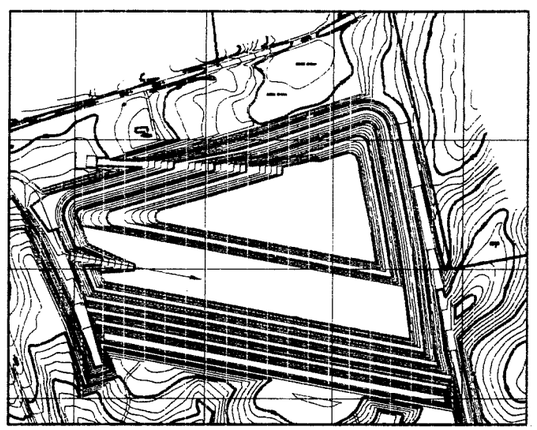
PHASE 3A: FILLED TO ELEVATION 310



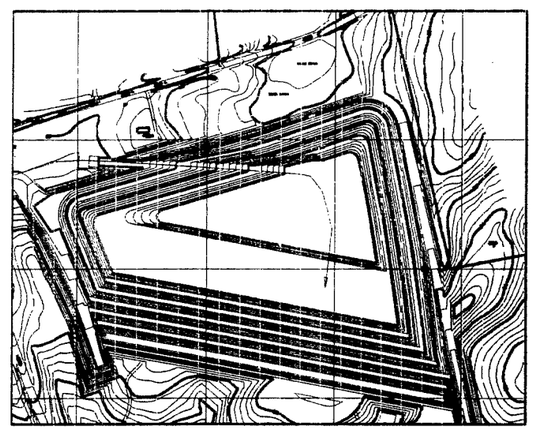
PHASE 3B: FILLED TO ELEVATION 320



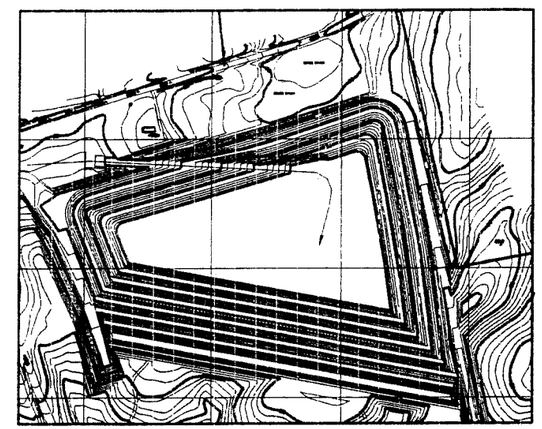
PHASE 3C: FILLED TO ELEVATION 330



PHASE 3D: FILLED TO ELEVATION 340



PHASE 3E: FILLED TO ELEVATION 350



PHASE 3F: FILLED TO ELEVATION 360

NOTES:
1. THESE DRAWINGS DEPICT THE SEQUENTIAL FILLING OF CELL 3 EACH PHASE DENOTES AN APPROXIMATE 10 FOOT LIFT OF ASH.
2. THE ACCESS ARROWS INDICATE ACCESS FOR THAT PHASE
3. THE CELL 3 INTERIM COVER ELEVATIONS ARE SHOWN ON THE FOLLOWING SHEET
4. CONTOURS DENOTE TOP OF ASH ELEVATIONS

——————— ACCESS TO ACTIVE FACE

NO	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

PHASING PLAN
CELL 3
HALIFAX COUNTY ASH MONOFILL

SCALE NTS	DRAWN BY: JDB	CHECKED BY: GNR
JOB NO. 3720	DATE: 2-92	PAGE 13 OF 29

LEGEND

- PROPERTY LINE
- STREAM
- DRAINAGE SWALE
- SILT FENCE
- DRAINAGE PIPE
- DRAINAGE DIRECTION ARROW
- DROP INLET
- INTERNAL STORMWATER COLLECTION SUMP
- BENCHMARK
- MW-1 EXISTING MONITOR WELL
- PMW-4 PROPOSED MONITOR WELL
- B-10 SOIL BORINGS PERFORMED 1991 (BY ENSCI CORP.)
- B-9 PIEZOMETER INSTALLED 199
- 280 EXISTING GROUND SURFACE CONTOURS
- 312 PROPOSED EARTHWORK CONTOURS
- BUFFER ZONE

NOTES:
1. DRAWING DEPICTS CELL 3, PHASE G, FILLED TO ELEVATION 374
2. CELL 4 WILL BE OPERATIONAL PRIOR TO REACHING THIS STAGE
3. FOR CELL 4 EXAVATION PLAN SEE SHEET 15
4. FOR EROSION AND SEDIMENTATION CONTROL SEE SHEET 18

0 25 50 75 100 200 300 400 500

SCALE: 1"=100'

TOPOGRAPHIC SURVEY BY

PHOTO SCIENCE INC.
GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

NO	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

INTERIM COVER CELL 3

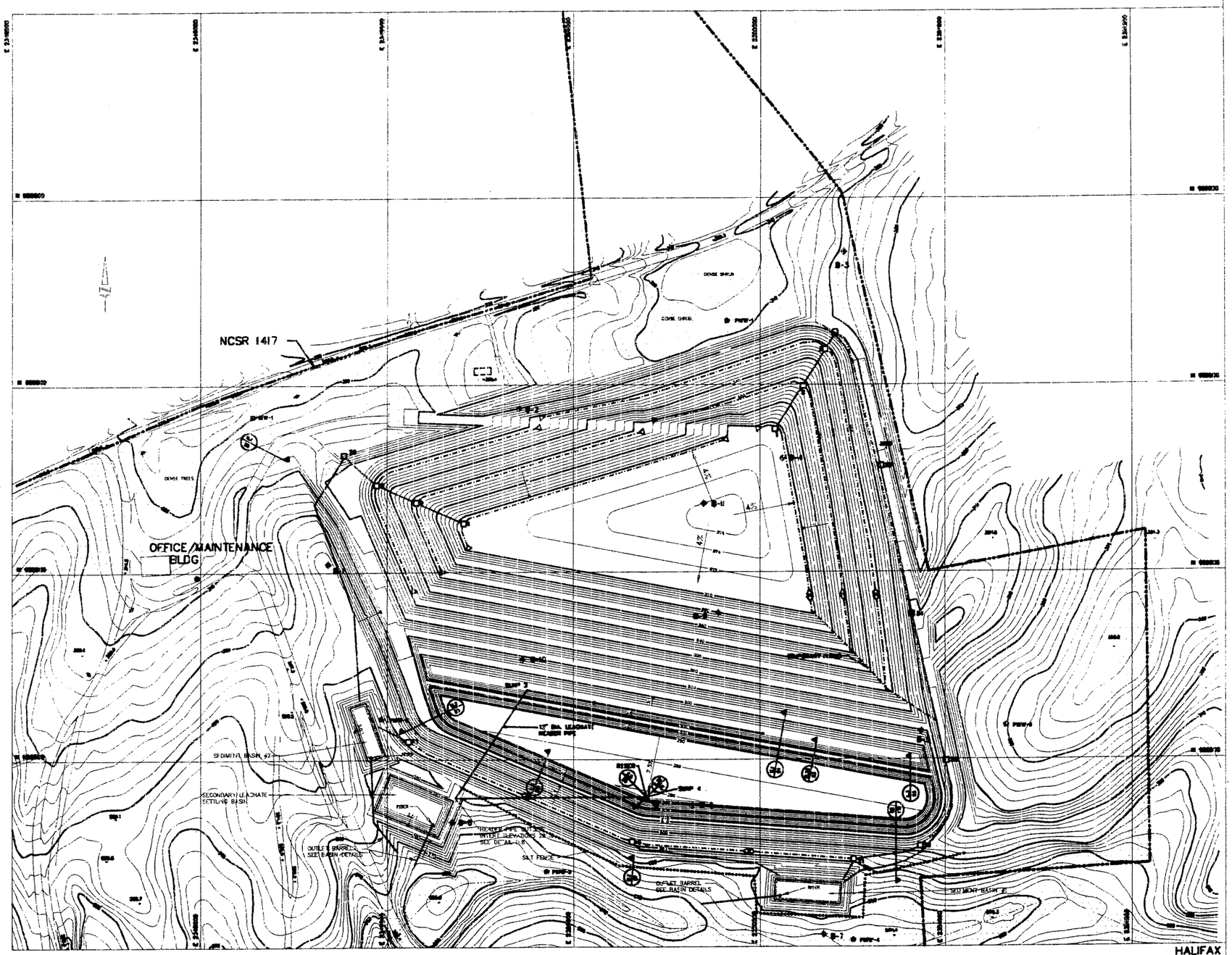
HALIFAX COUNTY ASH MONOFIL.

SCALE 1"=100'	DRAWN BY: JDB	CHECKED BY: GNR	
JOB NO. 3721	DATE 2-92	PAGE 14 OF 26	

LEGEND

- PROPERTY LINE
- STREAM
- DRAINAGE SWALE
- SILT FENCE
- DRAINAGE PIPE
- DRAINAGE DIRECTION ARROW
- DROP INLET
- INTERNAL STORMWATER COLLECTION SUMP
- BENCHMARK
- MW-1 EXISTING MONITOR WELL
- PMW-4 PROPOSED MONITOR WELL
- B-10 SOIL BORINGS PERFORMED 991 (BY ENSICI CORP.)
- B-9 PIEZOMETER INSTALLED 199
- 250 EXISTING GROUND SURFACE CONTOURS
- 512 PROPOSED EARTHWORK CONTOURS
- BUFFER ZONE

NOTES: 1. CONTOURS IN CELL 4 DENOTE SYNTHETIC LINER SUBGRADE ELEVATIONS
2. SEE OPERATIONAL COVER PLAN FOR TOP OF OPERATIONAL COVER ELEVATIONS
3. SUMP 3 AND ITS HEADER PIPE WERE INSTALLED DURING CONSTRUCTION OF CELL 1. INSTALL SUMP 4 AND ITS HEADER PIPE DURING CONSTRUCTION OF CELL 4



TOPOGRAPHIC SURVEY BY

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SURVEY FLOWN 2-1-91

0 50 100 200 300 400 500
25 75

SCALE: 1"=100'

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

EXCAVATION PLAN CELL 4

HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY: JCB	CHECKED BY: GNR
1"=100'		
JOB NO 3720	DATE 2-92	PAGE 15 OF 29

LEGEND

- PROPERTY LINE
- STREAM
- DRAINAGE SWALE
- SILT FENCE
- DRAINAGE PIPE
- DRAINAGE DIRECTION ARROW
- DROP INLET
- INTERNAL STORMWATER COLLECTION SUMP
- BENCHMARK
- MW-1 EXISTING MONITOR WELL
- PMW-4 PROPOSED MONITOR WELL
- B-10 SOIL BORINGS PERFORMED 1991 (BY ENSCI CORP.)
- B-9 PIEZOMETER INSTALLED 1991
- 280 EXISTING GROUND SURFACE CONTOURS
- 312 PROPOSED EARTHWORK CONTOURS
- BUFFER ZONE

TOPOGRAPHIC SURVEY BY

PHOTO SCIENCE INC.
GREENSBORO, N.C.

