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Oct 23 2019

Virginia Electric and Power Company, d/b/a Dominion Energy North Carolina
Application of Dominion Energy North Carolina for Adjustment of Rates and Charges Applicable to Electric Service in North Carolina
E-22, Sub 562 and E-22, Sub 566

Post-Hearing Exhibit 6

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Oct 23 2019

GAI CONSULTANTS

REVISED
CLOSURE PLAN
UPPER (EAST) POND
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

Submitted To: Virginia Electric and Power Company (Dominion)
Glen Allen, Virginia

Project 96-410-37

September 2003

CONSULTANTS

GAI Consultants, Inc.

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September 3, 2003

Project 96-410-37

Mr. Michael B. Lott, P.E.
Dominion Generation
Fossil & Hydro Technical Services
Innsbrook technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060-6711

Response to VDEQ Comments
Revised Closure Plan - Upper (East) Pond
Chesterfield Power Station
Chesterfield County, Virginia

Dear Mr. Lott:

GAI Consultants, Inc. (GAI) is pleased to offer the following responses to questions or comments that have been presented by the Virginia Department of Environmental Quality (VDEQ) on the revised closure plan (May 2003) submitted to them on June 5, 2003. The questions or comments will be presented first in this letter, followed by our response.

Questions/Comments from Ray Jenkins directed to Ron Birckhead of Dominion:

1. At the bottom of page 2 in the Closure Plan a statement is made concerning post-closure care for 5 years. The discussion continues on page 3 to reference ground water monitoring. On page 13, item A.11., ground water monitoring is also mentioned in the context of the VPDES permit requirements. I recall that we talked about this before and all understand that ground water monitoring will be governed by the VPDES permit. That is, monitoring is not tied to a post-closure time period. Would it help to clarify the discussion on pages 2 and 3?

   Our understanding is that all monitoring, groundwater or surface water will be governed by the VPDES permit and not by the closure plan. The intent was to simply reference the VPDES permit in the closure plan. A statement was added to the closure plan to indicate that groundwater and surface water monitoring is governed by the VPDES permit and not by the closure plan. See pages 2 and 3 of the Closure Plan.

2. Item A.11 on page 13 of the Closure Plan refers to both ground water and surface water monitoring. In context, I understand the meaning of surface water monitoring to actually be a reference to effluent monitoring at Outfall 005. The VPDES permit can be modified as necessary.

   The intent was to refer to the monitoring requirements at Outfall 005. See page 12 of the Closure Plan.

<u>Questions/Comments from John Godfrey</u>:

1. Closure Plan (CP), page 1: The addition of the flue gas emission control waste material to the wastes disposed of at this facility is acceptable, provided the material can be demonstrated to be non-hazardous. The flue gas emission control material is considered to be a coal combustion by-product (CCB) in the Virginia Solid Waste Management Regulations (VSWMR, 9 VAC 20-80), so the ability to reclaim the material from the disposal area is not affected.

   We believe the material will test to be non-hazardous. Material testing will be performed and the results submitted when the material is available. No further action is required.

2. CP, page 6: As you noted, the use of the word "(E)lsewhere…" in the discussion of ash placement is ambiguous. It would clarify the matter to state, "Elsewhere within the disposal pond…"

   Revision made for clarification. See page 5 of the Closure Plan.

3. CP, page 6: As we had previously noted, the revised moisture-density windows for the placement of the CCB is acceptable.

   No response necessary.

4. CP, page 7: The criteria for the vegetative cover that it should be a "…low maintenance species that does not require mowing…" is understandable, but the species must also have a root mass that is sufficiently dense to minimize soil erosion. High growing grasses can result in the loss of the lower, denser growth of grass, which can lead to rather sparse vegetation that does not hold the soil. It is recommended that mowing be conducted on a limited basis (2-3 times per year) to provide an effective vegetative cover, at least during the first couple of growing cycles. The maintenance measures discussed seem adequate. The seeding blend discussed on page A-2 is an example of a mixture that may be effective and require minimal mowing since the Fescue does not grow exceptionally tall and the Bermuda does provide a root structure.

   GAI concurs with the VDEQ comment on mowing as it relates to plant growth and root structure. A statement was added to indicate that mowing will be

conducted on a limited (2 to 3 times per year) basis. See page 7 of the Closure Plan.

5. CP, page 11: The groundwater monitoring requirements for industrial waste landfill that is provided in 9 VAC 20-80-300 of VSWMR may be a good resource in the development of the groundwater monitoring program.

   The referenced regulations will be consulted for guidance when appropriate for any changes in the groundwater monitoring system. Since the FGD material is a different material, the groundwater monitoring program will be evaluated to determine if changes are needed prior to placement of the material in the upper pond. No further action is required.

6. CP, page 16: Some more discussion is needed to explain the term "exhibiting erosion." It is suggested that a maximum allowable size of rill be defined.

   We have changed this section to have channel erosion repair begin when a 4-inch deep rill occurs. See page 14 of the Closure Plan.

7. CP, page 17: In the discussion of post-closure maintenance activities, more specific guidance should be provided to enable plant personnel to determine when the stormwater features must be cleaned.

   This section has been revised to indicate that sediment removal will begin once the accumulated sediments reach a depth equating to 25 percent of the hydraulic capacity. See page 15 of the Closure Plan.

8. CP, page A-1: Is the cover soil to be placed over the compacted surface of the CCB, or is the surface to be scarified prior to placement of the soil?

   The cover soil can be placed on the compacted CCB surfaces. See page A-1 of the Closure Plan.

9. CP, Page C-1: The inspection frequencies are good.

   No response necessary.

10. CQA Plan, Table II-4, page II-8: The testing frequencies are adequate.
    CQA Plan, page III-2: The instruction is that the geotextile be kept under tension during installation. Would it be reasonable to recommend that the material be deployed down the slope?

    No response necessary to testing frequency comment. 'Deploying' a geotextile downslope would help to ensure that the material is under tension, but may not be appropriate for all installations. For greater flexibility in material placement, we suggest that the requirement that it be 'kept under tension during installation' remain as written. No further action is required.

We believe that these responses adequately address the VDEQ questions and comments. As you requested, we have revised the Closure Plan in accordance with our responses above. Changes were not necessary to the Phasing Plan or the Construction Quality Assurance Plan.

As always, please do not hesitate to call me if you have any questions.

Sincerely,
GAI Consultants, Inc.

Timothy N. Kyper

Timothy N. Kyper, P.E.
Engineering Manager

TNK:CLN/cwi
9641037-ltr-cln/cwi132

Enclosures

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
GLEN ALLEN, VIRGINIA

REVISED
CLOSURE PLAN
UPPER (EAST) POND
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

COMMONWEALTH OF VIRGINIA
THOMAS A. GRAY, PE
CERTIFICATE NO.
11628
PROFESSIONAL ENGINEER

9/3/03

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570 BEATTY ROAD
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PROJECT 96-410-37

SEPTEMBER 2003

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CLOSURE PLAN - UPPER (EAST) POND
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

I. Introduction, Background of Site, and Closure Summary

A. Introduction

This Closure Plan for the Upper (East) Pond at the Chesterfield Power Station describes the closure of the existing, permitted facility, Permit No. VA004146. The location of the site is shown on Figure 1.

Included as a part of this Closure Plan is the description of the final cover, which will consist of 12 inches of soil material capable of supporting vegetation. Design calculations for the final closure are included in the appendices.

B. Background of Site

The Upper (East) Pond is an unlined, diked disposal site that was constructed in 1983 for long-term disposal of fly ash, bottom ash, and coal mill rejects, containing small amounts of pyrites. These materials are commonly referred to as coal combustion by-products (CCBs) and now include other types of materials, such as, but not limited to, flue gas emission control waste material. Historically, material was transferred from the lower west pond to the Upper (East) Pond about every three (3) years. Following a material transfer in July 1996, however, the Upper (East) Pond was reaching capacity and Virginia Electric and Power Company (Dominion), as part of their permit requirements under VA004146, prepared and submitted a Closure Plan for the facility. Dominion proposed to effect the closure of the

Upper (East) Pond by the continued placement of CCBs within the pond. The Closure Plan was reviewed and approved by the Commonwealth of Virginia. By submission of this revised Closure Plan, and other revised associated documents, Dominion proposes to continue the closure of the Upper (East) Pond by placement of CCBs on the interior of the dikes, but under different criteria.

C. Closure Summary

Closure of the site will occur simultaneously with the continued placement of CCBs, which will occur generally from east to west. Surface runoff will be handled with benches, lined or paved slope drains, surface swales, and perimeter collection channels. As final CCB surfaces are obtained, a 12-inch-thick final soil cover will be placed, then fertilized, seeded, and mulched. The final top surface will drain toward surface swales at a minimum two (2) percent slope. The surface swales will outlet into the slope drains around the site.

After CCB placement has been completed and the entire site has been stabilized with vegetation, post-closure care will commence. Post-closure care of the facility will continue for a period of five (5) years. Post-closure care will consist of regular site inspections, and routine site maintenance. Following post-closure, the temporary sediment pond will be filled in and flow from the two (2) perimeter collection channels will be combined into one culvert and discharged through the dike near the southeastern side of the pond. Detailed information pertaining to the site closure and post-closure is presented in the following sections. Ground water and surface water monitoring will continue per the VPDES Permit.

II. Closure Plan

A. Closure Activities

1. Closure Plan Time Frame. As final CCB surfaces are obtained during CCB placement, final closure will be performed. Based on the current CCB production of 300,000 cubic yards per year, final closure is expected sometime near the year 2028. However, additional environmental controls, e.g. flue gas emission control scrubbers, may be added to the Chesterfield Station around 2008 to 2010 and the final close year would be expected to change. If added, the amount of CCBs will increase and is estimated to be an additional 120,000 cubic yards per year. This would bring the annual production to 420,000 cubic yards. The flue gas emission control waste material would be co-mingled in the upper pond with the other materials removed from the lower pond, and, if all material goes to the upper pond, the final closure would be expected sometime near the year 2023. However, implementation of CCB utilization options could extend the site's useful life to a later date. For example, the flue gas emission control waste material may be used in the production of wallboard. Also, ash that has been placed at the site has been removed for other beneficial purposes. This practice is anticipated to continue.

If the site were to be closed before the final depicted configuration is achieved, the final cover and drainage channels would still be constructed as described in this plan and as shown on the Drawings. The only difference would be that the final top surface would be at a lower elevation and would have a slightly larger surface area. A minimum two (2) percent slope would also be maintained for surface drainage.

2. Closure Performance Standard. Post-Closure maintenance will be minimized by implementation of the following features, which are more fully described in subsequent sections of this plan:

- Final grading/surface water drainage channel system providing positive drainage away from the site
- Erosion-resistant channel linings
- Vegetated cover soil
- Regularly scheduled facility inspections

The site will be covered with a vegetated soil cover to reduce the potential for erosion and infiltration. The closure materials are CCBs, hence no waste decomposition products are expected.

3. CCB Placement. As the CCBs are placed, the working surface shall be graded in a manner to drain toward the lined slope drains. Grading shall be performed such that ponding of water is minimized on the surface.

Around the perimeter of the pond, and for a distance of at least 50 feet inward from the final surface, the CCBs shall be placed and graded in lifts not exceeding one foot. Each lift shall be compacted at optimum moisture, within a tolerance of plus four (4) percent or minus six (6) percent of optimum, to a minimum density of not less than 95 percent of Standard Proctor maximum dry density. This may require additional compactive effort to achieve. Elsewhere within the upper pond, material shall be placed and compacted at optimum moisture, within a tolerance of plus or minus eight (8) percent of optimum, to achieve a minimum density of not less than 92 percent of Standard Proctor maximum dry density. Surcharging techniques, such as storing the CCB material in stockpiles at least 15 feet high may be used to achieve the compaction and moisture requirements.

Fugitive dust shall be controlled at the site as required. A water truck and/or other methods will be available to spray the haul roads and active surfaces to control fugitive dust.

4. Final cover soil is to be carefully placed above the CCB surface. Soil used for cover will have physical and chemical characteristics conducive to the establishment of vegetation and be free of wood fragments, rocks over three (3) inches in size, and other debris. Placement of the soil will be monitored at all times. The soil material shall be acquired locally from nearby sites, such as on-site (Dominion property), the Chesterfield County Proctor Creek Wastewater

Treatment Plant, or the Shoosmith property. When on embankment slopes, the soil shall be placed from the bottom of the slope up to the top, and shall be placed in one 12-inch thick lift. The 12-inch thick lift shall be compacted with a minimum of two passes of the track area of the dozer used to place the soil. Tracking of the soil shall be up and down the slope, not transverse.

The proposed final cover vegetation will be a low maintenance species that does not require mowing. It will be chosen for it's demonstrated adaptability to growth in a wide range of soils. The seed mixture will include perennial cool-season grasses (e.g., Perennial Ryegrass or Tall Fescue) and a nitrogen-fixing perennial legume (e.g., Sericea Lespedeza). A complete description of the cover vegetation and fertilizing, seeding and mulching requirements are provided in Appendix A.

5. Maintenance Needs. The cover system is designed to function effectively with minimum maintenance needs. The top surface will be graded to provide positive drainage and to minimize ponding; embankment side-slopes will be graded at 3 horizontal to 1 vertical (3H:1V), with 20-foot-wide benches placed every 25 vertical feet maximum, which will minimize erosion. The vegetative cover specified will be monitored closely after major storm events, particularly in the establishment year and will be reseeded and mulched as necessary. The vegetation species will be chosen so as

to require mowing on a limited basis (2 to 3 times per year), and not to require maintenance fertilizer. Nutrient cycling and biological nitrogen fixation (by the perennial legume) will maintain and build fertility levels. Large woody plants will be cut down and the stumps treated as necessary.

6. Surface Drainage and Erosion. A surface water drainage system has been designed to provide run-off control at the facility. No run-on control is necessary since the pond does not receive any runoff from off-site. Benches located at the site have been designed to collect and convey surface runoff from the 3H:1V slopes to the slope drains and perimeter collection channels. The perimeter channels convey the flows to the temporary sediment pond located at the eastern end of the site. All channels are designed to accommodate the 25-year, 24-hour storm. The benches were designed at a slope of one (1) to three (3) percent, the slope drains were designed at a maximum slope of 33 percent and a minimum slope of five (5) percent, and the perimeter collection channels were designed at a grade of 0.4 percent. The benches and perimeter channels will be fertilized, seeded, and mulched the same way as the final cover on the rest of the site. The slope drains will be lined with concrete, concrete-like material, or paved with an Engineer-approved lining. The haul roads shall be constructed as shown on the Drawings. Bituminous-coated corrugated metal

pipe culverts will be used to convey the 25-year, 24-hour storm flows underneath the haul roads and ultimately underneath the closed temporary sediment pond, where shown on the Drawings. The layout and details of the channels are also shown on the Drawings. Hydrology and hydraulic calculations are provided in Appendix B.

Soil material that may erode during construction will be intercepted and channeled to the on-site sediment pond. Eroded areas will be repaired. Calculations have been performed to estimate erosion rates for the post-closure period (see Appendix B). The estimated rate of cover erosion was calculated by using the Universal Soil Loss Equation. The maximum estimated erosion rate was calculated to be 1.7 tons per acre per year for the final vegetated surface. The estimated erosion rate is less than the accepted maximum soil loss rates, which usually range from 2 to 5 tons per acre per year.

7. Stability and Settlement. Stability of the CCB placement areas was demonstrated by calculations performed for the design. These calculations are included in Appendix B. Based upon research performed, it was established that Chesterfield County has a seismic coefficient of 0.075 which indicates that the Upper Pond site is not susceptible to significant damages due to earthquake activity. This coefficient was taken into consideration in the stability analyses.

Stability of the site was analyzed for three (3) cases. The first case is for 1998 conditions, the second case is for CCB placement to elevation 80, and the third case is for CCB placement to elevation 130. Given the variability of subsurface soil profiles, geometry, and conditions around the perimeter of the pond, nine (9) sections were assessed. The factors of safety against a circular failure are summarized in Table 2 (Sheet 4 of the stability calculations, Appendix B).

The factors of safety for most of the cases under seismic conditions analyzed were above 1.5. Exceptions were found in the unstable areas at the eastern end of the site that are referred to as the North and South dikes (Sections H-H and I-I, respectively, Table 3, Sheet 4 of the stability calculations). Many of the factors of safety in these areas were below 1.5. Note that these factors of safety are conservative since they take into account the seismic coefficient and a higher than expected phreatic line through the dike. However, due to these lower factors of safety at the eastern end of the site, closure will involve terminating CCB placement for these areas at the same elevation as the top of the dike. Note that the factor of safety does not decrease for the additional CCB placement behind the dike. These areas and the dike will be monitored for movement. Maintenance action will be taken if and when needed. Most of the factors of safety for the second and third case (CCB placement to elevation 80 and elevation 130, respectively) were above 1.4. These results represent reasonably dry (i.e., not saturated) conditions for the CCB, conditions that are expected. Higher water elevations (that is, saturated CCB and/or dikes) could lead to lower factors of safety.

Since the site closure will be performed over a time span on the order of 20 to 30 years, much of the anticipated settlement will occur during construction. Given that the CCB material is expected to have a density of at least 92 percent of Standard Proctor maximum dry density, 95 percent around the pond perimeter, and placed in an unsaturated condition, post-construction settlement of the material should be relatively small. The calculations provided in Appendix B indicate that a maximum surface settlement of 1.1 feet can be expected, assuming a final nominal maximum surface elevation of 130 feet above mean sea level (MSL).

Stability and site life calculations were performed using anticipated material properties (unit weight, strength parameters, etc.) based upon GAI Consultants, Inc.'s (GAI's) experience with similar materials and laboratory testing as presented in the calculations. The materials should be monitored and tested in the future, especially if the flue gas emission control scrubbers are installed, and additional engineering analyses should be performed to confirm the parameters utilized at this point in time.

8. Freeze/Thaw Effects. The depth of maximum frost penetration is expected to be less than 24 inches (see Figure 2). Freeze/thaw effects are not expected to be detrimental. Any minor sloughing of cover soil will be repaired.

9. Schedule for Closure. Many factors will dictate the actual schedule for closure. The major factors include the CCB generation rate, with or without the addition of scrubbers to the station, and possible beneficial use applications. It is anticipated that the site will be closed in two phases. Using a CCB placement rate of 300,000 cubic yards per year, (i.e., without scrubbers), Phase I, consisting of 4 cells, will be completed in about 2016. Phase II, consisting of 3 additional cells on top of Phase I, will take another 12 years for completion. Accordingly, an anticipated closure date for the site could be the year 2028. If scrubbers are added in 2008 and 2010, the placement of CCBs is expected to increase to 420,000 cubic yards per year. Under this scenario, Phase I would be completed in 2014 and Phase II would require nine additional years and be completed in 2023.

A possible closure schedule for the site is shown on Figure 3.

10. Security and Posting. Signs will be posted at the locking gates at all facility access points and unauthorized entrance is prohibited. Vehicle access to the site will be controlled by bar gates secured with lock and key. Vehicle access adjacent to the gate will be denied by physical barriers (surface water channels, post barricades, or severe slopes).

11. Monitoring. Both ground water monitoring and surface water monitoring will continue throughout the closure period and will be performed in accordance with the terms and conditions of the Virginia Pollution Discharge Elimination System (VPDES) permit. Surface water monitoring will occur at the outlet of the temporary sediment pond, currently Outfall 005. The ground water and surface water monitoring requirements of the VPDES permit will be modified prior to the introduction of flue gas emission control waste material.

B. Post-Closure Activities

1. Security. Vehicle access to the site will be controlled by bar gates secured with lock and key. Vehicle access adjacent to the gate will be denied by physical barriers (surface water channels, post barricades or severe slopes). No CCB material will remain exposed upon completion of closure. Access to the closed site will not pose a health hazard.

2. Ground Water Monitoring System Maintenance. Maintenance of the ground water monitoring system will consist of repairing any damaged materials (e.g., protective casing) as needed, as observed during regular inspection (see Item II.B.3, below) or during sampling (see Item II.B.4, below). If any irreparable damage occurs, the appropriate part or parts of the system will be replaced in kind.

   Since the facility will accept CCBs, no gas generation should occur, hence no gas collecting/venting facilities will be installed.

The perimeter collection channels will continue to convey surface runoff and will be cleaned as required to keep them free-flowing.

3. Inspection Plan. Inspection during the post-closure care period will be performed for the items noted below. The frequency of inspection is detailed in Appendix C, Table C-1. Inspections are scheduled frequently enough so that any potential damage that might occur between inspections will be detected and repairs can be performed before significant harm can occur. Appendix C provides a checklist for facility inspections.

- Security Control Devices. The serviceability of the locking gates will be inspected during regular inspections.
- CCB Placement - The entire CCB placement area, including top surface and side-slopes, will be inspected for slides, settlement, and displacement, and cover condition (see below).
- Existing Upper (East) Pond Dike - The dike surrounding the placement areas will be inspected for slides, displacement, seepage and erosion.
- Cover - The final cover will be inspected for erosion and for the condition of the vegetated cover, i.e., gaps in vegetation or presence of undesirable trees or brush.
- Surface Drainage System - The surface drainage system, including benches, slope drains, haul road drainage channels,

surface swales, perimeter collection channels, and culverts, will be inspected for erosion, integrity of channel lining, ponding, and accumulated sediment.

- Ground Water Monitoring System - The ground water monitoring system will be inspected for the general integrity of the wells, well casings and protective casings.

4. Monitoring Plan.

- Ground water monitoring will continue during the post-closure period in accordance with the terms and conditions of the VPDES permit.
- In addition, water from the temporary sediment pond will also be sampled in accordance with the VPDES permit. Sampling will continue until the sediment pond is closed.

5. Maintenance Plan. Maintenance during the post-closure care period will be performed as discussed below, based upon the facility inspections described above and in the checklist in Appendix C.

- Security Control Devices. Any portions of the locking gates which might be damaged will be repaired or replaced.
- Erosion Damage Repair. Any areas exhibiting 4-inch rill erosion will be repaired by replacing and compacting the material in kind to design grade/specifications, and reseeding the area to the specifications. Application of additional fertilizer, selective herbicides, rodent control measures, etc. will

be implemented as necessary. Follow-up monitoring of the repaired area will be conducted to ascertain the integrity of the repair.

- Settlement, Sliding, or Displacement. Any areas at the closed site exhibiting evidence of settlement, sliding, or displacement will be examined to determine the cause of the movement. These areas will be backfilled with additional CCBs or soil material as needed to maintain positive drainage and the integrity of the closed site. Any backfilling will be performed in accordance with the site/closure specifications, including seeding. If the condition reoccurs or persists, or if the severity of the condition initially is judged to warrant it, a detailed investigation of the cause will be performed, and remedial action will be undertaken.
- Surface Water Drainage System. The channel linings are designed to withstand anticipated flow velocities. Maintenance of the surface water drainage system will consist of removing sediment and/or undesirable vegetation from the channels and culverts once accumulated sediments reach a depth equating to 25 percent of the hydraulic capacity. Eroded areas will be repaired by backfilling and reseeding according to the specifications. Damage to culverts will be repaired; structure replacement will be performed if needed.

- Ground Water Monitoring Wells. Any damaged portions of the monitoring wells and/or their protective casings will be replaced in kind. The protective casings are steel casings with locking covers to minimize tampering or damage due to vandalism.

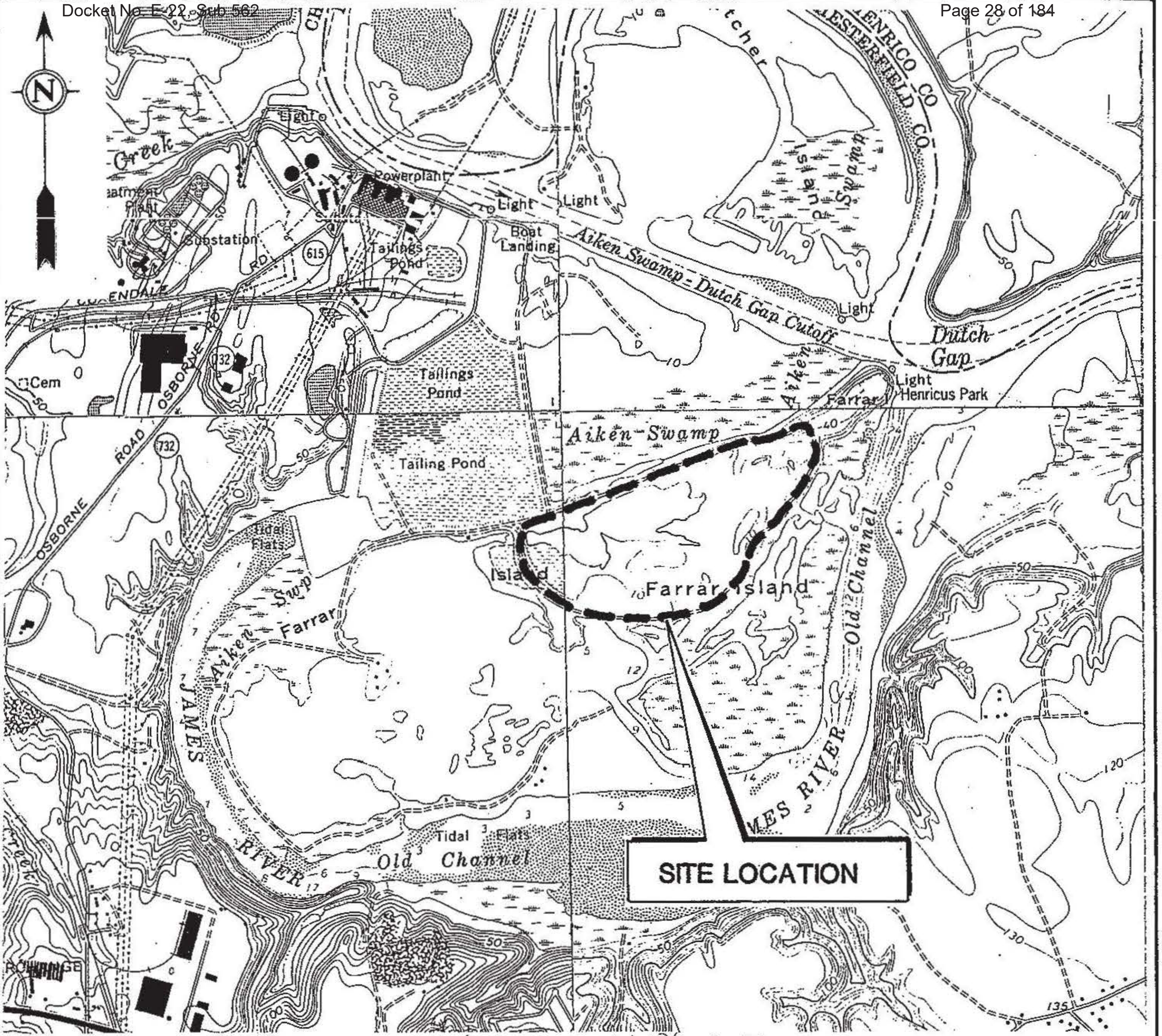
6. Training. Company personnel responsible for post-closure monitoring, inspection, and maintenance will be under the direct supervision of the company's engineering staff during performance of these duties.

7. Sediment Pond Closure. Following post-closure monitoring, the temporary sediment pond will be closed. This will be accomplished by constructing drainage modifications and by placing fill material. Flow from the two (2) perimeter collection channels will be combined into one (1) culvert, which will discharge through the dike in the vicinity of the existing riser structure and 24-inch diameter discharge pipe (see Drawing V-96-410-F14). The concrete riser will be demolished and removed from the pond, along with the 24-inch diameter discharge pipe. The larger replacement pipe that combines the two (2) perimeter collection channels will be the only surface drainage discharge point from the site. The pond will be filled in stages with either CCB or soil, or a combination thereof, in such a manner so that the water quality of the discharges from the site are maintained. As the pond fill reaches elevation 40, a final soil cover will be placed and

the surface will be limed, fertilized, seeded, and mulched according to Appendix A.

FIGURES

DWG. NO.



REFERENCE:

U.S.G.S. 7.5 MINUTE SERIES QUADRANGLES

DREWRYS BLUFF, VA. 37077-D4-TF-024 1969 REVISED 1994 DMA 5558 IV NW-SERIES V834	DUTCH GAP, VA. 37077-D3-TF-024 1969 REVISED 1994 DMA 5558 IV NE-SERIES V834
CHESTER, VA. 37077-C4-TF-024 1969 PHOTOREVISED 1987 DMA 5558 IV SW-SERIES V834	HOPEWELL, VA. 37077-C3-TF-024 1969 PHOTOREVISED 1987 DMA 5558 IV SE-SERIES V834

VIRGINIA
QUADRANGLE LOCATION

0 2000 ft
SCALE

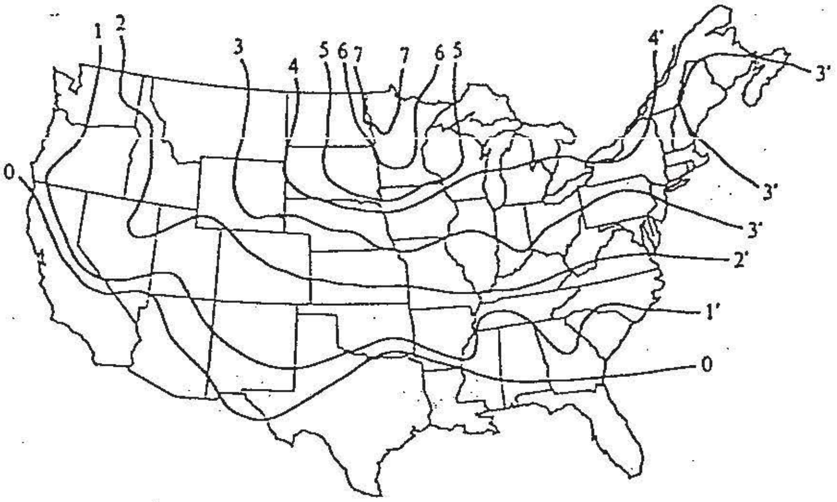
GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists
570 Beatty Rd. • Pittsburgh,
Monroeville, Pa. 15146
412-856-6400

SITE LOCATION MAP
UPPER (EAST) POND
CHESTERFIELD POWER STATION
CHESTERFIELD COUNTY, VIRGINIA

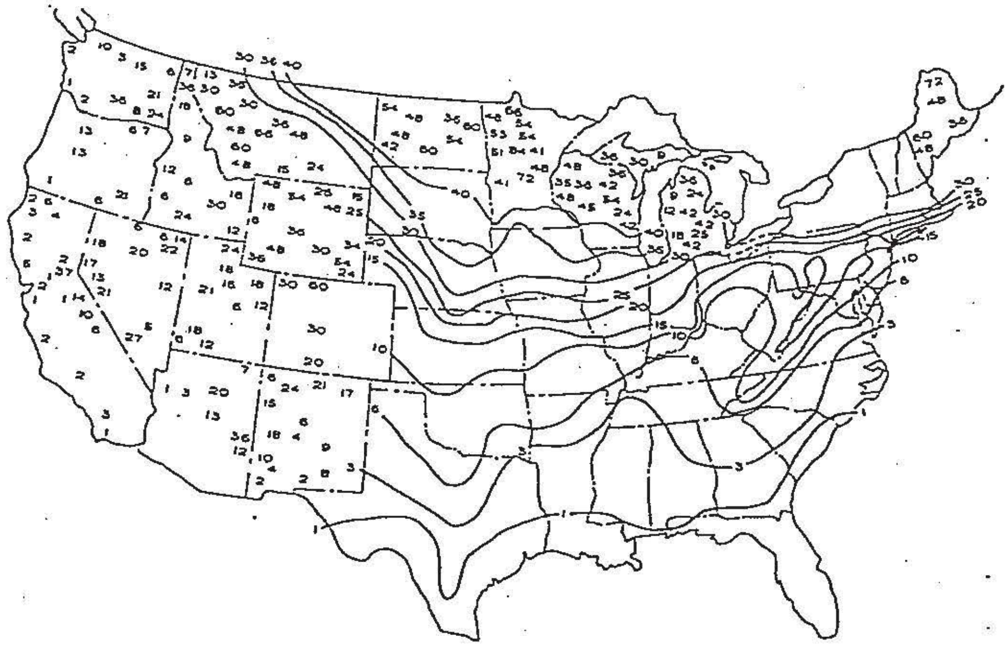
VIRGINIA POWER
GLEN ALLEN, VIRGINIA

DWN. GRL CHKD. MRL
APPD. TNK DATE 9/24/97
SCALE: AS SHOWN
DRAWING NUMBER
96-410-A9
REV

FIGURE 1



Approximate frost-depth contours for the United States, based on a survey by the author of a selected group of cities.



AVERAGE DEPTH OF FROST PENETRATION (IN.)
SOURCE: U.S. DEPT. OF COMMERCE WEATHER BUREAU

FIGURE 2 FROST DEPTH DATA

From: Foundation Analysis and Design, 4th Ed., J.E. Bowles, p. 305, and Architectural Graphic Standards, 8th Ed., J. R. Hoke, Jr.

Virginia Power - Chesterfield Closure
Closure Schedule
CRB 8/22/97 Rev. MRL 2/10/98 Rev. GJA 4/24/03
Chkd: MRL 5/15/03

CLOSURE SCHEDULE

Cell	Volume (Ac-ft)	Volume (yd^3)	Life Expectancy (yr) *	Closure Year *
1	625.55	1,009,298	3.4	**2001**
2	827.05	1,334,417	4.4	**2005**
3	979.18	1,579,874	4.8	**2010**
4	911.24	1,470,253	3.5	**2014**
Subtotal (Phase I)	3,343.02	5,393,842	16.1	**2014**
5	655.90	1,058,278	2.5	**2016**
6	774.79	1,250,092	3	**2019**
7	754.23	1,216,930	2.9	**2022**
Subtotal (Phase II)	2,184.93	3,525,299	8.4	**2022**
Pond Area **	151.20	243,956	0.6	**2023**
Total		9,163,097	25.1	**2023**

* based on 300,000 cubic yards placement per year starting in 1998. In year 2008, Scrubber 1 is assumed to be operating and will increase the production by approximately 60,000 cubic yards. In year 2010, Scrubber 2 is assumed to be operating and will increase the production an additional 60,000 cubic yards per year. At this point, the total production will be approximately 420,000 cubic yards per year.

** based on the temporary sediment pond filled in with CCB's

FIGURE 3

Path:P:\1996\96410\D37
ashproduction_vapower.xls

APPENDIX A

SURFACE PREPARATION, FERTILIZATION, SEEDING, AND MULCHING REQUIREMENTS

APPENDIX A

SURFACE PREPARATION, FERTILIZATION, SEEDING, AND MULCHING REQUIREMENTS

A. The establishment of vegetation on exposed areas of the CCB surface is necessary to control erosion. Establishment of permanent vegetation requires a growth medium both physically and chemically capable of supporting plant growth and the proper selection and planting of compatible grass and legume species. The major operations involved in vegetation shall include excavation, redistribution, and conditioning of topsoil, and the seedbed preparation, liming, fertilizing, seeding, mulching, and maintenance required for the establishment of a suitable stand of vegetation.

B. A one (1) foot thick cover soil will be placed on the compacted CCB surface to provide a final growth medium for the vegetation. The cover soil may be the same soil as was placed as temporary cover as long as vegetation can be properly established and maintained. The cover soil is required over all CCB surfaces at the site.

Following initial placement and compaction, the finished soil surface shall be thoroughly loosened to a depth of between six (6) and nine (9) inches by discing, harrowing, or other methods. All soil irregularities shall be satisfactorily corrected before liming, fertilizing, seeding, or mulching.

C. Cover will be obtained from one of the borrow areas listed in this plan.

D. An adequate number of samples of the borrow material shall be obtained for analysis. The analyses shall be performed by a qualified soil testing laboratory.

The analyses results will provide fertilizer formulation as well as the application rates for the lime and fertilizer.

E. Based upon the characteristics of the material as determined by the tests performed to establish lime and fertilizer application rates, a species composition of a seeding formula(s), a corresponding application rate(s), a time schedule for seeding and a method of application will be prepared. The seeding formula shall include cool season grass(es) and a nitrogen-fixing legume to ensure against nitrogen depletion. As an alternate method, one (1) of the seeding mixtures recommended in the 1992 Virginia Erosion and Sediment Control Handbook may be used for the final cover soil vegetation. The recommended seeding mixture is the "Low Maintenance Slope Seeding Mixture for Coastal Plain Areas". This seeding mixture is found in Table 3.32-E of the Virginia Erosion and Sediment Control Handbook, Standard and Specification 3.32, "Permanent Seeding". This seeding mixture consists of Kentucky 31 Tall Fescue, Common Bermuda Grass, Red Top Grass, a seasonal nurse crop, and Sericea Lespedeza. The seeding rates and application requirements shall be as specified in Standard and Specification 3.32.

F. Soil will be placed only when in a moderately dry condition in order to minimize clodding and compaction which can result from multiple passes with construction equipment. Soil used for cover will have physical and chemical characteristics conducive to the establishment of vegetation and be free of wood fragments, rocks over three (3) inches in size, and other debris. Cover soil placement will be inspected periodically to assure that the proper depth and soil densities are achieved. The surface will be left in a rough or furrowed manner along slope contours to minimize erosion and maximize available soil moisture during the interim period between soil covering and seeding operations. Final grading of the soil covered areas will be accomplished to assure free drainage with no depressions or drainage courses.

G. Liming, fertilizing, mulching and permanent seeding will be performed to the extent possible between the dates of March 1 and June 15 or between August 15 and October 15. If cover soil is placed during times other than the above-specified periods, temporary seeding shall be performed according to the 1992 Virginia Erosion and Sediment Control Handbook. No seeding shall be done when the ground is frozen, excessively wet, or otherwise untillable, or when prohibited by Dominion due to excessive wind.

H. Completed slopes shall be seeded and mulched within 15 days of final grading. It is the intent of the specifications that the duration of exposure of the construction slopes to the elements be as short as possible to minimize the potential for erosion and subsequent water pollution.

I. Prior to seeding, a seedbed shall be prepared on all slope and top surfaces in such a manner as to enhance seed germination, optimize plant root penetration, increase infiltration, minimize soil erosion, and optimize available water within the rooting zone. Seedbed preparation shall be accomplished by discing, harrowing, or using other suitable methods over the area in order to loosen the upper six (6) inches of cover. Fertilizer and other soil amendments may be incorporated into the soil during this operation.

J. Mulching material shall be free from mature seedbearing stalks or roots of prohibited or noxious weeds. Mulches for seeded areas shall be one or a combination of the following: hay, straw, or wood cellulose. Hay and straw mulching shall be well cured to less than 20 percent moisture content by weight and shall contain no stems of tobacco, soybeans, or other coarse or woody materials.

Hay shall consist of timothy hay, mixed clover and timothy hay, or other Dominion-approved native or forage grasses. Straw mulching shall be either wheat or oats straw. Wood cellulose shall consist of specially prepared wood cellulose fibers containing no growth or germination inhibiting factors and shall be dyed green, unless otherwise specified. Wood cellulose fiber shall be furnished air dry in packages not exceeding 100 pounds gross, with net weight indicated on the package.

K. Mulching shall be placed within 24 hours after seeding and shall be placed over all seeded areas. Mulching shall be placed uniformly in a continuous blanket at a minimum rate of 3,100 pounds per 1,000 square yards. The depth or rate of application may be increased based upon the materials, season, soil conditions and method of application. A mechanical blower may be used to apply mulch material, provided the machine has been specifically designed and approved for this purpose. Machines which cut mulch into short pieces will not be permitted. Mulching shall be anchored by the use of twine, stakes, wire staples, paper or plastic nets, or by other methods approved by Dominion. Wood cellulose fiber, when specified, shall be applied hydraulically and may be incorporated as an integral part of the slurry after the seed and soil supplements have been thoroughly mixed. It shall be applied uniformly at the rate of 320 pounds per 1,000 square yards.

L. Where seeded areas have become damaged by erosion or additional construction operations, the affected areas shall be promptly regraded, limed, fertilized, and reseeded as originally specified. If the seeding and soil supplement work on a slope has been satisfactorily completed, and erosion, slide, or slip occurs which requires redressing, excavation, or the establishment of a new slope, the seeding and soil supplement operations shall be performed again.

M. Areas that have not established a satisfactory vegetative cover at the end of one (1) growing season shall be reseeded, limed, fertilized, and mulched as originally specified.

APPENDIX B

CALCULATIONS

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 10/28/97 PROJ. NO. 96-410-33

CHKD. BY DATE SHEET NO. OF

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- HYDROLOGY AND HYDRAULIC CALCULATIONS
- UNIVERSAL SOIL LOSS EQUATION CALCULATIONS
- STABILITY ANALYSIS CALCULATIONS
- SETTLEMENT CALCULATIONS

SUBJECT

BY DATE PROJ. NO.

CHKD. BY DATE SHEET NO. OF

HYDROLOGY AND HYDRAULIC CALCULATIONS

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SUBJECT Virginia Power — Chesterfield Closure

BY MRL DATE 9/16/97 PROJ. NO. 96-410-33

CHKD. BY PHP DATE 23SEP97 SHEET NO. 1 OF 70

▲ REV. MRL 10/22/97

HYDROLOGY AND HYDRAULIC CALCULATIONS

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BY MRL DATE 9/16/97 PROJ. NO. 96-410-33

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SUBJECT Virginia Power - Chesterfield Closure

BY MRL DATE 9/10/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 2 OF 70

▲ Rev. MRL 10/21/97

HYDROLOGY AND HYDRAULICS CALCULATIONS

Objective : Calculate peak discharges for the site closure. Calculate the discharges after the site is closed and stabilized with vegetation, and also for when the maximum peak discharges occur during the phased closure. The peak discharges will be used to size....

- benches
- slope drains
- perimeter collection channels
- surface swales
- haul road drainage channels
- culverts
- final closure ▲culvert

The peak discharges will also be used to check the adequacy of the temporary sediment pond.

The temporary sediment pond, and all channels and culverts will be sized to handle the <u>25-year 24-hour storm.</u>

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Methodology : Peak discharges will be calculated using the USDA SCS computer program TR-20, "Computer Program for Project Formulation - Hydrology". The USDA SCS publication TR-55, "Urban Hydrology for Small Watersheds", will be used to obtain hydrologic parameters such as runoff curve number and time-of-concentration. Channel flow depths and velocities will be calculated using the computer program "Penn State Urban Hydrology Model" (PSUHM).

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REFERENCES

① Virginia Erosion and Sediment Control Handbook, 3rd Edition, 1992, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation

② United States Department of Agriculture, Soil Conservation Service, Computer Program TR-20: Computer Program for Project Formulation – Hydrology, September 1983

③ United States Department of Agriculture, Soil Conservation Service, TR-55: Urban Hydrology for Small Watersheds, June 1986

④ Pennsylvania State University, Computer Program PSUHM: Penn State Urban Hydrology Model, Nov. 1987

SUBJECT Virginia Power - Chesterfield closure

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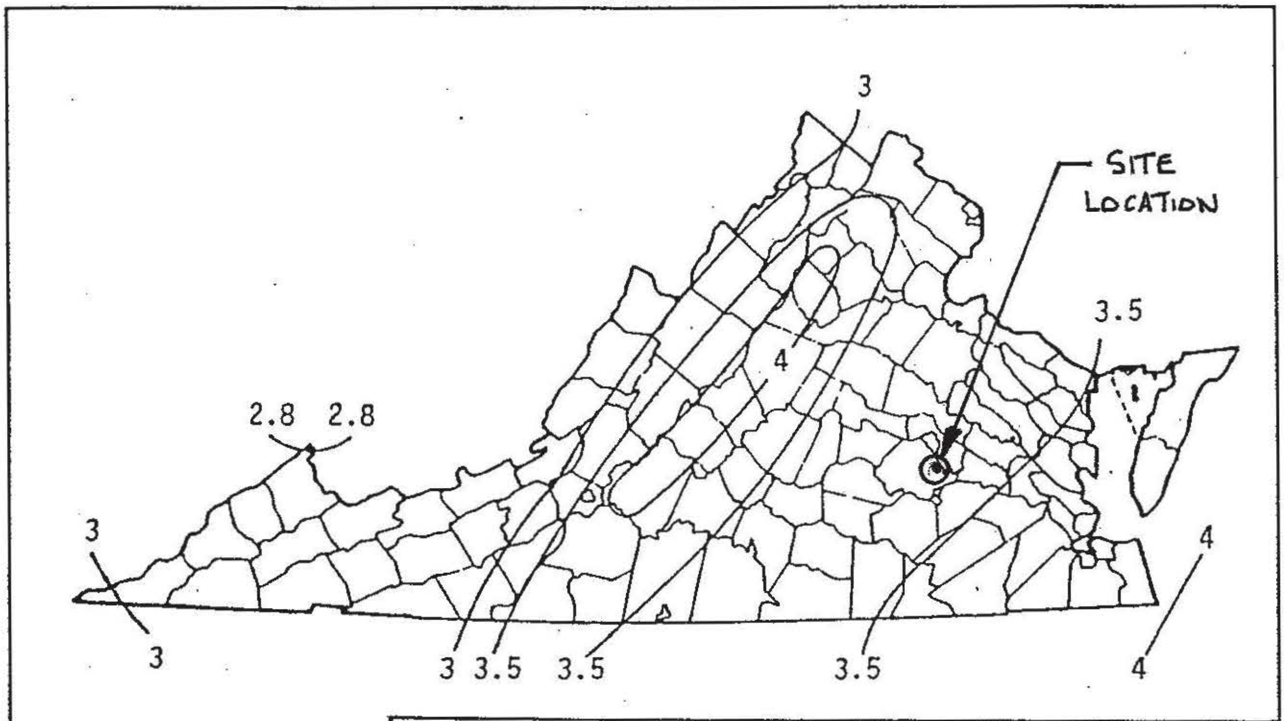
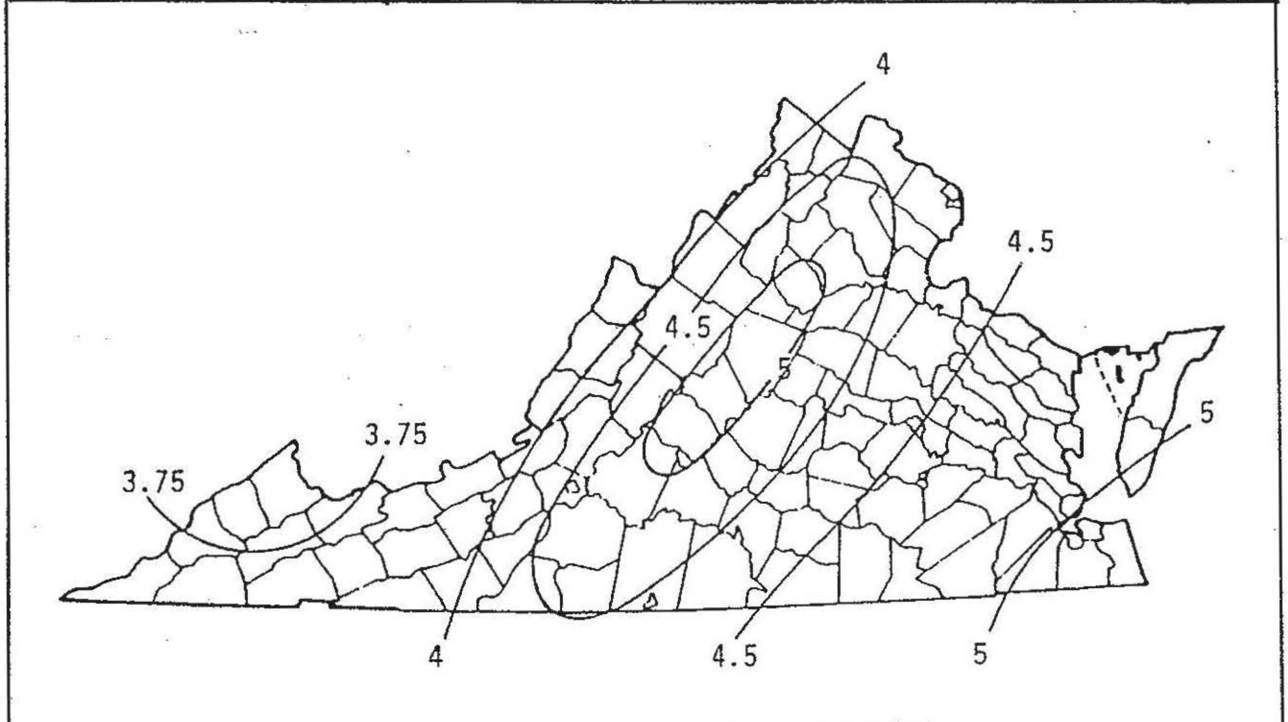
RAINFALL DEPTHS FOR SELECTED DESIGN STORMS



2-YEAR 24-HOUR RAINFALL (INCHES) = 3.5"



5-YEAR 24-HOUR RAINFALL (INCHES)

Ref: ①

Source: USDA-SCS and U.S. Weather Bureau

Plate 5-19

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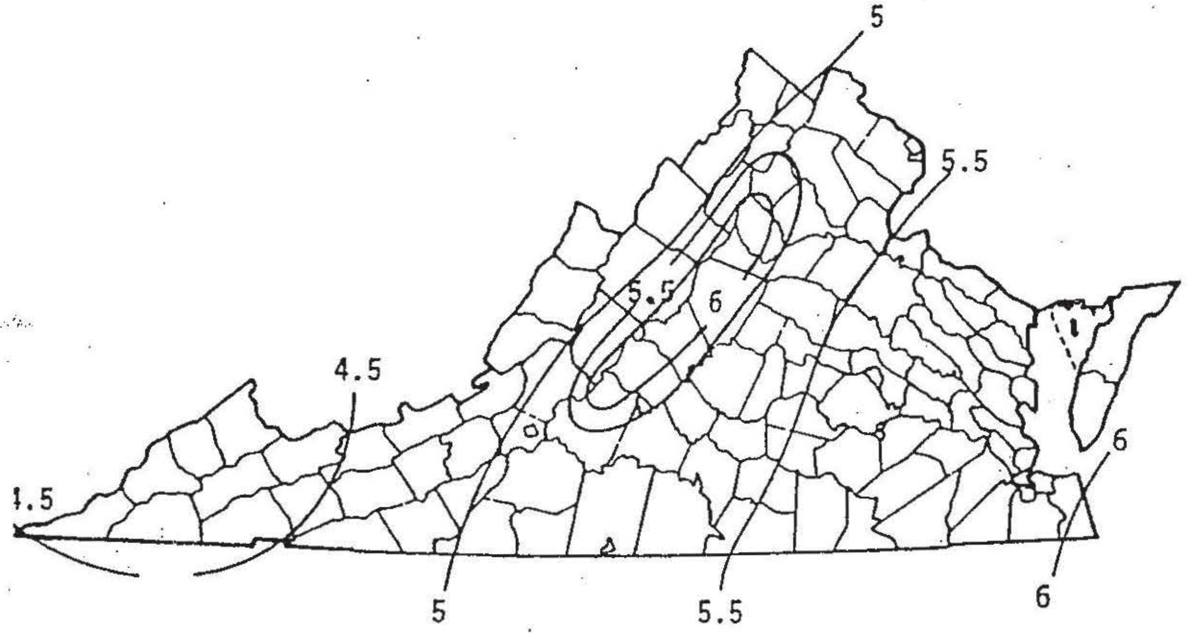
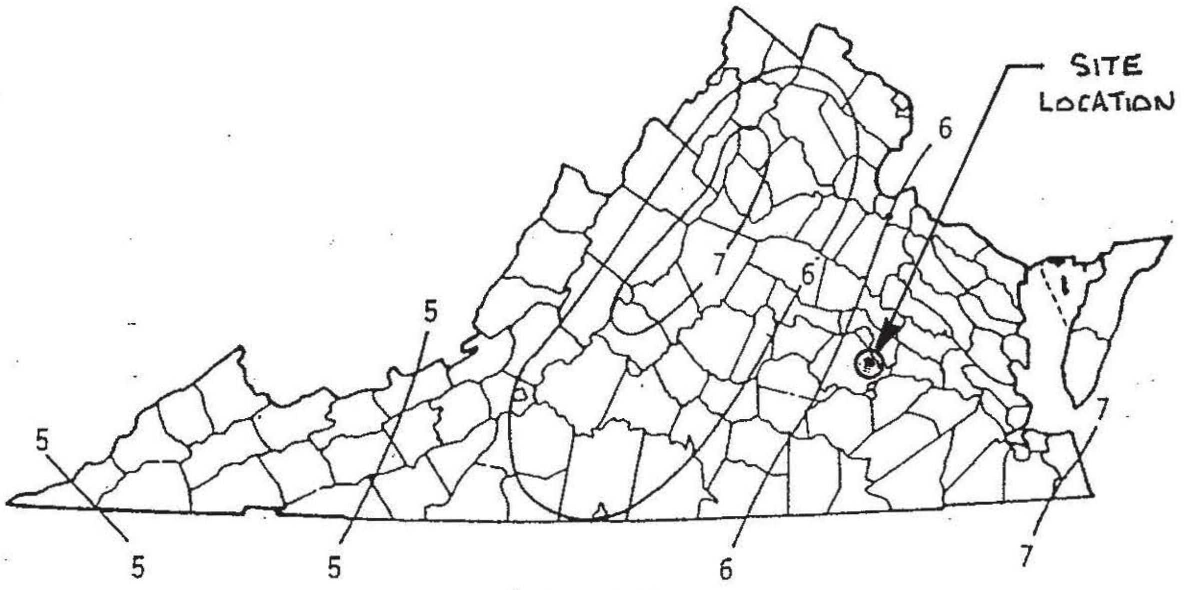
RAINFALL DEPTHS FOR SELECTED DESIGN STORMS (continued)



10-YEAR 24-HOUR RAINFALL (INCHES)



25-YEAR 24-HOUR RAINFALL (INCHES) = 6.2"

Ref: ①

Source: USDA-SCS and U.S. Weather Bureau

Plate 5-20

SUBJECT Virginia Power - Chesterfield Closure

BY MRL DATE 9/11/97 PROJ. NO. 96-410-33

CHKD. BY RHD DATE 23SEP97 SHEET NO. 7 OF 70

CURVE NUMBERS

Vegetated final soil cover (good condition)	74 ①
Temporary vegetation on CCB (fair condition)	79 ②
Temporary vegetation on CCB (poor condition)	85 ③
Coal combustion by-product (CCB)	85 ⑤
Gravel haul roads	89 ⑥
Temporary sediment pond pool	100

CN = 74 for hydrologic soil group C

① Ref ③, Table 2-2a, Open space, Good Condition (Grass cover > 75%)

② Ref ③, Table 2-2a, Open space, Fair Condition (Grass cover 50% to 75%)
CN = 79 for hydrologic soil group C

③ Ref ③, Table 2-2a, Open space, Poor Condition (Grass cover < 50%)
CN = 86 for hydrologic soil group C → Use 85 to match bare CCB

⑤ Permeability test results of CCB show values from 3×10^{-4} cm/sec to 1.5×10^{-4} cm/sec. These are typical of type A and B soils.
Use CN = 85 (typical permeable ash CN and close to newly graded soil CN, HSG B)

⑥ Ref ③, Table 2-2a, Gravel road, CN = 89 for hydrologic soil group C

SUBJECT Virginia Power – Chesterfield Closure

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REF ③

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]	
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011	
	0.03*	← CCB (no vegetation)
Fallow (no residue)	0.05	
Cultivated soils:		
Residue cover ≤20%	0.06	
Residue cover >20%	0.17	
Grass:	0.10	← CCB w/poor vegetation
Short grass prairie	0.15	← CCB w/fair vegetation
Dense grasses[2]	0.24	← final cover w/ good vegetation
Bermudagrass	0.41	
Range (natural)	0.13	
Woods:[3]		
Light underbrush	0.40	
Dense underbrush	0.80	

[1] The n values are a composite of information compiled by Engman (1986).

[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

* Rough Surface (bare soil, ash, etc.; graded but not smooth like a road)

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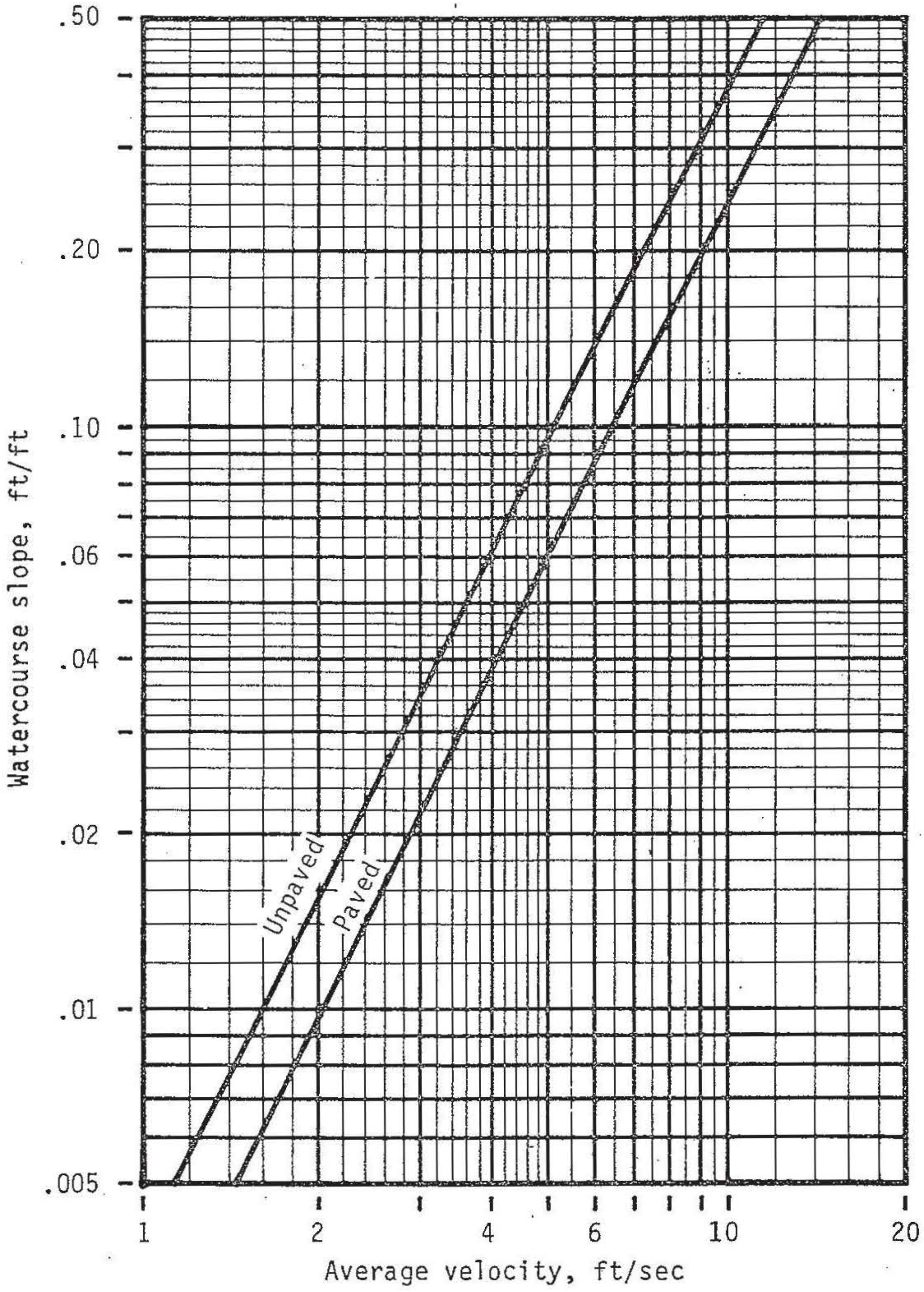
SHALLOW CONCENTRATED FLOW

REF ③

Reference : Figure 3-1, USDA SCS TR-55



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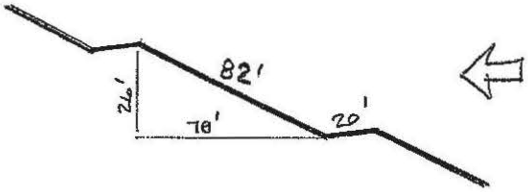
BENCHES

Typical bench length is less than 1000'. However, some benches may be as long as 1200'. Check the capacity of a 1200' long bench.



Typical bench geometry

$$AREA = (78' + 20') \times 1200' = 117,600 \text{ ft}^2$$

$$= 2.7 \text{ acres}$$

$$= \underline{0.00422 \text{ mi.}^2}$$

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

Circle one: Present [✓ Developed] BENCHES

Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

AREA		Vegetated Final Cover		CCB			
Sheet flow (Applicable to T_c only) Segment ID							
1. Surface description (table 3-1)		Grass		CCB			
2. Manning's roughness coeff., n (table 3-1)		0.24		0.03			
3. Flow length, L (total L ≤ 300 ft)	ft	82		82			
4. Two-yr 24-hr rainfall, P_2	in	3.5		3.5			
5. Land slope, s	ft/ft	0.33		0.33			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.06	+	0.01	+		+
Shallow concentrated flow Segment ID							
7. Surface description (paved or unpaved)							
8. Flow length, L	ft						
9. Watercourse slope, s	ft/ft						
10. Average velocity, V (figure 3-1)	ft/s						
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+		+		+
Channel flow Segment ID							
15. Channel slope, s	ft/ft	0.01		0.01			
16. Manning's roughness coeff., n		0.04		0.03			
17. Estimate V	ft/s	2.0		2.5			
18. Flow length, L	ft	1200		1200			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.17	+	0.13	+		+
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.23		0.14			

CN = 74 CN = 85

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/12/97 PROJ. NO. 96-410-33

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SLOPE DRAINS

There are 6 slope drains proposed for the site. Calculate the maximum peak discharge that would occur to any of the 6 slope drains. Design all six slope drains to handle this peak discharge.

Cell 1 active (see worksheet 96-410-33-MRL1)

All of the active area is conservatively assumed to discharge to the slope drain on the south side.

Cell 5 active (see worksheet 96-410-33-MRL2)

During the initial construction of cell 5, maximum discharge to a slope drain should occur. A conservatively large area has been directed to the slope drain on the south side.

The greater of the two peak discharges for the two cases described above will be used to design all of the slope drains.

SUBJECT Virginia Power – Chesterfield Closure

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RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed

Slope Drain (Cell 1 active)
Worksheet 96-410-33-MRL1

1. Runoff curve number (CN) Reference : USDA SCS TR-55

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☒ acres ☐ mi^2 ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
	Coal combustion by-product (no vegetation)	85			15.2	
					Totals = 15.2	

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ____ = ____; Use CN = 85

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

Slope Drain (Cell 1 active)
Worksheet 96-410-33-MRL 1

Circle one: Present Developed
Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

AREA		Cell 1					
Sheet flow (Applicable to T_c only) Segment ID		A-B					
1. Surface description (table 3-1)		CCB					
2. Manning's roughness coeff., n (table 3-1)		0.03					
3. Flow length, L (total L $\leq$ 300 ft)	ft	100					
4. Two-yr 24-hr rainfall, P_2	in	3.5					
5. Land slope, s	ft/ft	0.01					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.06	+		+		+
Shallow concentrated flow Segment ID		B-C					
7. Surface description (paved or unpaved)		unpaved					
8. Flow length, L	ft	880					
9. Watercourse slope, s	ft/ft	0.01					
10. Average velocity, V (figure 3-1)	ft/s	1.6					
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.15	+		+		+
Channel flow Segment ID							
15. Channel slope, s	ft/ft						
16. Manning's roughness coeff., n							
17. V	ft/s						
18. Flow length, L	ft						
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+		+		+
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.21					

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RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed Slope Drain (Cell 5 active)

Worksheet 96-410-33-MRL2

1. Runoff curve number (CN) Reference: USDA SCS TR-55

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☒ acres ☐ mi² ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
	Coal combustion by-product (no vegetation)	85			15.9	1351.5
	Vegetated final soil cover (good condition)	74			4.2	310.8

1/ Use only one CN source per line. Totals = 20.1 1662.3

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1662.3}{20.1} = 82.7$; Use CN = 83

SUBJECT Virginia Power – Chesterfield Closure

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

Slope Drain (Cell 5 active)
Worksheet 96-410-33-MRL2

Circle one: Present Developed

Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

AREA		Cell 5					
Sheet flow (Applicable to T_c only) Segment ID		A-B					
1. Surface description (table 3-1)		CCB					
2. Manning's roughness coeff., n (table 3-1)		0.03					
3. Flow length, L (total L ≤ 300 ft)	ft	100					
4. Two-yr 24-hr rainfall, P_2	in	3.5					
5. Land slope, s	ft/ft	0.01					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.06 +		+		+	
Shallow concentrated flow Segment ID		B-C					
7. Surface description (paved or unpaved)		unpaved					
8. Flow length, L	ft	750					
9. Watercourse slope, s	ft/ft	0.01					
10. Average velocity, V (figure 3-1)	ft/s	1.6					
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.13 +		+		+	
Channel flow Segment ID							
15. Channel slope, s	ft/ft						
16. Manning's roughness coeff., n							
17. V	ft/s						
18. Flow length, L	ft						
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	+		+		+	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.19					

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PERIMETER COLLECTION CHANNELS

There are 2 perimeter collection channels proposed for the site. One is on the north side and the other is on the south side. Both channels will be designed to handle the maximum peak discharge that is expected to occur throughout the life of the site. The maximum discharge should occur in the southern channel, so this is the channel that will be analyzed.

Cell 5 active (see worksheet 96-410-33-MRL 2)

A conservatively large area of cell 5 was analyzed as if discharging to the southern slope drain. Large portions of cells 2 through 4 are shown to drain to the southern collection channel. Cells 2 through 4 are considered to only have "fair" grass since it is only a temporary cover.

Site closed (see worksheet 96-410-33-MRL3)

The entire site is vegetated with good grass. This case was analyzed to show the peak discharge reduction for the closed site.

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/12/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP97 SHEET NO. 18 OF 70

RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed

Perimeter Collection Channel
(Cell 5 active)

1. Runoff curve number (CN)

Reference: USDA SCS TR-55
Worksheet 96-410-33-MRL2

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☒ acres ☐ mi^2 ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
	Coal combustion by-product (no vegetation)	85			15.9	1351.5
	Vegetated final soil cover (good condition)	74			4.2	310.8
	Temporary vegetation on CCB (fair condition)	79			46.0	3634
				Totals =	66.1	5296.3

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{5296.3}{66.1} = 80.1$; Use CN = 80

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/12/97 PROJ. NO. 96-410-33

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

- Temporary Sediment Pond &
- Perimeter collection channel

(cell 5 active)

Worksheet 96-410-33-MRL2

Circle one: Present Developed

Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Check for longest t_c

AREA		Cell 5		Cells 2-4			
Sheet flow (Applicable to T_c only) Segment ID		A-B		A-B			
1. Surface description (table 3-1)		CCB		Fair Grass			
2. Manning's roughness coeff., n (table 3-1) ..		0.03		0.15			
3. Flow length, L (total L ≤ 300 ft)	ft	100		100			
4. Two-yr 24-hr rainfall, P_2	in	3.5		3.5			
5. Land slope, s	ft/ft	0.01		0.02			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.06	+	0.16	+		+
Shallow concentrated flow Segment ID		B-C		B-C			
7. Surface description (paved or unpaved)		unpaved		unpaved			
8. Flow length, L	ft	750		500			
9. Watercourse slope, s	ft/ft	0.01		0.01			
10. Average velocity, V (figure 3-1)	ft/s	1.6		1.6			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.13	+	0.09	+		+
Channel flow Segment ID		C-D	D-E	C-D	D-E		
15. Channel slope, s	ft/ft	0.33	0.004	0.01	0.004		
16. Manning's roughness coeff., n		0.015	0.04	0.04	0.04		
17. Estimate V	ft/s	35	4	3	4		
18. Flow length, L	ft	180	3300	720	1400		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	— +	0.23	0.07 +	0.10	+	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.42		0.42			

Use t_c = 0.42

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/12/97 PROJ. NO. 96-410-33
CHKD. BY RHP DATE 23 SEP97 SHEET NO. 20 OF 70

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RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed   Perimeter Collection Channel
(Site closed)

1. Runoff curve number (CN)   Reference: USDA SCS TR-55
Worksheet 96-410-33-MRL3

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☒ acres ☐ mi² ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
	Vegetated final soil cover (good condition)	74			70	
				Totals =	70	

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ______ = ______; Use CN = $\boxed{74}$

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/12/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 21 OF 70

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

- Final Closure Channel &
- Perimeter Collection channel

(Site Closed)

Worksheet 96-410-33-MRL3

Circle one: Present Developed

Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

AREA							
Sheet flow (Applicable to T_c only) Segment ID		A-B					
1. Surface description (table 3-1)		Good Grass					
2. Manning's roughness coeff., n (table 3-1) ..		0.24					
3. Flow length, L (total L ≤ 300 ft)	ft	100					
4. Two-yr 24-hr rainfall, P_2	in	3.5					
5. Land slope, s	ft/ft	0.02					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.23 +		+		+	
Shallow concentrated flow Segment ID		B-C					
7. Surface description (paved or unpaved)		unpaved					
8. Flow length, L	ft	40					
9. Watercourse slope, s	ft/ft	0.33					
10. Average velocity, V (figure 3-1)	ft/s	9.3					
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	— +		+		+	
Channel flow Segment ID		C-D	D-E	E-F			
15. Channel slope, s	ft/ft	0.01	0.33	0.004			
16. Manning's roughness coeff., n		0.04	0.015	0.04			
17. Estimate V	ft/s	2	35	4			
18. Flow length, L	ft	440	340	3300			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.06 +	—	+ 0.23 +		+	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.52					

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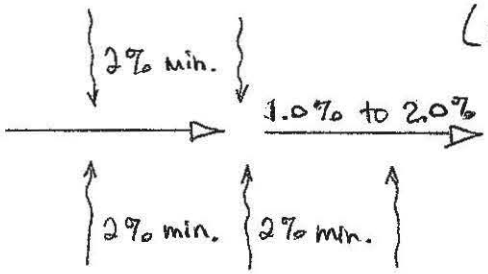
▲ Rev. MRL 10/21/97

SURFACE SWALES

Surface swales will be constructed on top surfaces to channel discharge to the slope drains. Top surfaces will be sloped a minimum of 2 percent to the surface swales. Surface swales will be sloped from ▲1.0 % to ▲2.0 %.

(Worksheet 96-410-33-MRL 2)



A surface swale on a CCB area with temporary vegetation (Fair condition) was analyzed. The fair condition vegetation yields a maximum peak discharge when compared against a good condition vegetation on the final cover.

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/12/97 PROJ. NO. 96-410-33
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RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed Surface Swales

Worksheet 96-410-33-MRL2

1. Runoff curve number (CN) Reference: USDA SCS TR-55

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☒ acres ☐ mi² ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
	Temporary vegetation on CCB (Fair condition)	79			700' x 800' 12.9	
				Totals =	12.9	

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ____ = ____; Use CN = 79

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BY MRL DATE 9/12/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 24 OF 70

TIME OF CONCENTRATION

Reference: USDA SCS TR-55

Circle one: Present Developed

Circle one: T_c T_t through subarea

Surface Swales

Worksheet 96-410-33-MRL2

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

AREA		Surface of cell 3		
Sheet flow (Applicable to T_c only)	Segment ID	A–B		
1. Surface description (table 3-1)		Fair Grass		
2. Manning's roughness coeff., n (table 3-1)		0.15		
3. Flow length, L (total L ≤ 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	3.5		
5. Land slope, s	ft/ft	0.02		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.16 +	+	+
Shallow concentrated flow	Segment ID	B–C		
7. Surface description (paved or unpaved)		unpaved		
8. Flow length, L	ft	500		
9. Watercourse slope, s	ft/ft	0.01		
10. Average velocity, V (figure 3-1)	ft/s	1.6		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.09 +	+	+
Channel flow	Segment ID	C–D		
15. Channel slope, s	ft/ft	0.01		
16. Manning's roughness coeff., n		0.04		
17. Estimate V	ft/s	3		
18. Flow length, L	ft	720		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.07 +	+	+
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.32		

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HAUL ROAD DRAINAGE CHANNELS

Haul road drainage channels are proposed to be installed along the inside of the haul roads. The watershed to these channels is relatively small.

(Worksheet 96-410-33-MRL3)

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RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed

Haul road drainage channels
Worksheet 96-410-33-MRL3

1. Runoff curve number (CN) Reference: USDA SCS TR-55

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
	Gravel haul road	89			1.1	97.9
	Vegetated final soil cover (good condition)	74			0.7	51.8
					Totals = 1.8	149.7

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{149.7}{1.8} = 83.2$; Use CN = 83

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/12/97 PROJ. NO. 96 - 410 - 33

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

Haul road drainage channels
Worksheet 96-410-33-MRL3

Circle one: Present Developed

Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

AREA							
Sheet flow (Applicable to T_c only) Segment ID		A-B					
1. Surface description (table 3-1)		Gravel					
2. Manning's roughness coeff., n (table 3-1) ..		0.011					
3. Flow length, L (total L ≤ 300 ft)	ft	100					
4. Two-yr 24-hr rainfall, P_2	in	3.5					
5. Land slope, s	ft/ft	0.10					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.01 +		+		+	
Shallow concentrated flow Segment ID							
7. Surface description (paved or unpaved)							
8. Flow length, L	ft						
9. Watercourse slope, s	ft/ft						
10. Average velocity, V (figure 3-1)	ft/s						
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	+		+		+	
Channel flow Segment ID							
15. Channel slope, s	ft/ft	0.10					
16. Manning's roughness coeff., n		0.03					
17. Estimate V	ft/s	25					
18. Flow length, L	ft	900					
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.01 +		+		+	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.02					

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CULVERTS

There are two culvert locations in the north perimeter collection channel. They are located at the NW and NE corners and are needed for the haul roads. The west side culvert will be sized to handle the 25-year 24-hour storm from its watershed. (see worksheet 96-410-33-MRL3). The east side culvert(s) will be sized to handle the peak discharge from the north perimeter collection channel.

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RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed West side Culvert.

Worksheet 96-410-33-MRL3

1. Runoff curve number (CN) Reference: USDA SCS TR-55

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☒ acres ☐ mi² ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
	Gravel haul road	89			1.1	97.9
	Vegetated final soil cover (good condition)	74			0.7+1.7 2.4	177.6
				Totals =	3.5	275.5

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{275.5}{3.5} = 78.7$; Use CN = 79.

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

West side culvert
Worksheet 96-410-33-MRL3

Circle one: Present Developed

Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

AREA		1.7 acre parcel					
Sheet flow (Applicable to T_c only) Segment ID		A-B					
1. Surface description (table 3-1)		Good Grass					
2. Manning's roughness coeff., n (table 3-1)		0.24					
3. Flow length, L (total L ≤ 300 ft)	ft	80					
4. Two-yr 24-hr rainfall, P_2	in	3.5					
5. Land slope, s	ft/ft	0.33					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.06	+		+		+
Shallow concentrated flow Segment ID							
7. Surface description (paved or unpaved)							
8. Flow length, L	ft						
9. Watercourse slope, s	ft/ft						
10. Average velocity, V (figure 3-1)	ft/s						
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+		+		+
Channel flow Segment ID		B-C					
15. Channel slope, s	ft/ft	0.004					
16. Manning's roughness coeff., n		0.04					
17. Estimate V	ft/s	3					
18. Flow length, L	ft	650					
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.06	+		+		+
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.12					

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SUBJECT Virginia Power – Chesterfield Closure

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FINAL CLOSURE ▲CULVERT

Upon final closure and stabilization of the site, the temporary sediment pond will be filled in and the two perimeter collection channels will be ▲discharged into the ▲ "final closure culvert" which will discharge through the south embankment.

(see worksheet 96-410-33-MRL3)

SUBJECT Virginia Power – Chesterfield Closure

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CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 32 OF 70

RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed Final Closure Channel

worksheet 96-410-33-MRL3

1. Runoff curve number (CN) Reference : USDA SCS TR-55

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☒ acres ☐ mi² ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
	Gravel haul roads	89			2.2	195.8
	Vegetated final soil cover (good condition)	74			115-2.2 112.8	8347.2

1/ Use only one CN source per line. Totals = 115 8543

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{8543}{115} = 74.3;$$ Use CN = 75

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/12/97 PROJ. NO. 96-410-33

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

- Final Closure Channel &
- Perimeter Collection Channel

(Site Closed)

Worksheet 96-410-33-MRL3

Circle one: Present Developed

Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

AREA							
Sheet flow (Applicable to T_c only) Segment ID		A-B					
1. Surface description (table 3-1)		Good Grass					
2. Manning's roughness coeff., n (table 3-1) ..		0.24					
3. Flow length, L (total L ≤ 300 ft)	ft	100					
4. Two-yr 24-hr rainfall, P_2	in	3.5					
5. Land slope, s	ft/ft	0.02					
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.23 +		+		+	
Shallow concentrated flow Segment ID		B-C					
7. Surface description (paved or unpaved)		unpaved					
8. Flow length, L	ft	40					
9. Watercourse slope, s	ft/ft	0.33					
10. Average velocity, V (figure 3-1)	ft/s	9.3					
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	— +		+		+	
Channel flow Segment ID		C-D	D-E	E-F			
15. Channel slope, s	ft/ft	0.01	0.33	0.004			
16. Manning's roughness coeff., n		0.04	0.015	0.04			
17. Estimate V	ft/s	2	35	4			
18. Flow length, L	ft	440	340	3300			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.06 +	— +	0.23 +		+	
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.52					

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TEMPORARY SEDIMENT POND

Two phases of construction will be analyzed to determine the peak discharge to the temporary sediment pond. The pond will be designed to handle the largest peak discharge from the site.

Cell 1 active (worksheet 96-410-33-MRL1)

Cell 1 is active and cells 2 through 4 are covered with poor condition vegetation.

Cell 5 active (worksheet 96-410-33-MRL2)

Cell 5 is active, some final cover areas are covered with good condition vegetation, and the temporary cover areas are covered with fair condition vegetation. Note that some of the final cover areas are "labeled" as fair condition vegetation. This just adds conservatism into the calculations.

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/11/97 PROJ. NO. 96-410-33
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RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed Temporary Sediment Pond
(Cell 1 active)

1. Runoff curve number (CN) Reference : USDA SCS TR-55
Worksheet 96-410-33-MRL1

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/			Area ☒ acres ☐ mi² ☐ %	Product of CN x area
		Table 2-2	Fig. 2-3	Fig. 2-4		
	Coal combustion by-product (no vegetation)	85			15.2	
	Temporary vegetation on CCB (poor condition)	85			52.6+47.2 99.8	

1/ Use only one CN source per line. Totals = 115

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ___ = ____; Use CN = $\boxed{.85}$

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/11/97 PROJ. NO. 96-410-33
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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

Temporary Sediment Pond
(Cell 1 active)
Worksheet 96-410-33-MRL 1

Circle one: Present Developed
Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Check for longest tc

AREA		Cell 1		Undeveloped Cells 2-4			
Sheet flow (Applicable to T_c only)	Segment ID	A–B		A–B			
1. Surface description (table 3-1)		c<B		c<B w/ poor vegetation			
2. Manning's roughness coeff., n (table 3-1)		0.03		0.10			
3. Flow length, L (total L ≤ 300 ft)	ft	100		100			
4. Two-yr 24-hr rainfall, P_2	in	3.5		3.5			
5. Land slope, s	ft/ft	0.01		0.004			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.06	+	0.21	+		+
Shallow concentrated flow	Segment ID	B–C		B–C			
7. Surface description (paved or unpaved)		unpaved		unpaved			
8. Flow length, L	ft	880		640			
9. Watercourse slope, s	ft/ft	0.01		0.002			
10. Average velocity, V (figure 3-1)	ft/s	1.6		1			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.15	+	0.18	+		+
Channel flow	Segment ID	C–D	D–E	C–D			
15. Channel slope, s	ft/ft	0.33	0.004	0.002			
16. Manning's roughness coeff., n		0.015	0.03	0.03			
17. Estimate V	ft/s	35	5	4			
18. Flow length, L	ft	80	3450	1950			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	—	+ 0.19	0.14	+		+
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	~~0.40~~		0.53			

Use tc = 0.53

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CHKD. BY PHP DATE 23SEP97 SHEET NO. 37 OF 70

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RUNOFF CURVE NUMBER AND RUNOFF

Circle one: Present Developed Temporary Sediment Pond (cell 5 active)

1. Runoff curve number (CN) Reference : USDA SCS TR-55 Worksheet 96-410-33-MRL2

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	Fig. 2-3	Fig. 2-4	Area ☒ acres ☐ mi^2 ☐ %	Product of CN x area
	Coal combustion by-product (no vegetation)	85			15.9+4.1 20	1700
	Vegetated final soil cover (good condition)	74			4.2	310.8
	Temporary vegetation on CCB (fair condition)	79			29.9+46 75.9	5996.1
	Vegetated final soil cover (good condition)	74			10.2	754.8
	Temporary sediment pond pool	100			4.7	470
				Totals =	115	9231.7

1/ Use only one CN source per line.