SURVEY FLOWN 2-1-91

NOTES: 1. DRAWING DEPICTS TOTAL DEVELOPMENT OF ASH MONOFILL
2. CONTOURS DEPICT TOP OF COVER ELEVATIONS
3. FOR EROSION AND SEDIMENTATION CONTROL, SEE SHEET 18

0 50 100 200 300 400 500
25 75

SCALE: 1"=100'

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

FINAL ELEVATION PLAN

HALIFAX COUNTY ASH MONOFILL

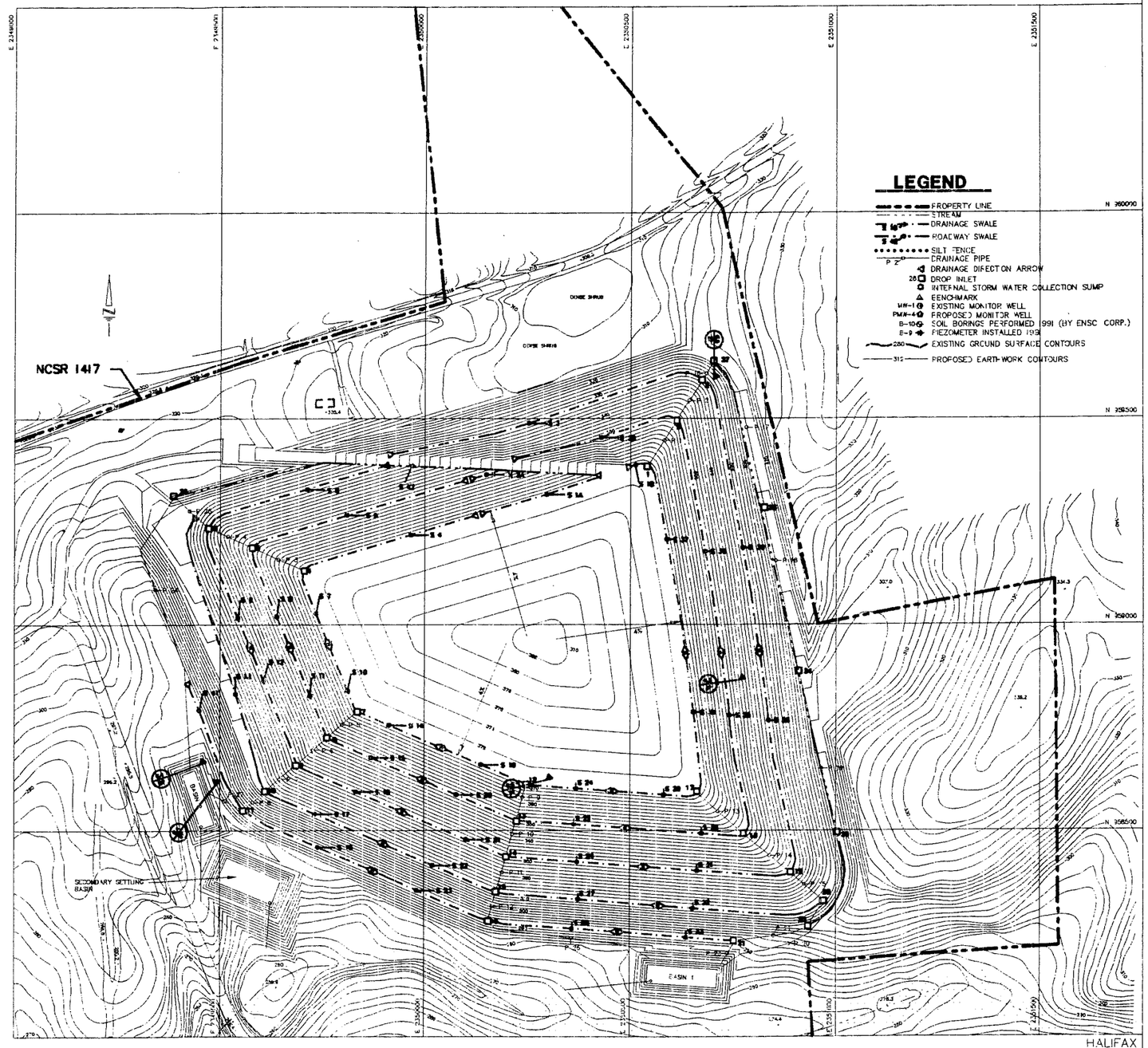
SCALE	DRAWN BY	CHECKED BY
1"=100'	JDB	GNR
JOB NO. 3720	DATE 2-92	PAGE 17 OF 29

PIPE SCHEDULE

PIPE SECTION	FROM	TO	UPSTREAM INVERT	DOWNSTREAM INVERT	LENGTH	DIA. (IN.)
1	D1	D2	367.0	347.0	140'	18"
2	D2	D3	346.8	327.0	110'	18"
3	D4	D5	367.0	347.0	140'	18"
4	D5	D6	346.8	327.0	120'	18"
5	D7	D8	367.0	347.0	90'	18"
6	D8	D9	346.8	327.0	100'	18"
7	D9	D10	326.8	307.0	90'	18"
8	D10	D11	306.8	287.0	80'	18"
9	D12	D13	367.0	347.0	90'	18"
10	D13	D14	346.8	327.0	90'	18"
11	D14	D15	326.8	307.0	90'	18"
12	D15	D13	306.8	287.0	75'	18"
13	D17	D19	367.0	347.0	150'	18"
14	D18	D19	346.8	327.0	150'	18"
15	D19	D20	326.8	307.0	90'	18"
16	D3	D27	326.8	317.0	50'	18"
17	D27	D23	316.5	312.5	400'	24"
18	D23	D24	312.3	305.9	400'	24"
19	D24	D25	305.7	299.6	400'	24"
20	D25	BASIN 1	299.0	286.0	450'	24"
21	D22	D21	300.8	297.0	230'	18"
22	D20	D22	306.8	301.0	30'	18"
23	D21	BASIN 1	286.8	285.0	50'	18"
24	D28	BASIN 2	307.5	295.0	650'	24"
25	D6	D26	326.8	308.0	110'	18"
26	D16	BASIN 1	286.5	284.0	440'	24"
27	D11	BASIN 2	286.5	285.0	90'	24"

SWALE & DROP INLET SCHEDULE

SWALE	DROP INLET	LENGTH	BEGINNING SWALE ELEV.	DROP INLET TOP ELEV.	DROP INLET BOTTOM ELEV.
1A	SWALE 42	280'	372.25	–	–
1B	D1	50'	370.25	370.0	346.0
2A	SWALE 42	70'	352.75	–	–
2B	D2	400'	352.00	350.0	346.0
3	D3	600'	333.00	330.0	326.0
4	D4	450'	372.25	370.0	346.0
5	D5	550'	352.75	350.0	346.0
6	D6	650'	333.25	330.0	326.0
7	D4	197'	370.95	370.0	346.0
8	D5	250'	351.25	350.0	346.0
9	D6	350'	331.75	330.0	326.0
10	D7	183'	370.90	370.0	346.0
11	D8	250'	351.25	350.0	346.0
12	D9	320'	331.60	330.0	326.0
13	D10	150'	321.50	310.0	306.0
14	D7	230'	371.15	370.0	346.0
15	D8	280'	351.30	350.0	346.0
16	D9	290'	331.45	330.0	326.0
17	D10	313'	311.55	310.0	306.0
18	D11	140'	291.70	290.0	286.0
19	D12	230'	371.15	370.0	346.0
20	D13	260'	351.30	350.0	346.0
21	D14	275'	331.38	330.0	326.0
22	D15	313'	311.55	310.0	306.0
23	D16	330'	291.65	290.0	286.0
24	D12	220'	371.10	370.0	346.0
25	D13	290'	351.45	350.0	346.0
26	D14	350'	331.72	330.0	326.0
27	D15	400'	312.00	310.0	306.0
28	D16	313'	291.55	290.0	286.0
29	D17	230'	371.15	370.0	346.0
30	D18	290'	351.45	350.0	346.0
31	D19	360'	331.80	330.0	326.0
32	D20	400'	312.10	310.0	306.0
33	D21	350'	291.50	290.0	286.0
34	D17	410'	372.05	370.0	346.0
35	D18	530'	352.65	350.0	346.0
36	D19	630'	333.15	330.0	326.0
37	D1	460'	372.00	370.0	346.0
38	D2	510'	352.55	350.0	346.0
39	D3	600'	333.00	330.0	326.0
40	D23,24,25	1440'	320.00	[illegible]	[illegible]
41	D11	235'	291.18	290.0	286.0
42	D26	1000'	370.00	311.5	307.5



TOPOGRAPHIC SURVEY BY

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SURVEY FLOWN 2-1-91

RISER/BARREL SCHEDULE

BASIN	RISER HEIGHT	RISER DIAMETER	BARREL DIAMETER	BARREL LENGTH
1	5'	24"	18"	310'
2	5'	18"	12"	275'

NOTE: SEE SHEETS 28 AND 29 FOR BASIN DETAILS

SCALE: 1"=100'

NO.	DATE	DESCRIPTION	BY

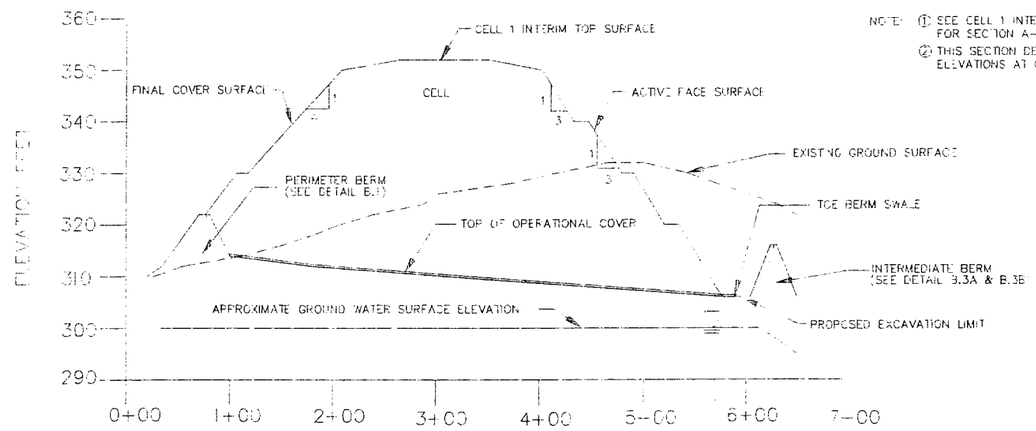
HAZEN AND SAWYER
Environmental Engineers & Scientists

SEDIMENTATION AND EROSION CONTROL PLAN

HALIFAX COUNTY ASH MONOFILL

SCALE 1"=100'	DRAWN BY: JSB	DESIGNED BY: CNR
JOB NO. 3720	DATE 2-92	PAGE 18 OF 29

SECTION A-A



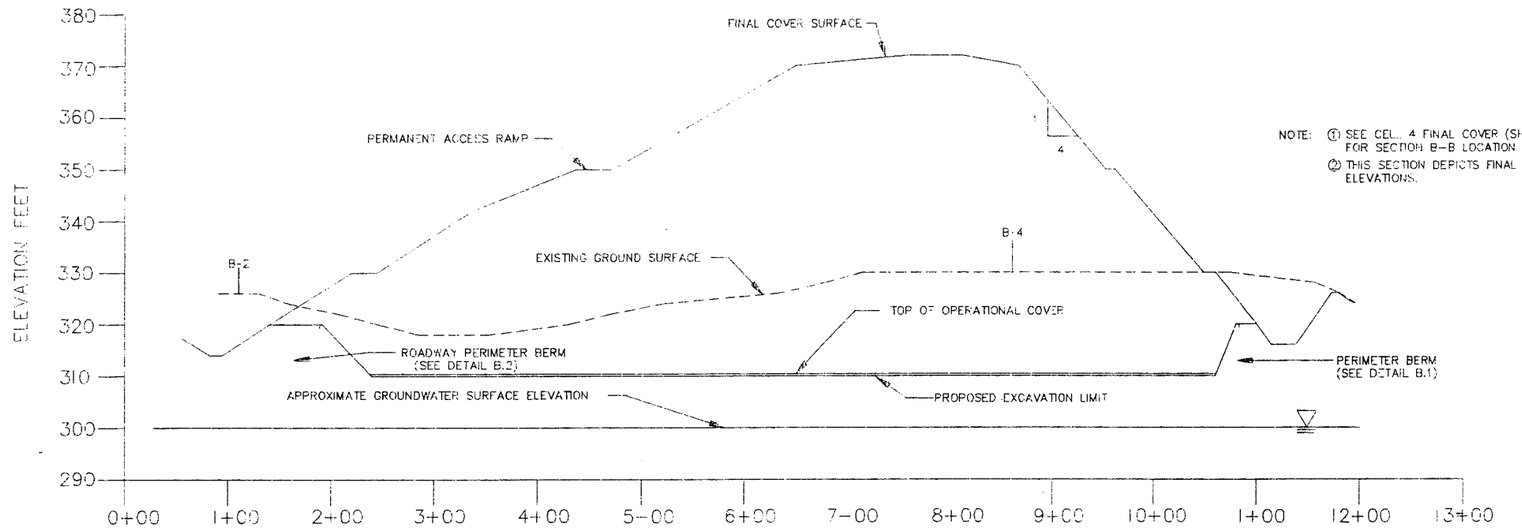
NOTE: ① SEE CELL 1 INTERIM COVER (SHEET 7) FOR SECTION A-A LOCATION
② THIS SECTION DEPICTS ASH PLACEMENT ELEVATIONS AT COMPLETION OF CELL 1.