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{9231.7}{115} = 80.3;$$ Use CN = $\boxed{81}$

SUBJECT Virginia Power – Chesterfield Closure

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TIME OF CONCENTRATION

Reference: USDA SCS TR-55

- Temporary Sediment Pond &
- Perimeter collection channel (cell 5 active)

Worksheet 96-410-33-MRL2

Circle one: Present Developed

Circle one: [✓ T_c] T_t through subarea

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Check for longest tc

AREA		Cell 5		Cells 2-4			
Sheet flow (Applicable to T_c only)	Segment ID	A-B		A-B			
1. Surface description (table 3-1)		CCB		Fair Grass			
2. Manning's roughness coeff., n (table 3-1)		0.03		0.15			
3. Flow length, L (total L ≤ 300 ft)	ft	100		100			
4. Two-yr 24-hr rainfall, P_2	in	3.5		3.5			
5. Land slope, s	ft/ft	0.01		0.02			
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t	hr	0.06	+	0.16	+		+
Shallow concentrated flow	Segment ID	B-C		B-C			
7. Surface description (paved or unpaved)		unpaved		unpaved			
8. Flow length, L	ft	750		500			
9. Watercourse slope, s	ft/ft	0.01		0.01			
10. Average velocity, V (figure 3-1)	ft/s	1.6		1.6			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.13	+	0.09	+		+
Channel flow	Segment ID	C-D	D-E	C-D	D-E		
15. Channel slope, s	ft/ft	0.33	0.004	0.01	0.004		
16. Manning's roughness coeff., n		0.015	0.04	0.04	0.04		
17. Estimate V	ft/s	35	4	3	4		
18. Flow length, L	ft	180	3300	720	1400		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	—	+ 0.23	0.07	+ 0.10		+
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.42		0.42			

Use $t_c = 0.42$

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SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/13/97 PROJ. NO. 96-410-33

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Hydrologic and Hydraulic input parameters

Summary

CHANNEL	AREA (mi.²)	CN	T_c (hrs.)
Bench (CCB)	0.0042	85	0.14
Bench (Vegetated final cover)	0.0042	74	0.23
Slope Drains (Cell 1 active)	0.0238	85	0.21
Slope Drains (Cell 5 active)	0.0314	83	0.19
East side culvert & Perimeter Collection Channels			
(Cell 5 active)	0.1033	80	0.42
(Site Closed)	0.1094	74	0.52
Surface Swale	0.0202	79	0.32
Haul road drainage channels	0.0028	83	0.02
West side culvert	0.0055	79	0.12
Final Closure ▲Culvert (Site Closed)	0.1797	75	0.52
Temporary Sediment Pond			
* (Cell 1 active)	0.1797	85	0.53
* (Cell 5 active)	0.1797	81	0.42

* Information to be used for reservoir routing

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```
1

 *****************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

 JOB TR-20                                               SUMMARY   NOPLOTS
 TITLE 111 VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33    CLOSURE.INP
 TITLE     PEAK DISCHARGE CALCULATIONS
  3 STRUCT      01                                                        SEDPOND
  8                               26.0         0.0         0.0
  8                               27.0        0.01         5.0
  8                               27.2         1.1         6.0
  8                               27.4         3.1         7.0
  8                               27.6         5.8         8.0
  8                               27.8         8.9         9.0
  8                               28.0        12.4        10.0
  8                               28.5        24.0        12.5
  8                               29.0        35.1        15.0
  8                               29.5        48.0        17.5
  8                               29.9        61.0        19.5
  8                               30.0        61.1        20.0
  8                               32.0        64.0        31.0
  8                               34.0        67.0        42.0
  8                               36.0        70.0        53.5
  8                               38.0        73.0        65.5
  8                               40.0        76.0        79.0
  9 ENDTBL
  3 STRUCT      02                                                        SEDPOND
  8                               26.0         0.0         0.0
  8                               27.0        0.01         5.0
  8                               27.2         1.1         6.0
  8                               27.4         3.1         7.0
  8                               27.6         5.8         8.0
  8                               27.8         8.9         9.0
  8                               28.0        12.4        10.0
  8                               28.5        24.0        12.5
  8                               29.0        35.1        15.0
  8                               29.5        48.0        17.5
  8                               29.9        61.0        19.5
  8                               30.0        61.1        20.0
  8                               32.0        64.0        31.0
  8                               34.0        67.0        42.0
  8                               36.0        70.0        53.5
  8                               38.0        73.0        65.5
  8                               40.0        76.0        79.0
  9 ENDTBL
  6 RUNOFF 1 001        1       0.0042        85.0       0.140 1            BNCHCCB
  6 RUNOFF 1 001        1       0.0042        74.0       0.230 1            BNCHGRSS
  6 RUNOFF 1 002        1       0.0238        85.0       0.210 1            SD CELL1
  6 RUNOFF 1 002        1       0.0314        83.0       0.190 1            SD CELL5
  6 RUNOFF 1 003        1       0.1033        80.0       0.420 1            PC CELL5
1


 *********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

  6 RUNOFF 1 003        1       0.1094        74.0       0.520 1            PC CLSED
  6 RUNOFF 1 004        1       0.0202        79.0       0.320 1            SR SWALE
```

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```
 6 RUNOFF 1 005      1      0.0028        83.0       0.020 1              HR CHAN
 6 RUNOFF 1 005      1      0.0055        79.0       0.120 1              WEST CUL
 6 RUNOFF 1 006      1      0.1797        75.0       0.520 1              FC CHAN
~~6 RUNOFF 1 006      1      0.1797        85.0       0.530 1              PNDCELL1~~
~~6 RESVOR 2    01 1  2        27.0                           1   1        POND1~~
~~6 RUNOFF 1 006      1      0.1797        81.0       0.420 1              PNDCELL5~~
~~6 RESVOR 2    02 1  2        27.0                           1   1        POND1~~
   ENDATA
 7 LIST
 7 INCREM 6                 0.0500
 7 COMPUT 7 001      02        0.0          6.2          1.0 2 2  01  01 25-YR
   ENDCMP 1
   ENDJOB 2

0******************************END OF 80-80 LIST******************************
1


 TR20 XEQ 09-14-97  16:45        VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33     CLOSURE.INP                  JOB  1    PAS
      REV PC 09/83(.2)           PEAK DISCHARGE CALCULATIONS                                                                PAGE



 EXECUTIVE CONTROL OPERATION LIST                                                                                    RECORD ID


 LISTING OF CURRENT DATA



            STRUCT NO.     ELEVATION   DISCHARGE     STORAGE
 3 STRUCT        1

 8                            26.00         .00         .00
 8                            27.00         .01        5.00
 8                            27.20        1.10        6.00
 8                            27.40        3.10        7.00
 8                            27.60        5.80        8.00
 8                            27.80        8.90        9.00
 8                            28.00       12.40       10.00
 8                            28.50       24.00       12.50
 8                            29.00       35.10       15.00
 8                            29.50       48.00       17.50
 8                            29.90       61.00       19.50
 8                            30.00       61.10       20.00
 8                            32.00       64.00       31.00
 8                            34.00       67.00       42.00
 8                            36.00       70.00       53.50
 8                            38.00       73.00       65.50
 8                            40.00       76.00       79.00
 9 ENDTBL

            STRUCT NO.     ELEVATION   DISCHARGE     STORAGE
 3 STRUCT        2

 8                            26.00         .00         .00
 8                            27.00         .01        5.00
 8                            27.20        1.10        6.00
```

Chkd: RHP 23 SEP 97

```
   9.00       ELEV      27.09     27.10     27.10     27.11     27.11     27.12     27.12     27.12     27.13     27.13

   9.50       ELEV      27.14     27.14     27.15     27.16     27.16     27.17     27.17     27.18     27.18     27.19

  10.00       ELEV      27.20     27.20     27.21     27.22     27.22     27.23     27.24     27.25     27.25     27.26

  10.50       ELEV      27.27     27.28     27.29     27.30     27.31     27.32     27.33     27.34     27.36     27.37

  11.00       ELEV      27.38     27.40     27.42     27.43     27.45     27.47     27.49     27.51     27.53     27.55

  11.50       ELEV      27.57     27.60     27.63     27.66     27.71     27.77     27.85     27.95     28.08     28.26

  12.00       ELEV      28.47     28.73     29.03     29.35     29.65     29.92     30.14     30.32     30.46     30.57

  12.50       ELEV      30.65     30.72     30.77     30.81     30.84     30.86     30.88     30.89     30.90     30.90

  13.00       ELEV      30.90     30.90     30.89     30.88     30.88     30.86     30.85     30.84     30.82     30.80

  13.50       ELEV      30.79     30.77     30.75     30.73     30.71     30.68     30.66     30.64     30.61     30.59

  14.00       ELEV      30.56     30.54     30.51     30.49     30.46     30.43     30.40     30.38     30.35     30.32

  14.50       ELEV      30.29     30.26     30.23     30.20     30.17     30.14     30.11     30.08     30.04     30.01
1


TR20 XEQ 09-14-97  16:45        VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33     CLOSURE.INP                   JOB  1    PASS   2
     REV PC 09/83(.2)           PEAK DISCHARGE CALCULATIONS                                                                  PAGE  12



EXECUTIVE CONTROL OPERATION ENDCMP                                                                                   RECORD ID
                                             COMPUTATIONS COMPLETED FOR PASS   1



EXECUTIVE CONTROL OPERATION ENDJOB                                                                                   RECORD ID



TR20 XEQ 09-14-97  16:45        VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33     CLOSURE.INP                   JOB  1    SUMMARY
     REV PC 09/83(.2)           PEAK DISCHARGE CALCULATIONS                                                                   PAGE  13


SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
                  (A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
                   A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/     STANDARD                  RAIN  ANTEC  MAIN          PRECIPITATION                               PEAK DISCHARGE
STRUCTURE     CONTROL     DRAINAGE    TABLE  MOIST  TIME   -------------------------  RUNOFF   -------------------------------------
             OPERATION      AREA        #     COND  INCREM  BEGIN    AMOUNT  DURATION  AMOUNT   ELEVATION    TIME       RATE        RATE
                          (SQ MI)                    (HR)   (HR)     (IN)     (HR)     (IN)      (FT)       (HR)      (CFS)       (CSM)


   ALTERNATE     1    STORM     1
```

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```
 XSECTION  1  RUNOFF    .00   2   2   .05   .0   6.20   24.00   3.63 Bench (CCB)          11.99     15.61    3716.0
 XSECTION  1  RUNOFF    .00   2   2   .05   .0   6.20   24.00   2.58 Bench (vegetated)    12.05     10.89    2593.4
 XSECTION  2  RUNOFF    .02   2   2   .05   .0   6.20   24.00   3.62 Slope Drain          12.03  *(  81.56     3427.1
 X    )ON  2  RUNOFF    .03   2   2   .05   .0   6.20   24.00   3.42 Slope Drain          12.02    (105.53)   3360.8
 SECTION   3  RUNOFF    .10   2   2   .05   .0   6.20   24.00   3.10 Perimeter channel    12.15    238.80    2311.7
                                                                                                        **
 XSECTION  3  RUNOFF    .11   2   2   .05   .0   6.20   24.00   2.54 Perimeter channel    12.21    189.71    1734.1
 XSECTION  4  RUNOFF    .02   2   2   .05   .0   6.20   24.00   3.02 Surface Swale        12.09     51.99    2573.6
 SECTION   5  RUNOFF    .00   2   2   .05   .0   6.20   24.00   3.40 Haul road chan.      11.98     11.75    4196.0
 XSECTION  5  RUNOFF    .01   2   2   .05   .0   6.20   24.00   3.05 West culvert         11.99     18.60    3381.9
 XSECTION  6  RUNOFF    .18   2   2   .05   .0   6.20   24.00   2.63 Final closure chan.  12.21    321.06    1786.6
```

~~SECTION 6 RUNOFF .18 2 2 .05 .0 6.20 24.00 3.57 12.21 407.57 2268.1~~
~~STRUCTURE 1 RESVOR .18 2 2 .05 .0 6.20 24.00 1.67 31.36 13.15 63.08 351.0~~
~~SECTION 6 RUNOFF .18 2 2 .05 .0 6.20 24.00 3.19 12.15 425.50 2367.8~~
~~TRUCTURE 2 RESVOR .18 2 2 .05 .0 6.20 24.00 1.62 30.90 12.95* 62.41* 347.3~~

```
1



 TR20 XEQ 09-14-97  16:45      VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33    CLOSURE.INP          JOB  1   SUMMARY
      REV PC 09/83(.2)         PEAK DISCHARGE CALCULATIONS                                                    PAGE  14



 UMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

 XSECTION/            DRAINAGE
 TRUCTURE               AREA       STORM NUMBERS..........
                      (SQ MI)            1

  STRUCTURE   2            .18
 ______________________________
    ALTERNATE     1                  62.41
 0 STRUCTURE  1            .18
 ______________________________
    ALTERNATE     1                  63.08
 0 XSECTION   1            .00
 ______________________________
    ALTERNATE     1                  10.89
 0 XSECTION   2            .03
 ______________________________
    ALTERNATE     1                 105.53
 0 XSECTION   3            .11
+______________________________
    ALTERNATE     1                 189.71
   XSECTION   4            .02
+______________________________
    ALTERNATE     1                  51.99
   SECTION    5            .01
+______________________________
    ALTERNATE     1                  18.60
   SECTION    6            .18
+______________________________
      ERNATE      1                 425.50


 MAIN - UNEXPECTED RECORD FOUND(IGNORED) >>>                                                                   <<<
1  D OF  1 JOBS IN THIS RUN
```

* Use the maximum discharge of 105.5 CFS to design the slope drain.

** Use perimeter channel discharge to size east culvert.

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BY MRL DATE 9|15|97 PROJ. NO. 96-410-33

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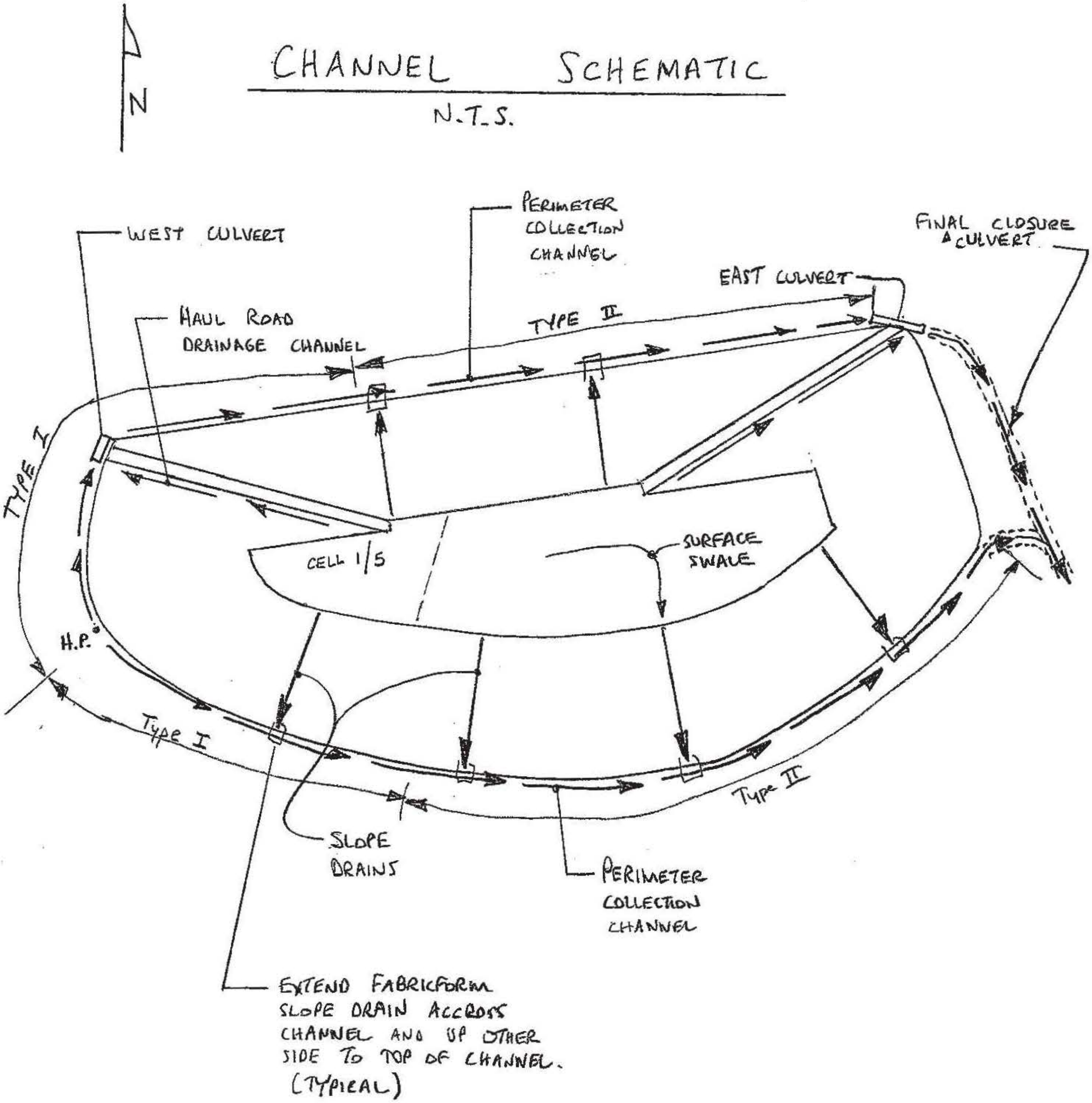
CHANNEL SCHEMATIC

N.T.S.



EXTEND FABRICFORM SLOPE DRAIN ACCROSS CHANNEL AND UP OTHER SIDE TO TOP OF CHANNEL. (TYPICAL)

SUBJECT Virginia Power – Chesterfield Closure

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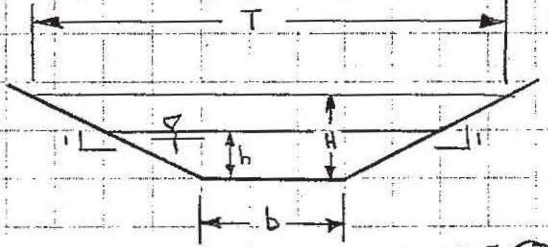
CHANNEL DESIGN



See Ref ④

										DESIGN INFORMATION FOR DRAWINGS				
Channel	Design Q ① (CFS)	Channel Slope (Ft/Ft)	Sides Slopes H:V	Bottom Width b (Ft.)	Mannings n	Depth of Flow h (Ft.)	Design Velocity V (Fps)	Wetted Perimeter P (Ft)	Froude No. F	Minimum Design Depth H (Ft.)	Proposed Design Depth H (Ft.)	Max. Design Velocity (fps)	Lining Material	Channel Type
Bench-CCB	15.6	0.01	20:1 & 3:1 11.5	0	0.03	0.73	2.5	16.9	0.7	0.73	1.0	2.5	Grass	
Bench-Vegetated	10.9	0.01	11.5	0	0.04	0.71	1.9	16.5	0.5					
Slope Drain	105.5	0.05	2	2	Fabricform 0.015	1.27	18.3	7.7	3.6	1.27	2.0	36.6	Fabriform-USM	
Slope Drain	105.5	0.33	2	2	0.015	0.80	36.6	5.6	8.7					
Perimeter channel Cell 1/5	105.5	0.004	2.5	2	Grass 0.04	3.20	3.3	19.2	0.4	3.2	3.5	3.3	Grass	Type I
Perimeter channel Total	238.8	0.004	2.5	2	0.04	4.47	4.1	26.1	0.5	4.5	5.0	4.1	Grass	Type II
Perimeter channel-closed	189.7	0.004	2.5	2	0.04	4.07	3.8	23.9	0.4					
Surface Swale	52.0	0.01	10	0	0.04	1.35	2.9	27.2	0.6	1.35	1.5	2.9	Grass	
Haul road channel	11.8	0.10	2	0	0.04	0.94	6.6	4.2	1.7	0.94	1.5	6.6	NSA R-4 Riprap	
▲ Surface Swale	52.0	0.02	10	0	0.04	1.19	3.7	23.9	0.8	1.19	1.5	3.7	Grass	

① From Sheet 43

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/15/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 46 OF 70

PROJECT : WEST CULVERT

STATION :

SHEET ______ **OF** ______

CULVERT DESIGN FORM

DESIGNER / DATE : ______ / ______

REVIEWER / DATE : ______ / ______

HYDROLOGICAL DATA

SEE ADD'L SHTS.

☐ METHOD:

☐ DRAINAGE AREA: ______ ☐ STREAM SLOPE:

☐ CHANNEL SHAPE:

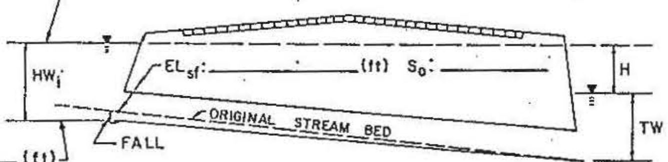
☐ ROUTING: ______ ☐ OTHER:

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
25 yr.	18.6 (see sheet 43)	≈ 1.5

ROADWAY ELEVATION : ______ (ft)

EL_{hd}: ______ (ft)



EL_i 39.3 (ft)

$S \approx S_o - FALL / L_a$

S = 0.004

L_a = 70'

EL_o: 39.0 (ft)

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL											CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
			HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL: TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)			
30" ϕ CMP, projecting	18.6	18.6	0.95	2.4	–	41.7	1.5	1.45	2.0	2.0	0.9	0.91	41.9	41.9		< 42' O.K.
24" ϕ CMP, projecting	18.6	18.6	1.5	3.0	–	42.3	1.5	1.55	1.8	1.8	0.9	2.7	43.5	43.5		> 42' Not O.K.

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) FALL = $HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

Use 30" ϕ CMP, projecting

CULVERT BARREL SELECTED:

SIZE:

SHAPE:

MATERIAL: ______ n

ENTRANCE:

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SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/16/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 47 OF 70

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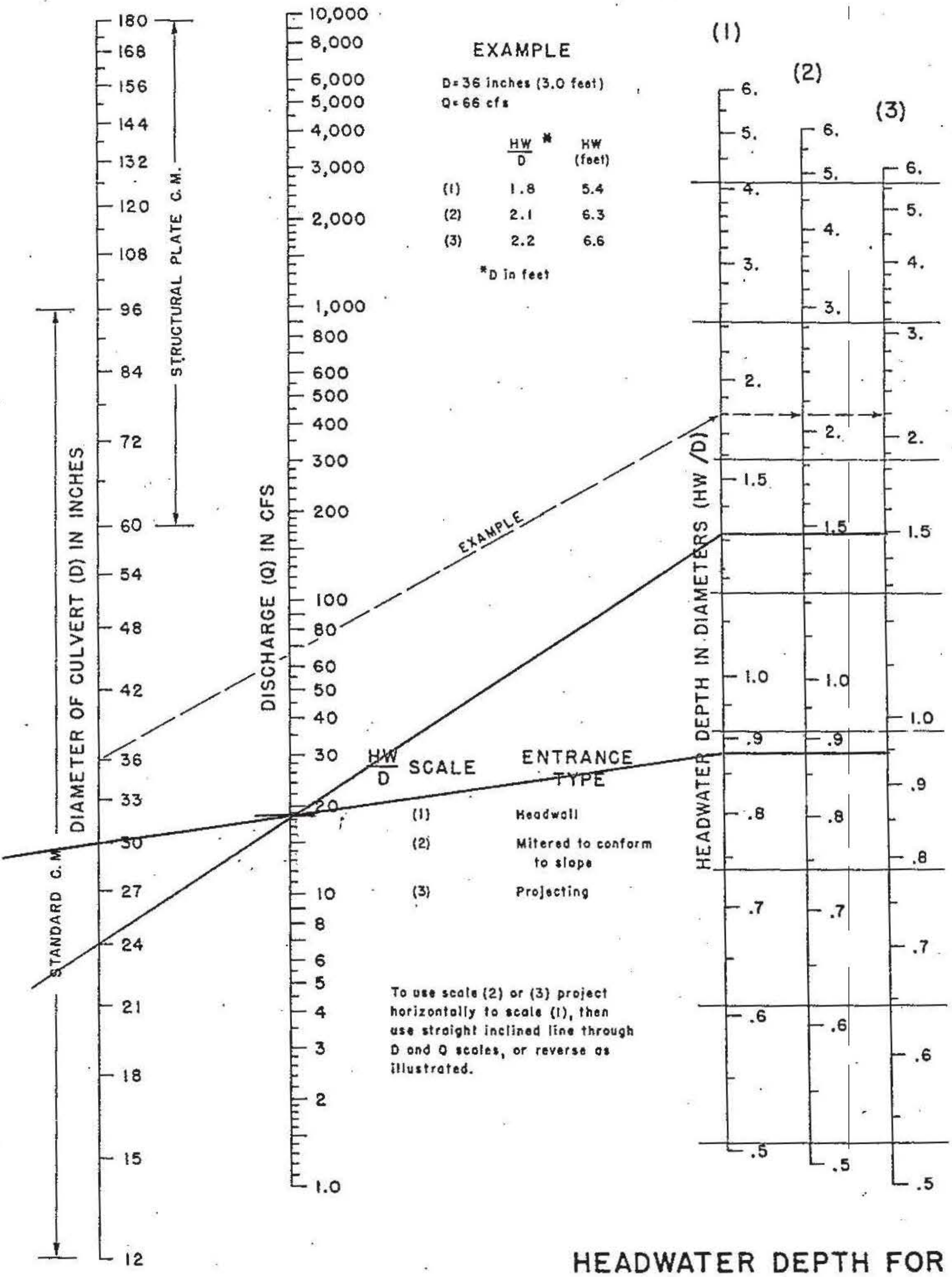

EXAMPLE

D=36 inches (3.0 feet)
Q=66 cfs

	$\frac{HW}{D}$ *	HW (feet)
(1)	1.8	5.4
(2)	2.1	6.3
(3)	2.2	6.6

*D in feet

$\frac{HW}{D}$ SCALE	ENTRANCE TYPE
(1)	Headwall
(2)	Mitered to conform to slope
(3)	Projecting

To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

CHART 2 ○

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

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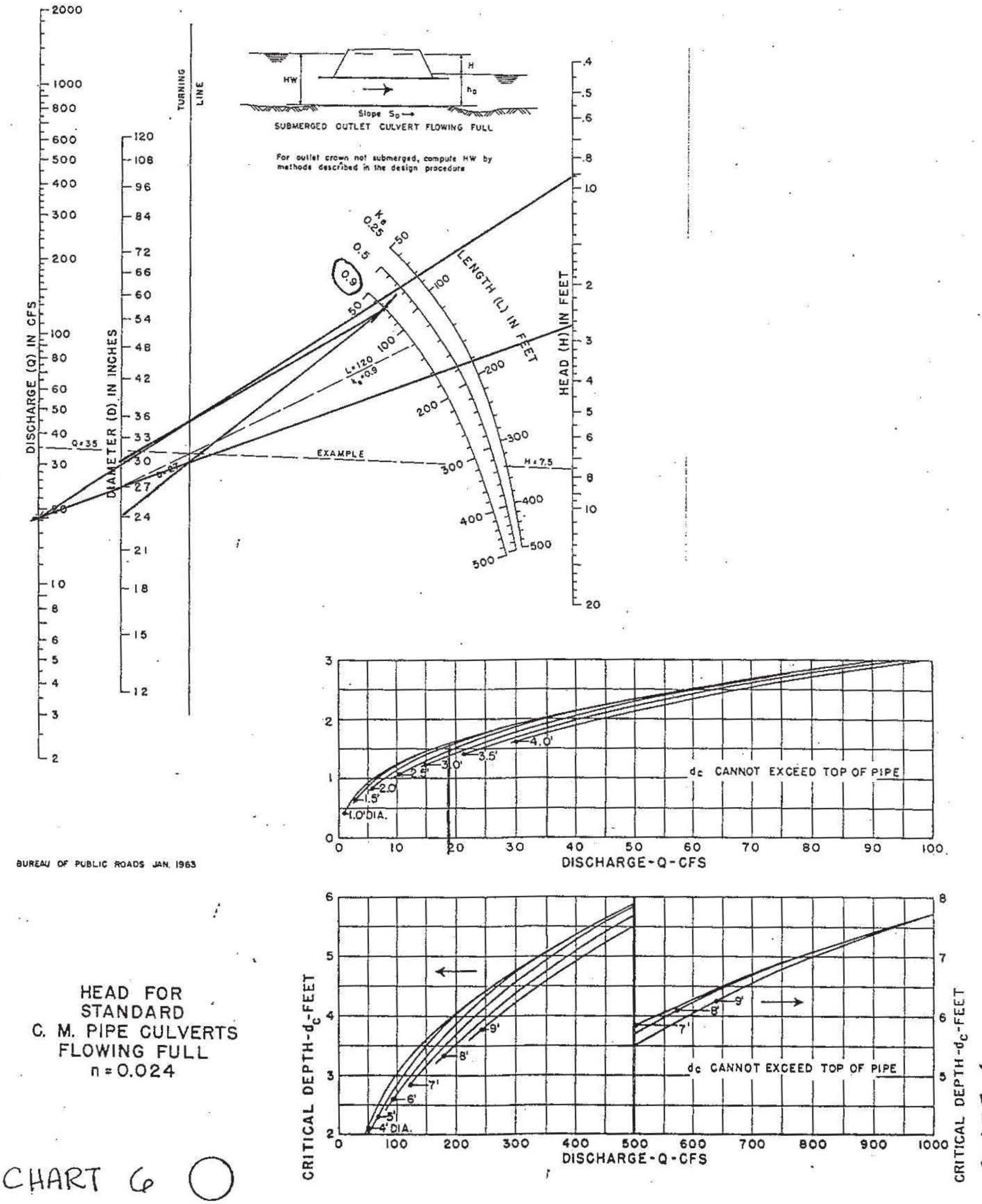


BUREAU OF PUBLIC ROADS JAN. 1963

HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

CHART 6 ○

CHART 4

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/16/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 49 OF 70

PROJECT: EAST CULVERT

STATION: ______

SHEET ______ OF ______

CULVERT DESIGN FORM

DESIGNER / DATE: ______ / ______

REVIEWER / DATE: ______ / ______

HYDROLOGICAL DATA

SEE ADD'L SHTS.

☐ METHOD: ______

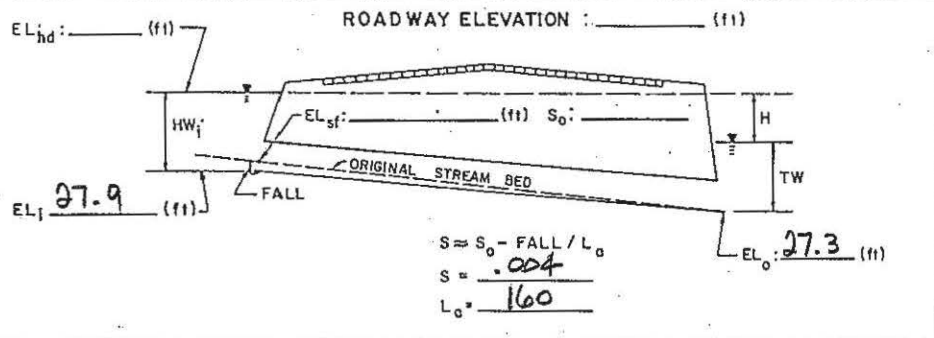
☐ DRAINAGE AREA: ______ ☐ STREAM SLOPE: ______

☐ CHANNEL SHAPE: ______

☐ ROUTING: ______ ☐ OTHER: ______

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
25 yr.	238.8	≈4.5



CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS											CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
			INLET CONTROL				OUTLET CONTROL									
			HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)			
2 – 36"φ CMPs, projecting	238.8	119.4	6.2	18.6	—	46.5	4.5	3.0	3.0	4.5	0.9	≈26	57.8	57.8		
48"φ CMP, projecting	238.8	238.8	5.6	22.4	—	50.3	4.5	4.0	4.0	4.5	0.9	≈26	57.8	57.8		
60"φ CMP, projecting	238.8	238.8	2.2	11.0	—	38.9	4.5	4.3	4.7	4.7	0.9	8.8	40.8	40.8		←
72"φ CMP, projecting	238.8	238.8	1.24	7.4	—	35.3	4.5	4.2	5.1	5.1	0.9	3.8	36.2	36.2		
48"φ CMP, projecting	150	150	2.68	10.7	—	38.6	4.5	3.6	3.8	4.5	0.9	11.0	42.8	42.8		
60" CMP	150	150	1.24	6.2	—	34.1	4.5	3.3	4.2	4.5	0.9	3.55	35.4	35.4		←

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i / D = HW / D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) $h_o = TW$ or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L) / R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

60"φ pipe, BCCMP, galvanized & paved invert, 10 ga. → ≈ $76.50/L.F material only
≈ $ 145 /L.F. installed

CULVERT BARREL SELECTED:

SIZE: ______
SHAPE: ______
MATERIAL: ______ n ______
ENTRANCE: ______

USE 60"φ CMP, projecting ends

THE 238.8 CFS PEAK DISCHARGE USED ABOVE WAS CALCULATED FOR THE SOUTHERN PERIMETER CHANNEL. THE SOUTHERN CHANNEL SHOULD RECEIVE MORE DISCHARGE THAN THE NORTHERN CHANNEL (WHICH IS THE LOCATION OF THE EAST CULVERT) THROUGHOUT THE LIFE OF THE CLOSURE. AS SHOWN ABOVE, THE EAST CULVERT CAN HANDLE THIS DISCHARGE AT AN ELEV. OF 40.8, WHICH IS LESS THAN 42! HOWEVER, FOR FINAL CLOSURE, THE PEAK DISCHARGE WOULD BE CLOSER TO 150 [illegible] NORTHERN CHA

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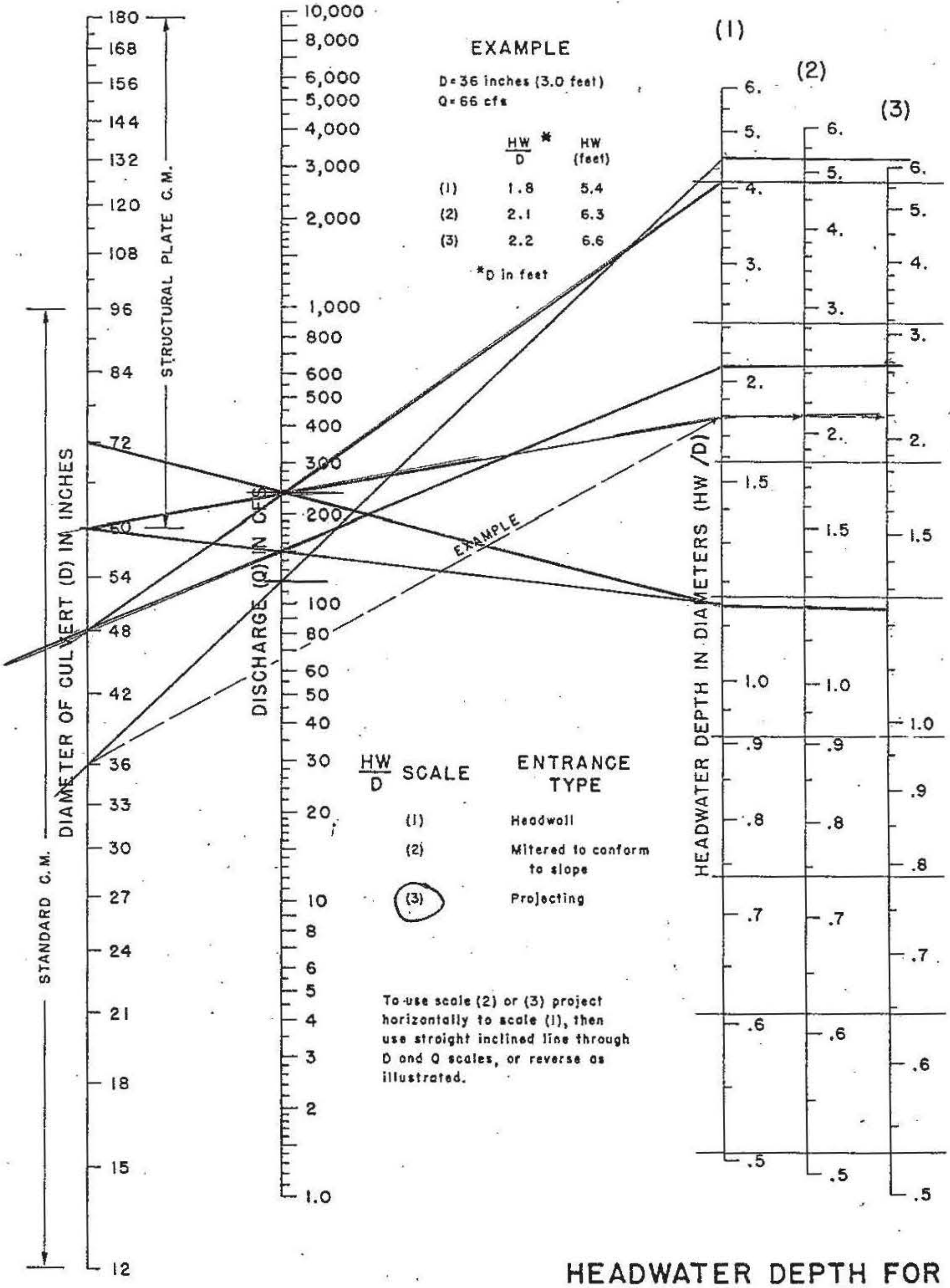
BY MRL DATE 9/16/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 50 OF 70



EXAMPLE

D=36 inches (3.0 feet)
Q=66 cfs

	$\frac{HW}{D}$ *	HW (feet)
(1)	1.8	5.4
(2)	2.1	6.3
(3)	2.2	6.6

*D in feet

$\frac{HW}{D}$ SCALE	ENTRANCE TYPE
(1)	Headwall
(2)	Mitered to conform to slope
(3)	Projecting

To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

CHART 2

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

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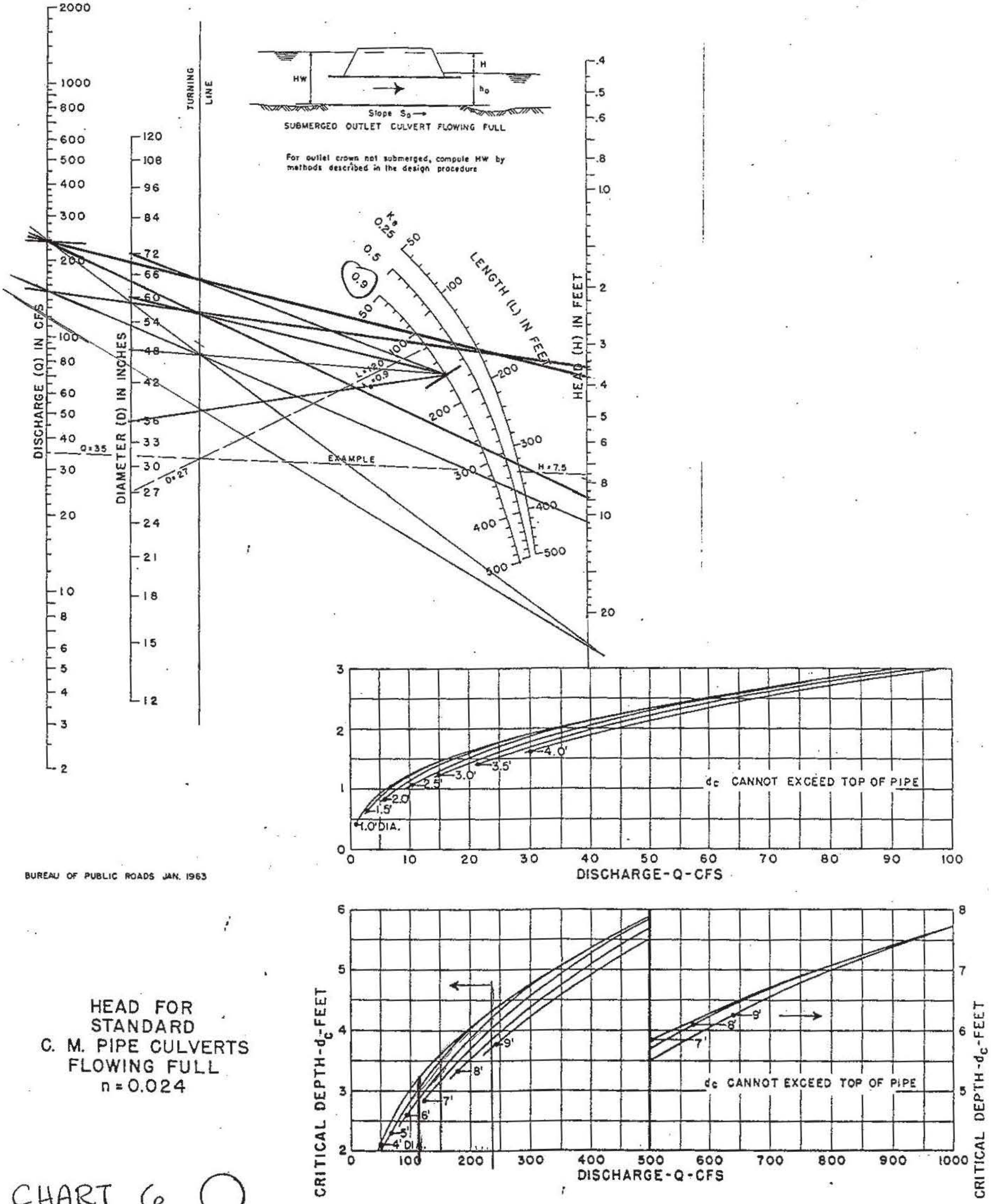
SUBJECT Virginia Power. - Chesterfield Closure

BY MRL DATE 9/16/97 PROJ. NO. 96-410-33

CHKD. BY RHO DATE 22 SEP 97 SHEET NO. 51 OF 70

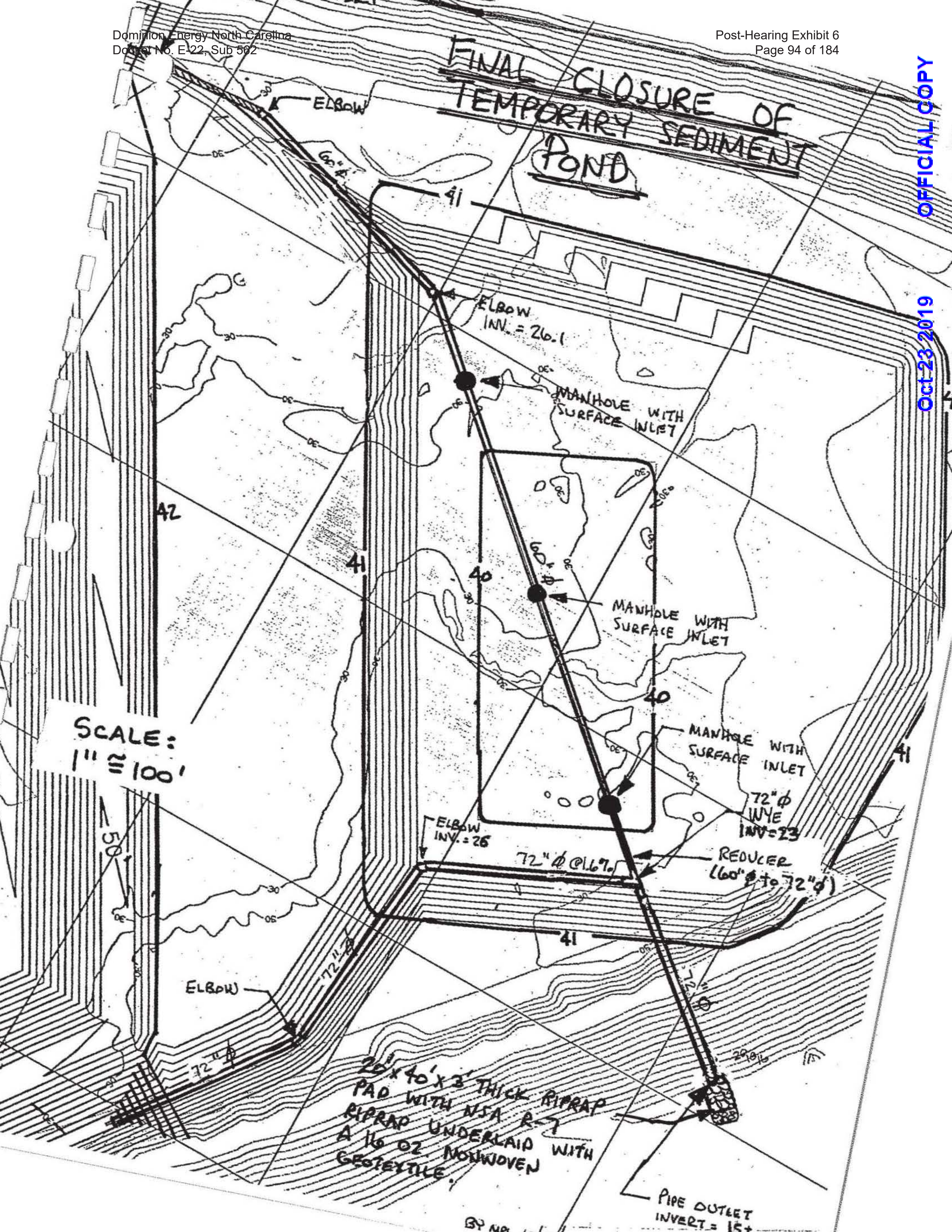


HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

CHART 6 ○

CHART 4

FINAL CLOSURE OF TEMPORARY SEDIMENT POND



SUBJECT: Virginia Power – Chesterfield Closure
BY: MRL DATE: 10/22/97
CHKD. BY: ______ DATE: ______
PROJ. NO. 96-410-33
SHEET NO. 51 B OF 70

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PROJECT: Chesterfield closure

STATION: ______

SHEET ______ OF ______

CULVERT DESIGN FORM

DESIGNER / DATE: ______ / ______
REVIEWER / DATE: ______ / ______

HYDROLOGICAL DATA

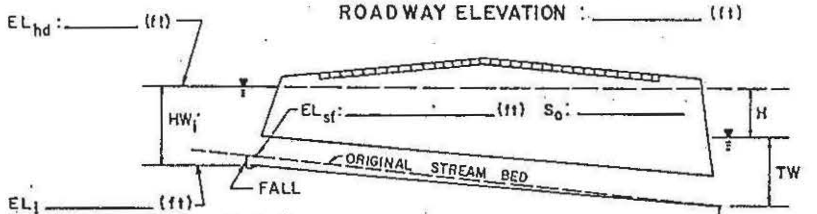
SEE ADD'L. SHTS.

☐ METHOD: ______
☐ DRAINAGE AREA: ______ ☐ STREAM SLOPE: ______
☐ CHANNEL SHAPE: ______
☐ ROUTING: ______ ☐ OTHER: ______

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
North	150	Use 5'
South	240	Use 5'
combined	321	Assume 2'

ROADWAY ELEVATION: ______ (ft)



27.3 North final closure
28.0 South final closure
23.0 Combined final closure

$S \approx S_o - FALL / L_a$

S = 770' @ 0.0056

N/o = 370' @ 0.0054
190' @ 0.042

23.0 North
26.0 South
15.0 combined

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	OUTLET CONTROL TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
North: 60"ϕ CMP, projecting	150	150	1.26	6.3	–	33.6	5	3.5	4.3	5	0.9	10.5	38.5	38.5		O.K. outlet control
South: 60"ϕ CMP, projecting	240	240	2.32	11.6	–	39.6	5	4.4	4.7	5	0.9	16	47	47		Too high N.G.
Combined: 60"ϕ CMP, "Headwall"	321	321	2.88	14.4	–	37.4	2	4.9	5.0	5	0.25	16	36	37.4		O.K. inlet control
Combined: 72"ϕ CMP, "Headwall"	321	321	1.53	9.2	–	32.2	2	4.9	5.5	5.5	0.25	6.1	26.6	32.2		O.K. inlet control
South: 72"ϕ CMP, projecting	240	240	1.28	7.7	–	35.7	5	4.4	5.2	5.2	0.9	6.6	37.8	37.8		O.K. outlet control

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29 n^2 L) / R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION:

Since the South closure pipe needs to be 72"ϕ, make the combined closure pipe 72"ϕ also, so that a 72"ϕ pipe does not reduce into a 60"ϕ pipe.

CULVERT BARREL SELECTED:

SIZE: ______
SHAPE: ______
MATERIAL: ______ n ______
ENTRANCE: ______

SUBJECT Virginia Power - Chesterfield Closure

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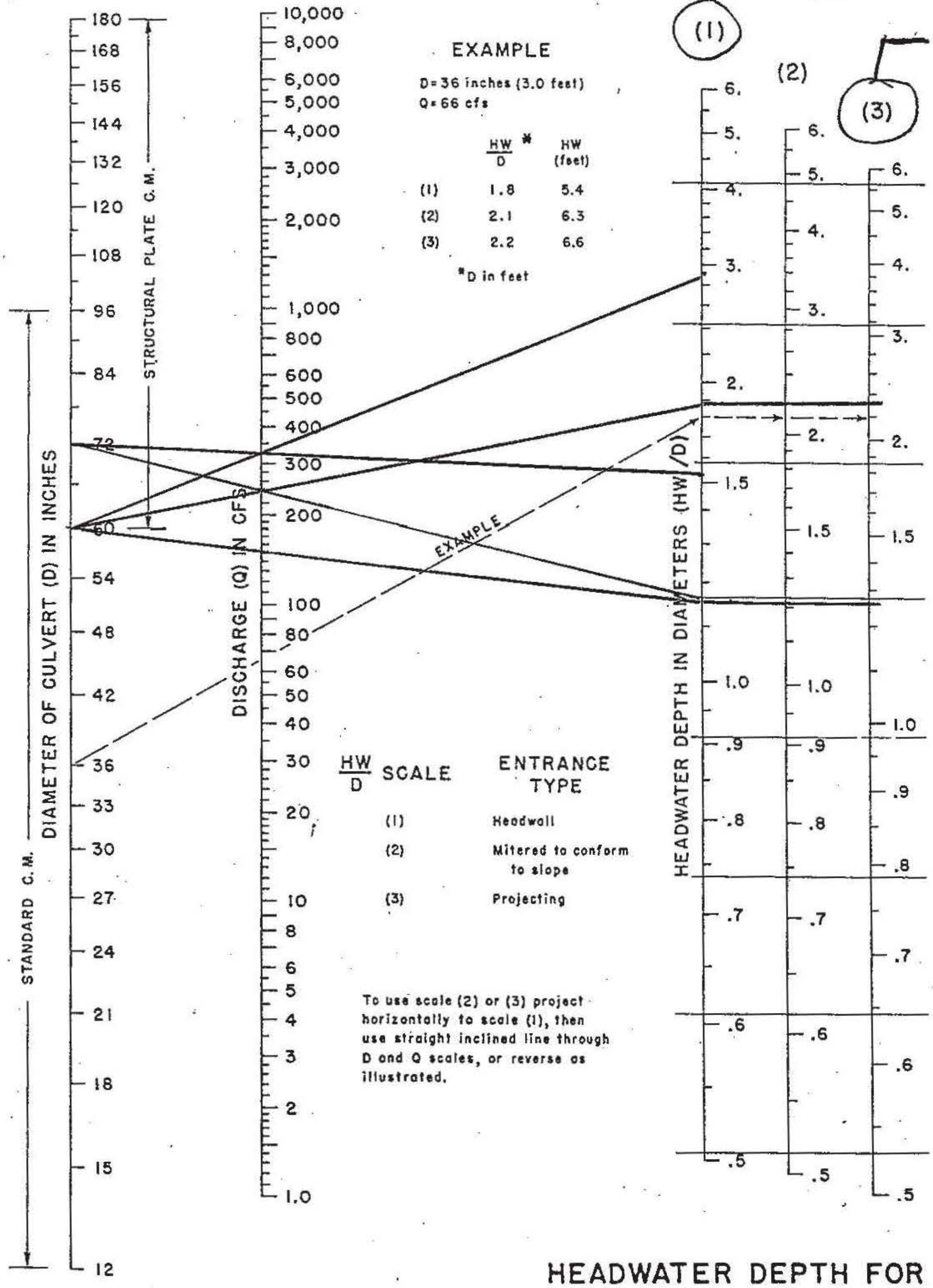
Combined : Assume efficient entrance since flow is already in pipes.

North & South



EXAMPLE

D=36 inches (3.0 feet)
Q=66 cfs

	$\frac{HW}{D}$ *	HW (feet)
(1)	1.8	5.4
(2)	2.1	6.3
(3)	2.2	6.6

*D in feet

$\frac{HW}{D}$ SCALE	ENTRANCE TYPE
(1)	Headwall
(2)	Mitered to conform to slope
(3)	Projecting

To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

CHART 2

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

SUBJECT Virginia Power - Chesterfield Closure

BY MRL DATE 10/22/97 PROJ. NO. 96-410-33

CHKD. BY ______ DATE ______ SHEET NO. 51 D OF 70

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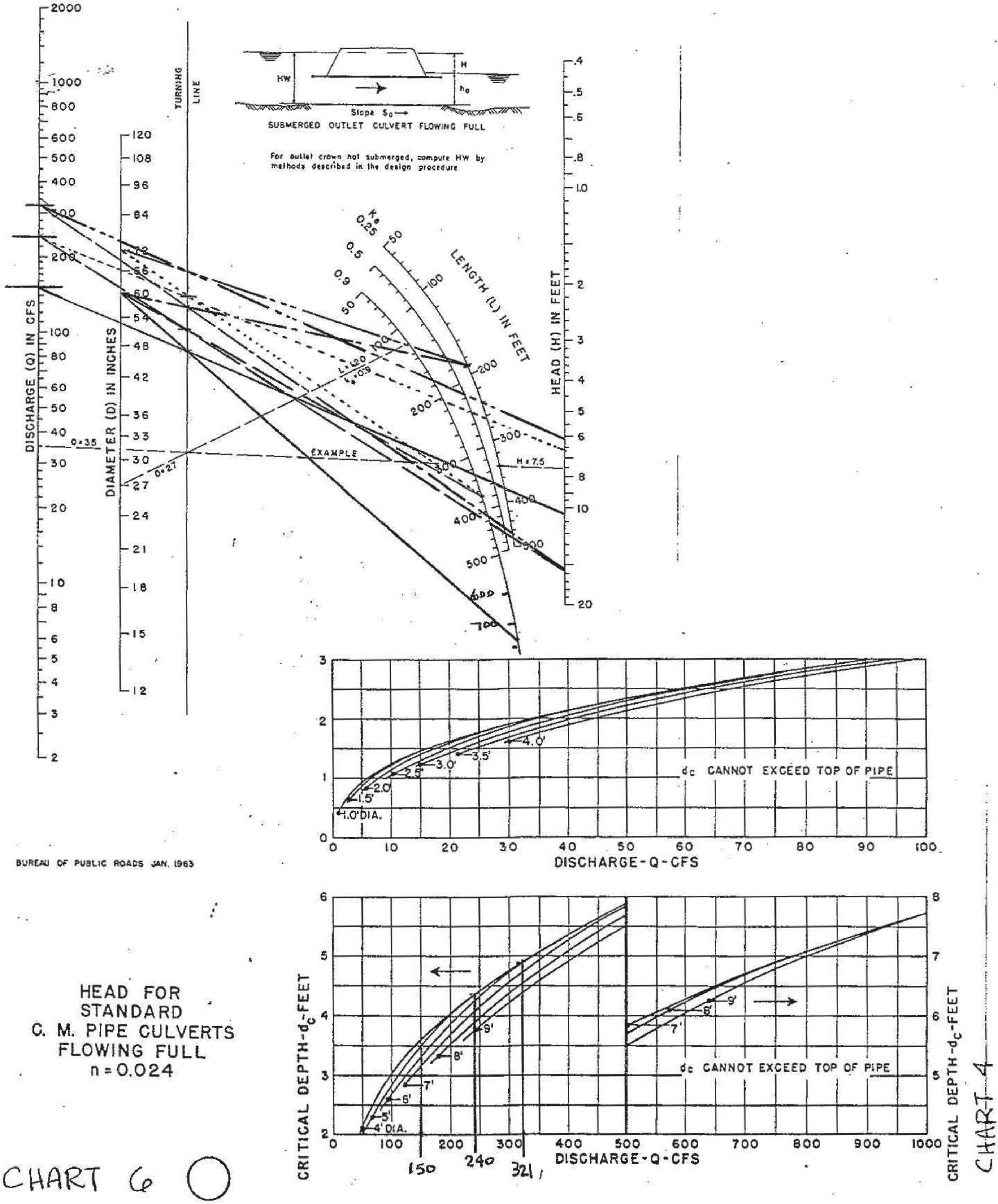

BUREAU OF PUBLIC ROADS JAN. 1963

HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

CHART 6 ○

SUBJECT Virginia Power - Chesterfield Closure

BY MEL DATE 9/13/97 PROJ. NO. 96-410-33

CHKD. BY PJD DATE 23 SEP 97 SHEET NO. 52 OF 70

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TEMPORARY SEDIMENT POND : DESIGN REQUIREMENTS

The temporary sediment pond will be designed based on the requirements of the Virginia Erosion and Sediment Control Handbook (Reference ⑪).

These requirements are summarized below:

- Total storage volume required equals 134 yd.^{3} per acre of drainage area. Of this volume, 67 yd.^{3}/acre is for "wet" storage (i.e. a permanent pool), and 67 yd^3/acre is for "dry" storage (i.e the water is temporarily stored so that it takes at least 6-hours to drawdown this "dry" pool.

- clean-out of the pond is to occur when the "wet" pool is 1/2 full of sediment.

- The pond shall be able to handle the expected peak runoff from a 25-year 24-hour storm. Since there is no emergency spillway, the principal spillway must be able to handle the 25-year storm with a minimum 2 feet freeboard between the design storm high water and the top of the pond (i.e elevation 41).

  Therefore, maximum design storm elevation = 39.

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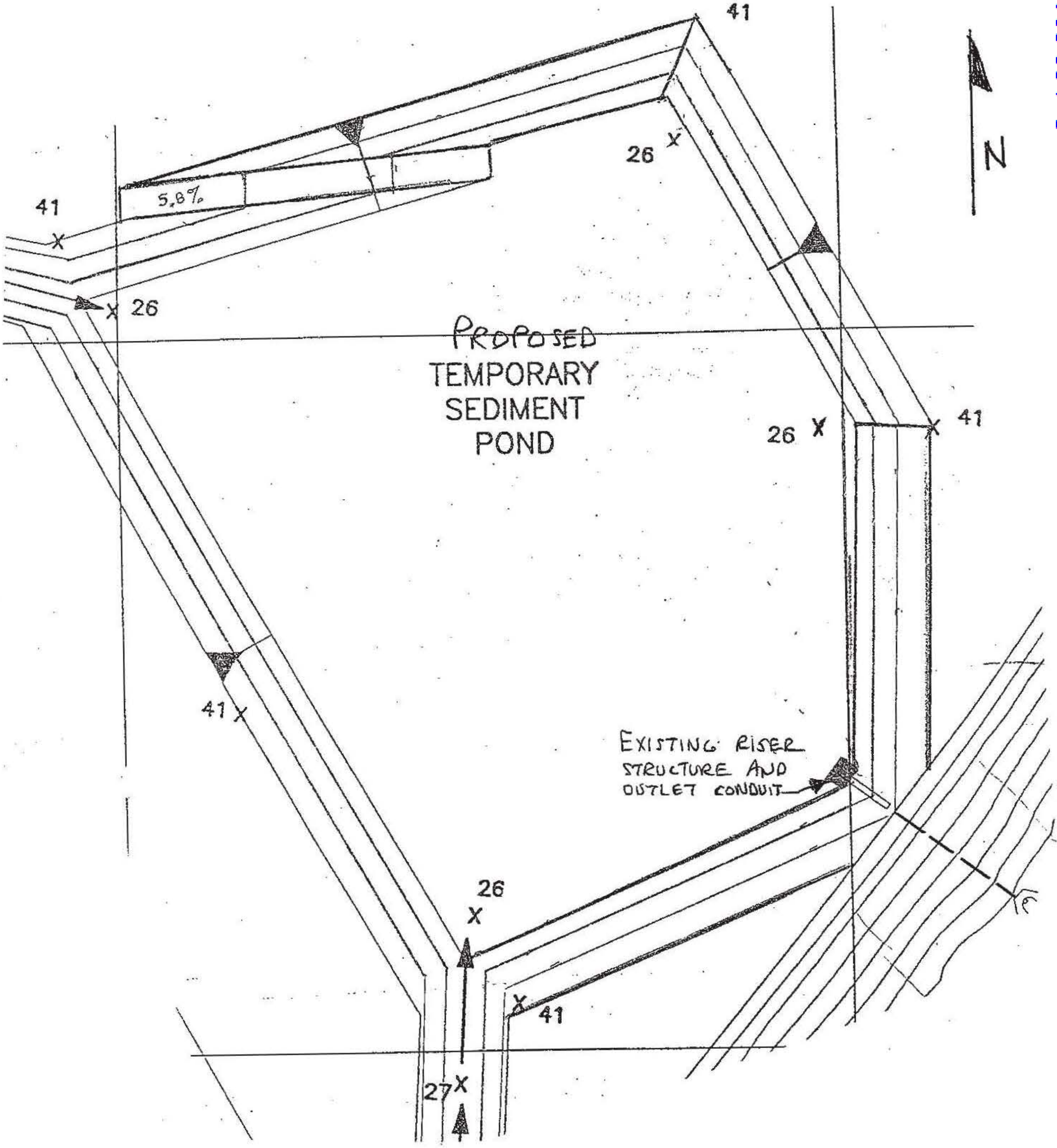
CHKD. BY RHD DATE 23 SEP 97 SHEET NO. 53 OF 70

TEMPORARY SEDIMENT POND



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SUBJECT Virginia Power – Chesterfield Closure
STAGE - STORAGE DATA

BY MRL DATE 9/5/97 PROJ. NO. 96-410-33

CHKD. BY RKD DATE 23 SEP 97 SHEET NO. 54 OF 70

TOPO MAP SCALE 1" = ______ FT. 1 in.² = ______ ft.²

ELEV.	DIFFERENCE IN ELEV. (Feet)	AREA		AVERAGE AREA	INTERVAL STORAGE	TOTAL STORAGE	
		IN²	ACRES	ACRES	AC. FT.	AC. IN.	AC. FT.
26			4.6				0
	4			4.9	19.6		
30			5.2				19.6
	5			5.6	28.0		
35			6.0				47.6
	6			6.4	38.4		
41			6.8				86.0

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BY MRL DATE 9/5/97 PROJ. NO. 96-410-33

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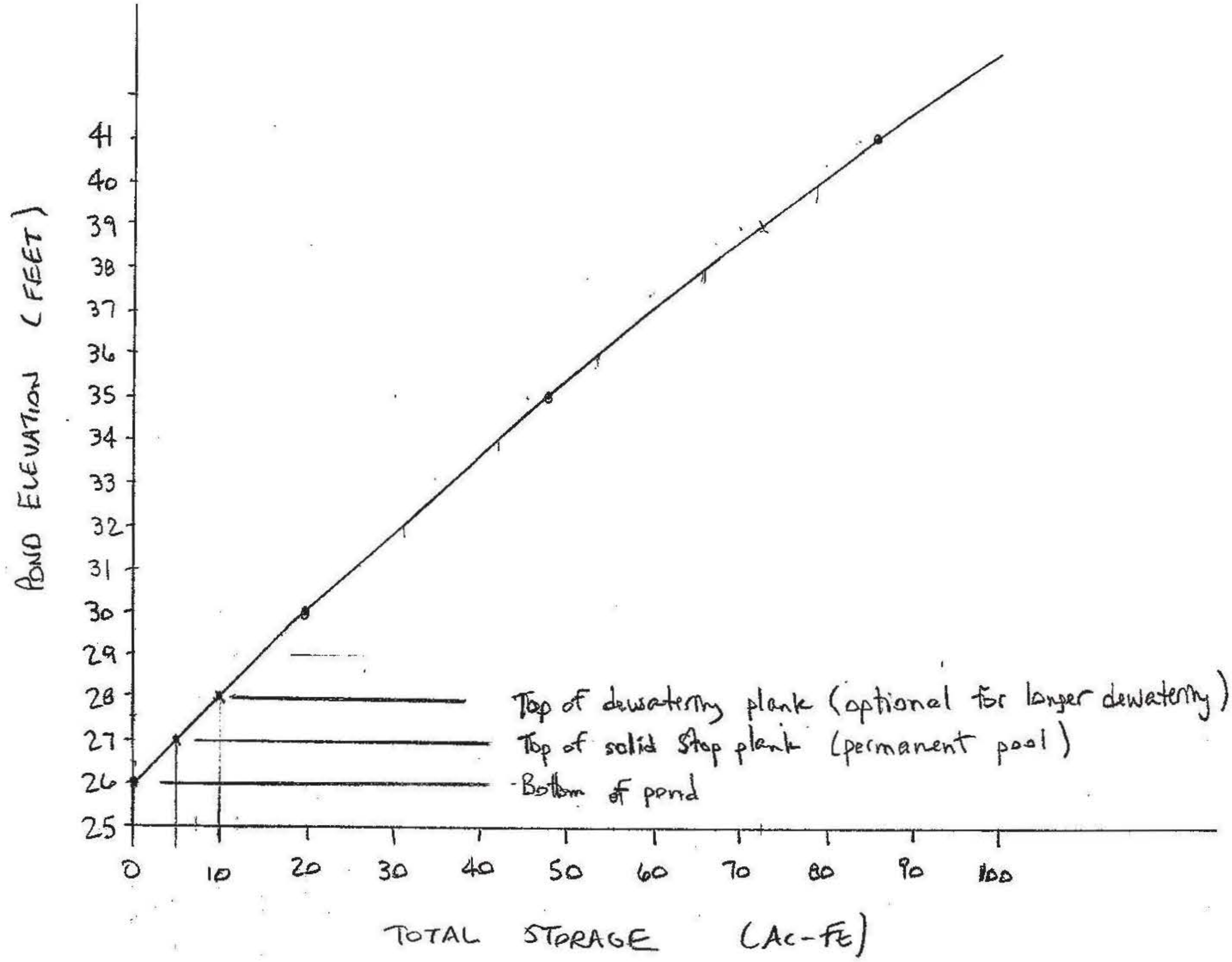
STAGE - STORAGE CURVE



SUBJECT Virginia Power — Chesterfield Closure

BY MRL DATE 9/13/97 PROJ. NO. 96-410-33

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CHECK STORAGE REQUIREMENTS

Maximum drainage area to pond = 115 acres.

Analyze "wet" storage:

$67\ yd.^3/acre \times 115\ acres = 7705\ yd.^3$

From the stage storage curve ... Pond bottom = elev. 26
Top of "wet" storage = elev. 27

Storage = 5 Ac.-Ft. = 8067 yd^3

$$\boxed{8067\ yd.^3 > 7705\ yd^3 \quad \therefore \text{O.K.}}$$

Analyze "dry" storage:

$67\ yd.^3/acre \times 115\ acres = 7705\ yd^3 = 4.8$ Ac.-Ft.

Total Storage = 5 ac.-ft. + 4.8 ac.-ft. = 9.8 ac.-ft.
(elev. 27.9)

→ Analyze to see if the 4.8 ac.-ft of "dry" storage takes longer than 6 hours to dewater. (see sheet 70)

Calculate the stage discharge curve of the riser/conduit to make this analysis.

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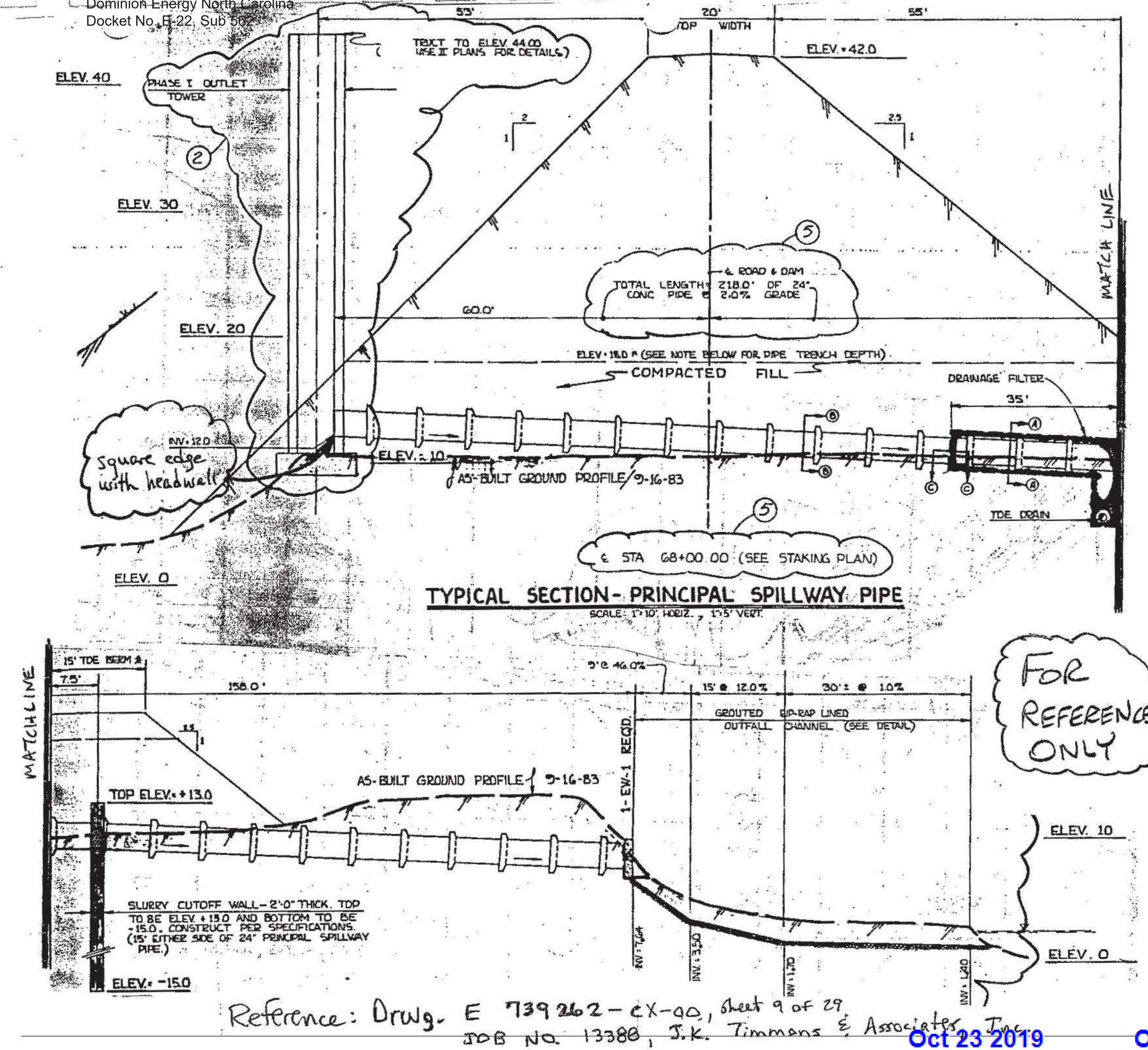

TYPICAL SECTION – PRINCIPAL SPILLWAY PIPE

SCALE: 1" = 10' HORIZ., 1" = 5' VERT.

FOR REFERENCE ONLY

Reference: Drwg. E 739262-CX-00, sheet 9 of 29, JOB NO. 13388, J.K. Timmons & Associates, Inc.

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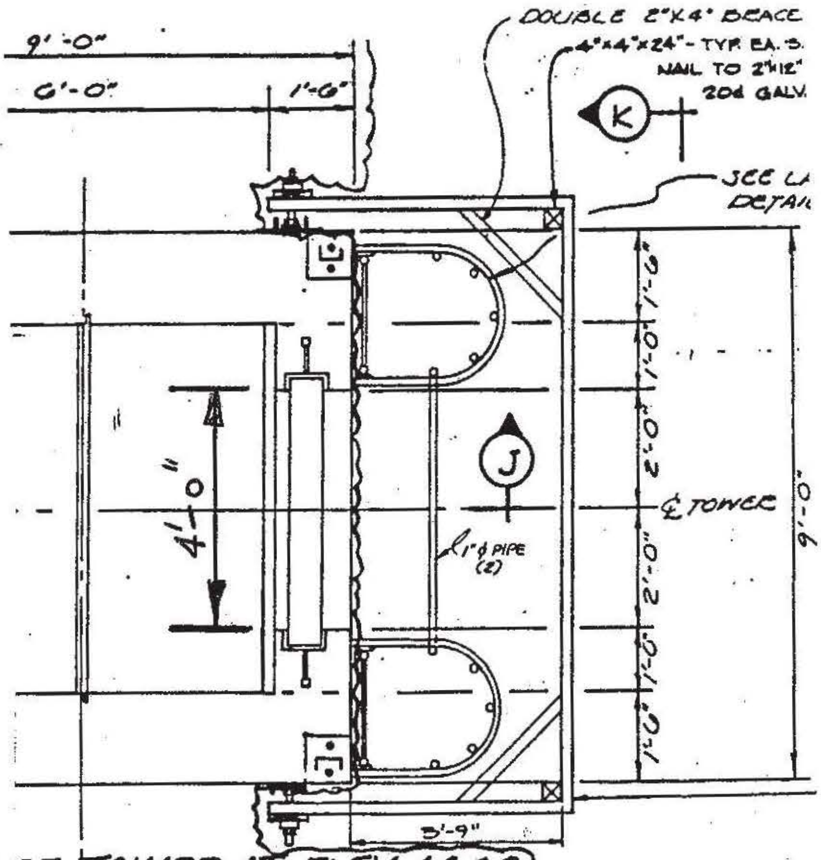
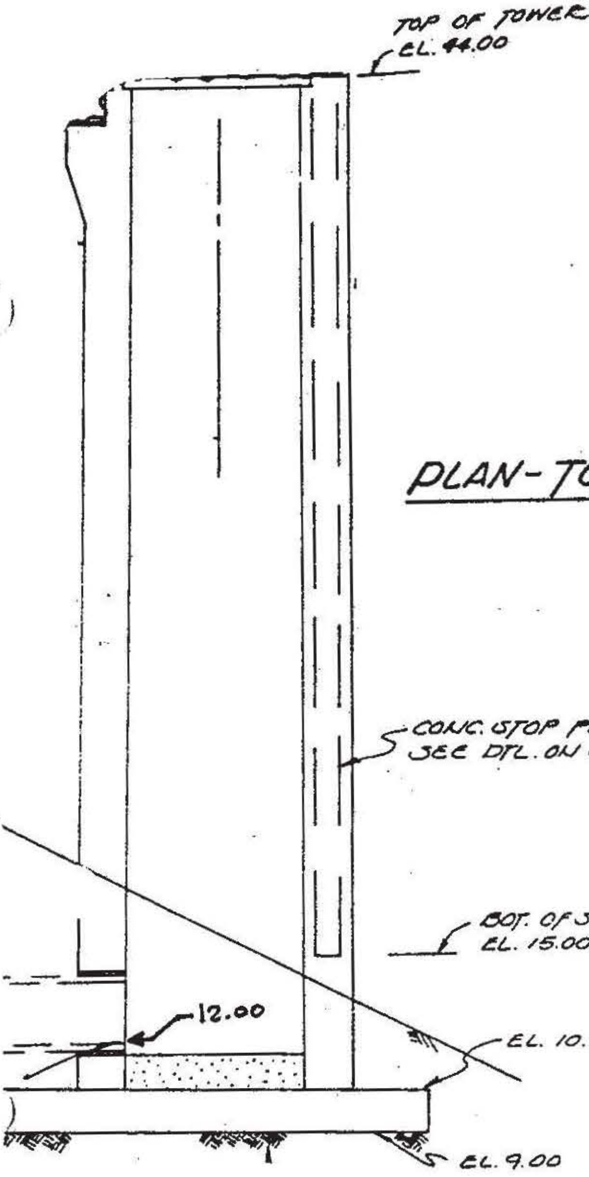
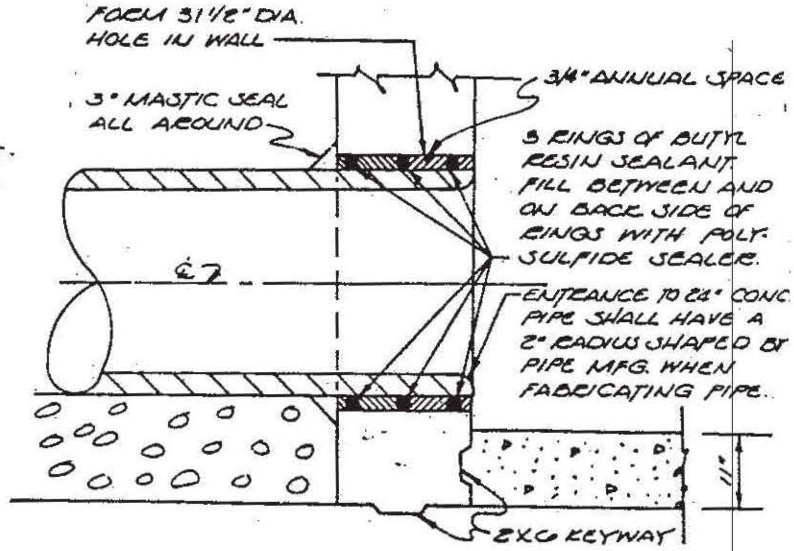
FOR REFERENCE ONLY

From dwg E739262-CX-05 & 06
Job No. 13388,
J.K. Timmons & Associates, Inc.



PLAN - TOP OF TOWER AT ELEV. 44.00





DETAIL - 24" PIPE EXIT AT TOWER

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PROJECT : ______

STATION : ______

SHEET ______ OF ______

CULVERT DESIGN FORM

DESIGNER / DATE : ______ / ______

REVIEWER / DATE : ______ / ______

HYDROLOGICAL DATA

SEE ADD'L. SHTS.

☐ METHOD: ______

☐ DRAINAGE AREA: ______ ☐ STREAM SLOPE: ______

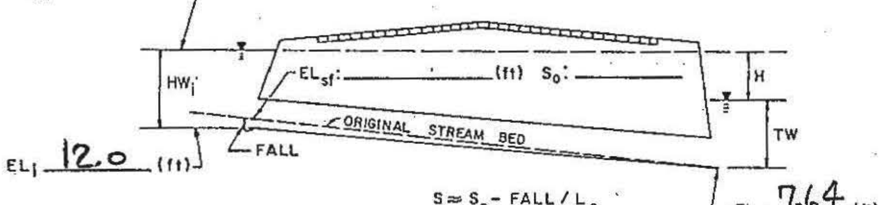
☐ CHANNEL SHAPE: ______

☐ ROUTING: ______ ☐ OTHER: ______

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)

ROADWAY ELEVATION : ______ (ft)



EL_i: 12.0 (ft)

EL_o: 7.64 (ft)

$S \approx S_o - FALL / L_a$

S = 2.0%

L_a = 218'

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS											CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
			INLET CONTROL				OUTLET CONTROL									
			HW_i/D (2)	HW_i	FALL (3)	EL_{hi} (4)	TW (5)	d_c	$\frac{d_c+D}{2}$	h_o (6)	k_e	H (7)	EL_{ho} (8)			
24" ϕ RCP, rounded edge headwall	10	10	.82	1.64	–	13.6	–	1.1	1.6	1.6	0.2	0.54	9.8	13.6		
"	20	20	1.3	2.6	–	14.6	–	1.6	1.8	1.8	0.2	2.2	11.6	14.6		
"	40	40	3.0	6.0	–	18.0	–	2.0	2.0	2.0	0.2	8.5	18.1	18.1		
"	60	60	6.0	12.0	–	24.0	–	2.0	2.0	2.0	0.2	19.5	29.1	29.1		
"	75	75					–	2.0	2.0	2.0	0.2	30.0	39.6	39.6		

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i / D = HW / D$ OR HW_f / D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L) / R^{1.33}\right] V^2 / 2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS :

a. APPROXIMATE
i. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho. HEADWATER IN OUTLET CONTROL
i. INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw. TAILWATER

COMMENTS / DISCUSSION :

CULVERT BARREL SELECTED :

SIZE: ______
SHAPE: ______
MATERIAL: ______ n: ______
ENTRANCE: ______

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TABLE 12 - ENTRANCE LOSS COEFFICIENTS

Outlet Control, Full or Partly Full

$$H_e = k_e \left[\frac{V^2}{2g} \right]$$

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Square-edge	0.5
→ Rounded (radius = 1/12D)	0.2 ← 24" RISER CONDUIT
Socket end of pipe (groove-end)	0.2
Projecting from fill, socket end (groove-end)	0.2
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Mitered to conform to fill slope, paved or unpaved slope	0.7
Headwall or headwall and wingwalls square-edge	0.5
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side-or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Wingwalls at 10° to 25° or 30° to 75° to barrel	
Square-edged at crown	0.5
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Side-or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both <u>inlet</u> and <u>outlet</u> control. Some end sections, incorporating a <u>closed</u> taper in their design have a superior hydraulic performance. These latter sections can be designed using the information given for the beveled inlet.

Reference : HDS No. 5, US DOT, Federal Highway Administration

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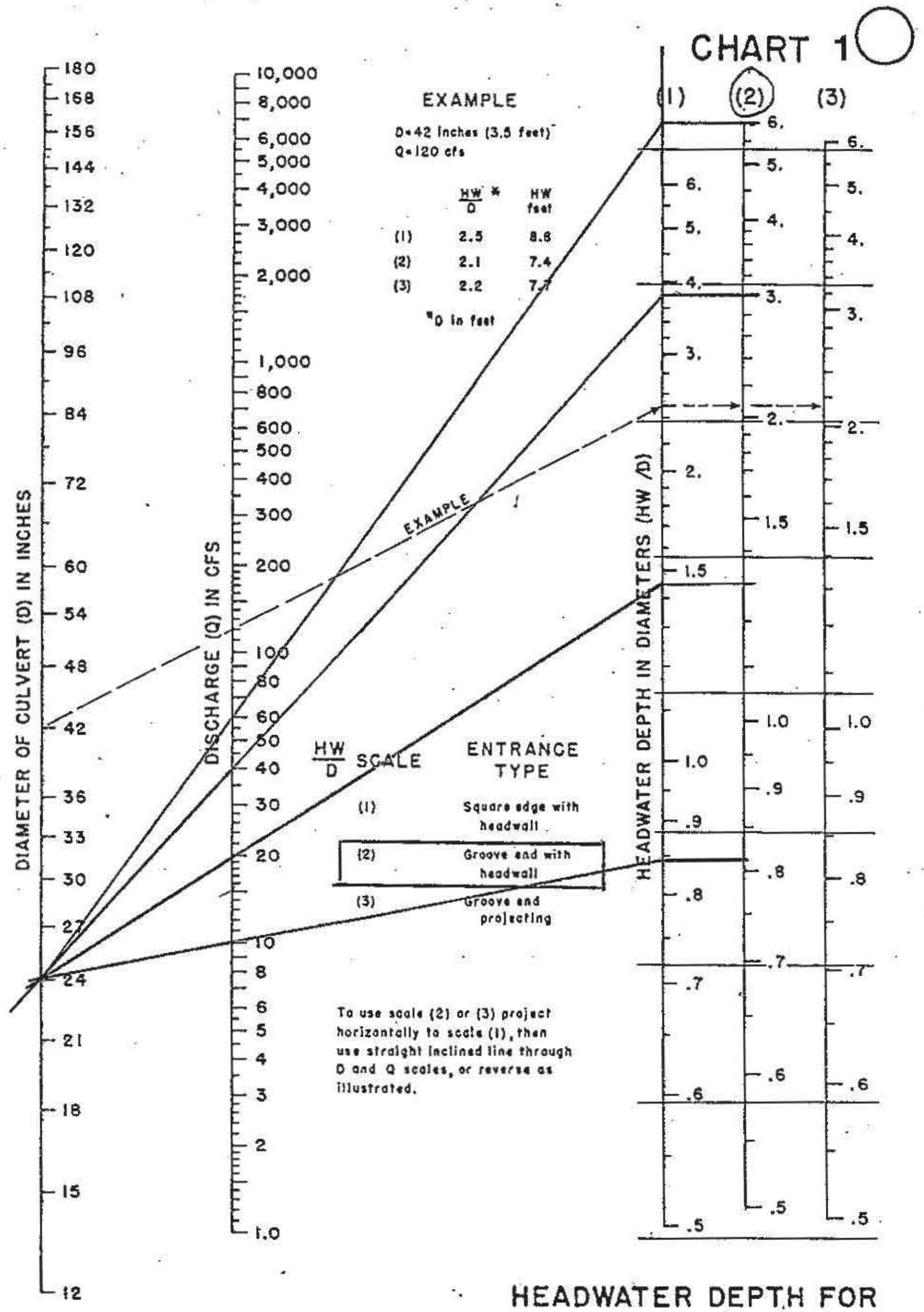
BY MRL DATE 9/13/97 PROJ. NO. 96-410-33

CHKD. BY RNP DATE 23 SEP 97 SHEET NO. 61 OF 70



EXAMPLE

D=42 inches (3.5 feet)
Q=120 cfs

	$\frac{HW}{D}$ *	HW feet
(1)	2.5	8.8
(2)	2.1	7.4
(3)	2.2	7.7

*D in feet

$\frac{HW}{D}$ SCALE	ENTRANCE TYPE
(1)	Square edge with headwall
(2)	Groove end with headwall
(3)	Groove end projecting

To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR
CONCRETE PIPE CULVERTS
WITH INLET CONTROL

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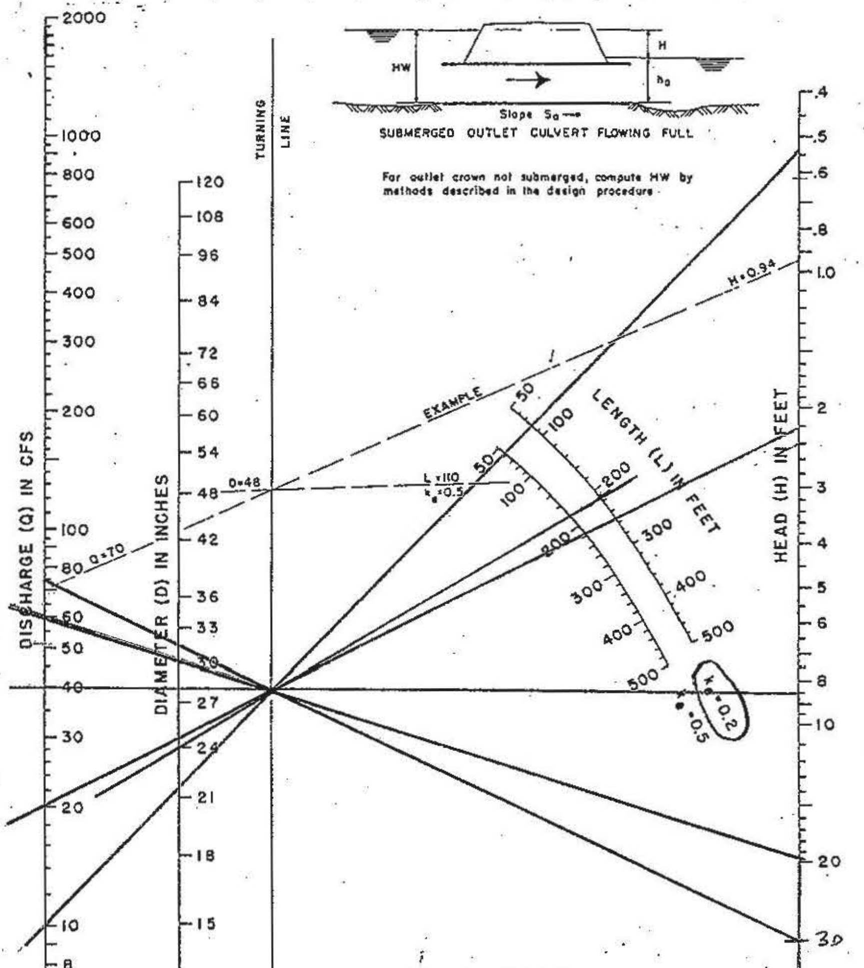

BUREAU OF PUBLIC ROADS JAN. 1963

HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

CHART 5

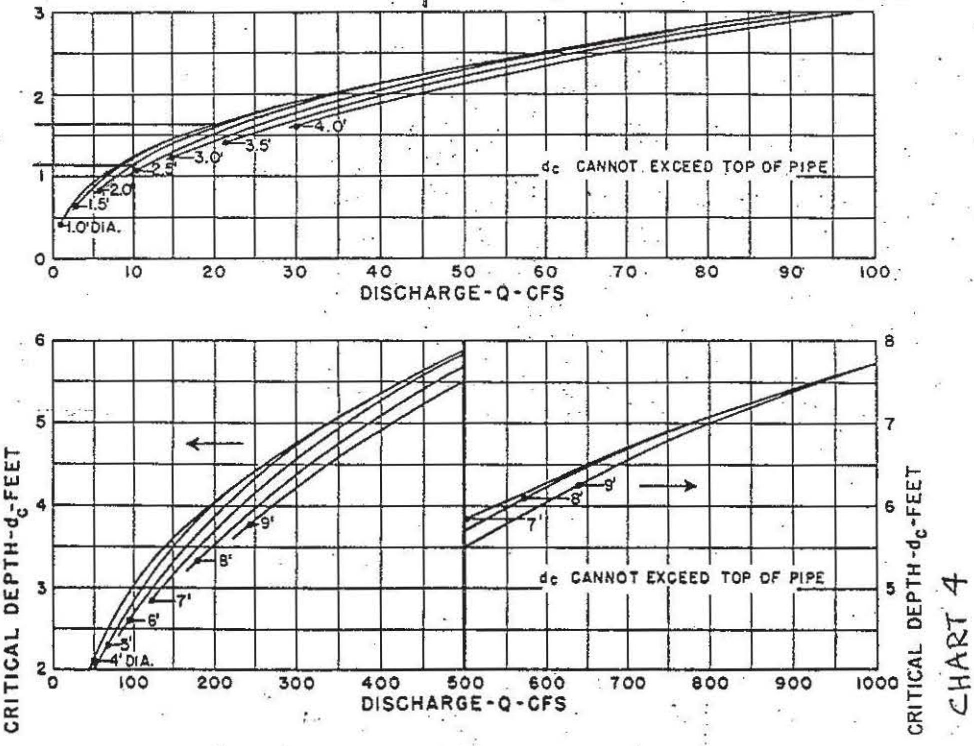

CHART 4

SUBJECT Virginia Power – Chesterfield Closure

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Calculate the stage discharge of the opening into the riser. The opening is formed by the stop planks and is a broad crested weir that can be represented by the equation $Q = 3.1\ L\ H^{3/2}$, where $L = 4'$

$$Q = 3.1(4)\ H^{3/2} = 12.4\ H^{3/2}$$

H (feet)	Q (CFS)	Elev. (feet)
0	0	27
0.2	1.1	27.2
0.4	3.1	27.4
0.6	5.8	27.6
0.8	8.9	27.8
1.0	12.4	28
2	35.1	29
3	64.4	30
4	99.2	31
5	138.6	32
6	182.2	33
7	229.7	34
8	280.6	35
9	334.8	36
10	392.1	37
11	452.4	38
12	515.5	39

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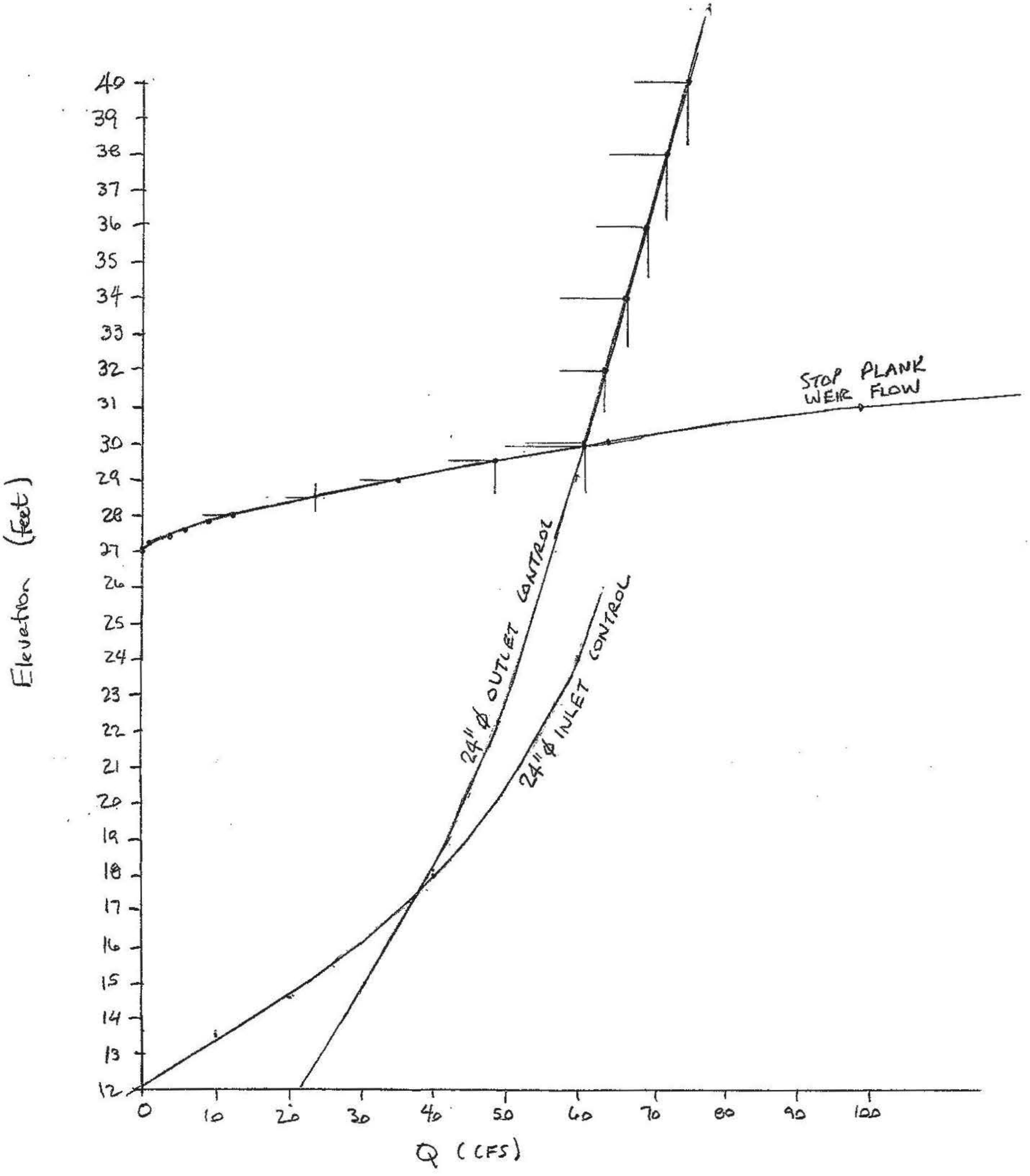
STAGE DISCHARGE CURVE



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STAGE - DISCHARGE - STORAGE TABLE

TEMPORARY SEDIMENT POND

ELEV. (Feet)	DISCHARGE (CFS)	TOTAL STORAGE (Ac-Ft)
27.0	0	5
27.2	1.1	6
27.4	3.1	7
27.6	5.8	8
27.8	8.9	9
28.0	12.4	10
28.5	24	12.5
29.0	35.1	15
29.5	48	17.5
29.9	61	19.5
30.0	61.1	20
32.0	64	31
34.0	67	42
36.0	70	53.5
38.0	73	65.5
40.0	76	79

CHKD 23 SEP 92

66/70