LEGEND

60 MIL HDPE LINER

B-2 BORING LOCATIONS

SECTION B-B



NOTE: ① SEE CELL 4 FINAL COVER (SHEET 16) FOR SECTION B-B LOCATION
② THIS SECTION DEPICTS FINAL COVER ELEVATIONS.

NOTE: FOR BORING DETAILS SEE DESIGN REPORT

NO	DATE	DESCRIPTION	BY

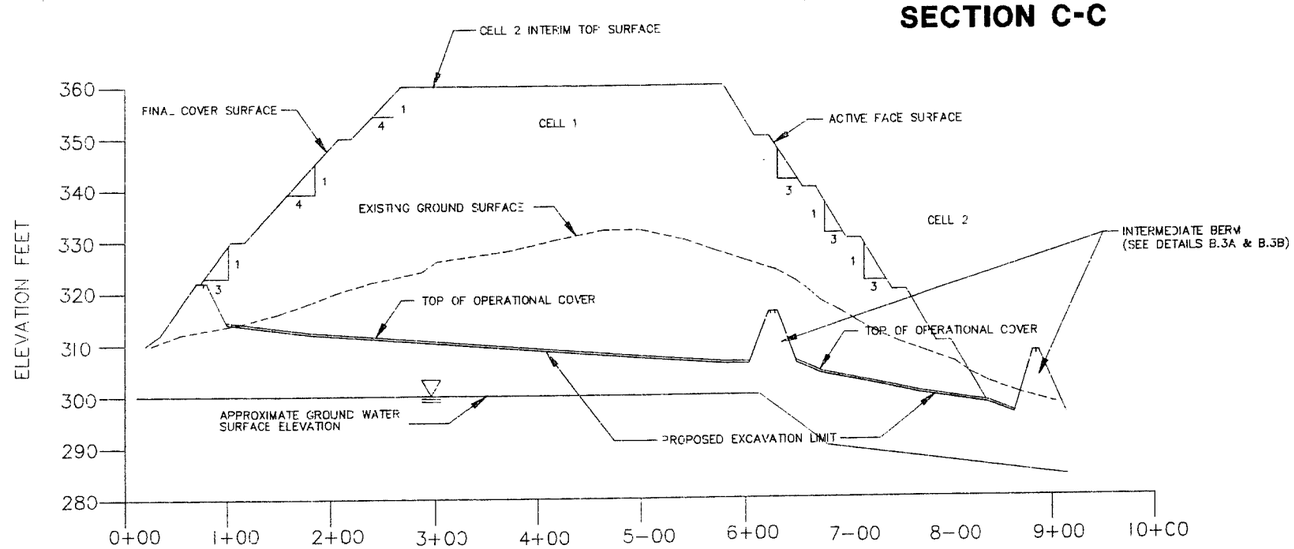
HAZEN AND SAWYER
Environmental Engineers & Scientists

SECTIONS A & B

HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY	CHECKED BY
AS SHOWN	SAS	DNR
JOB NO. 3720	DATE 2-97	PAGE 17 OF 29

SECTION C-C



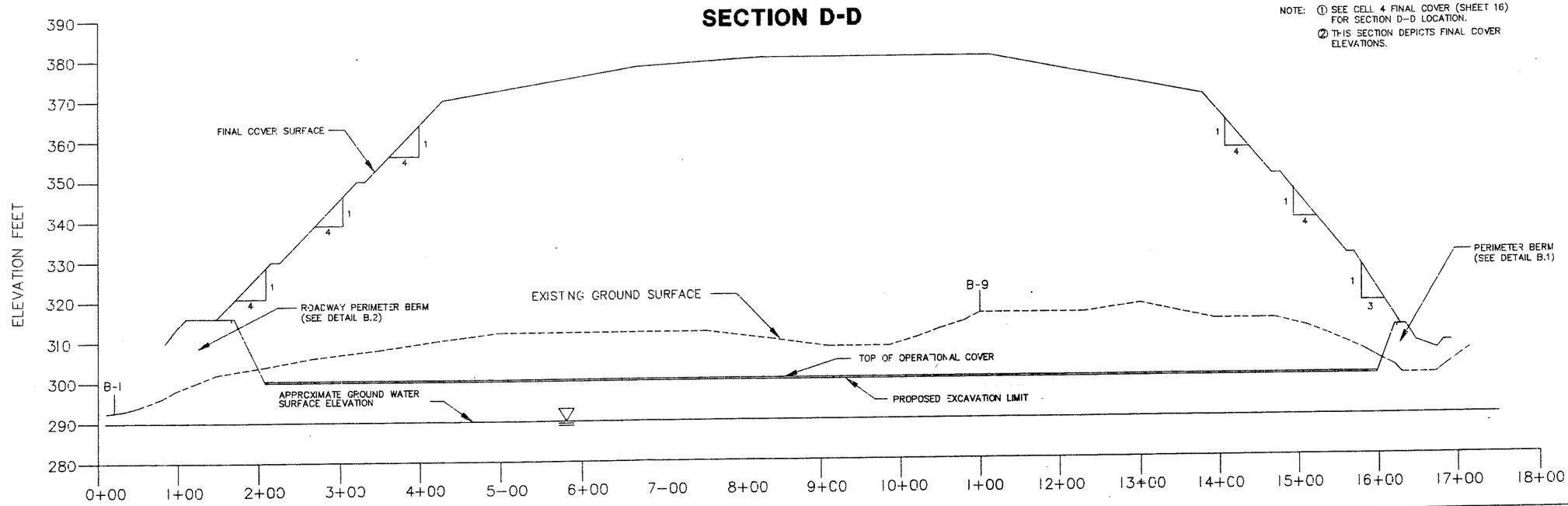
NOTE: ① SEE CELL 2 INTERIM COVER (SHEET 10) FOR SECTION C-C LOCATION.
② THIS SECTION DEPICTS ASH PLACEMENT ELEVATIONS FOR CELL 2.

LEGEND

50 MIL HDPE LINER

B-2 BORING LOCATIONS

SECTION D-D



NOTE: ① SEE CELL 4 FINAL COVER (SHEET 16) FOR SECTION D-D LOCATION.
② THIS SECTION DEPICTS FINAL COVER ELEVATIONS.

NOTE: FOR BORING DETAILS SEE DESIGN REPORT

NO.	DATE	DESCRIPTION	BY

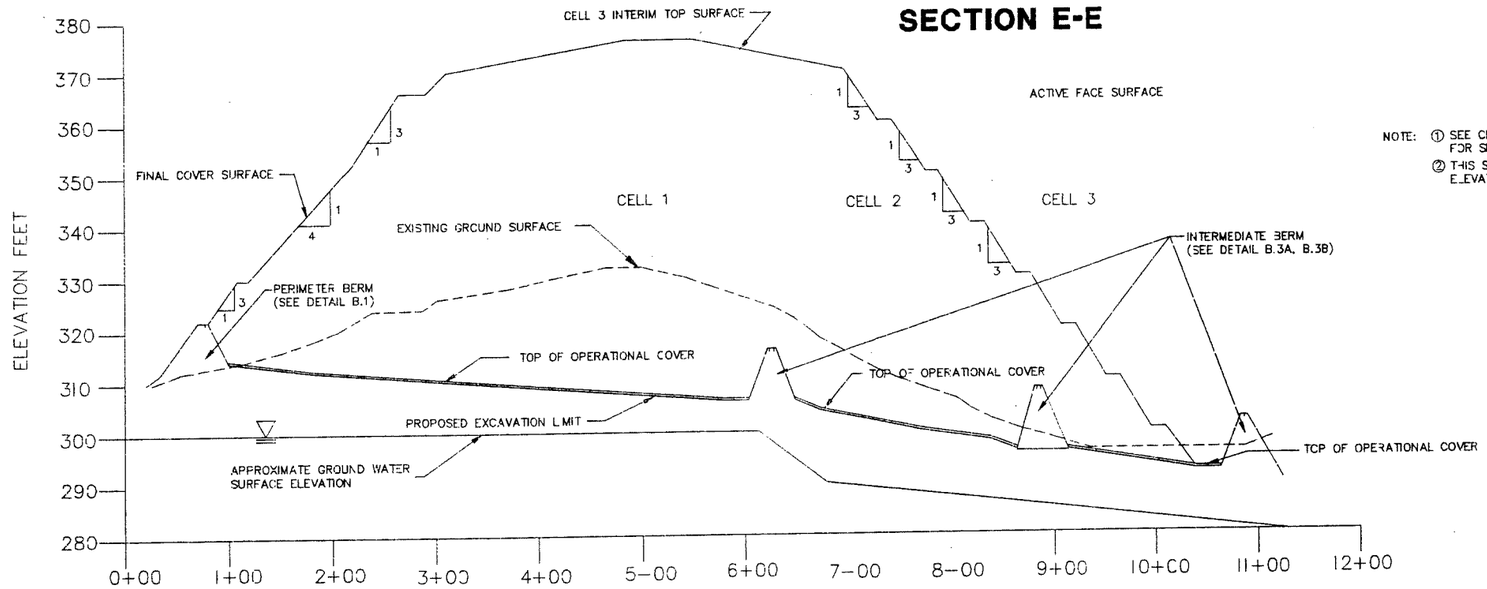
HAZEN AND SAWYER
Environmental Engineers & Scientists