```
1


 ******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*******************

 JOB TR-20                                              SUMMARY    NOPLOTS
 TITLE 111 VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33     CLOSURE.INP
 TITLE     PEAK DISCHARGE CALCULATIONS
  3 STRUCT       01                                                        SEDPOND
  8                         26.0          0.0          0.0
  8                         27.0          0.01         5.0
  8                         27.2          1.1          6.0
  8                         27.4          3.1          7.0
  8                         27.6          5.8          8.0
  8                         27.8          8.9          9.0
  8                         28.0         12.4         10.0
  8                         28.5         24.0         12.5
  8                         29.0         35.1         15.0
  8                         29.5         48.0         17.5
  8                         29.9         61.0         19.5
  8                         30.0         61.1         20.0
  8                         32.0         64.0         31.0
  8                         34.0         67.0         42.0
  8                         36.0         70.0         53.5
  8                         38.0         73.0         65.5
  8                         40.0         76.0         79.0
  9 ENDTBL
  3 STRUCT       02                                                        SEDPOND
  8                         26.0          0.0          0.0
  8                         27.0          0.01         5.0
  8                         27.2          1.1          6.0
  8                         27.4          3.1          7.0
  8                         27.6          5.8          8.0
  8                         27.8          8.9          9.0
  8                         28.0         12.4         10.0
  8                         28.5         24.0         12.5
  8                         29.0         35.1         15.0
  8                         29.5         48.0         17.5
  8                         29.9         61.0         19.5
  8                         30.0         61.1         20.0
  8                         32.0         64.0         31.0
  8                         34.0         67.0         42.0
  8                         36.0         70.0         53.5
  8                         38.0         73.0         65.5
  8                         40.0         76.0         79.0
  9 ENDTBL
```

~~6 RUNOFF 1 001   1   0.0042   85.0   0.140 1   BNGHGGB~~

~~6 RUNOFF 1 001   1   0.0042   74.0   0.230 1   BNGHGRSS~~

~~6 RUNOFF 1 002   1   0.0238   85.0   0.210 1   SD CELL1~~

~~6 RUNOFF 1 002   1   0.0314   83.0   0.190 1   SD CELL5~~

~~6 RUNOFF 1 003   1   0.1033   80.0   0.420 1   PC CELL5~~

```
1


 ********************80-80 LIST OF INPUT DATA (CONTINUED)**********************
```

~~6 RUNOFF 1 003   1   0.1094   74.0   0.520 1   PG CLSED~~

~~6 RUNOFF 1 004   1   0.0202   79.0   0.320 1   SR SWALE~~

ChKd: RHD 23SEP97

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```
~~6 RUNOFF 1 005         1       0.0028       83.0       0.020 1            HR CHAN~~
~~6 RUNOFF 1 005         1       0.0055       79.0       0.120 1            WEST CUL~~
~~6 RUNOFF 1 006         1       0.1797       75.0       0.520 1            FG CHAN~~
 6 RUNOFF 1 006         1       0.1797       85.0       0.530 1            PNDCELL1
 6 RESVOR 2    01 1     2         27.0                        1     1       POND1
 6 RUNOFF 1 006         1       0.1797       81.0       0.420 1            PNDCELL5
 6 RESVOR 2    02 1     2         27.0                        1     1       POND1
   ENDATA
 7 LIST
 7 INCREM 6                     0.0500
 7 COMPUT 7 001        02          0.0         6.2         1.0 2 2   01   01 25-YR
   ENDCMP 1
   ENDJOB 2
```

input from sheet 39

```
0*******************************END OF 80-80 LIST*******************************
1



  TR20 XEQ 09-14-97  16:45       VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33     CLOSURE.INP                JOB  1  PAS
       REV PC 09/83(.2)          PEAK DISCHARGE CALCULATIONS                                                           PAG


  EXECUTIVE CONTROL OPERATION LIST                                                                              RECORD ID


  LISTING OF CURRENT DATA


            STRUCT NO.     ELEVATION   DISCHARGE     STORAGE
  3 STRUCT       1

  8                          26.00         .00          .00
  8                          27.00         .01         5.00
  8                          27.20        1.10         6.00
  8                          27.40        3.10         7.00
  8                          27.60        5.80         8.00
  8                          27.80        8.90         9.00
  8                          28.00       12.40        10.00
  8                          28.50       24.00        12.50
  8                          29.00       35.10        15.00
  8                          29.50       48.00        17.50
  8                          29.90       61.00        19.50
  8                          30.00       61.10        20.00
  8                          32.00       64.00        31.00
  8                          34.00       67.00        42.00
  8                          36.00       70.00        53.50
  8                          38.00       73.00        65.50
  8                          40.00       76.00        79.00
  9 ENDTBL

            STRUCT NO.     ELEVATION   DISCHARGE     STORAGE
  3 STRUCT       2

  8                          26.00         .00          .00
  8                          27.00         .01         5.00
  8                          27.20        1.10         6.00
```

Chkd: RHP 23SEP97

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```
  9.00     ELEV     27.09    27.10    27.10    27.11    27.11    27.12    27.12    27.12    27.13    27.13

  9.50     ELEV     27.14    27.14    27.15    27.16    27.16    27.17    27.17    27.18    27.18    27.19

 10.00     ELEV     27.20    27.20    27.21    27.22    27.22    27.23    27.24    27.25    27.25    27.26

 10.50     ELEV     27.27    27.28    27.29    27.30    27.31    27.32    27.33    27.34    27.36    27.37

 11.00     ELEV     27.38    27.40    27.42    27.43    27.45    27.47    27.49    27.51    27.53    27.55

 11.50     ELEV     27.57    27.60    27.63    27.66    27.71    27.77    27.85    27.95    28.08    28.26

 12.00     ELEV     28.47    28.73    29.03    29.35    29.65    29.92    30.14    30.32    30.46    30.57

 12.50     ELEV     30.65    30.72    30.77    30.81    30.84    30.86    30.88    30.89    30.90    30.90

 13.00     ELEV     30.90    30.90    30.89    30.88    30.88    30.86    30.85    30.84    30.82    30.80

 13.50     ELEV     30.79    30.77    30.75    30.73    30.71    30.68    30.66    30.64    30.61    30.59

 14.00     ELEV     30.56    30.54    30.51    30.49    30.46    30.43    30.40    30.38    30.35    30.32

 14.50     ELEV     30.29    30.26    30.23    30.20    30.17    30.14    30.11    30.08    30.04    30.01



TR20 XEQ 09-14-97  16:45        VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33     CLOSURE.INP              JOB  1   PASS   2
     REV PC 09/83(.2)           PEAK DISCHARGE CALCULATIONS                                                          PAGE  12



EXECUTIVE CONTROL OPERATION ENDCMP                                                                        RECORD ID
                                        COMPUTATIONS COMPLETED FOR PASS   1



EXECUTIVE CONTROL OPERATION ENDJOB                                                                        RECORD ID



R20 XEQ 09-14-97  16:45         VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33     CLOSURE.INP              JOB  1   SUMMARY
     REV PC 09/83(.2)           PEAK DISCHARGE CALCULATIONS                                                          PAGE  13


SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
                  (A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
                   A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

ECTION/    STANDARD               RAIN  ANTEC  MAIN          PRECIPITATION                             PEAK DISCHARGE
TRUCTURE    CONTROL   DRAINAGE   TABLE  MOIST  TIME    -------------------------  RUNOFF   ------------------------------------
           OPERATION    AREA       #    COND  INCREM  BEGIN    AMOUNT  DURATION  AMOUNT   ELEVATION    TIME      RATE      RATE
                      (SQ MI)                  (HR)   (HR)     (IN)     (HR)     (IN)      (FT)       (HR)     (CFS)     (CSM)


   ALTERNATE     1   STORM     1
```

ChKd = RHP 23 SEP 97

```
~~XSECTION  1  RUNOFF     .00    2     2    .05     .0     6.20   24.00    3.63     ---     11.99     15.61    3716.0~~
~~XSECTION  1  RUNOFF     .00    2     2    .05     .0     6.20   24.00    2.58             12.05     10.89    2593.4~~
~~XSECTION  2  RUNOFF     .02    2     2    .05     .0     6.20   24.00    3.62             12.03     81.56    3427.1~~
~~X     TON  2  RUNOFF     .03    2     2    .05     .0     6.20   24.00    3.42             12.02    105.53    3360.8~~
~~X     ION  3  RUNOFF     .10    2     2    .05     .0     6.20   24.00    3.10             12.15    238.80    2311.7~~

~~XSECTION  3  RUNOFF     .11    2     2    .05     .0     6.20   24.00    2.54     ---     12.21    189.71    1734.1~~
~~XSECTION  4  RUNOFF     .02    2     2    .05     .0     6.20   24.00    3.02             12.09     51.99    2573.6~~
~~XSECTION  5  RUNOFF     .00    2     2    .05     .0     6.20   24.00    3.40             11.98     11.75    4196.0~~
~~XSECTION  5  RUNOFF     .01    2     2    .05     .0     6.20   24.00    3.05             11.99     18.60    3381.9~~
~~XSECTION  6  RUNOFF     .18    2     2    .05     .0     6.20   24.00    2.63             12.21    321.06    1786.6~~

 XSECTION  6  RUNOFF     .18    2     2    .05     .0     6.20   24.00    3.57     ---     12.21    407.57    2268.1
 STRUCTURE 1  RESVOR     .18    2     2    .05     .0     6.20   24.00    1.67    31.36    13.15     63.08     351.0
 XSECTION  6  RUNOFF     .18    2     2    .05     .0     6.20   24.00    3.19     ---     12.15    425.50    2367.8
 STRUCTURE 2  RESVOR     .18    2     2    .05     .0     6.20   24.00    1.62    30.90    12.95*    62.41*    347.3
1



 TR20 XEQ 09-14-97  16:45       VIRGINIA POWER; CHESTERFIELD CLOSURE 96-410-33     CLOSURE.INP            JOB  1   SUMMARY
    REV PC 09/83(.2)            PEAK DISCHARGE CALCULATIONS                                                        PAGE  14



 UMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

 XSECTION/          DRAINAGE
  TRUCTURE            AREA        STORM NUMBERS..........
                     (SQ MI)          1

  STRUCTURE   2          .18
               ---------------
   ALTERNATE    1                   62.41
0 STRUCTURE   1          .18
               ---------------
   ALTERNATE    1                   63.08
0 XSECTION    1          .00
               ---------------
   ALTERNATE    1                   10.89
0 XSECTION    2          .03
               ---------------
   ALTERNATE    1                  105.53
0 XSECTION    3          .11
+              ---------------
   ALTERNATE    1                  189.71
0 XSECTION    4          .02
+              ---------------
   ALTERNATE    1                   51.99
0 XSECTION    5          .01
+              ---------------
   ALTERNATE    1                   18.60
0 XSECTION    6          .18
+              ---------------
      ERNATE    1                  425.50


 MAIN - UNEXPECTED RECORD FOUND(IGNORED) >>>                                                                  <<<
1  D OF  1 JOBS IN THIS RUN
```

Elevations from 25-yr. 24-hr. storm are less than 39' (see sheet 52).

Therefore, the temporary sediment pond can handle a 25-yr. storm.

SUBJECT Virginia Power – Chesterfield Closure

BY MRL DATE 9/15/97 PROJ. NO. 96-410-33

CHKD. BY PHP DATE 23 SEP 97 SHEET NO. 70 OF 70

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CALCULATE DEWATERING TIME

"Dry" storage requirements are 67 yd.^{3}/acre (see sheet 52)

67 yd.^{3}/acre × 115 acres = 7705 yd^3 (see sheet 56)

7705 yd.^{3} = 4.8 ac-ft ≅ 5 ac-ft

→ 5 ac-ft. above the permanent pool (elev. 27) results in a pond elevation of approximately 28 (see sheet 55)

Calculate the dewatering time from elev. 28 to elev. 27.

Elev. (ft.) *	Storage volume (ft.^{3}) *	Δ storage Volume (ft.^{3})	Q (CFS) *	avg. Q (CFS)	Dewatering Time (hrs.)	Accum. Dewatering Time (hrs.)
28	217,800		12.4			
		43,560		10.7	1.13	1.13
27.8	174,240		8.9			
		43,560		7.4	1.64	2.77
27.6	130,680		5.8			
		43,560		4.5	2.69	5.46
27.4	87,120		3.1			
		43,560		2.1	5.76	11.22
27.2	43,560		1.1			
		43,560		0.6	20.17	31.39
27.0	0		0			

Dewatering time = 31.4 hrs., which is > 6 hrs. ∴ O.K.

* Information from sheet 65 (5 ac-ft. of permanent pool below elev. 27 not included)

SUBJECT ______________________

BY __________ DATE __________ PROJ. NO. __________

CHKD. BY __________ DATE __________ SHEET NO. ______ OF ______

UNIVERSAL SOIL LOSS

EQUATION CALCULATIONS

SUBJECT Virginia Power - Chesterfield Closure
USLE
BY MRL DATE 9/4/97 PROJ. NO. 96-410-33
CHKD. BY RHP DATE 23SEP97 SHEET NO. 1 OF 8

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UNIVERSAL SOIL LOSS EQUATION

Estimate the rate of soil erosion that would take place on the stabilized final cover of the ash fill site. The locations analyzed will be the longest and steepest slopes for the entire site.

Soil erosion rates will be calculated using the UNIVERSAL SOIL LOSS EQUATION (USLE). The soil loss equation is ...

$A = RKLSCP$

where : A = Soil loss in tons of soil per acre per year
R = Rainfall and runoff factor
K = Soil erodibility factor
L = Slope - length factor
S = Slope - steepness factor
C = Cover and management factor
P = Support practice factor

Agricultural Handbook # 537, "Predicting Rainfall Erosion Losses, A Guide to Conservation Planning", published by the United States Department of Agriculture, was used to determine the factors required for use in the USLE. The Chesterfield County Soil Survey, published by the USDA National Resource Conservation Service, was used to assist in determining the K factor.

SUBJECT Virginia Power – Chesterfield Closure
USLE

BY MRL DATE 9/4/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23SEP97 SHEET NO. 2 OF 8

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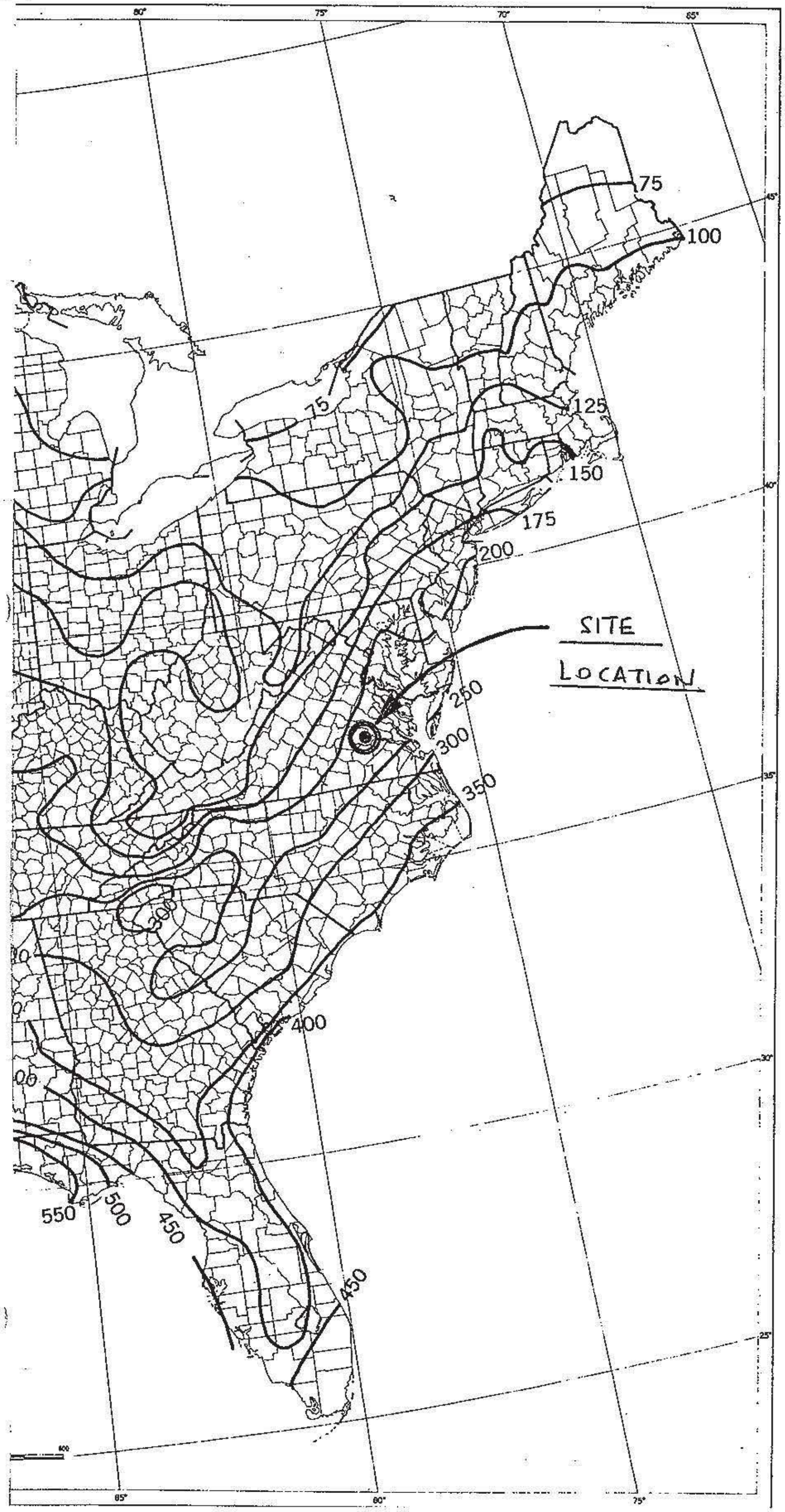
AVERAGE ANNUAL VALUES OF THE RAINFALL EROSION INDEX



$\boxed{R = 220}$

Erosive forces of runoff from spring thaw, snowmelt, or irrigation, are not included, and are considered insignificant.

SUBJECT Virginia Power – Chesterfield Closure
USLE

BY MRL DATE 9/10/97 PROJ. NO. 96-410-33
CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 3 OF 8

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K – SOIL ERODIBILITY FACTOR

The 12" thick final soil cover shall be obtained from the surrounding area(s). The soil from these areas generally consist of clayey or loamy subsoils (see next page).

TABLE 5. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[11]

Texture class	Organic matter content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

Kavg. = 0.34

Kavg. = 0.25

Kavg. = 0.21

Kavg. = 0.27

USE K=0.3

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

(REFERENCE: USEPA "Evaluating Cover Systems for Solid and Hazardous Waste")

SUBJECT Virginia Power - Chesterfield Closure
USLE

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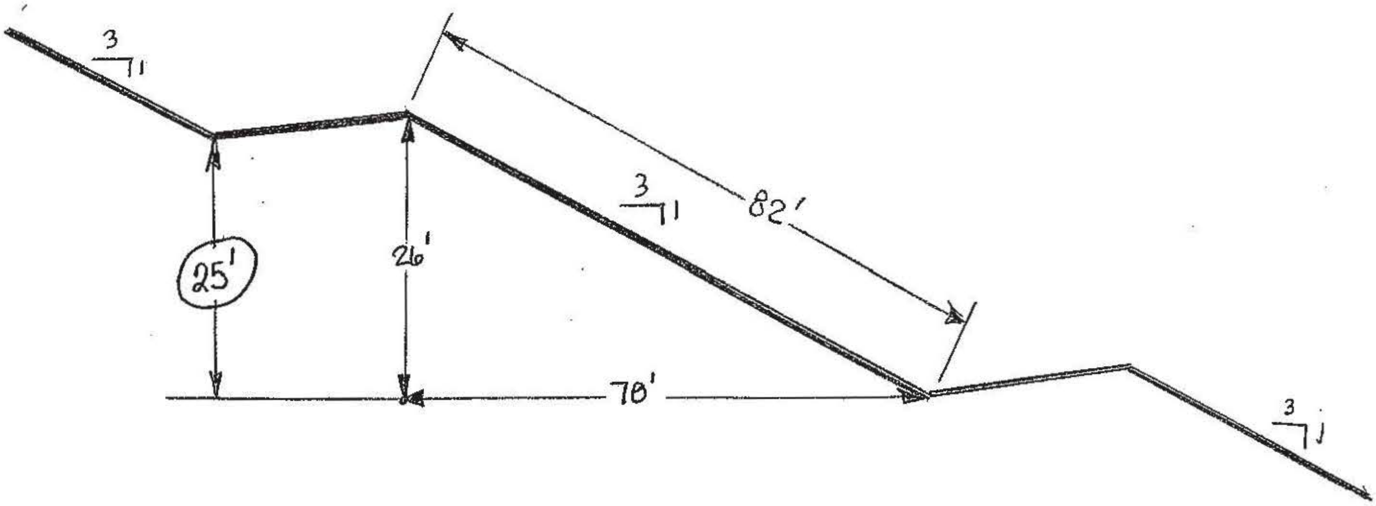
CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 5 OF 8

▲ Rev. MRL 10/21/97

LS FACTOR

The length and steepness factor are considered as a single topographic factor, LS. Benches will be used with the final closure to limit the length of flow. Maximum vertical spacing between benches shall be 25 feet as shown below.



From the above bench geometry, the maximum flow length is 82'.

The maximum slope = 1/3 = 33.3%

Use the chart on the following page to determine the LS Factor.

▲ Also, look at the final top surface.
Maximum flow length ≅ 600'
Corresponding slope ≅ 2%

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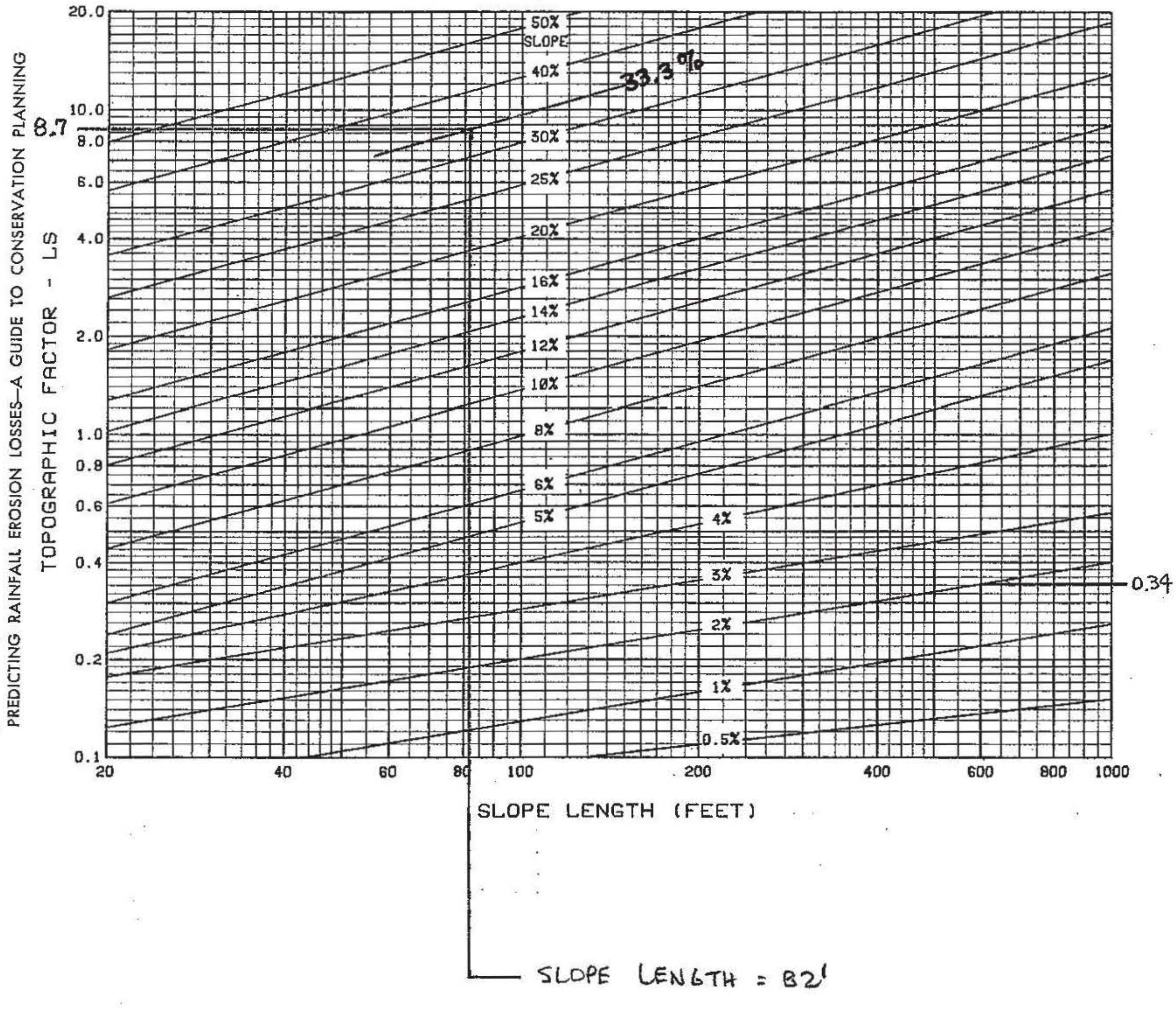
▲ Rev. MRL 10/21/97

$\boxed{LS = 8.7}$ on 3H:1V slopes



▲ $\boxed{LS = 0.34}$ on 2% top slope

SUBJECT Virginia Power - Chesterfield Closure
USLE

BY MRL DATE 9/10/97 PROJ. NO. 96-410-33

CHKD. BY RHP DATE 23 SEP 97 SHEET NO. 7 OF 8

C - COVER AND MANAGEMENT FACTOR

After final vegetative stabilization of the site, the surface will be covered with grasses and/or low growing legumes. 95+ % of the ground will be covered with plants or vegetative litter.

The "C" value is estimated to be $\boxed{C = 0.003.}$

TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
			Percent ground cover					
Type and height[2]	Percent cover[3]	Type[4]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011

[1] The listed **C** values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.
W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

P - SUPPORT PRACTICE FACTOR

No associated conservation support practices proposed.

Therefore, $\boxed{P = 1.0}$

SUBJECT Virginia Power – Chesterfield Closure
USLE

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▲ Rev. MRL 10/21/97

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CALCULATE EROSION RATES

$$A = RK(LS)CP$$

FOR 3H:1V SLOPES : $A = (220)(0.3)(8.7)(0.003)(1.0) =$ 1.7 tons/acre/year

▲ FOR 2% TOP SLOPE : $A = (220)(0.3)(0.34)(0.003)(1.0) =$ 0.1 tons/acre/year

Soil loss tolerances range from *2 to 5 tons/acre/year. Therefore, the estimated 1.7 tons/acre/year is acceptable.

* Reference: Agricultural Handbook #537, "Predicting Rainfall Erosion Losses, A Guide to Conservation Planning", USDA, page 3, paragraph 2.

SUBJECT Virginia Power – Chesterfield Closure

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CHKD. BY ______ DATE ______ SHEET NO. ______ OF ______

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STABILITY ANALYSIS CALCULATIONS

SUBJECT CHESTERFIELD POWER STATION CLOSURE PLAN
VIRGINIA POWER
BY NCBA DATE 08 Apr 2003 PROJ. NO. 1996-410-37
CHKD. BY KCC DATE 5-15-03 SHEET NO. 1 OF 8

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OBJECTIVE:

Evaluate the slope stability of the Chesterfield Upper Pond (Figure 1). The slope stability analyses will be conducted for three cases:

I. 1998 conditions
II. Proposed Phase I pond levels at approximately El. 80 ft.
III. Proposed Phase II pond levels at approximately El. 130 ft.

METHODOLOGY:

Slope stability will be evaluated for both static and seismic conditions. Stability will be evaluated using limit equilibrium methodology using Bishop's method (ordinary and Janbu) via SLOPE/W analyses.

REFERENCES:

1. Project 02131106.01, Geotechnical Engineering Services, Ash Moisture Criteria Evaluation, Chesterfield Power Station, Dominion Generation, Chesterfield County, Virginia, dated May 5, 2003. Prepared by Schnabel Engineering Associates, Inc. (Copy included in Appendix B2).

2. Project 02131106.01, Response to VDEQ Comments of January 21, 2003, Ash Shear Strength Evaluation, Chesterfield Power Station, Dominion Generation, Chesterfield County, Virginia, dated February 13, 2003. Prepared by Schnabel Engineering Associates, Inc. (Copy included in Appendix B2).

3. Project 02131106.01, Geotechnical Engineering Services, Ash Shear Strength Evaluation, Chesterfield Power Station, Dominion Generation, Chesterfield County, Virginia, dated December 13, 2002. Prepared by Schnabel Engineering Associates, Inc. (Copy included in Appendix B2).

4. Geotechnical Engineering Study, Long Term Ash Storage Pond Dike, Chesterfield County, Virginia, dated April 22, 1996. Prepared by Schnabel Engineering Associates, Inc.

5. Final report, Virginia Power Chesterfield Inactive Pond, dated April 14, 1997. Prepared by GAI.

SUBJECT CHESTERFIELD POWER STATION CLOSURE PLAN
VIRGINIA POWER
BY NCBA DATE 08 Apr 2003 PROJ. NO. 1996-410-37
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6. Geotechnical Engineering and Groundwater Hydrology Services, Ash Disposal Pond, Chesterfield Power Station, dated 12/20/82. Prepared by Schnabel Engineering Associates, Inc.

7. Conceptual Closure Plan, Phase I, Upper (East) Ash Pond, Chesterfield Power Station, Drawing No. 96-410-F3, Sheet 1 of 2.

8. Conceptual Closure Plan, Phase II, Upper (East) Ash Pond, Chesterfield Power Station, Drawing No. 96-410-F4, Sheet 2 of 2.

9. Sections and Details, Upper (East) Ash Pond, Chesterfield Power Station, Drawing No. 96-410-F4, Sheet 2 of 2.

10. SEA Project 963321, Slope Inclinometer Readings, Henricus Park Road, Chesterfield County, Virginia, May 21, 1997.

11. SEA Project 963321, Slope Inclinometer Readings, Henricus Park Road, Chesterfield County, Virginia, July 22, 1997.

12. U.S. Army Corps of Engineers publication ER 1110-2-1806, "Engineering and Design – Earthquake Design and Evaluation for Civil Works Projects", dated 31 July 1995.

ASSUMPTIONS:

1) Steady state conditions in the pond.

2) Properties of the ash in the pond are homogeneous.

3) Water levels of the ash placement area are located at or below an elevation of approximately 27 feet above MSL.

4) Ash will be added to the existing placement area using dry disposal methods and is assumed not to increase water levels in the placement area.

5) Pseudo static analysis, seismic coefficient used = 0.075.

6) For sections with a toe berm, the phreatic surface came down to the top of the berm:

SUBJECT CHESTERFIELD POWER STATION CLOSURE PLAN
VIRGINIA POWER

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ANALYSIS:

Data on the subsurface geology and general subsurface stratigraphy are obtained from references 4 and 6.

Soil strength parameters are based on testing done by Schnabel (references 4 and 6); the ash strength parameters are based on strength laboratory testing (references 3 and 5). The soil parameters used for stability are presented in Table 1.

TABLE 1 – Soil Parameters Used in Slope Stability Analyses

Soil description	γ_T (pcf)	$\phi=\phi'$ (degrees)	c=c' (psf)
Embankment fill/ dike fill	125	32	0
Road fill	110	27	0
Alluvium	100	23	0
Silty Sand	130	35	0
Clayey silt	110	30	0
Loose sand	110	30	0
Clay	110	27	0
Silty/clayey sand	140	40	0
Sandy clay/clayey sand	135	35	0
Marsh soil	95	9	40
Ash	92	30	0

The stability of nine sections was analyzed. The sections were A-A through I-I. Three cases were considered for each section (refer to pp. 1 of these calculations). Refer to Figure 1 of these calculations for the approximate location of the sections.

Section A-A

Figure 1 shows the location of section A-A. Figure 2 shows a graphical layout of section A-A in SLOPE/W.

SUBJECT CHESTERFIELD POWER STATION CLOSURE PLAN
VIRGINIA POWER
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Results

The results obtained for sections A-A through I-I are shown in Tables 2, 3 and 4. The SLOPE/W runs for sections A-A and I-I are presented in Appendix C1.

TABLE 2 - Summary of Dike Minimum Safety Factors
Sections A-A through G-G (***seismic coefficient = 0.075***)

Section	**Case I**	**Case II**	**Case III**
A-A(1)	1.61	1.61	1.61
B-B	1.21	1.17	1.17
C-C	1.50	1.58	1.60
D-D	1.45	1.41	1.40
E-E	2.01	1.42	1.49
F-F	1.64	1.65	1.54
G-G (Ash only)	1.66	1.64	1.75

(1) Plots included in Appendix B1

TABLE 3 - Summary of Dike Minimum Safety Factors
Sections H-H and I-I (***seismic coefficient = 0.075***)

Section	**Ash at El. 26 Water at El. 32**		**Ash at El. 32 Water at El. 32**	
	Road	Dike	Road	Dike
H-H	**0.90**	**1.41**	**0.90**	**1.41**
I-I(1)	**0.54**	**1.50**	**0.62**	**1.50**

(1) Plots included in Appendix B1

SUBJECT CHESTERFIELD POWER STATION CLOSURE PLAN
VIRGINIA POWER

BY NCBA DATE 08 Apr 2003 PROJ. NO. 1996-410-37

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TABLE 4 - Summary of Minimum Factors of Safety for Section A-A (Case III)

Plot No. (1)	Modified parameter	Minimum F.S.	Occurrence of failure	Comments
1	None	0.91	At toe of dike	Phreatic surface to El. 27. Localized failure.
2	Seismic coefficient = 0	1.20	At toe of dike	Phreatic surface to El. 27. Stable.
3	C = 850	0.91	At toe of dike	Same as plot no. 1.
4	Phreatic surface @ El. 38 to toe of dike	1.21	At toe of dike and through alluvium	S.F. > 1.5 for seismic coefficient = 0.
5	Phreatic surface @ El. 38 to toe of dike. Seismic coefficient = 0	1.69	At toe of dike and through alluvium	
6	None	1.63	Along bench surface	
7	None	1.84	Circular failure along pile	S.F. > 1.8 under seismic conditions.
8	γ_{ash} = 103 pcf (vs. 92 pcf)	1.82	Circular failure along pile	S.F. > 1.8 under seismic conditions.

(1) **Plots included in Appendix B1**

CONCLUSIONS AND RECOMMENDATIONS:

- The ash placement area should be stable for cases I, II, and III at the assumed water levels with the parameters defined and used.
- The dike should be stable for cases I, II and III at the assumed water levels. Maintenance may be required to fix local instabilities at the toe of the dike.
- North and South dike instability areas (sections H-H and I-I at the eastern end of the pond) may experience continued instability at present conditions. If these conditions are not mitigated, these instabilities will likely be present for the proposed closure phases. It is recommended placement of material be terminated at the same elevation as the top of the dike.

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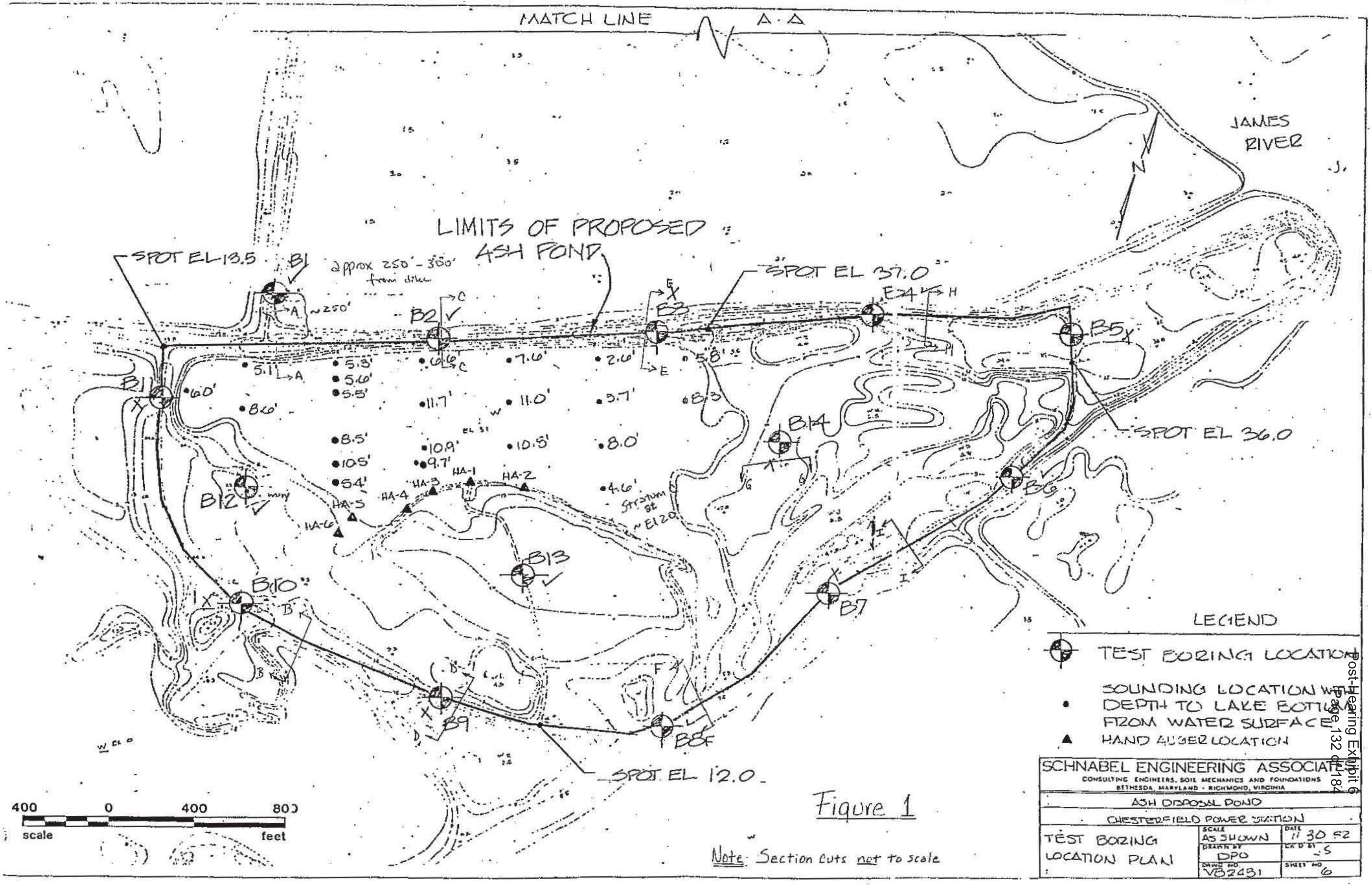
- The ash should be placed and compacted as follows. Ash should be placed in lifts not exceeding one foot. Around the perimeter of the dike, and for a minimum distance of 50 feet from the final surface, each lift should be compacted at optimum moisture within a tolerance of plus or minus four (4) percent and to a density of at least 95 percent of Standard Proctor maximum dry density. A lower dry percent of optimum moisture, six (6) percent, may be achieved with a higher compaction effort (reference 1). Everywhere else, each lift should be compacted at optimum moisture within a tolerance of plus six (6) percent or minus eight (8) percent optimum and to a density of at least 92 percent of Standard Proctor maximum dry density. A lower dry percent of optimum moisture, eight (8) percent, may be achieved with a higher compaction effort (reference 1).

- Future consolidated undrained (CU) tests are recommended to determine the strength parameters for the short-term, undrained loading conditions.

- Future test on FGD material and co-mingled FGD and ash materials are recommended to confirm the parameters used herein.



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BETHESDA, MARYLAND · RICHMOND, VIRGINIA

ASH DISPOSAL POND

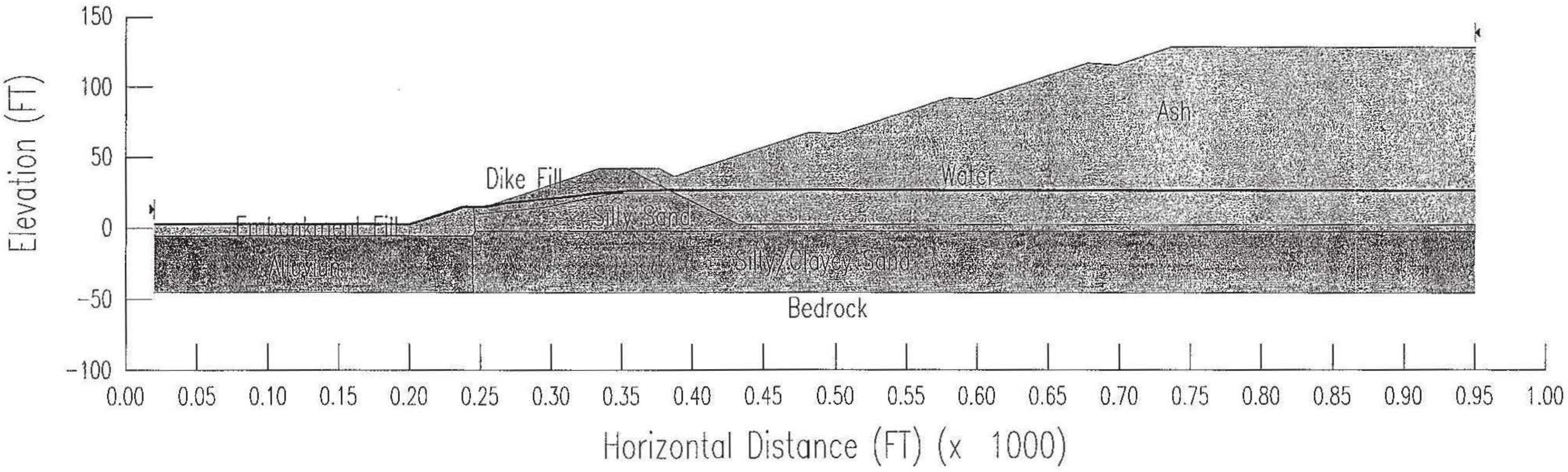
CHESTERFIELD POWER STATION

TEST BORING LOCATION PLAN	SCALE AS SHOWN	DATE 11 30 82
	DRAWN BY DPO	CK'D BY JS
	DRWG NO. V82431	SHEET NO 6

Figure 1

Note: Section cuts not to scale

FIGURE 2 - SECTION A-A



SUBJECT CHESTERFIELD POWER STATION CLOSURE PLAN
VIRGINIA POWER

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APPENDIX B1

SLOPE/W OUTPUT RESULTS

Chesterfield Stability Analysis
Section A-A - Case I
16 April 2003
File Name 96410A1B.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Soil 1
Water
Soil Model No Strength
Unit Weight 62.4

Soil 2
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 3
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

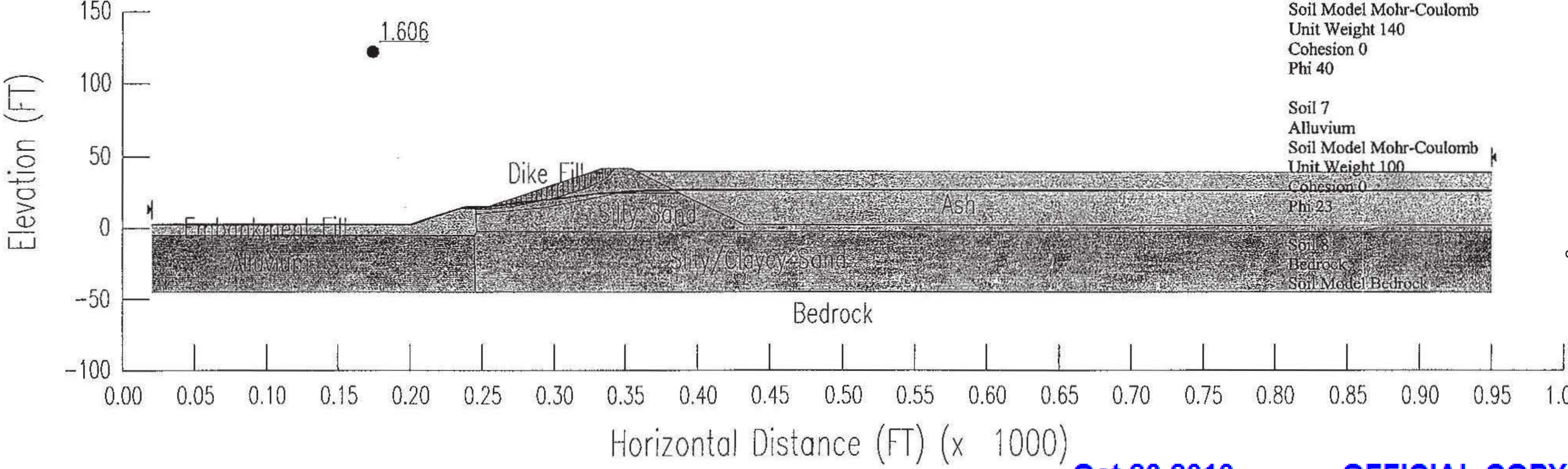
Soil 4
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 5
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 6
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 7
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 8
Bedrock
Soil Model Bedrock



Chesterfield Stability Analysis
Section A-A - Case II
16 April 2003
File Name 96410A2B.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Soil 1
Water
Soil Model No Strength
Unit Weight 62.4

Soil 2
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 3
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

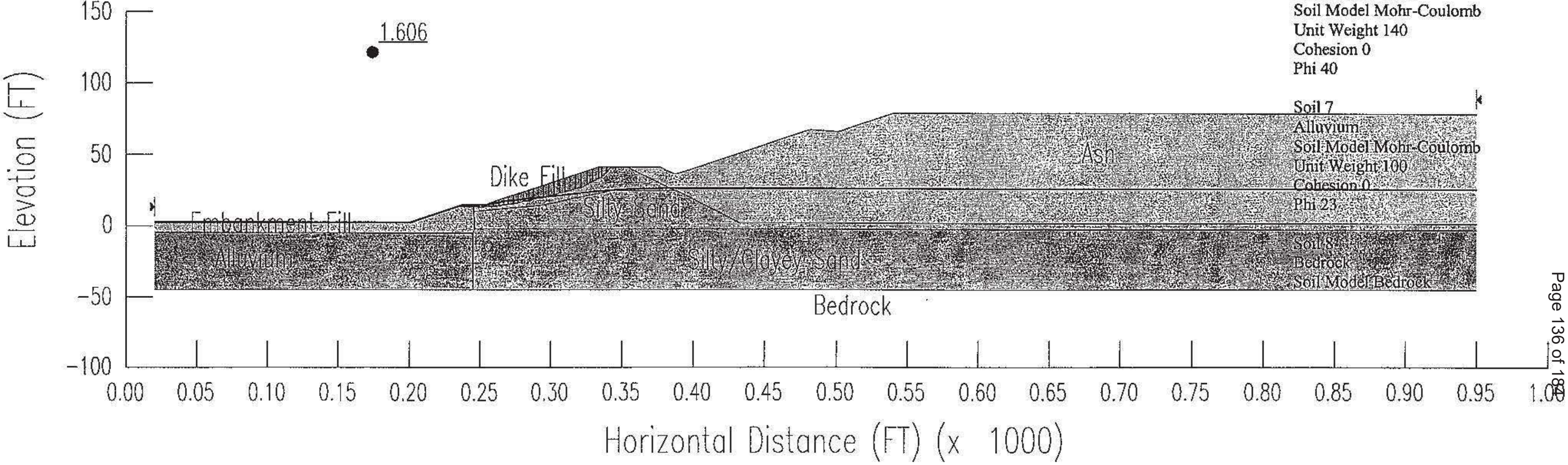
Soil 4
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 5
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 6
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 7