SECTIONS C & D

HALIFAX COUNTY ASH MONOFILL

SCALE AS SHOWN	DRAWN BY SAS	CHECKED BY GNR
JOB NO. 90-001	DATE 2-92	PAGE 20 OF 29

SECTION E-E



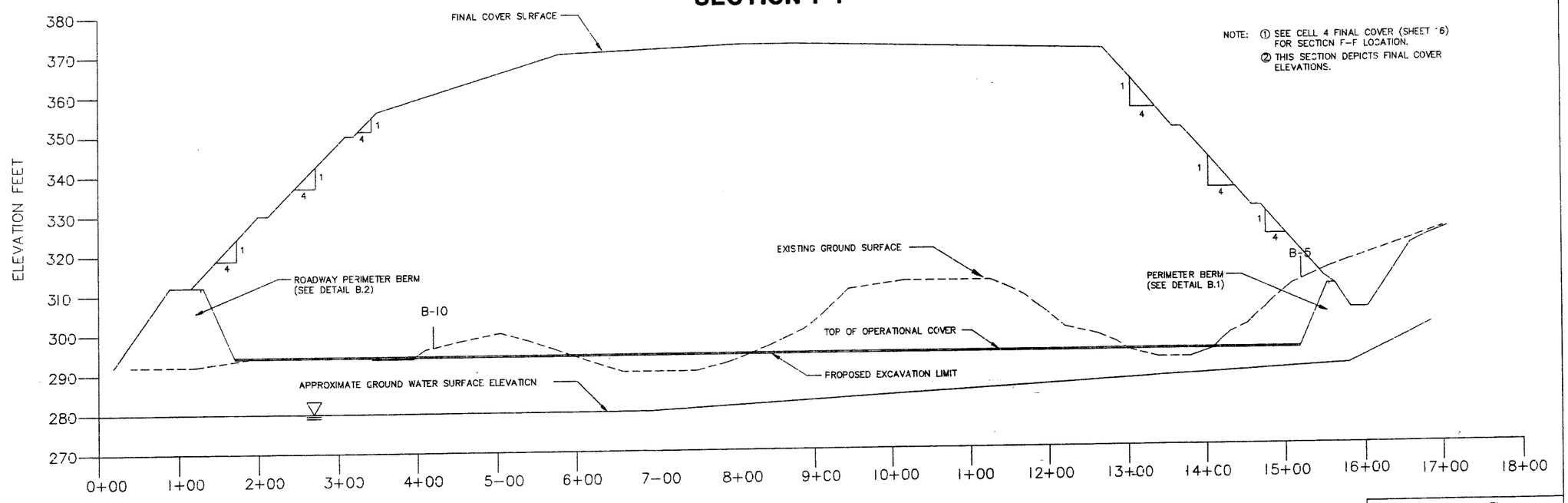
NOTE: ① SEE CELL 3 INTERIM COVER (SHEET 13) FOR SECTION E-E LOCATION.
② THIS SECTION DEPICTS ASH PLACEMENT ELEVATIONS AT COMPLETION OF CELL 2.

LEGEND

60 MIL HDPE LINER

B-2 BORING LOCATIONS

SECTION F-F



NOTE: ① SEE CELL 4 FINAL COVER (SHEET 16) FOR SECTION F-F LOCATION.
② THIS SECTION DEPICTS FINAL COVER ELEVATIONS.

NOTE: FOR BORING DETAILS SEE DESIGN REPORT

NO.	DATE	DESCRIPTION	BY

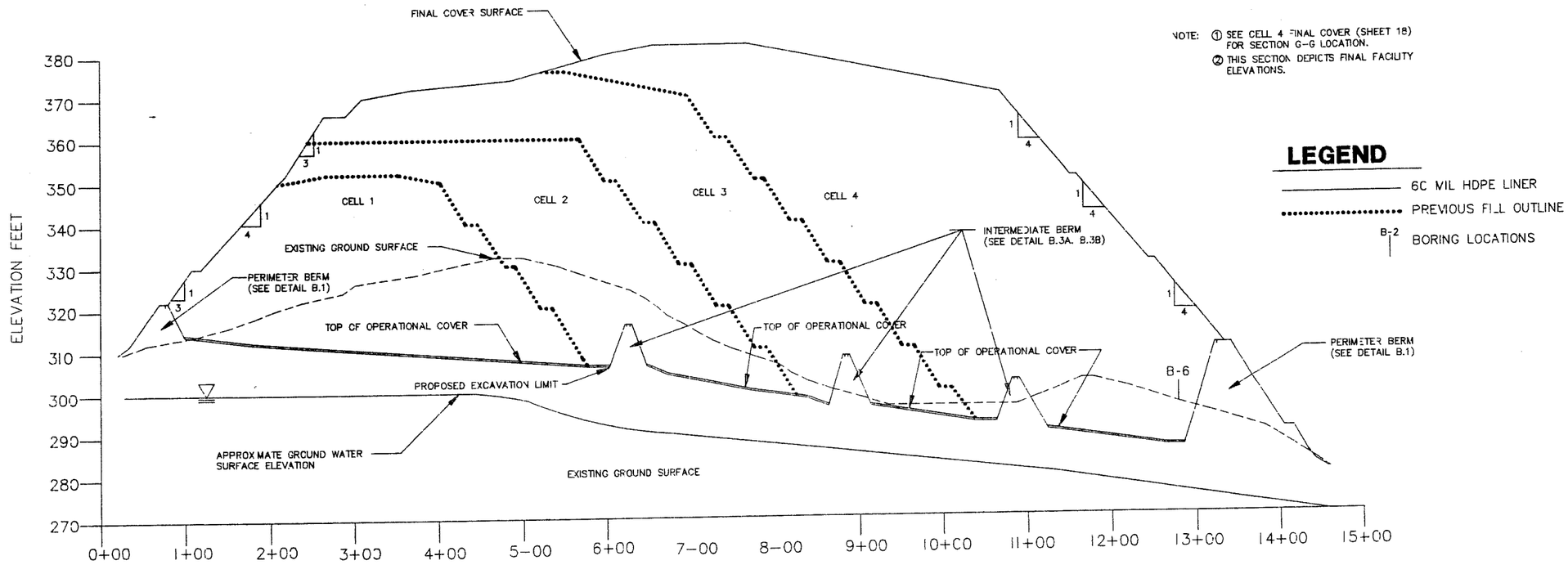
HAZEN AND SAWYER
Environmental Engineers & Scientists

SECTIONS E & F

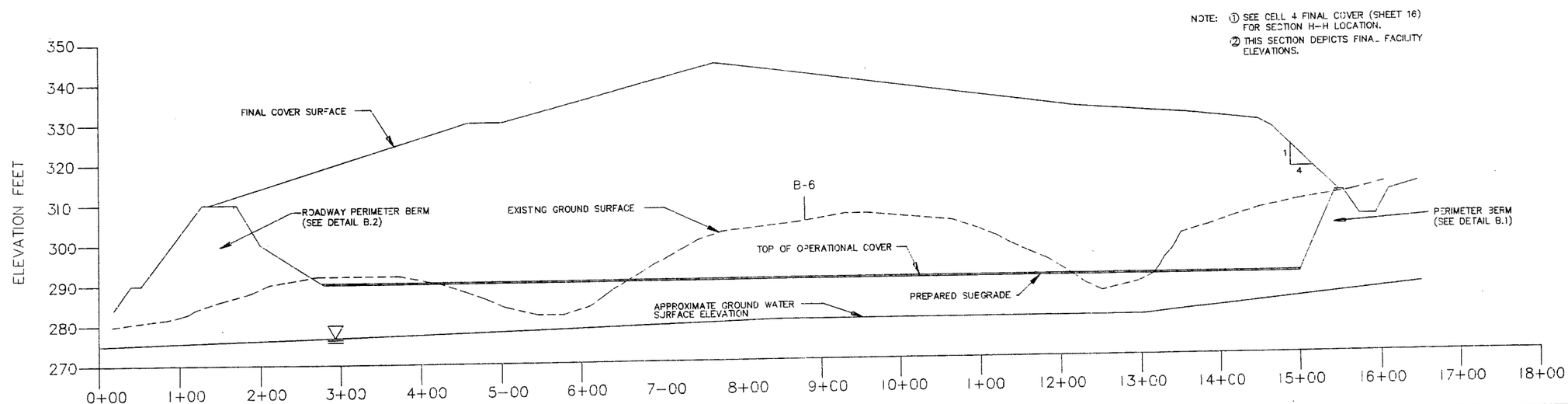
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY:	CHECKED BY:
AS SHOWN	SAS	DMR
JOB NO. 372C	DATE 2-92	PAGE 21 OF 29

SECTION G-G



SECTION H-H



NOTE: FOR BORING DETAILS SEE DESIGN REPORT

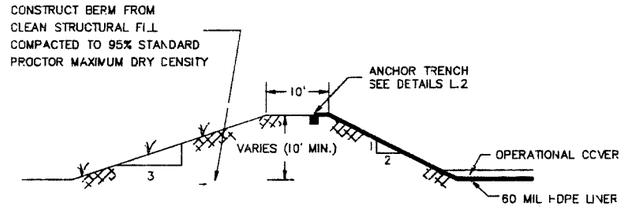
NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

SECTIONS G & H

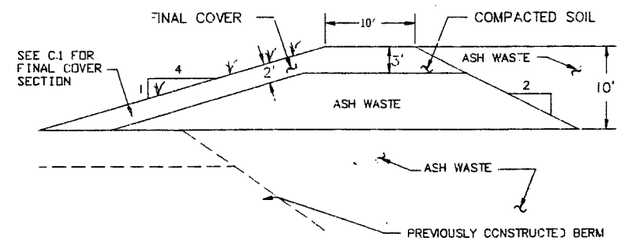
HALIFAX COUNTY ASH MONOFILL

SCALE AS SHOWN	DRAWN BY SAS	CHECKED BY CNR
JOB NO. 3720	DATE 2-92	PAGE 22 OF 29



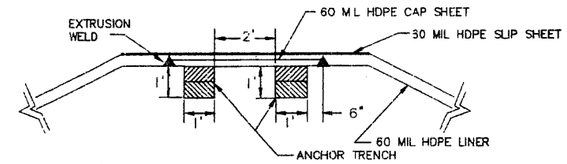
NOTE: 1. HEIGHT OF BERM VARIES AROUND PERIMETER OF FACILITY. SEE APPROPRIATE GRADING PLAN FOR EXACT BERM HEIGHT.
2. THIS DETAIL IS USED ON THE NORTH, SOUTH, AND EAST PERIMETER BERMS. SEE GRADING PLANS.

B.1 / 4 PERIMETER BERM (TYP.)
NTS

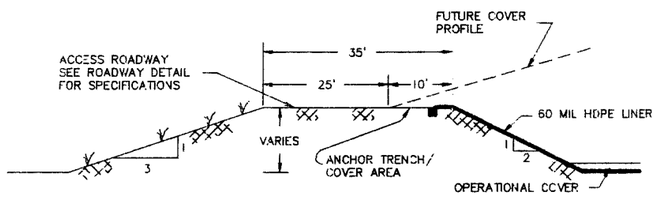


NOTES: 1. THIS DETAIL FOR USE IN EXPANDING CELL 4 ABOVE THE PERIMETER BERM
2. CONSTRUCT BERM PRIOR TO COMPLETION OF THE PREVIOUS 10' ASH LIFT

B.4 / 16 SOIL/ASH EXPANSION BERM
NTS

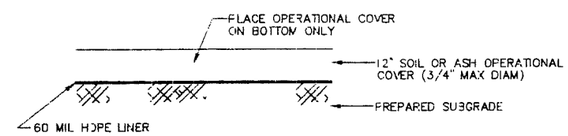


L.5 / 23 CAP SHEET CROSS-SECTION
NTS



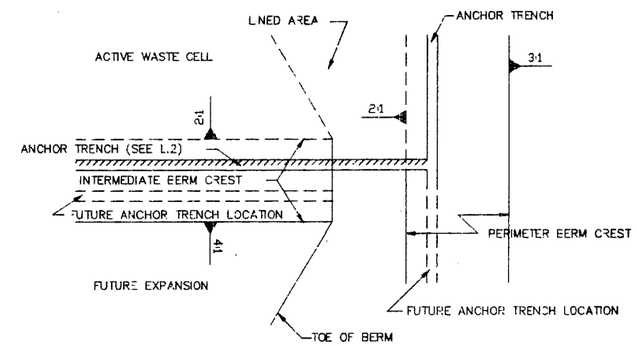
NOTES: 1. HEIGHT OF BERM VARIES. SEE APPROPRIATE GRADING PLAN FOR EXACT BERM HEIGHT
2. THIS DETAIL IS USED ON THE WEST PERIMETER BERM ONLY. SEE GRADING PLANS

B.2 / 4 PERIMETER BERM W/ACCESS ROADWAY
NTS

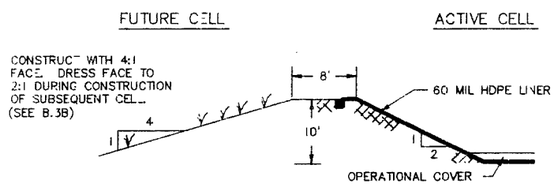


NOTE: 1. SUBGRADE SHALL BE STRUCTURALLY SOUND, FREE OF STONES LARGER THAN 1/2" DIA. AND SMOOTH DRUM ROLLED PRIOR TO PLACEMENT OF 60 MIL HDPE SHEET
2. OPERATIONAL COVER SHALL BE ON SITE SOILS IN CELL 1. CELL 2 AND 3 SHALL USE SOIL IN A 50' STRIP ALONG THE INTERMEDIATE BERM AND ASH ELSWHERE. CELL 4 SHALL USE SOIL IN A 50' STRIP ALONG THE SOUTH PERIMETER BERM ANS ASH ELSEWHERE. (SEE OPERATIONAL COVER PLAN)
3. OPERATIONAL COVER SHALL BE PLACED UDING A LGP (6 PSI MAX.) D-3DOZER OR EQUIVALENT. COMPACT COVER BY "TRACKING IN" WITH DOZER. NO RUBBER TIRED VEHICLES OR COMPACTION EQUIPMENT SHALL BE ALLOWED ON BOTTOM PRIOR TO PLACEMENT OF ENTIRE 12" COVER LIFT.

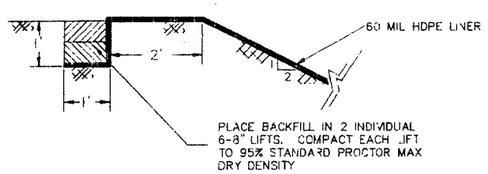
L. / 5 TYPICAL LINER SECTION
NTS



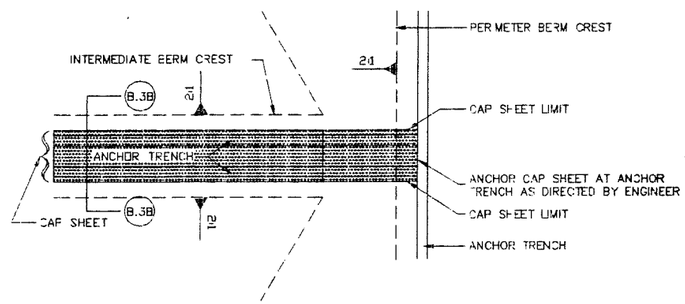
L.3 / 6 ANCHOR DETAIL AT PERIMETER & INTERMEDIATE BERM INTERSECTION. (PRE-EXPANSION)
NTS



B.3A / 6 INTERMEDIATE BERM (PRE-EXPANSION)
NTS

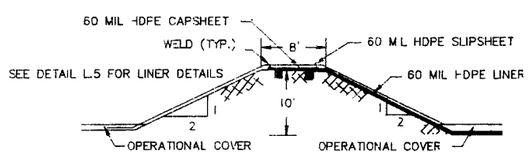


L.2 / 4 ANCHOR TRENCH DETAIL
NTS



NOTE: HDPE SLIPSHEET NOT SHOWN FOR CLARITY

L.4 / 4 ANCHOR DETAIL AT PERIMETER & INTERMEDIATE BERM INTERSECTION. (POST-EXPANSION)
NTS



B.3B / 4 INTERMEDIATE BERM (POST-EXPANSION)
NTS

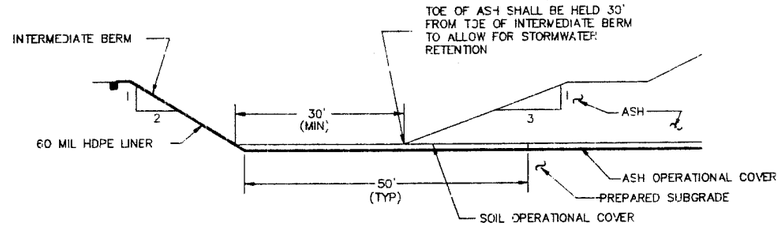
NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

DETAILS

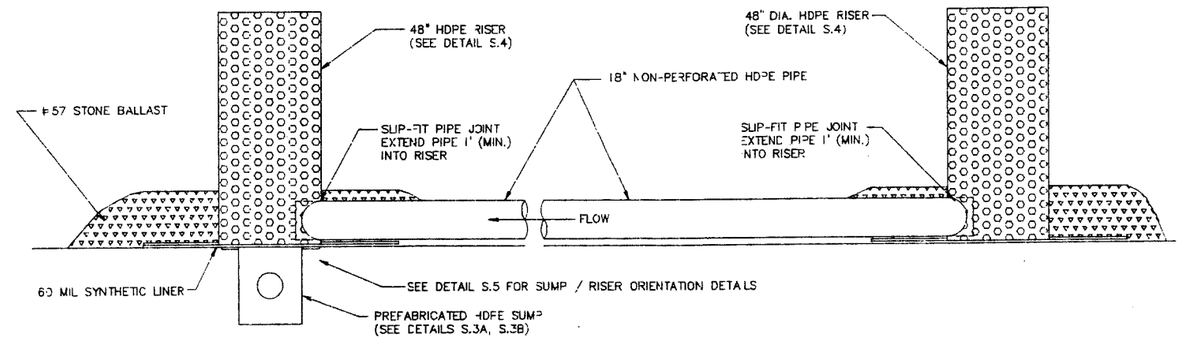
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY	CHECKED BY
NTS	BEK	GNR
JOB NO 3720	DATE 2-92	PAGE 23 OF 29



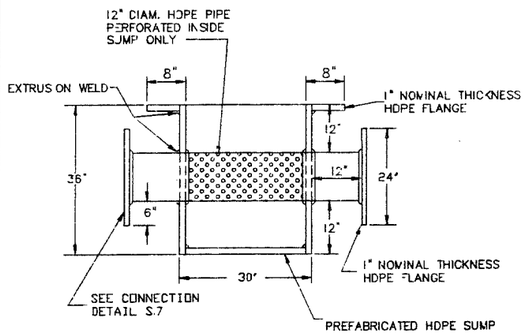
NOTE: OPERATIONAL COVER TRANSITIONS FROM SOIL TO ASH IN CELLS 2, 3, 4 ONLY. OPERATIONAL COVER IN CELL 1 CONSISTS OF SOIL ONLY.

S.1 / 8 TOE BASIN SCHEMATIC
NTS



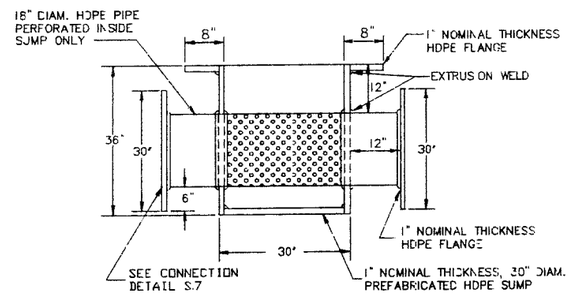
NOTE: RISER LOCATIONS ARE SHOWN ON EXCAVATION PLANS

S.2 / 6 RISER / LATERAL / SUMP SCHEMATIC
NTS



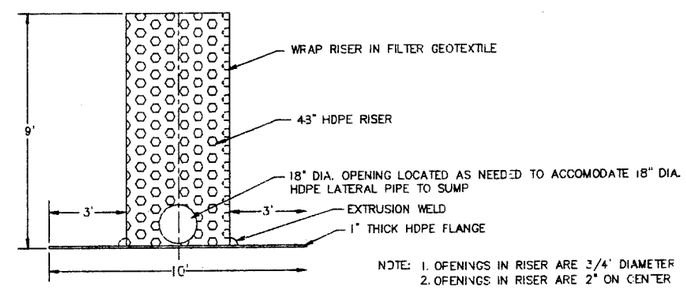
NOTE: EXTRUSION WELD ALL JOINTS.

SIDE VIEW



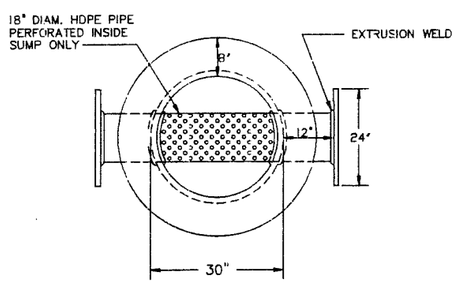
NOTE: EXTRUSION WELD ALL JOINTS.

SIDE VIEW



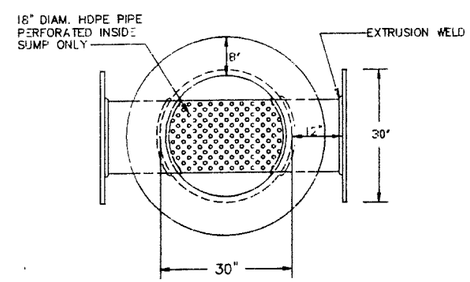
NOTE: 1. OPENINGS IN RISER ARE 3/4" DIAMETER
2. OPENINGS IN RISER ARE 2" ON CENTER

SIDE VIEW



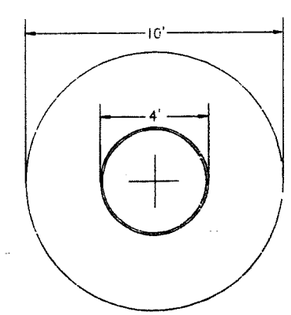
TOP VIEW

S.3A / 6 PREFABRICATED HDPE SUMP DETAIL
NTS



TOP VIEW

S.3B / 5 PREFABRICATED HDPE SUMP DETAIL
NTS



TOP VIEW

S.4 / 6 INTERNAL DRAINAGE SYSTEM RISER DETAIL
NTS

SUMP SCHEDULE

SUMP	CENTER COORDINATES N	CENTER COORDINATES E	ELEVATION OF TOP	ELEVATION OF BOTTOM
1	9598098.3	2350.58.0	306.5	303.5
2	9598671	2349994.8	298.5	295.5
3	9586806.1	2349873.9	292.5	289.5
4	9586395.5	2350196.0	286.5	283.5