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 8
Bedrock
Soil Model Bedrock



Chesterfield Stability Analysis
Section A-A - Case III
16 April 2003
File Name 96410A3B.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Soil 1
Water
Soil Model No Strength
Unit Weight 62.4

Soil 2
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 3
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

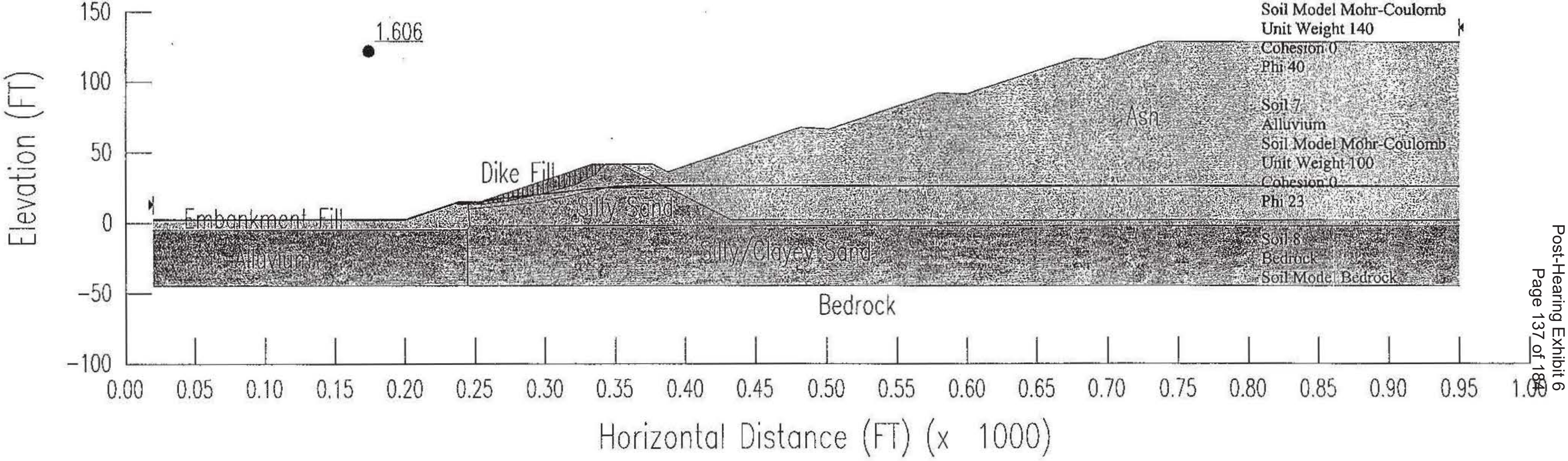
Soil 4
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 5
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 6
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 7
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 8
Bedrock
Soil Model Bedrock



Chesterfield Stability Analysis
Section I-I, South Dike
16 April 2003
File Name 96410II-2.SLZ
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Soil 1
Water
Soil Model No Strength
Unit Weight 62.4

Soil 2
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 3
Road Fill
Soil Model Mohr-Coulomb
Unit Weight 110
Cohesion 0
Phi 27

Soil 4
Alluvial Soil
Soil Model Mohr-Coulomb
Unit Weight 95
Cohesion 40
Phi 9

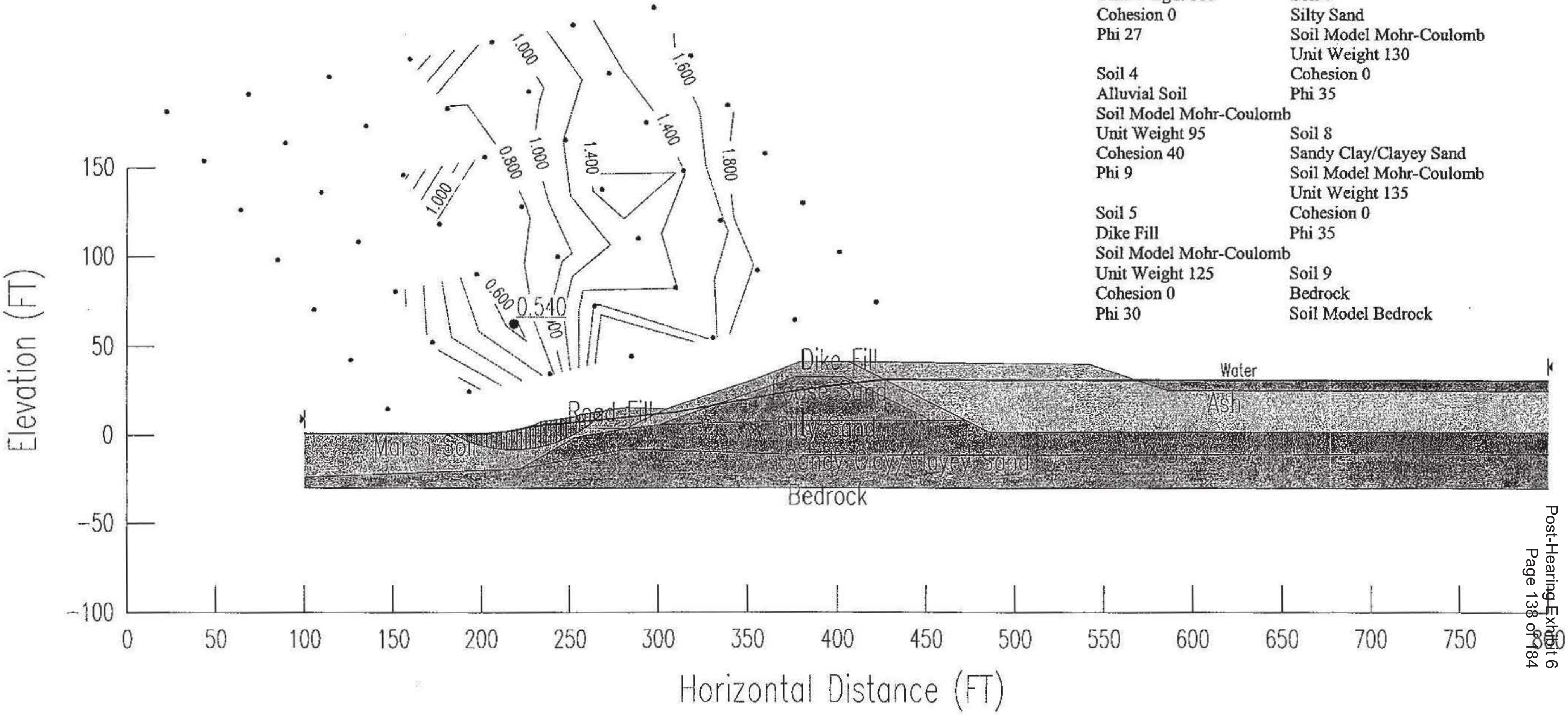
Soil 5
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 30

Soil 6
Loose Sand
Soil Model Mohr-Coulomb
Unit Weight 110
Cohesion 0
Phi 30

Soil 7
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 8
Sandy Clay/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 135
Cohesion 0
Phi 35

Soil 9
Bedrock
Soil Model Bedrock



Chesterfield Stability Analysis
Section I-I, South Dike
16 April 2003
File Name 96410II-dike 1.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Soil 1
Water
Soil Model No Strength
Unit Weight 62.4

Soil 2
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 3
Road Fill
Soil Model Mohr-Coulomb
Unit Weight 110
Cohesion 0
Phi 27

Soil 4
Alluvial Soil
Soil Model Mohr-Coulomb
Unit Weight 95
Cohesion 40
Phi 9

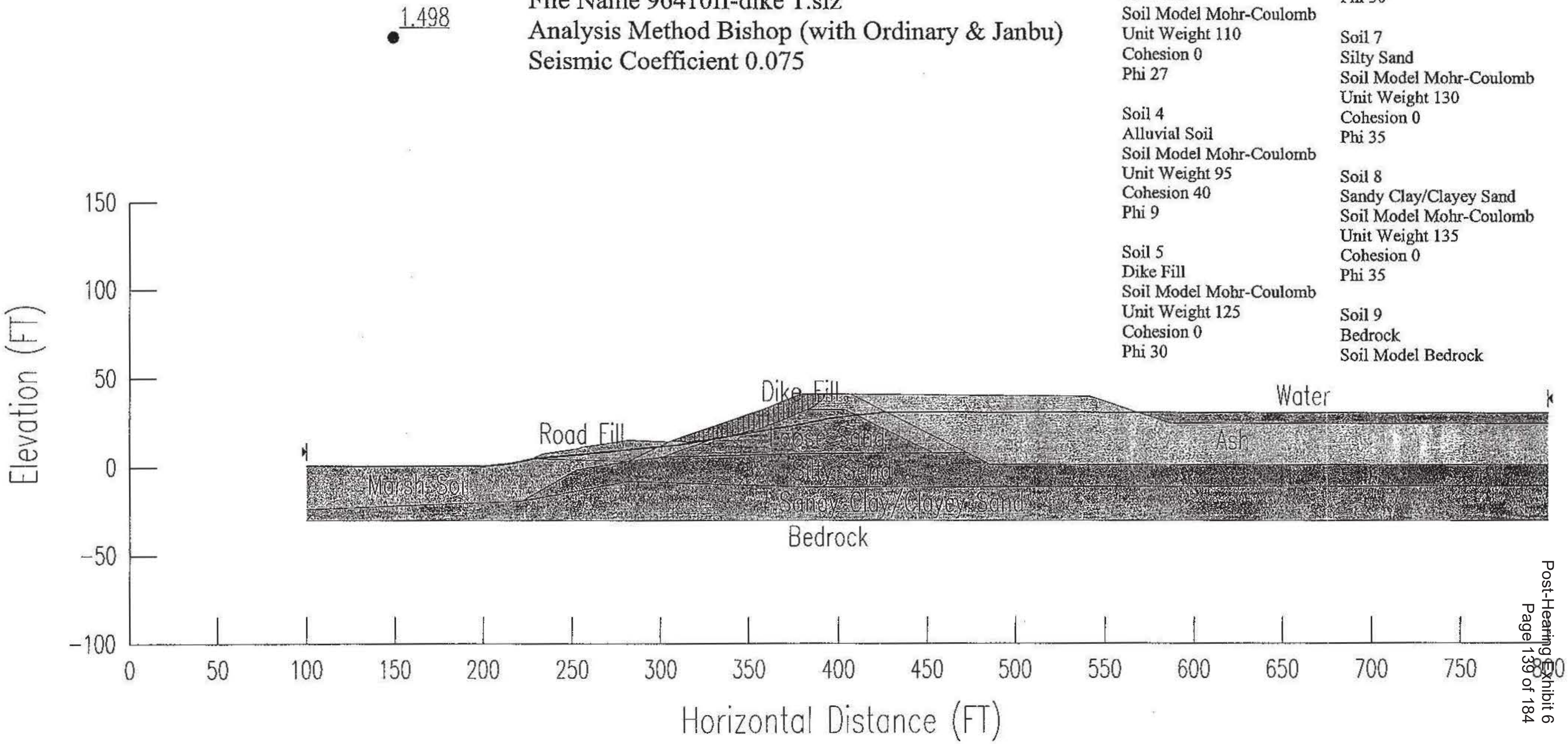
Soil 5
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 30

Soil 6
Loose Sand
Soil Model Mohr-Coulomb
Unit Weight 110
Cohesion 0
Phi 30

Soil 7
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 8
Sandy Clay/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 135
Cohesion 0
Phi 35

Soil 9
Bedrock
Soil Model Bedrock



Chesterfield Stability Analysis
Section I-I, South Dike
16 April 2003
File Name 96410II-road 2.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Soil 1
Water
Soil Model No Strength
Unit Weight 62.4

Soil 2
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 3
Road Fill
Soil Model Mohr-Coulomb
Unit Weight 110
Cohesion 0
Phi 27

Soil 4
Alluvial Soil
Soil Model Mohr-Coulomb
Unit Weight 95
Cohesion 40
Phi 9

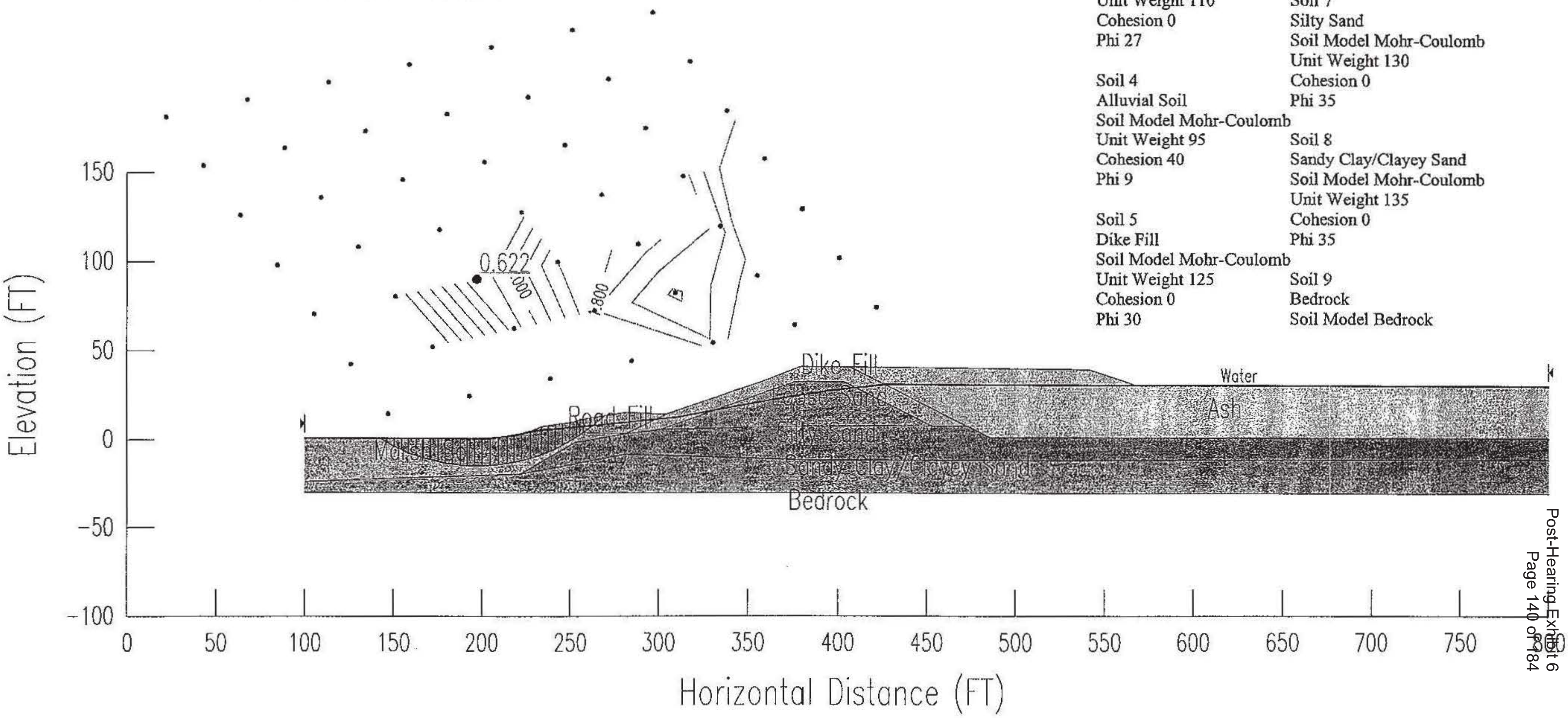
Soil 5
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 30

Soil 6
Loose Sand
Soil Model Mohr-Coulomb
Unit Weight 110
Cohesion 0
Phi 30

Soil 7
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 8
Sandy Clay/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 135
Cohesion 0
Phi 35

Soil 9
Bedrock
Soil Model Bedrock



Chesterfield Stability Analysis
Section I-I, South Dike
16 April 2003
File Name 96410II-dike 2.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Soil 1
Water
Soil Model No Strength
Unit Weight 62.4

Soil 2
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 3
Road Fill
Soil Model Mohr-Coulomb
Unit Weight 110
Cohesion 0
Phi 27

Soil 4
Marsh Soil
Soil Model Mohr-Coulomb
Unit Weight 95
Cohesion 40
Phi 9

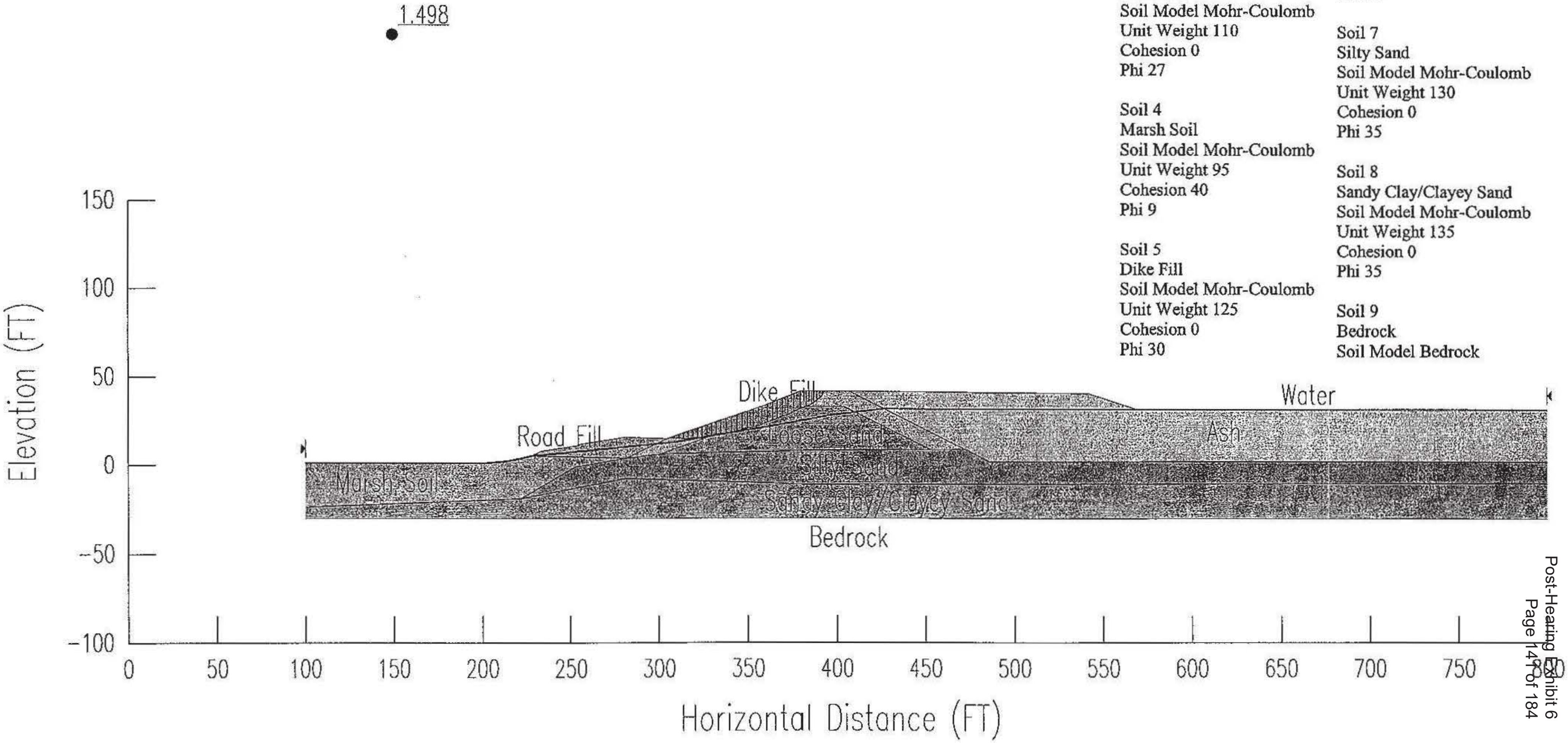
Soil 5
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 30

Soil 6
Loose Sand
Soil Model Mohr-Coulomb
Unit Weight 110
Cohesion 0
Phi 30

Soil 7
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

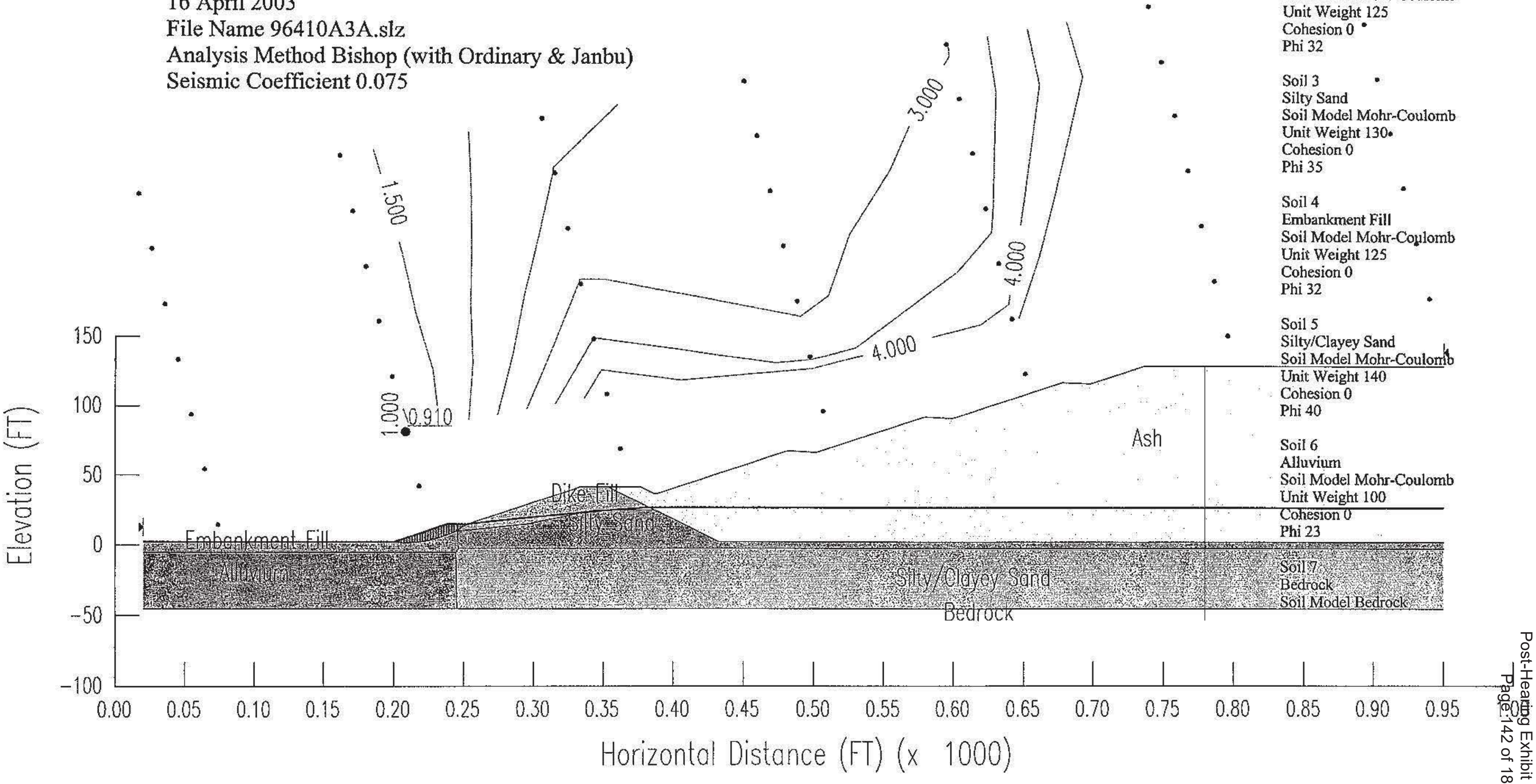
Soil 8
Sandy Clay/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 135
Cohesion 0
Phi 35

Soil 9
Bedrock
Soil Model Bedrock



Plot No. 1

Chesterfield Stability Analysis
Section A-A - Case III
16 April 2003
File Name 96410A3A.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075



Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 2
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 3
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 4
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

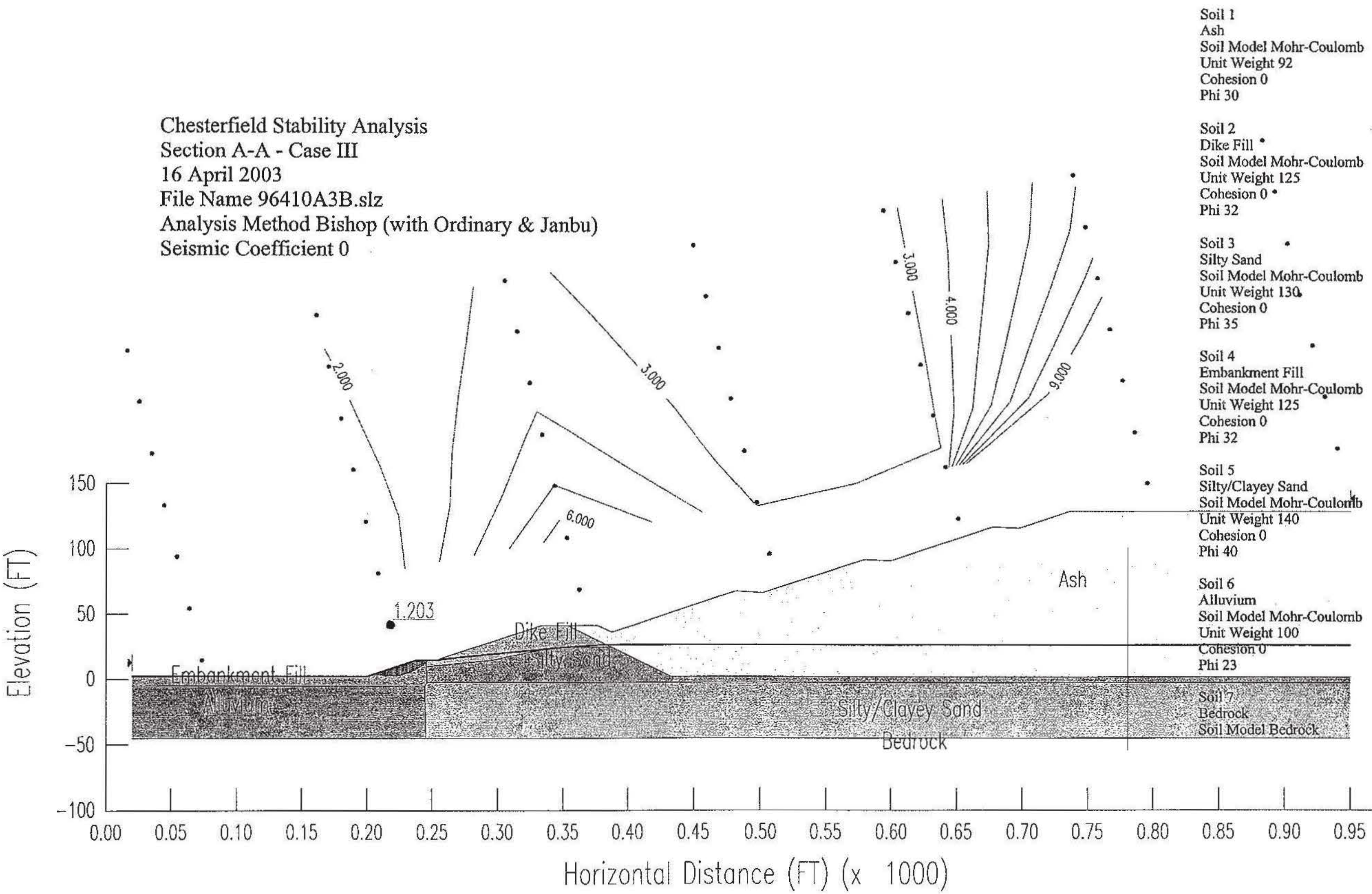
Soil 5
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 6
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 7
Bedrock
Soil Model Bedrock

Plot No. 2

Chesterfield Stability Analysis
Section A-A - Case III
16 April 2003
File Name 96410A3B.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0



Soil 1
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 2
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 3
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

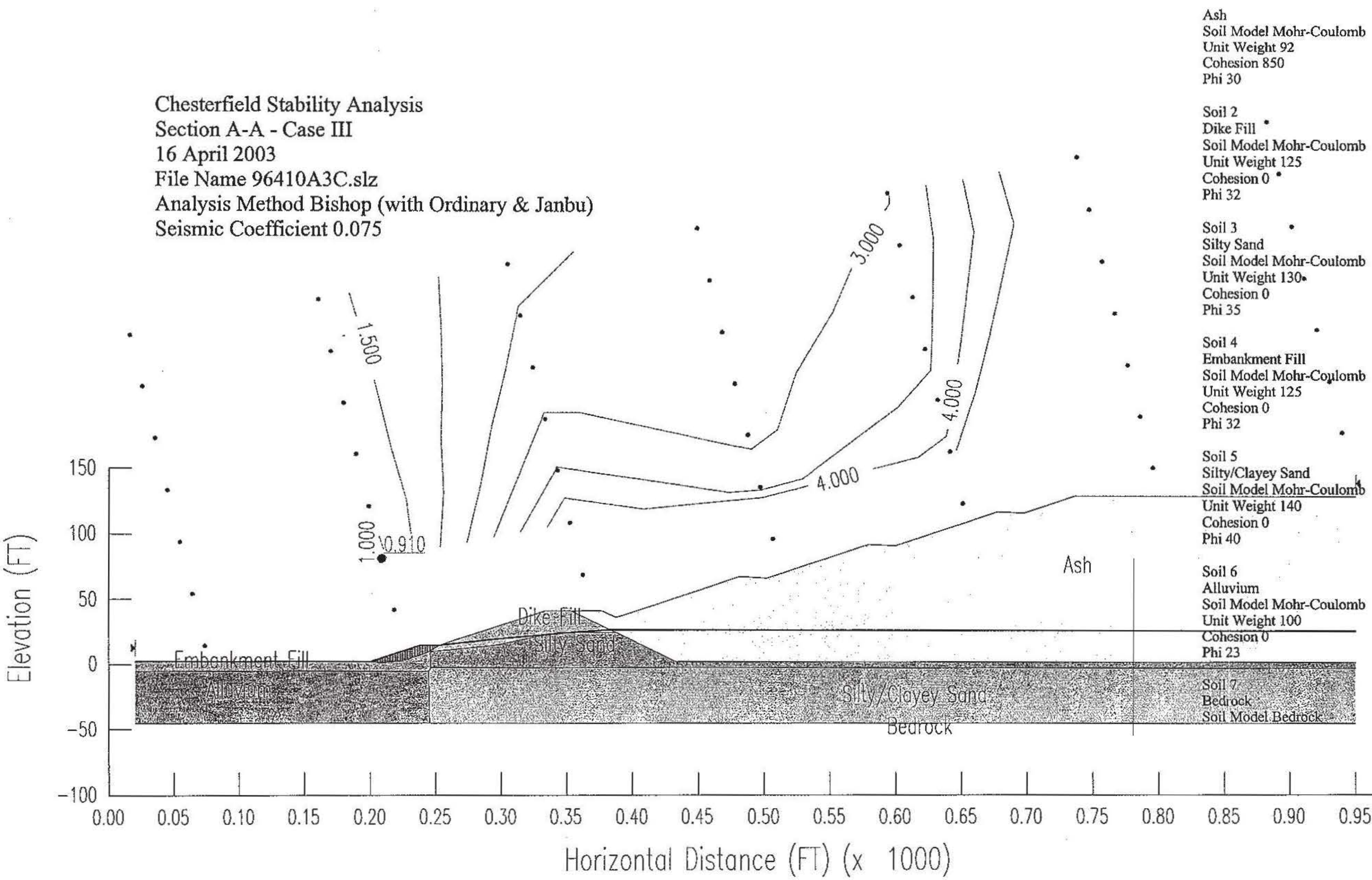
Soil 4
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 5
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 6
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 7
Bedrock
Soil Model Bedrock

Plot No. 3



Chesterfield Stability Analysis
Section A-A - Case III
16 April 2003
File Name 96410A3C.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 850
Phi 30

Soil 2
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 3
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

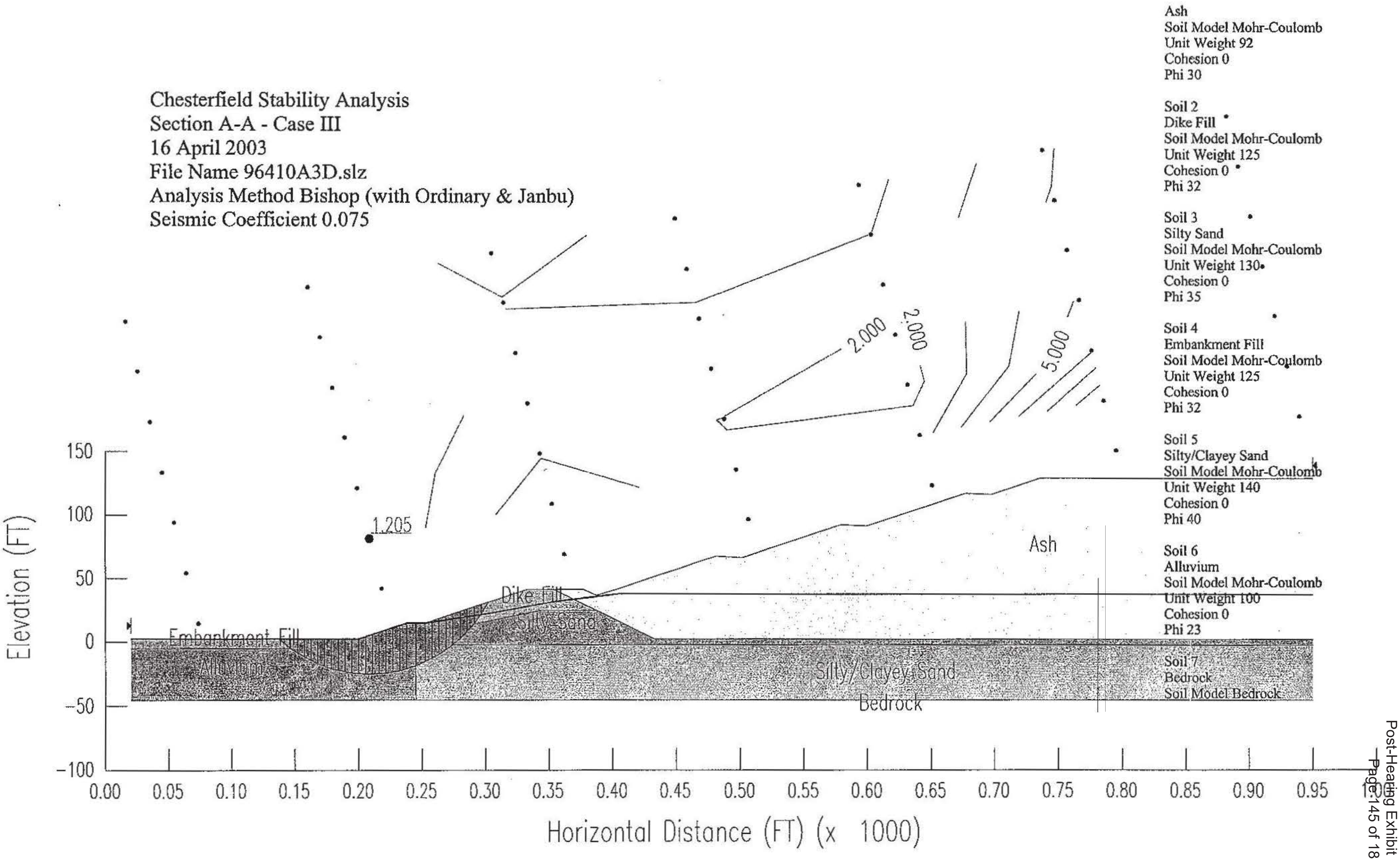
Soil 4
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 5
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 6
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 7
Bedrock
Soil Model Bedrock

Plot No. 4



Chesterfield Stability Analysis
Section A-A - Case III
16 April 2003
File Name 96410A3D.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075

Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 2
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 3
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

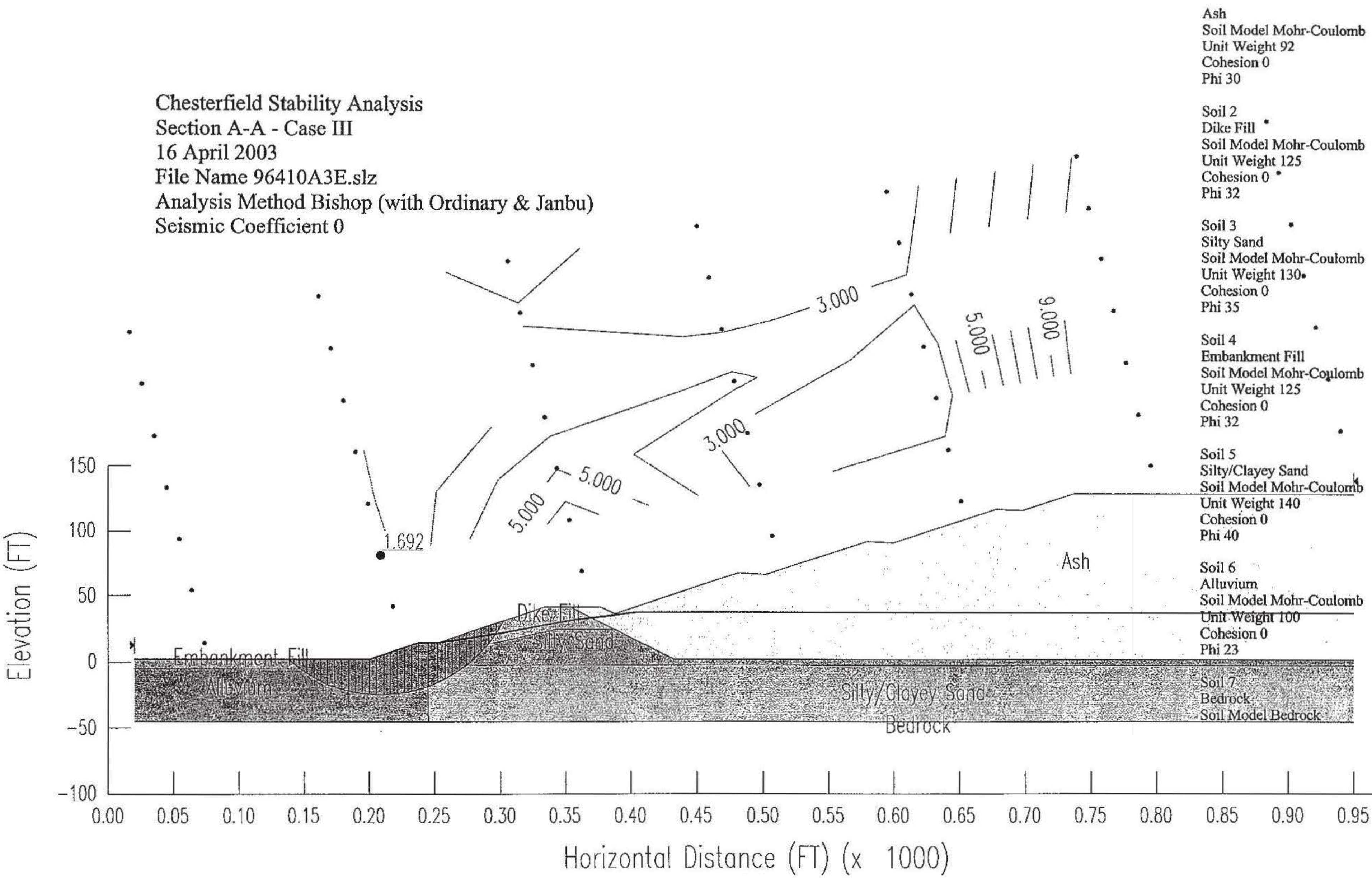
Soil 4
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 5
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 6
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 7
Bedrock
Soil Model Bedrock

Plot No. 5



Chesterfield Stability Analysis
Section A-A - Case III
16 April 2003
File Name 96410A3E.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0

Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 2
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 3
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

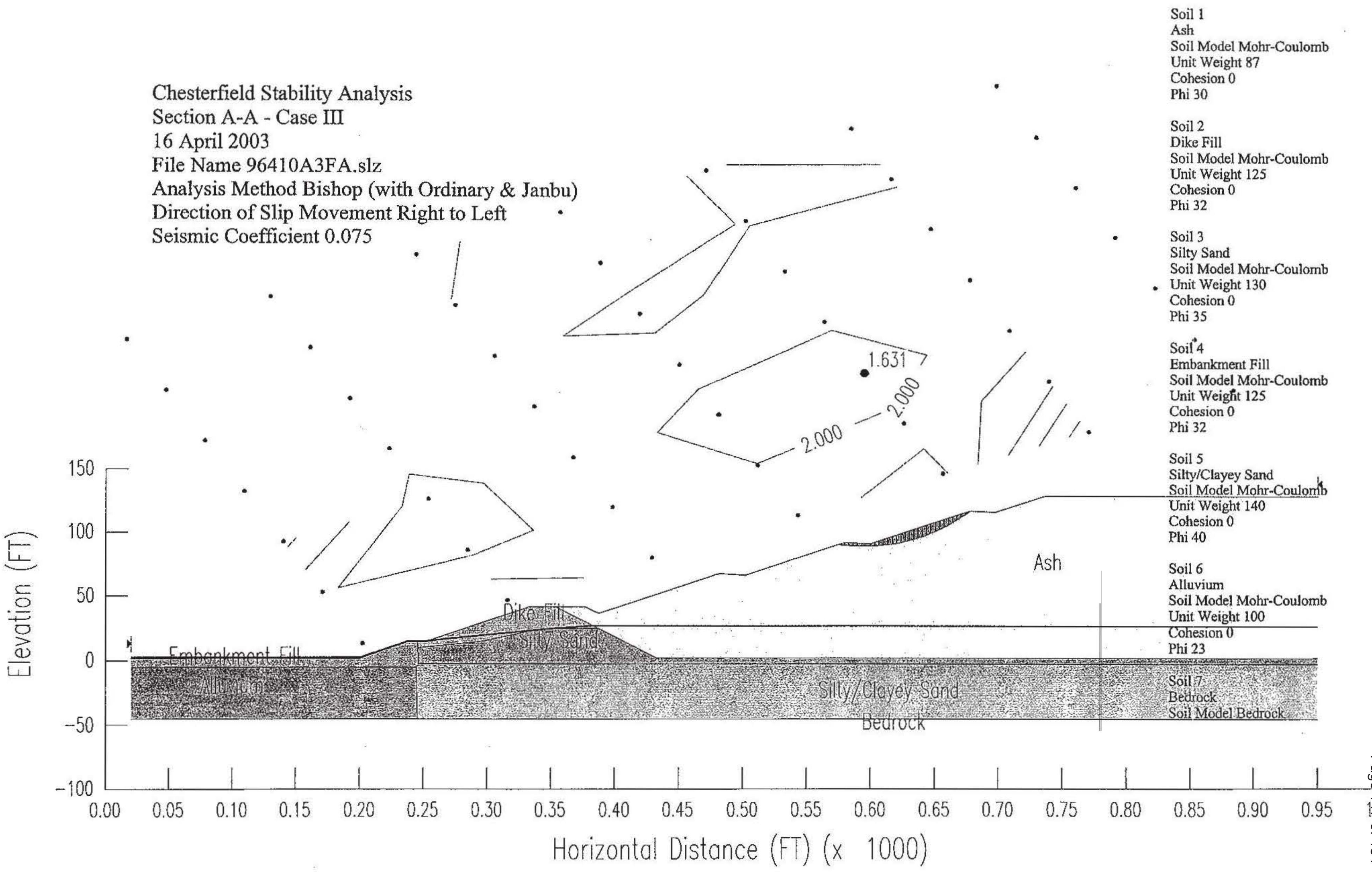
Soil 4
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 5
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 6
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 7
Bedrock
Soil Model Bedrock

Plot No. 6


Chesterfield Stability Analysis
Section A-A - Case III
16 April 2003
File Name 96410A3FA.slz
Analysis Method Bishop (with Ordinary & Janbu)
Direction of Slip Movement Right to Left
Seismic Coefficient 0.075

Soil 1
Ash
Soil Model Mohr-Coulomb
Unit Weight 87
Cohesion 0
Phi 30

Soil 2
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 3
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 4
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

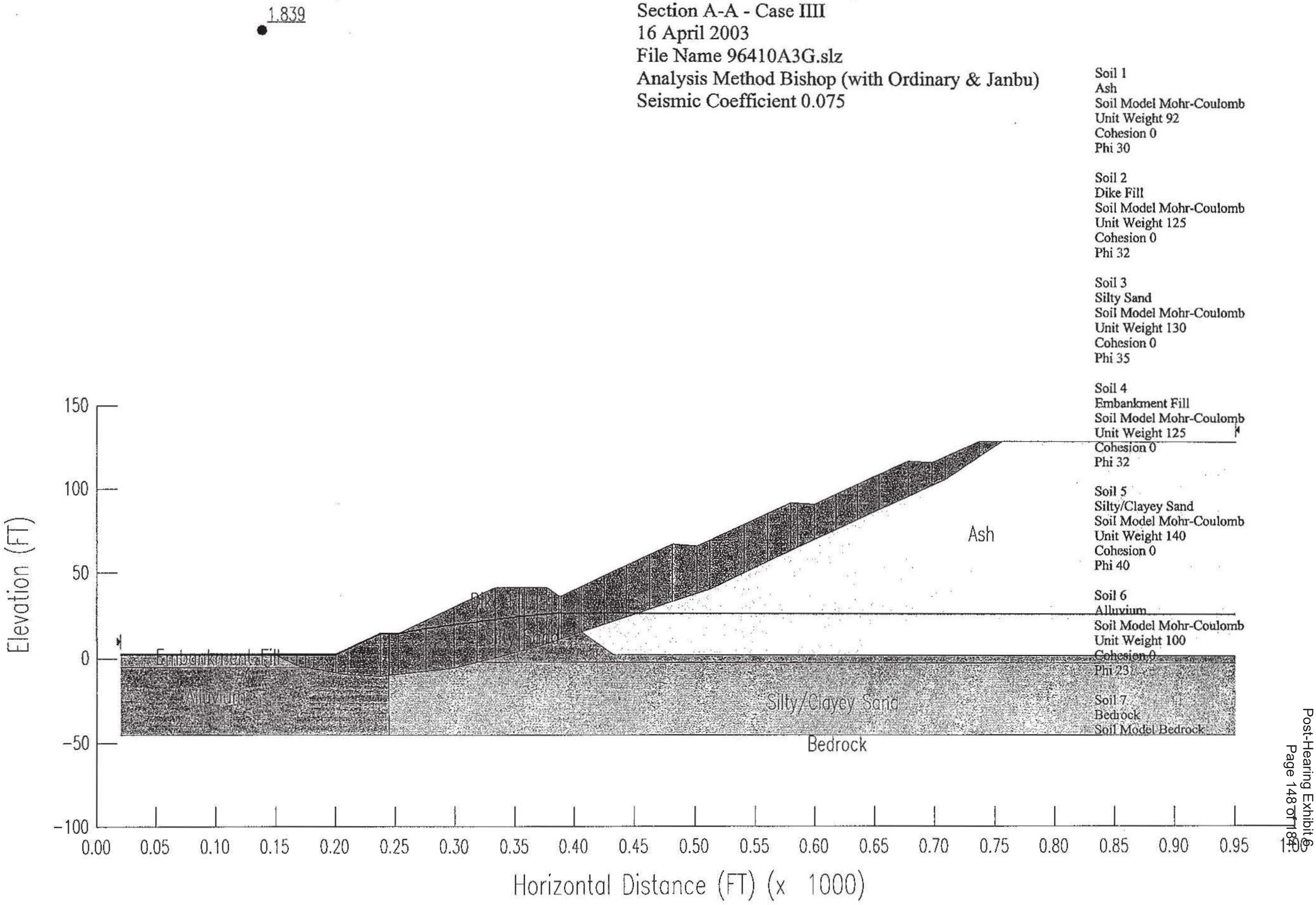
Soil 5
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 6
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 7
Bedrock
Soil Model Bedrock

Plot No 7

Chesterfield Stability Analysis
Section A-A - Case IIII
16 April 2003
File Name 96410A3G.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075



Soil 1
Ash
Soil Model Mohr-Coulomb
Unit Weight 92
Cohesion 0
Phi 30

Soil 2
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 3
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 4
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

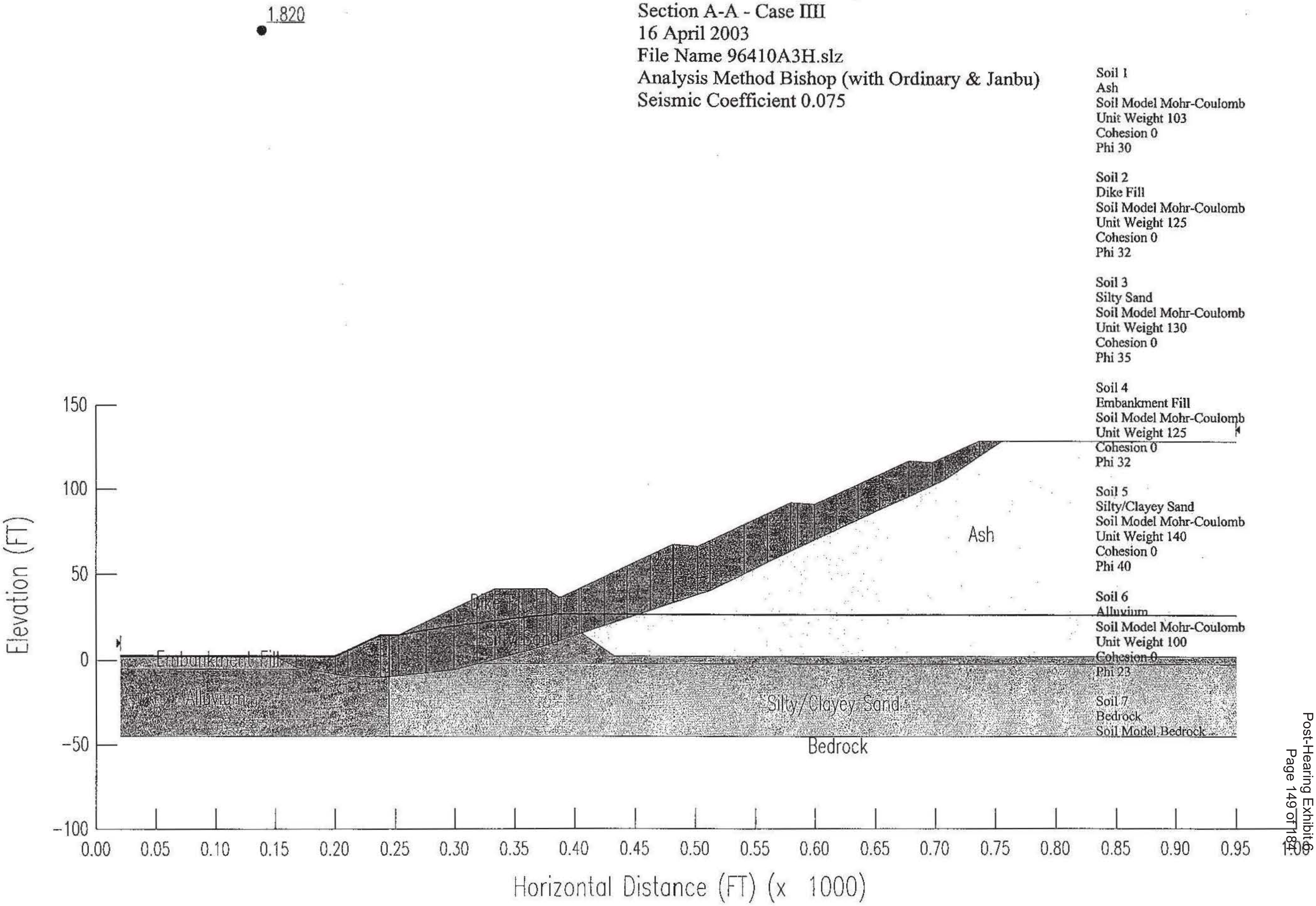
Soil 5
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 6
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 7
Bedrock
Soil Model Bedrock

Plot No. 8

Chesterfield Stability Analysis
Section A-A - Case IIII
16 April 2003
File Name 96410A3H.slz
Analysis Method Bishop (with Ordinary & Janbu)
Seismic Coefficient 0.075



Soil 1
Ash
Soil Model Mohr-Coulomb
Unit Weight 103
Cohesion 0
Phi 30

Soil 2
Dike Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 3
Silty Sand
Soil Model Mohr-Coulomb
Unit Weight 130
Cohesion 0
Phi 35

Soil 4
Embankment Fill
Soil Model Mohr-Coulomb
Unit Weight 125
Cohesion 0
Phi 32

Soil 5
Silty/Clayey Sand
Soil Model Mohr-Coulomb
Unit Weight 140
Cohesion 0
Phi 40

Soil 6
Alluvium
Soil Model Mohr-Coulomb
Unit Weight 100
Cohesion 0
Phi 23

Soil 7
Bedrock
Soil Model Bedrock

SUBJECT CHESTERFIELD POWER STATION CLOSURE PLAN
VIRGINIA POWER

BY NCBA DATE 08 Apr 2003 PROJ. NO. 1996-410-37
CHKD. BY KCC DATE 5-15-03 SHEET NO. 8 OF 8

gai CONSULTANTS
Engineers • Geologists • Planners
Environmental Specialists

APPENDIX B2

REFERENCES 1, 2, AND 3

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December 13, 2002

Mr. Mr. Mike Lott
Dominion Generation
F & H Technical Services
Innsbrook Technical Center
Glen Allen, Virginia 23060

Subject: Project 02131106.01, Geotechnical Engineering Services, Ash Shear Strength Evaluation, Chesterfield Power Station, Dominion Generation, Chesterfield County, Virginia

Dear Mr. Lott:

We have completed our evaluation of the shear strength of the ash currently being placed as fill at the Upper Ash Pond at the Chesterfield Power Station as requested. Our services have been provided according to our existing agreement.

Introduction

The ash is being excavated from the Lower Ash Pond, stacked for a short time next to the Lower Ash Pond to drain, and then trucked to the Upper Ash Pond for final storage. By the time the ash reaches the Upper Ash Pond, it is too wet to achieve the required compaction without further drying. Drying the ash at this time of year has been very difficult because of high precipitation and cool temperatures.

The Revised Closure Plan, Upper (East) Ash Pond, Chesterfield Power Station, Chesterfield County, Virginia dated March 1998 (Closure Plan) requires the ash be compacted to at least 95% of the maximum Standard Proctor dry density, at optimum moisture content with a tolerance of +/- 2%. You have requested that we evaluate whether the compaction requirement can be reduced below 95% without a reduction in the factors of safety for slope stability.

We reviewed the slope stability analyses in the Closure Plan to obtain the shear strength and unit weight used in the slope stability analyses. The original soil parameters used for the ash in the analyses included an angle of internal friction (ϕ) of 30° and a moist unit weight of 93 pcf. According to data in the Closure Plan, these parameters were assumed in the design (i.e. they were not based on actual soil laboratory test results).

We suggested a battery of soil laboratory tests to evaluate the shear strength (angle of internal friction (ϕ)) at compaction levels less than currently required by the Closure Plan. This report is a summary of the testing we performed in our laboratory, and our recommendations with regard to compaction of the ash.

Soil Laboratory Testing

We tested two samples in our laboratory that appeared to be representative of the ash at the Chesterfield facility. We performed Standard Proctor (per ASTM D-698), Atterberg Limits, Gradation, and Direct Shear tests. The Direct Shear tests were performed to measure the shear strength of the ash at various relative compaction values.

Sample No. 3 was a mixture of flyash and bottom ash classified as sandy silt (ML) per ASTM D-2487. This material had a maximum dry density of 87.7 pcf at an optimum moisture content of 21.2 %. The corresponding moist density at optimum moisture content was 106.3 pcf. Sample No. 4 was predominantly flyash and classified as sandy silt (ML) per ASTM D-2487. This sample had much less coarse sand size material (bottom ash), and had a lower maximum dry density of 68.1 pcf (as expected for the finer-grained material) at an optimum moisture content of 36.0%. The corresponding moist unit weight of this material at optimum moisture content was 92.6 pcf.

We performed consolidated-drained direct shear tests on both samples. Both samples were initially compacted to about 92% of the maximum Standard Proctor dry density at a moisture content of about 8% above the optimum moisture content. Sample No. 3 exhibited an angle of internal friction (ϕ) of 32° and Sample No. 4 exhibited an angle of internal friction (ϕ) of 39°. Prior to consolidation, the average moist unit weight of Sample No. 3 was 104.9 pcf and the average moist unit weight of Sample No. 4 was 90.4 pcf.

We then compacted Sample No. 3 to about 88% of the of the maximum Standard Proctor dry density at a moisture content of 12% above the optimum moisture content. This direct shear test resulted in an angle of internal friction (ϕ) of 32°. Prior to consolidation, the average moist unit weight of this material was 102.9 pcf.

The angle of internal friction (ϕ) for Sample No. 3 at 88% and 92% relative compaction was 32° for both compaction levels. We believe this occurred because the samples showed significant consolidation under the normal stress imposed during the test resulting in higher relative compaction prior to shearing, especially at the higher normal stresses used in the tests.

The direct shear tests indicated the unit weight (and corresponding relative compaction) of the samples increased after application of the normal stress. The normal stress is similar to a surcharge pressure on the material. For the samples compacted to 92% relative compaction, the increase in relative compaction varied from an average of 0.6% at a normal stress of 4 psi (576 psf) to an average of 3.8% at 20 psi (2,880 psf). These normal stresses are equivalent to a surcharge of about 6 ft and 30 ft of ash, respectively.

Analysis and Recommendations

The slope stability calculations in the Closure Plan used a design angle of internal friction (ϕ) for the ash of 30° and a moist unit weight of 93 pcf. The Closure Plan also indicates the ash should be compacted to at least 95% relative compaction at the optimum moisture content +/- 2%.

Our soil laboratory tests for samples compacted to 92% of the maximum Standard Proctor dry density indicate an angle of internal friction (ϕ) of 32 to 39° with a moist soil unit weight of 90.4 to 104.9 pcf. These angle of internal friction (ϕ) values exceed the values used in the stability analyses in the Closure Plan, which means the ash is actually stronger than anticipated in the original analyses. The soil unit weights are slightly above and slightly below the unit weights those used in the Closure Plan slope stability analyses, which means the average unit weights are about the same as the original unit weights. Accordingly, slope stability analyses using the higher angle of internal friction (ϕ) values and similar unit weights will result in factors of safety higher than those from the original analyses.

We believe the compaction specification can be changed to 92% of the Standard Proctor compaction at optimum moisture content +/-8% while maintaining ash angles of internal friction (ϕ) equal to or greater than those used in the Closure Plan stability analyses. We recommend amending the Closure Plan to reflect these recommendations.

Our test results also indicate the wet ash will consolidate under the weight of an ash surcharge. During the winter of 2003, we recommend temporarily storing the ash in the Upper Ash Pond area in stockpiles at least 15 ft high. The weight of the upper portion of the ash pile (the surcharge) will cause an increase in unit weight (and thus relative compaction) of the lower portion of the pile.

We recommend evaluating the relative compaction of the lower portion of the pile by digging test pits and performing field density (compaction) tests. If the density of the ash meets the compaction requirements of the amended Closure Plan (i.e. 92% relative compaction), we believe the ash can be left in place to become part of the ash fill. Where compaction does not meet the required values, the ash should be excavated, spread out to dry, and then recompacted to achieve the required relative compaction. We recommend the Closure Plan also be amended to allow compaction by surcharging where confirmed with field density testing or other geotechnical methods such as in-situ Dilatometer or Cone Penetrometer tests.

We anticipate all of upper parts of the temporary stockpiles (the surcharge) and some or all of the lower parts of the stockpiles will require drying and recompaction. We recommend this work be done during the drier, warmer months from later spring to early fall of each year.