HEADER PIPE LAYOUT INFORMATION

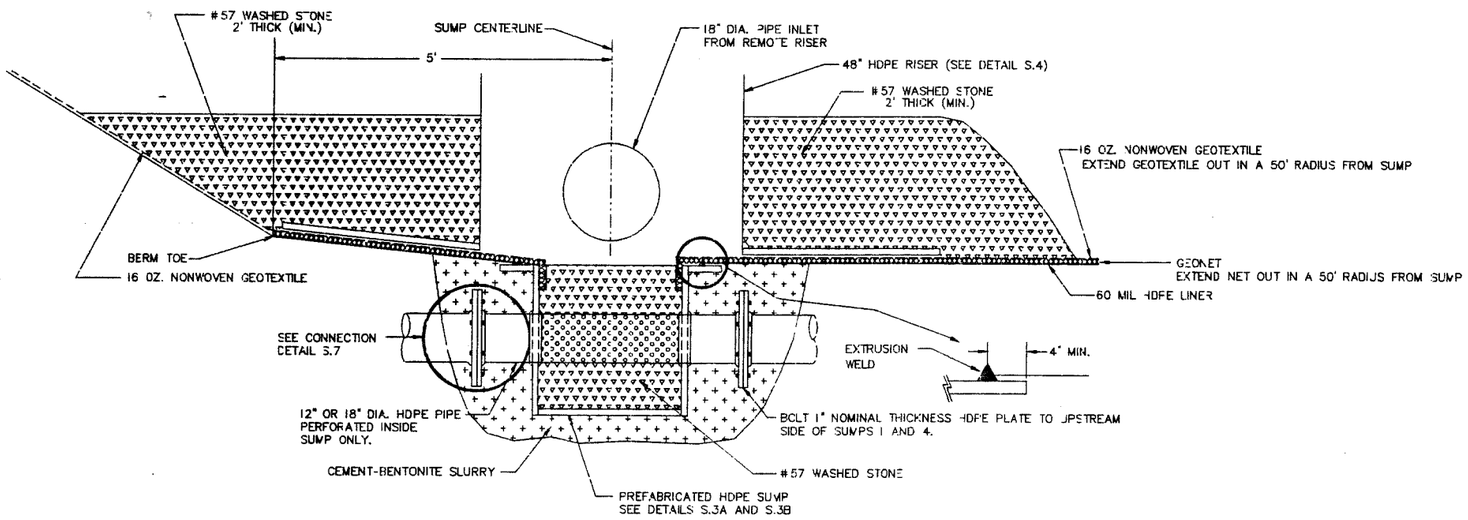
PIPE	DIA.	FROM	TO	UPSTREAM INVERT	DOWNSTREAM INVERT	LENGTH
1	12"	SUMP 1	SUMP 2	304.5	296.5	284'
2	12"	SUMP 2	SUMP 3	296.5	290.5	210'
3	12"	SUMP 3	BASIN	290.5	284.5	222'
4	24"	SUMP 4	BASIN	284.0	281.0	527'

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

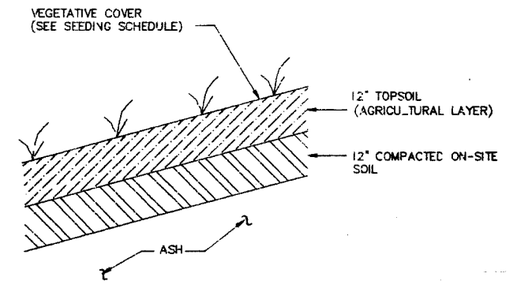
DETAILS
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY	CHECKED BY
NTS	BEK	GNR
JOB NO. 3720	DATE 2-92	PAGE 24 OF 29

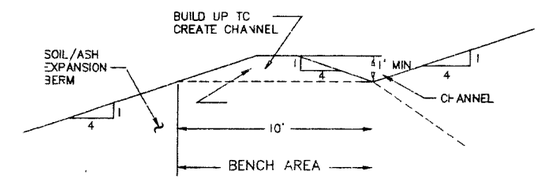


NOTES 1. PLACE SUMP CENTER 5' FEET FROM TOE OF BERM
2. THE #57 STONE OUTSIDE OF THE SUMP WILL BE PLACED A MINIMUM OF 2' THICK OVER THE RISER FLANGE ONLY.

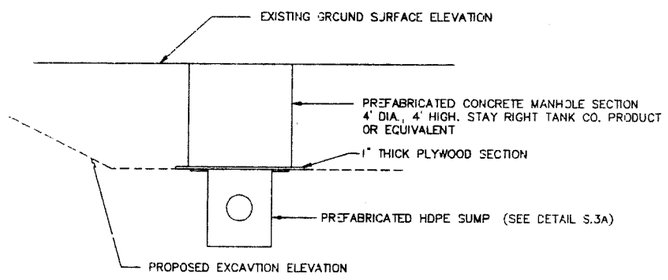
S.5 / 6 SUMP/RISER DETAIL
NTS



C.1 / 8 CAP SECTION (TYP)
NTS

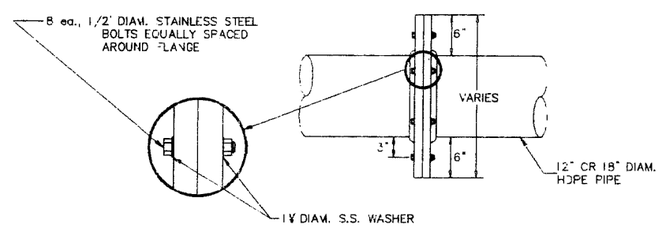


C.2 / 8 CAP SWALES & BENCH
NTS

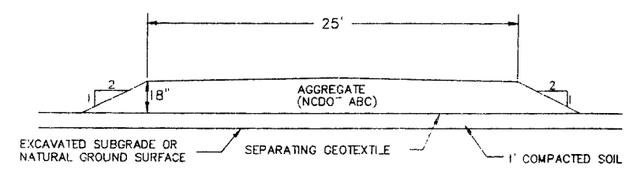


NOTES: 1. THIS DETAIL FOR USE ON SUMPS 2 AND 3 AFTER CONSTRUCTION OF LEACHATE REMOVAL LINE
2. INSTALL PROTECTIVE COVER AS SOON AS POSSIBLE AFTER SUMP INSTALLATION
3. INSTALL TEMPORARY 60 MIL HDPE SEAL ACROSS SUMP FLANGE PRIOR TO THE LINER INSTALLATION AS REQUIRED BY THE ENGINEER

S.6 / 6 TEMPORARY SUMP PROTECTION DETAIL
NTS



S.7 / 25 PIPE FLANGE CONNECTION DETAIL
NTS



NOTE: CROWN ROADWAY SUBGRADE TO PROVIDE DRAINAGE

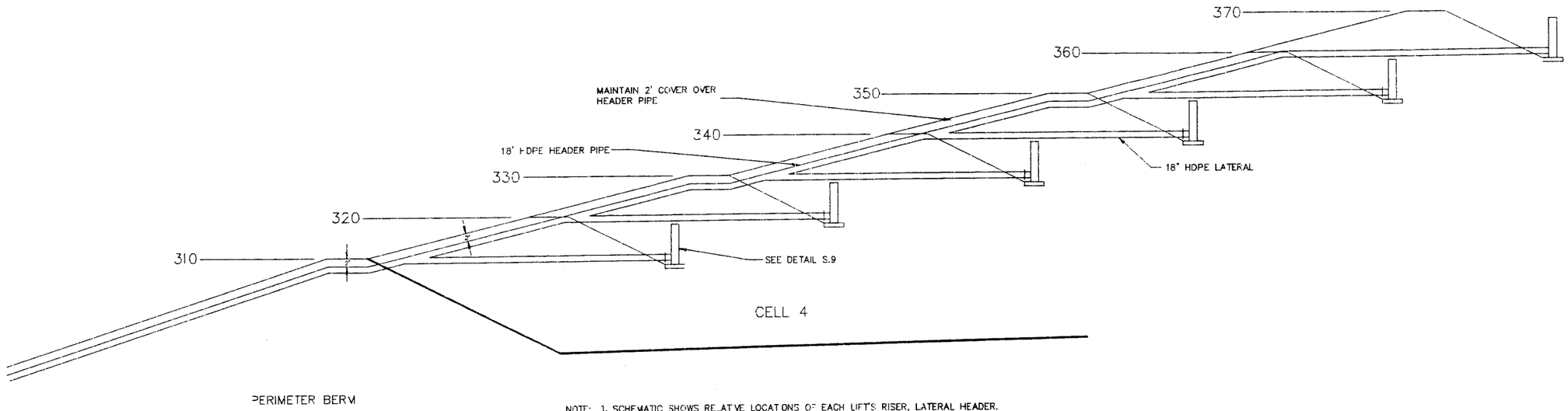
R.1 / 6 TYPICAL ALL-WEATHER ACCESS ROAD
NTS

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

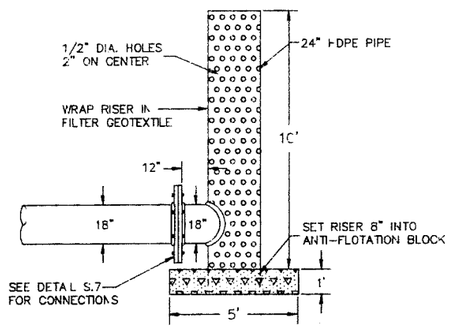
DETAILS
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY	CHECKED BY
NTS	BEK	GNR
JOB NO. 3720	DATE 2-92	PAGE 25 OF 29

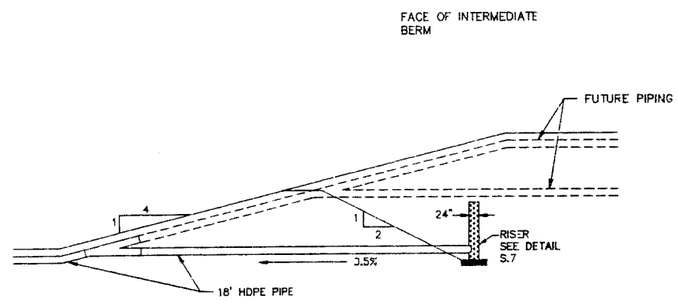


NOTE: 1. SCHEMATIC SHOWS RELATIVE LOCATIONS OF EACH LIFT'S RISER, LATERAL HEADER. SEE CELL 4 FINAL CONTOURS (SHEET 16) FOR PLAN LOCATION OF HEATER PIPE
2. RISERS SHALL BE BURIED AS NEXT STAGE OF FILLING PROGRESSES.

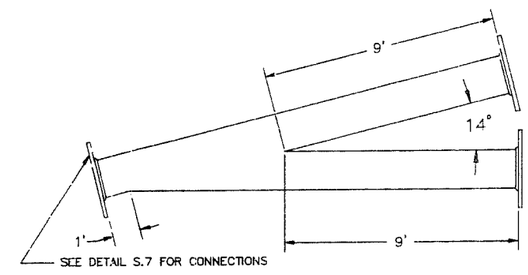
S.8 / 17 CELL 4 RISER/HEADER SCHEMATIC
NTS



S.9 / 26 CELL 4 UPPER RISER
NTS



S.10 / 26 CELL 4 RISER/LATERAL DETAIL
NTS



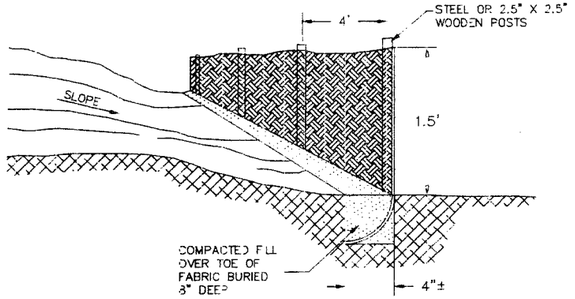
S.11 / 26 CELL 4 HEADER "Y"
NTS

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

DETAILS
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY:	CHECKED BY:
NTS	BEK	GNR
JOB NO. 3720	DATE 2-92	PAGE 26 OF 29



G.1 / 6 SILT FENCE DETAIL
NTS

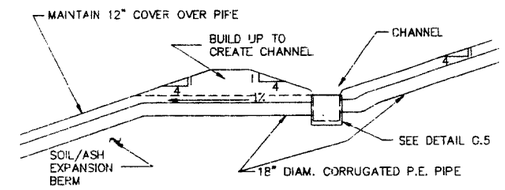
SEEDING SCHEDULE

AGRICULTURAL LIMESTONE: 2 TON/ACRE
FERTILIZER: 10-10-10 AT 800-1000 LBS/ACRE
SUPERPHOSPHATE: 500 LBS/ACRE OF 20% ANALYSIS SUPERPHOSPHATE
MULCH: 1.5 TONS SMALL GRAIN STRAW/ACRE (APPROX 80 BALES)
ANCHOR: CRIMP STRAW INTO SOIL WITH MACHINE OR TACK WITH LIQUID ASPHALT AT 400 GAL/ACRE OR EMULSIFIED ASPHALT AT 300 GAL./ACRE.

PLANTS & MIXTURES	RATES/ACRE	PLANTING DATES
TALL FESCUE	90-150 LBS/ACRE	AUG. 15 - OCT. 15
TALL FESCUE &	100 LBS/ACRE	FEB. 15 - APR. 20
TALL FESCUE &	50 LBS/ACRE	FEB. 15 - APR. 20
SERICEA LESPEDEZA	60 LBS/ACRE	NOV. 1 - FEB.
TALL FESCUE &	60 LBS/ACRE	JULY - AUGUST
BROWN TOP MILLET OR	30 LBS/ACRE	
SORGHUM-SUDAN HYBRIDE (MILLET & SORGUM MUST BE KEPT AT 10-12" MAXIMUM HEIGHT)		
TALL FESCUE AND RYEGRASS	70 LBS/ACRE 25 LBS/ACRE	NOV. 1 - JAN.
WEEPING LOVEGRASS (KEEP ANNUAL CUTS TO 10-12")	5 LBS/ACRE	MAY 1 - JUNE
COMMON BERMUDAGRASS:	8-12 LBS/ACRE (HULLED) 15-20 LBS/ACRE (UNHULLED)	APR. 15 - JUNE 30 FEB. 1 - MARCH

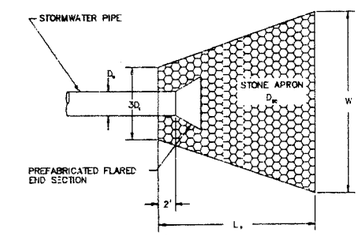
CONSULT HALIFAX COUNTY, DIVISION OF SOIL SCIENCE, OR THE COUNTY AGICULTURAL AGENT ON MAINTENANCE TREATMENT AND FERTILIZATION AFTER PERMANENT COVER IS ESTABLISHED.

G.2 / 27 SEEDING SCHEDULE
NTS



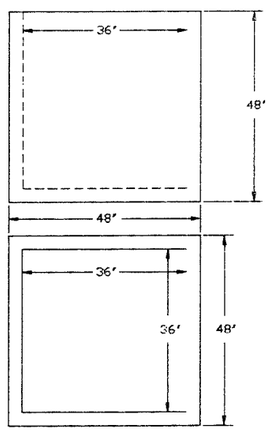
G.3 / 8 DROP INLET PIPING DETAIL
NTS

PIPE	D_i	Q	L_1	W	RIP-RAP D_m	APRON THICKNESS
22	24	27.1	7'	16'	7"	12"
23	18	22.4	4'	18'	5"	12"
24	24	20.1	3'	15'	5"	12"
25	24	20.4	3'	15	5"	12"
27	24	19.5	3'	15	5"	12"



NOTES: 1. PER N.C. EROSION AND SEDIMENTATION CONTROL PLANNING AND DESIGN MANUAL
2. PLACE SEPARATING GEOTEXTILE BELOW RIP-RAP FOR ALL OUTLET APRONS

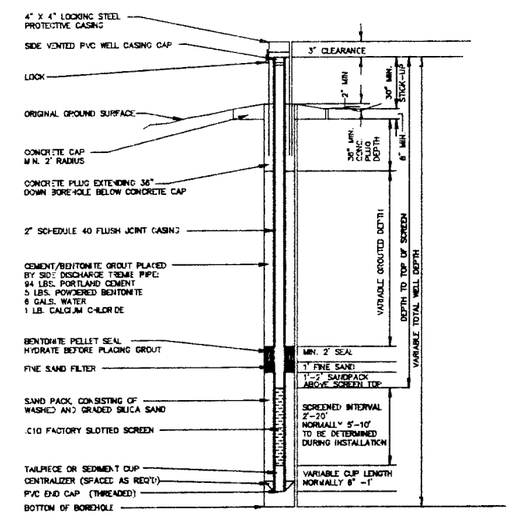
G.4 / 6 STORM WATER PIPE OUTLET DETAIL
NTS



NOTES: 1. DROP INLETS SHALL BE STAY RIGHT TANK COMPANY 4X4X4 PREFABRICATED DROP INLETS OR EQUIVALENT.
2. DROP INLETS SHALL BE ABLE TO ACCEPT 18" OR 24" PIPES ON EITHER SIDE AS CALLED FOR IN THE PLANS.

DROP INLET	INLET PIPE DIA.	OUTLET PIPE DIA.
1	-	18"
2	18"	18"
3	18"	18"
4	-	18"
5	18"	18"
6	18"	18"
7	-	18"
8	18"	18"
9	18"	18"
10	18"	18"
11	18"	24"
12	-	18"
13	18"	18"
14	18"	18"
15	18"	18"
16	18"	24"
17	-	18"
18	18"	18"
19	18"	18"
20	18"	18"
21	18"	18"
22	18"	18"
23	24"	24"
24	24"	24"
25	24"	24"
26	18"	24"
27	18"	24"

G.5 / 6 PREFABRICATED DROP INLET STRUCTURE (TYPICAL DIMENSIONS)
NTS



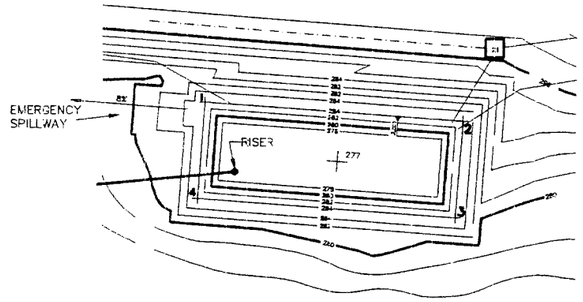
G.6 / 6 TYPICAL GROUND WATER MONITORING WELL DETAIL
NTS

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

DETAILS
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY	REVIEWED BY
NTS	BEK	GNR
JOB NO. 3720	DATE 2-92	PAGE 27 OF 29



LAYOUT INFORMATION

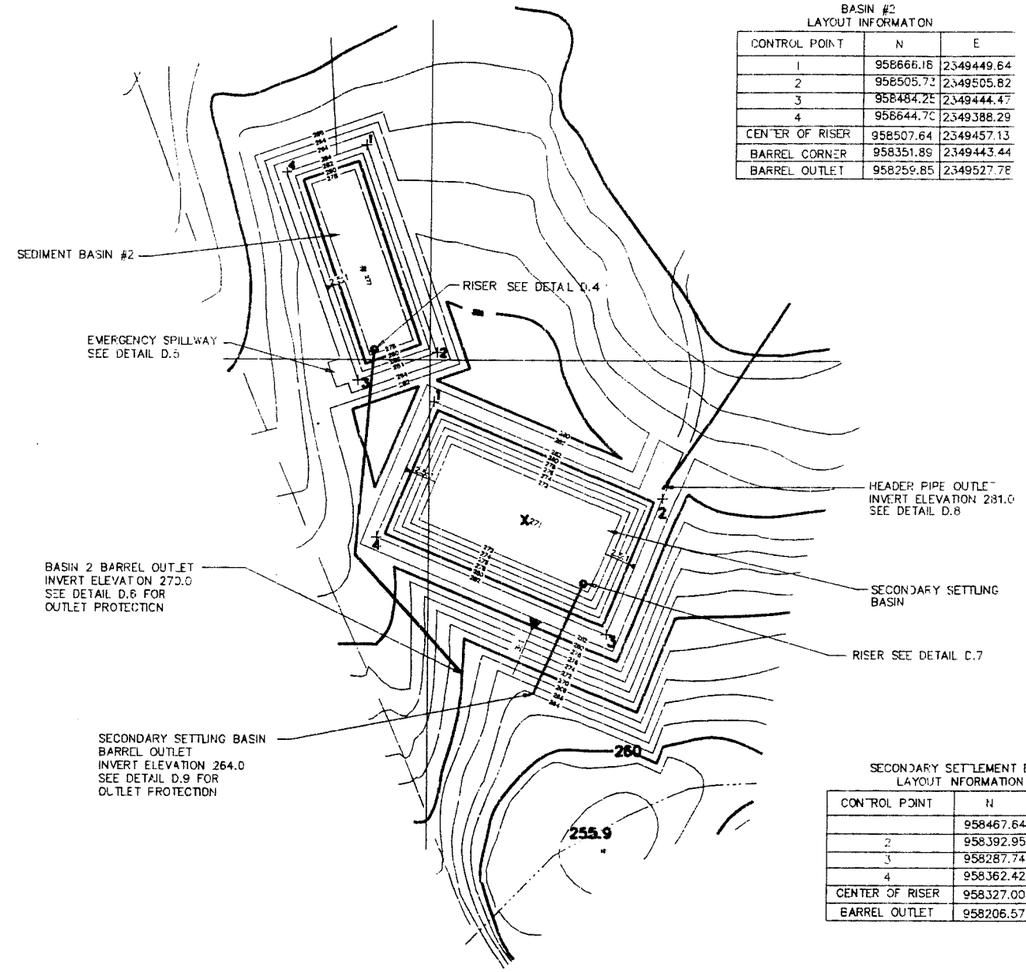
CONTROL POINT	N	E
	958190.54	2350531.53
2	958175.91	2350730.99
3	958101.1	2350725.51
4	958115.74	2350526.04
CENTER OF RISER	958135.04	2350553.23
BARREL OUTLET	958104.53	2350354.16

BASIN 1 GRADING DETAIL

NOTES: 1. CONTOURS DENOTE TOP OF EXCAVATION OR FILL ELEVATIONS
2. ALL BASIN SLOPES ARE AS FOLLOWS:
INSIDE SLOPE 2.5 H : 1 V
OUTSIDE SLOPE 3 H : 1 V
3. BASIN DETAILS ARE SHOWN ON SHEET 29

BASIN #2
LAYOUT INFORMATION

CONTROL POINT	N	E
1	958666.18	2349449.64
2	958505.72	2349505.82
3	958484.25	2349444.47
4	958644.70	2349388.29
CENTER OF RISER	958507.64	2349457.13
BARREL CORNER	958351.89	2349443.44
BARREL OUTLET	958259.85	2349527.78



SECONDARY SETTLEMENT BASIN
LAYOUT INFORMATION

CONTROL POINT	N	E
	958467.64	2349503.92
2	958392.95	2346682.96
3	958287.74	2349639.08
4	958362.42	2349460.03
CENTER OF RISER	958327.00	2349621.66
BARREL OUTLET	958206.57	2349567.31

BASIN 2 AND SECONDARY SETTLEMNET BASIN EXCAVATION PLAN

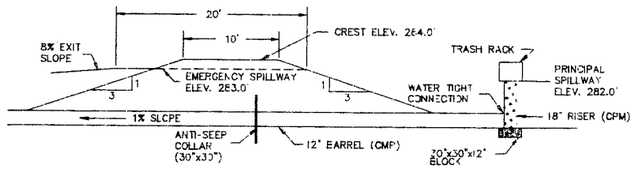
NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

BASIN EXCAVATION PLAN

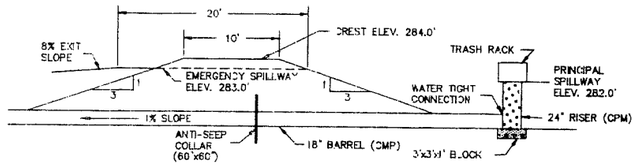
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY:	CHECKED BY:
1" = 40'	BEK	GNR
JOB NO. 3720	DATE 2-92	PAGE 28 OF 29

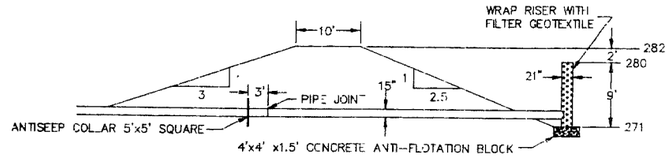


NOTE: PER N.C. EROSION AND SEDIMENTATION CONTROL PLANNING AND DESIGN MANUAL

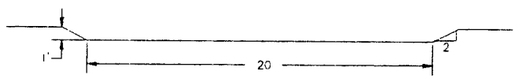
D.1 / 28 BASIN 1 RISER/BARREL DETAIL
NTS



D.4 / 28 BASIN 2 RISER/BARREL DETAIL
NTS

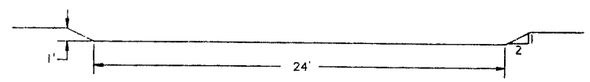


D.7 / 28 SECONDARY SETTLING BASIN RISER/BARREL DETAIL
NTS

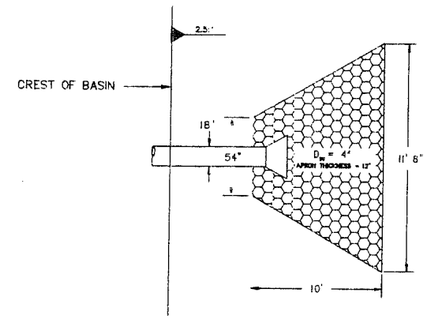


NOTE: PER N.C. EROSION AND SEDIMENTATION CONTROL PLANNING AND DESIGN MANUAL

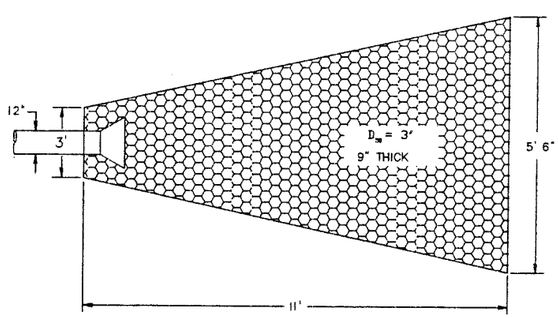
D.2 / 28 BASIN 1 EMERGENCY SPILLWAY
NTS



D.5 / 28 BASIN 2 EMERGENCY SPILLWAY CROSS-SECTION
NTS

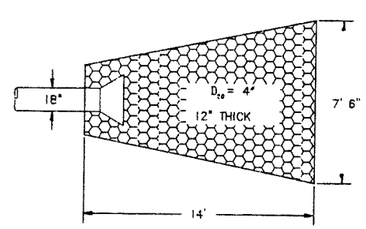


D.8 / 28 SECONDARY SETTLING BASIN INLET PROTECTION
NTS

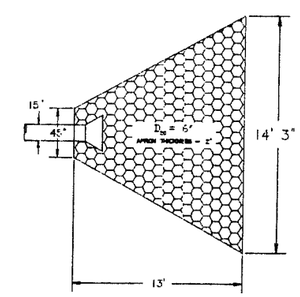


NOTE: PER N.C. EROSION AND SEDIMENTATION CONTROL PLANNING AND DESIGN MANUAL

D.3 / 28 BASIN 1 OUTLET PROTECTION
NTS



D.6 / 28 BASIN 2 OUTLET PROTECTION
NTS



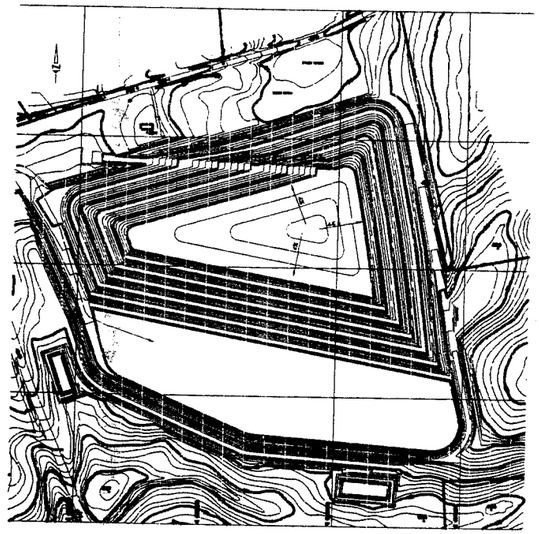
D.9 / 28 SECONDARY SETTLING BASIN OUTLET PROTECTION
NTS

NO.	DATE	DESCRIPTION	BY

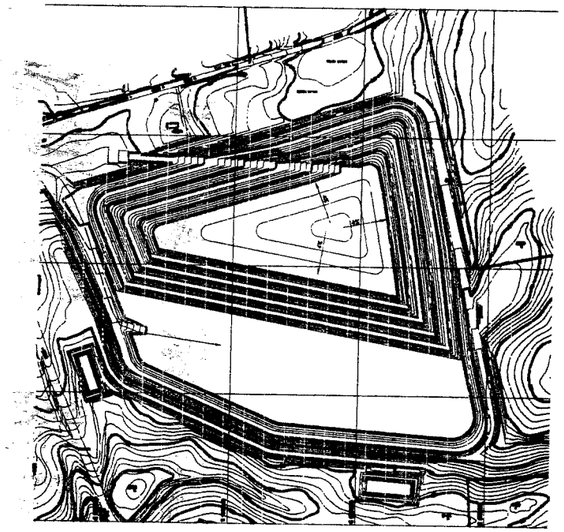
HAZEN AND SAWYER
Environmental Engineers & Scientists

DETAILS
HALIFAX COUNTY ASH MONOFILL

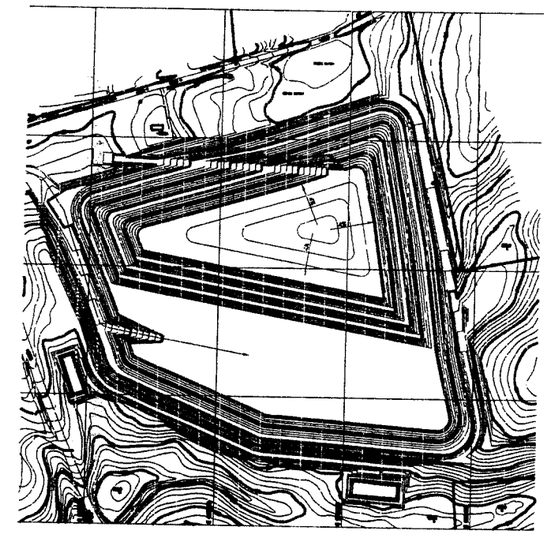
SCALE NTS	DRAWN BY BEK	CHECKED BY GNR
JOB NO. 3720	DATE 2-92	PAGE 29 OF 29



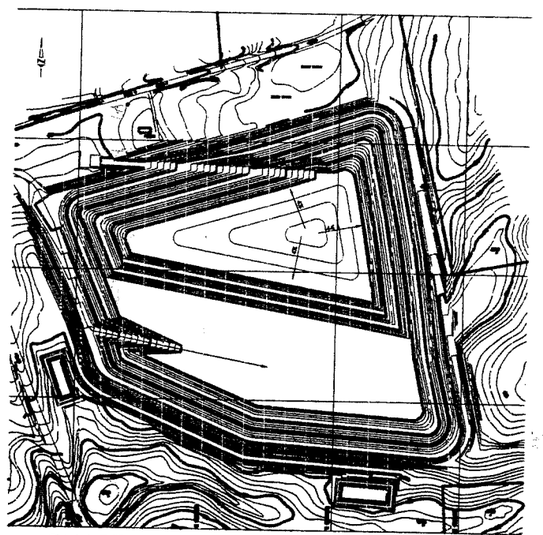
PHASE 4A: FILLED TO ELEVATION 304



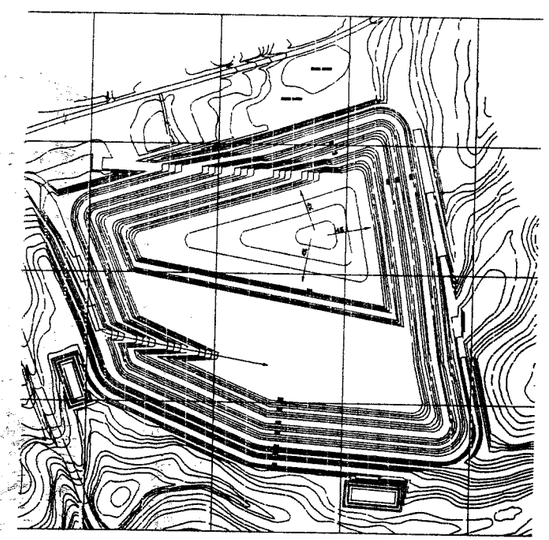
PHASE 4B: FILLED TO ELEVATION 320



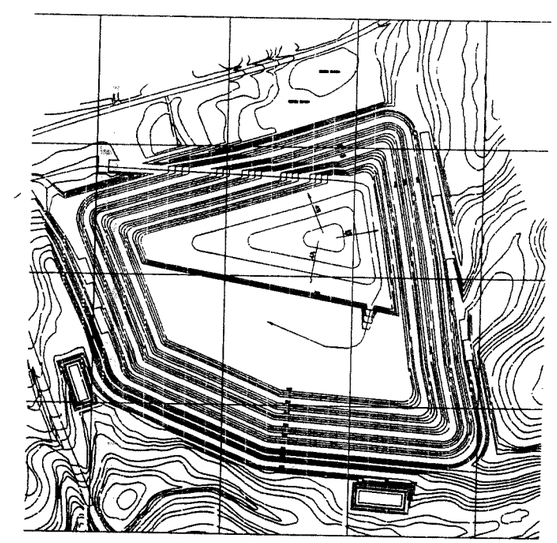
PHASE 4C: FILLED TO ELEVATION 330



PHASE 4D: FILLED TO ELEVATION 340



PHASE 4E: FILLED TO ELEVATION 350



PHASE 4F: FILLED TO ELEVATION 360

NOTES:
1. THESE DRAWINGS DEPICT THE SEQUENTIAL FILLING OF CELL 4 EACH PHASE DENOTES AN APPROXIMATE 10 FOOT LIFT OF ASH.
2. THE ACCESS ARROWS INDICATE ACCESS FOR THAT PHASE
3. THE CELL 4 INTERIM COVER ELEVATIONS ARE SHOWN ON THE FOLLOWING SHEET
4. CONTOURS DENOTE TOP OF ASH ELEVATIONS

ACCESS TO ACTIVE FACE

NO.	DATE	DESCRIPTION	BY

HAZEN AND SAWYER
Environmental Engineers & Scientists

PHASING PLAN
CELL 4
HALIFAX COUNTY ASH MONOFILL

SCALE	DRAWN BY:	DESIGNED BY:
1"=200'	JDB	GMR
JOB NO. 3720	DATE: 2-92	PAGE 16 OF 29