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or any other instrument of service.

We appreciate the opportunity to be of continued service for this project. Please call us if you have any questions or if we can be of any other service.

Very truly yours,
SCHNABEL ENGINEERING ASSOCIATES, INC.

Edward G. Drahos

Edward G. Drahos, P.E.
Principal

COMMONWEALTH OF VIRGINIA
EDWARD G. DRAHOS
No. 015605
PROFESSIONAL ENGINEER

James J. Seli, P.E.
Principal

COMMONWEALTH OF VIRGINIA
JAMES. J. SELI
No. 14957
PROFESSIONAL ENGINEER

EGD:JJS:vw

Attachments:

1. Summary of Soil Laboratory Tests (1)
2. Gradation Curves (1)
3. Moisture-Density Relation (Standard Proctor per ASTM D-698) (2)
4. Consolidated Drained Direct Shear (ASTM D-3080) (3)

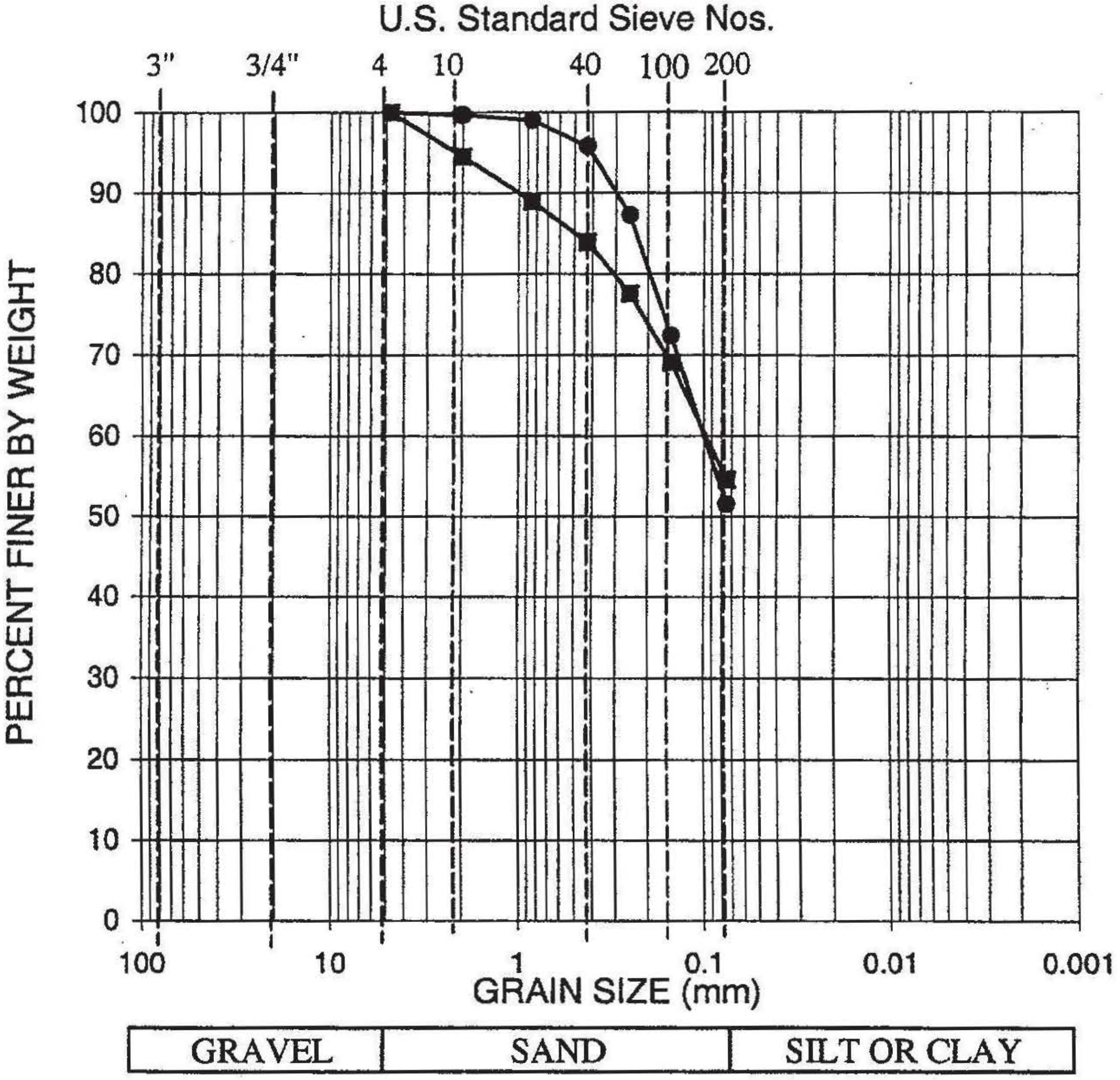
c: Mike Pantele (by email)
Bennie Tomlinson (by email)
Jack Shahan (by email)

Contract 02131106.01

SUMMARY OF SOIL LABORATORY TESTS

SAMPLE NO.	3	4		
DEPTH	--	--		
SAMPLE TYPE	BULK	BULK		
STRATUM	--	--		
SAMPLE DESCRIPTION	FLY ASH (ML), BLACK	FLY ASH (ML), BLACK		
NATURAL MOISTURE CONTENT (%)	--	61.8		
NATURAL WET DENSITY (pcf)	--	--		
LIQUID LIMIT	NP	NP		
PLASTIC LIMIT	NP	NP		
PLASTICITY INDEX	NP	NP		
GRADATION DATA				
(% FINER THAN SIEVE)				
¾"	100.0	100.0		
NO. 4	100.0	100.0		
NO. 40	83.9	95.8		
NO. 200	54.6	51.5		
MOISTURE DENSITY RELATION DATA (ASTM D-698)				
MAXIMUM DRY DENSITY (pcf)	87.7	68.1		
OPTIMUM MOISTURE CONTENT (%)	21.2	36.0		
CBR TEST DATA (VTM-8)				
BEFORE SOAK CBR	--	--		
AFTER SOAK CBR	--	--		
% SWELL	--	--		
COMPACTED SAMPLE DRY DENSITY (pcf)	--	--		
COMPACTED SAMPLE MOISTURE CONTENT (%)	--	--		
REMARKS	SEE GRADATION, MOISTURE DENSITY RELATIONSHIP, AND DIRECT SHEAR CURVES	SEE GRADATION, MOISTURE DENSITY RELATIONSHIP, AND DIRECT SHEAR CURVES		

NOTES: 1. Soil tests in accordance with applicable ASTM, AASHTO and VTM Standards



ey	Sample	Depth(ft.)	Sample Description	Class.	LL	PI
■	3	-	FLY ASH, BLACK	ML	NP	NP
●	4	-	FLY ASH, BLACK	ML	NP	NP

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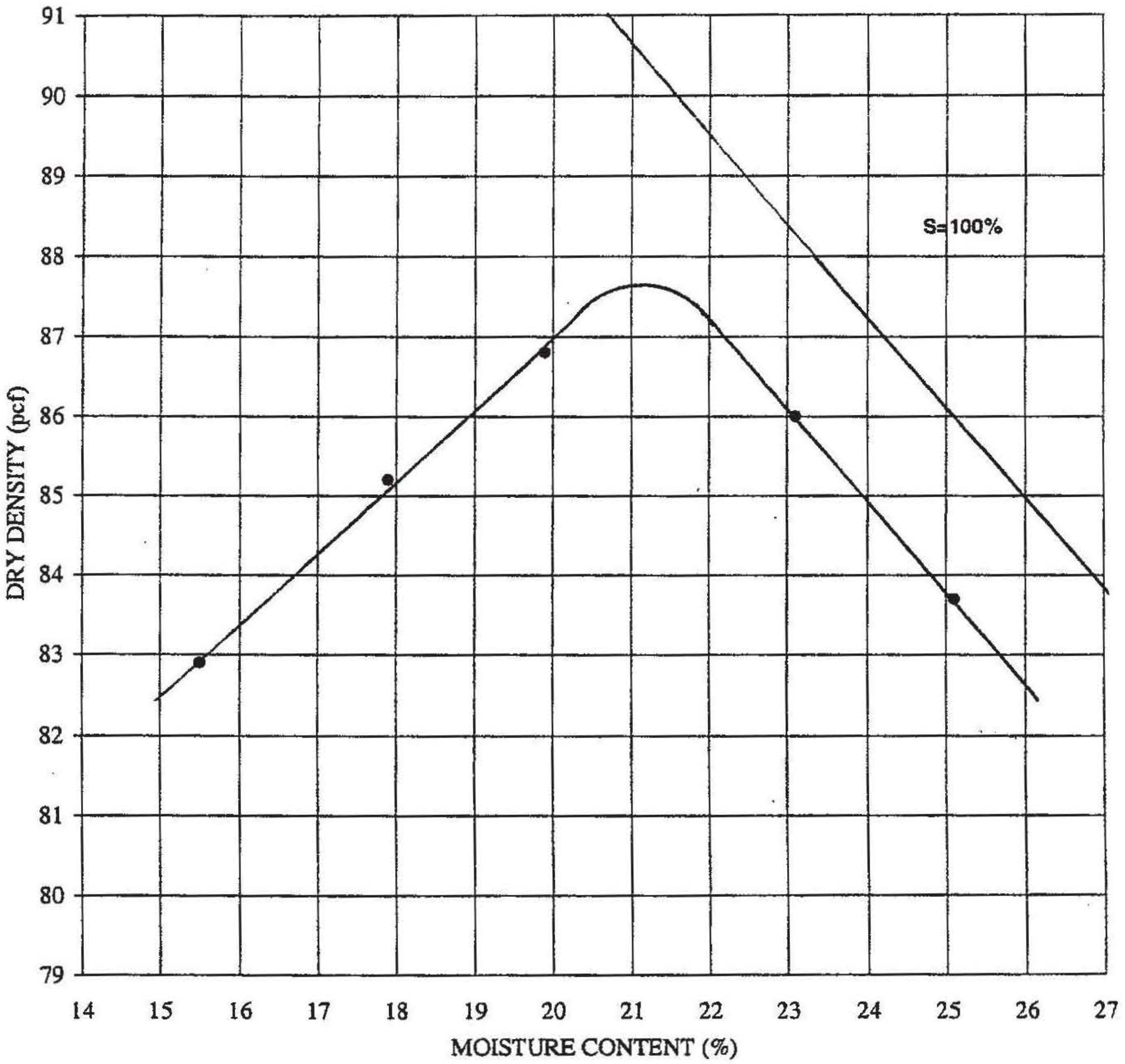
GRADATION CURVES

Project:
Dominion Ash Pond,
Chesterfield County, Virginia

Contract No. 02131106.01



Sample Description:

FLY ASH, BLACK

Classification: ML

Sample Number: 3

Sample Depth (Ft.): -

Sample Source: ON-SITE

% Passing 3/4" Sieve: 100.0

% Passing #200 Sieve: 54.6

Assumed Specific Gravity: 2.10

Liquid Limit (LL): NP

Plasticity Index (PI): NP

Max. Dry Density (pcf): 87.7

Opt. Moist. Content (%): 21.2

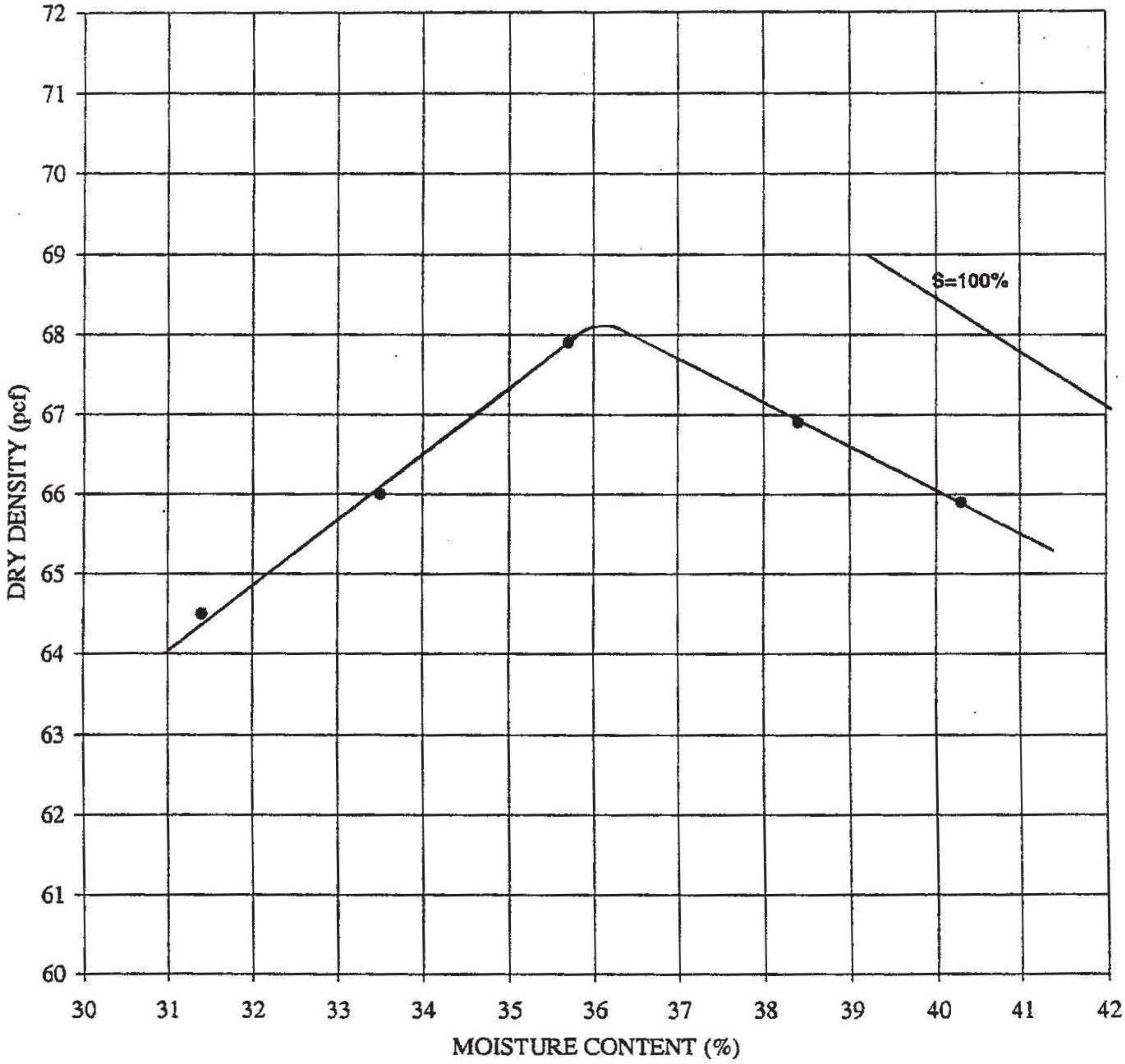
Schnabel Engineering Associates, Inc.

MOISTURE-DENSITY RELATION

Specification: ASTM-D698 Method: A

Project: Dominion Ash Pond, Chesterfiel
County, Virginia

Project No.: 02131106.01



Sample Description:

FLY ASH, BLACK

Classification: ML

Sample Number: 4

Sample Depth (Ft.): -

Sample Source: ON-SITE

% Passing 3/4" Sieve:	100.0
% Passing #200 Sieve:	51.5
Assumed Specific Gravity:	1.95
Liquid Limit (LL):	NP
Plasticity Index (PI):	NP
Max. Dry Density (pcf):	68.1
Opt. Moist. Content (%):	36.0

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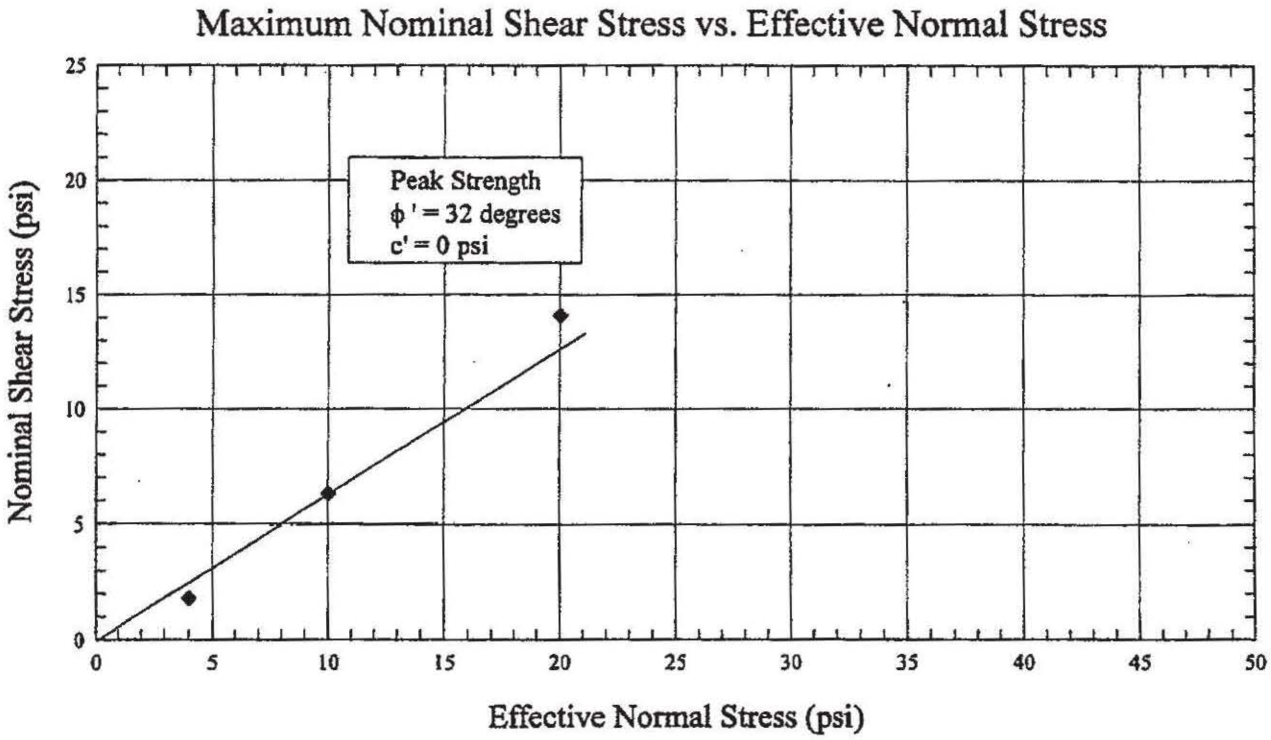
MOISTURE-DENSITY RELATION

Specification: ASTM D-698 **Method:** A

Project: Dominion Ash Pond, Chesterfiel
County, Virginia

Project No.: 02131106.01

Consolidated Drained Direct Shear (ASTM D3080)



Sample No.: *No. 3 (88%γ_{dmax}, OMC+12%)* **Depth:** *NA* **SEA Contract:** *02131106.01* **Date:** *12/2/02*

Sample Description: *Fly Ash (ML) - black* **Reviewed By:** *CJS*

Specimen Type: *Remolded* **Specific Gravity:** *2.10 (Assumed)* **LL:** *--* **PI:** *NP* **%<200:** *54.6*

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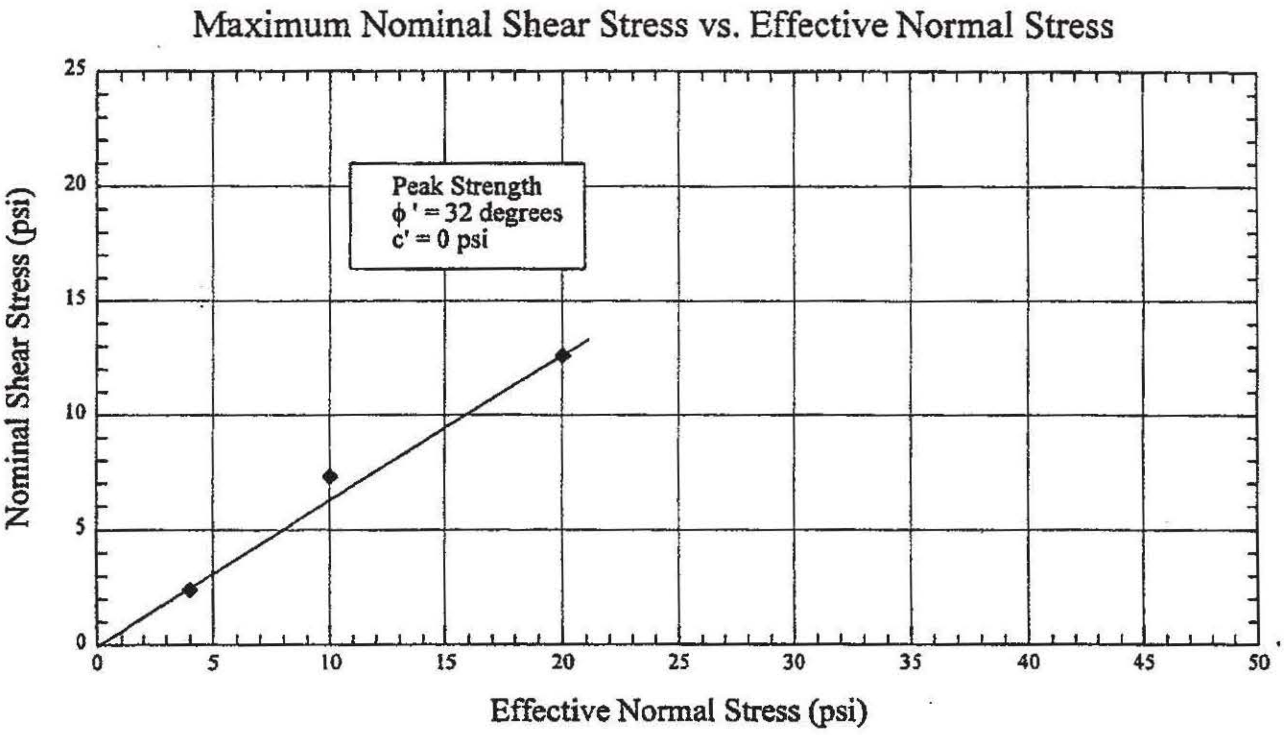
Dominion Chesterfield Power Station
Upper Ash Pond, Phase I
Chesterfield County, Virginia

Consolidated Drained Direct Shear (ASTM D3080)



Sample No.: *No. 3 (92%γ_{dmax}, OMC+8%)* **Depth:** *NA* **SEA Contract:** *02131106.01* **Date:** *11/19/02*

Sample Description: *Fly Ash (ML) - black* **Reviewed By:** *CJS*

Specimen Type: *Remolded* **Specific Gravity:** *2.10 (Assumed)* **LL:** -- **PI:** *NP* **%<200:** *54.6*

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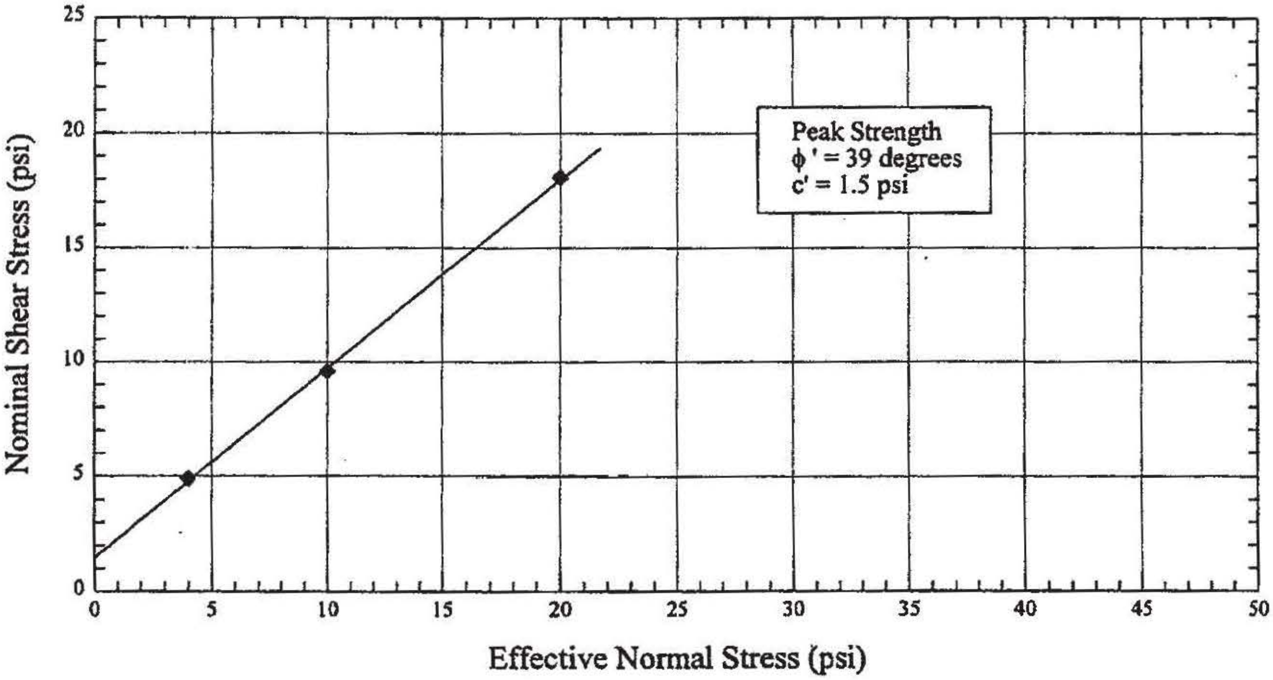
Dominion Chesterfield Power Station
Upper Ash Pond, Phase I
Chesterfield County, Virginia

Consolidated Drained Direct Shear (ASTM D3080)

Maximum Nominal Shear Stress vs. Effective Normal Stress



Sample No.: *No. 4 (92%γ_{dmax}, OMC+8%)* **Depth:** *NA* **SEA Contract:** *02131106.01* **Date:** *11/19/02*

Sample Description: *Fly Ash (ML) - black* **Reviewed By:** *CJS*

Specimen Type: *Remolded* **Specific Gravity:** *1.95 (Assumed)* **LL:** *--* **PI:** *NP* **%<200:** *51.5*

Schnabel
Schnabel Engineering Associates, Inc.

Dominion Chesterfield Power Station
Upper Ash Pond, Phase I
Chesterfield County, Virginia

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February 13, 2003

Mr. Mike Lott
Dominion Generation
F & H Technical Services
Innsbrook Technical Center
Glen Allen, Virginia 23060

Subject: Project 02131106.01, Response to VDEQ Comments of January 21, 2003, Ash Shear Strength Evaluation, Chesterfield Power Station, Dominion Generation, Chesterfield County, Virginia

Dear Mr. Lott:

We have reviewed the comments by Mr. John Godfrey of the Virginia Department of Environmental Quality (VDEQ) in his email to Mr. Ray Jenkins (VDEQ) dated January 21, 2003. The following is our response to Mr. Godfrey's comments as requested.

With regard to the soil shear strength in relation to the moisture content, Mr. Godfrey is correct that an increase in moisture content will typically result in lower shear strength. This relationship is readily apparent with highly plastic clay soils, but much less so with non-plastic sands. The increase in moisture content of up to about 8% above the optimum moisture content did not have a significant deleterious effect on the shear strength of the ash primarily because of the composition of the ash. The ash is essentially a non-plastic mixture of hollow glass spheres with about 45% to 50% sand size or larger. Accordingly, based on our experience the ash behaves more like a sand than a clay and the higher moisture content has a much smaller effect on the shear strength.

We agree with Mr. Godfrey that the surcharging and testing should be implemented. We will then be able to evaluate the feasibility of increasing the density of the ash fill by surcharging.

The project Construction Quality Assurance Plan (1998) requires four field density tests per acre per lift of common soil fill, but is silent on the frequency of testing for the ash. We are currently performing field density testing of the ash (for moisture content and density) on an as needed basis. We have been present on site three or four days a week when the ash is being placed and compacted, and about twice a month when the ash is being stockpiled.

We recommend the same frequency of testing for the ash as for the common soil fill (i.e. four tests per acre per lift) or as recommended by the Engineer. We will continue to make these tests on a periodic basis as the ash fill is being placed and compacted. We will also perform direct shear tests on the ash (to confirm the design angle of internal friction, ϕ) twice a year or as recommended by the Engineer.

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or any other instrument of service.

We appreciate the opportunity to be of continued service for this project. Please call me if you have any questions or if we can be of any other service.

Very truly yours,
SCHNABEL ENGINEERING ASSOCIATES, INC.

Edward G. Drahos

Edward G. Drahos, P.E.
Principal

EGD:vw

c: Mike Pantele (by email)
Bennie Tomlinson (by email)
Jack Shahan (by email)

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May 5, 2003

Mr. Mr. Mike Lott
Dominion Generation
F & H Technical Services
Innsbrook Technical Center
Glen Allen, Virginia 23060

Subject: Project 02131106.01, Geotechnical Engineering Services, Ash Moisture Criteria Evaluation, Chesterfield Power Station, Dominion Generation, Chesterfield County, Virginia

Dear Mr. Lott:

We have completed our evaluation of the moisture criteria of the ash currently being placed as fill at the Upper Ash Pond at the Chesterfield Power Station as requested. Our services have been provided according to our existing agreement.

INTRODUCTION

In our previous report titled, Geotechnical Engineering Services, Ash Shear Strength Evaluation, Chesterfield Power Station, dated December 13, 2002, we recommended amending the compaction and moisture content criteria specified in the Closure Plan. We believe the compaction specification can be changed to 92% of the Standard Proctor compaction at optimum moisture content ±8% while maintaining ash angles of internal friction (ϕ) equal to or greater than those used in the Closure Plan stability analyses. GAI has agreed to the above referenced criteria for placing and compacting ash that is at least 50 feet away from the perimeter drainage channels. In the outer 50 feet, GAI recommended that the current moisture content (±2% of optimum moisture content) and compaction (95% of the maximum dry density per ASTM D-698) specifications be followed.

"We are committed to serving our clients by exceeding their expectations."

In the outer 50 feet adjacent to the perimeter drainage channels, we recommend that the moisture content criteria be revised to allow ash to be placed and compacted between 4% above and 6% below its optimum moisture content while maintaining the compaction criteria of 95% of the maximum dry density per ASTM D-698. To demonstrate the feasibility of achieving these results in the field, we have performed a Modified Proctor Test (ASTM D-1557) on Sample 5. A Standard Proctor Test (ASTM D-698) was previously performed on Sample 5 and reported in Report No. 2.

SOIL LABORATORY TESTING

The maximum dry densities and optimum moistures for the Standard and Modified Proctor Tests for Sample 5 are 71.8 pcf at 32.3% moisture and 78.9 pcf at 25.8% moisture, respectively. With Modified Proctor compaction effort, the ash is compacted to about 110% of its Standard Proctor maximum dry density at a moisture content that is about 6.5% below the Standard Proctor optimum moisture. Likewise, when the ash sample is at 26.3% moisture content (i.e. 6% below the Standard Proctor optimum moisture), a dry density of 78.6 pcf is achieved when Modified Proctor compaction effort is applied to the ash sample (i.e. 109% of the Standard Proctor maximum dry density).

It should also be noted that the ash has a dry density of 69.3 pcf at 36.3% moisture on the Standard Proctor Moisture-Density Relation. This correlates to compaction to 97% of the Standard Proctor maximum dry density at 4% above the Standard Proctor optimum moisture content. The test results for the Standard and Modified Proctor Tests for Sample 5 are included as Attachment 1.

CONCLUSIONS

The Standard Proctor and Modified Proctor Tests were both performed on the same ash sample, Sample 5. The difference between these two tests is that greater compaction effort is applied to the sample during the Modified Proctor Test than in the Standard Proctor Test. As a result, higher dry densities are obtained during the Modified Proctor Test than in the Standard Proctor Test.

Based on the Modified and Standard Proctor Tests performed on Sample 5, compaction equal to or greater than 95% of the maximum Standard Proctor dry density per ASTM D-698 can be achieved on the ash at moisture contents that are up to 6% below the Standard Proctor optimum moisture content as long as sufficient compaction effort is applied to the ash. Also, compaction equal to or greater than 95% of the maximum Standard Proctor dry density per ASTM D-698 can be achieved on the ash at the site at a moisture content of 4% above the Standard Proctor optimum moisture content.

It should be noted that in order to achieve 95% of the maximum dry density per ASTM D-698 at 6% below optimum moisture content, greater compaction effort might be required by the contractor. Greater compaction effort would involve placing and compacting ash in thinner lifts, making additional passes over each lift with the compaction equipment, and/or using heavier compaction equipment. Alternatively, if the ash is dry, it could be moistened to achieve the required Standard Proctor compaction.

We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or any other instrument of service.

We appreciate the opportunity to be of continued service for this project. Please call us if you have any questions or if we can be of any other service.

Very truly yours,
Schnabel Engineering South, LLC

Theron R. Fluker, E.I.T.
Senior Staff Engineer

Edward G. Drahos

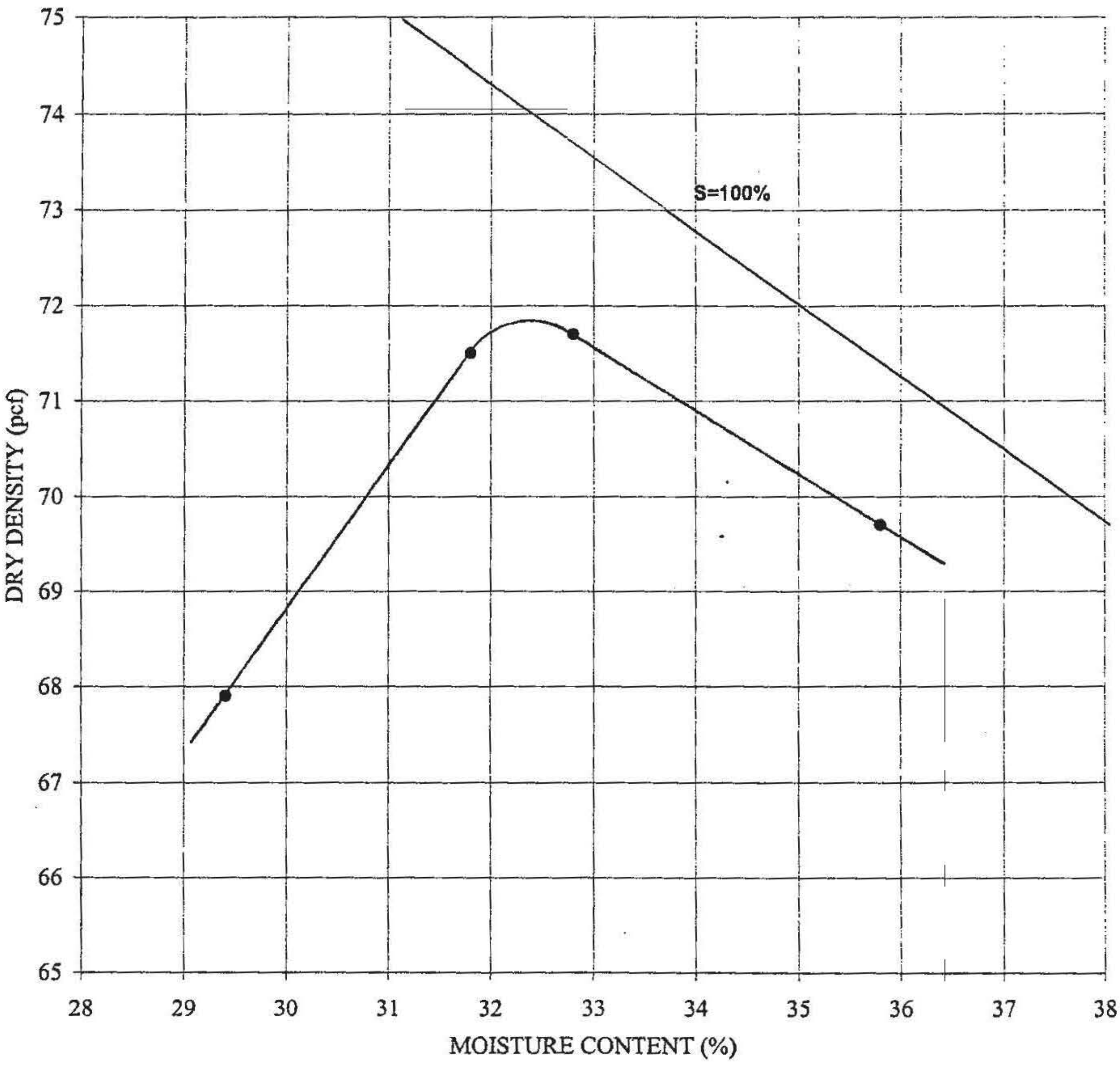
Edward G. Drahos, P.E.
Principal

EDWARD G. DRAHOS

TRF:EGD:vav

Attachments:
1. Moisture-Density Relation (ASTM D-698 and ASTM D-1557) (2)

c: Mike Pantele (by email)
Bennie Tomlinson (by email)
Jack Shahan (by email)



Sample Description:

FLY ASH, BLACK

Classification: ML

Sample Number: 5

Sample Depth (Ft.): -

Sample Source: ON-SITE

% Passing 3/4" Sieve: -

% Passing #200 Sieve: 67.1

Assumed Specific Gravity:	1.93
Liquid Limit (LL):	NP
Plasticity Index (PI):	NP
Max. Dry Density (pcf):	71.8
Opt. Moist. Content (%):	32.3

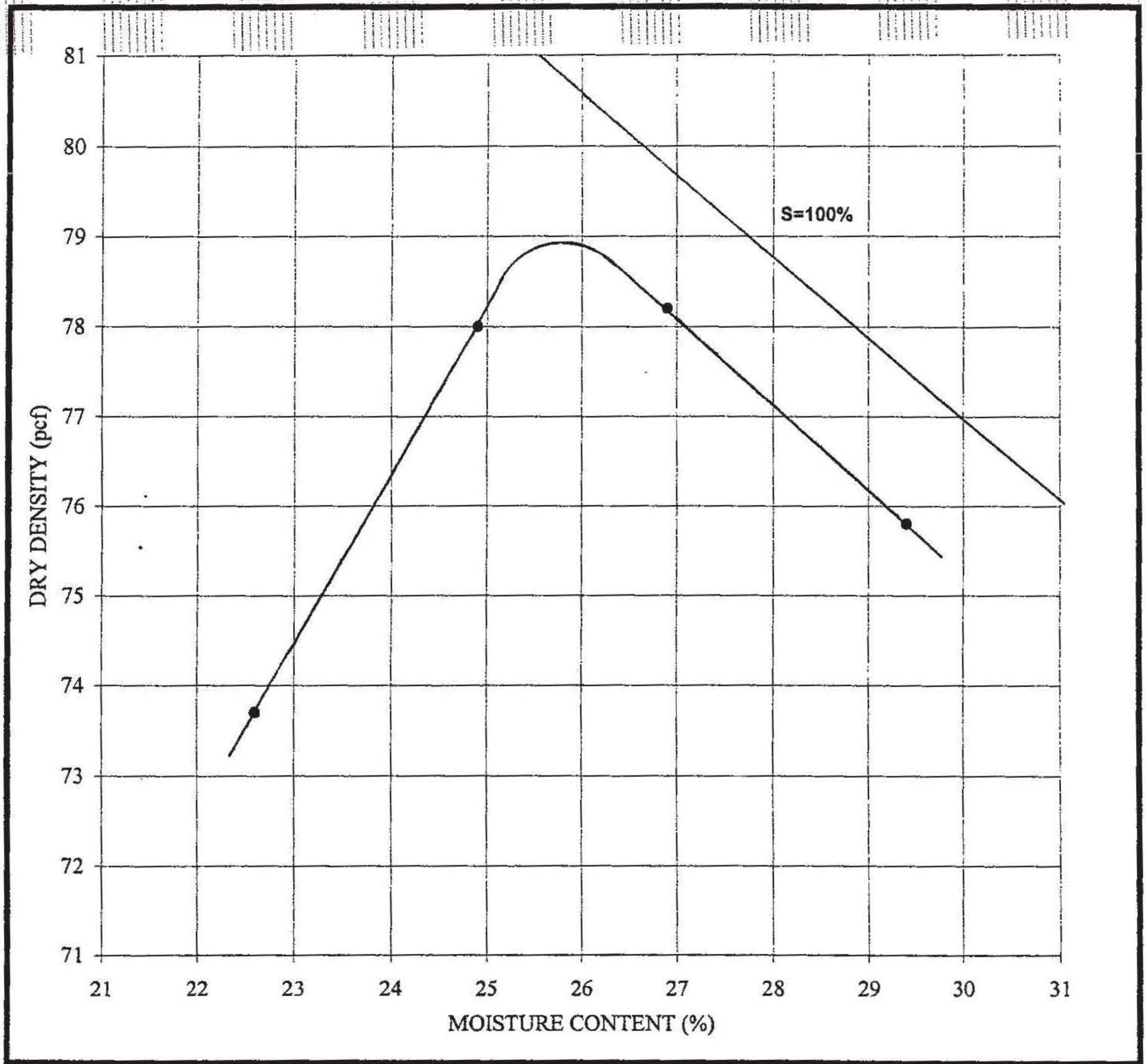
Schnabel
Schnabel Engineering

MOISTURE-DENSITY RELATION

Specification: ASTM D-698 Method: A

Project: Dominion Ash Pond,
Chesterfield County, Virginia

Project No.: 02131106.01



Sample Description:

FLY ASH, BLACK

Classification: ML

Sample Number: 5

Sample Depth (Ft.): -

Sample Source: ON-SITE

% Passing 3/4" Sieve: -

% Passing #200 Sieve: 67.1

Assumed Specific Gravity: 1.95

Liquid Limit (LL): NP

Plasticity Index (PI): NP

Max. Dry Density (pcf): 78.9

Opt. Moist. Content (%): 25.8

Schnabel
Schnabel Engineering

MOISTURE-DENSITY RELATION

Specification: ASTM D-1557 Method: A

Project: Dominion Ash Pond,
Chesterfield County, Virginia

Project No.: 02131106.01

SUBJECT Virginia Power - Chesterfield Closure

BY ______ DATE ______ PROJ. NO. ______

CHKD. BY ______ DATE ______ SHEET NO. ______ OF ______

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SETTLEMENT CALCULATIONS

SUBJECT Virginia Power Chesterfield
Ash Disposal Pond Settlement

BY NCBA DATE 9/24/97 PROJ. NO. 96-410-33

CHKD. BY KCC DATE 10/28/97 SHEET NO. 1 OF 7

Problem:

Refer to Conceptual Closure Plans for Phase I & II.

It is proposed to raise the top of the ash placement area to El 80 from current elevations that vary from ~El 32 to ~El 45 for Phase I.

For Phase II, the top of the ash placement area would be at El 130.

Side slopes proposed are 3H:1V. with benches every 25' in elevation.

Purpose:

To calculate the effect on settlement from the additional ash placement.

References:

1) Final Report, Virginia Power, Chesterfield Inactive Pond Ash. Laboratory Testing done by GAI. April 14, 1997. (Copy attached)

2) Holtz, Robert D. & Kovacs, William D. "An Introduction to Geotechnical Engineering". Prentice-Hall Civil Engineering & Engineering Mechanics Series. Englewood Cliffs, N.J. 1981

SUBJECT VEPCO Chesterfield Ash Disposal Pond Settlement

BY NCBA DATE 9/24/97 PROJ. NO. 96-410-33

CHKD. BY KCC DATE 10/28/97 SHEET NO. 2 OF 7

3) Geotechnical Engineering Study, Long Term Ash Storage Pond Dike, Chesterfield County, Virginia
Prepared by Schnabel Engineering Associates, Inc.
April 22, 1996

4) Laboratory testing performed by Golder Associates, Inc. Appendix B, one-dimensional consolidation (ASTM D2435) dated 8/5/97 (Copy attached)

SUBJECT VEPCO Chesterfield Ash Disposal Pond Settlement

BY NCBA DATE 9/24/97 PROJ. NO. 96-410-33

CHKD. BY KCC DATE 10/28/97 SHEET NO. 3 OF 7

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Settlement - Phase I

Vertical stress due to wt. of embankment is approx.

$$80 - 32 = 48' \text{ of ash @ } \gamma' = 100 \text{ pcf} = 4800 \text{ psf}$$
$$= 2.4 \text{ tsf}$$
$$\text{say } 2.5 \text{ tsf} = \Delta\sigma_v$$

From Ref. 1, Use $e_o = 1.00$. From results plotted from consolidation test report @ location CF#1 the average recompression index, C_{cr}, to ~2.5 tsf is 0.016. (say 0.02)

From ref. 3, sec 1.2 area of pond graded at El. 2.5 ∴ thickness of existing layer ~43' at highest elevation

The initial effective stress at the midpt. of the ash layer is:

$$\sigma'_{v_0} = (100 \text{ pcf})(21.5 \text{ ft}) - (62.4 \text{ pcf})(21.5 \text{ ft})$$

$$\sigma'_{v_0} = 808.4 \text{ psf or } 0.404 \text{ tsf say } \underline{0.41 \text{ tsf}}$$

Assume soil is normally consolidated. (N-C.)

From ref. 2, pp. 317, eq (8-11), settlement of N.C. soils:

$$S_{cr} = C_{cr} \frac{H_o}{1+e_o} \log \frac{\sigma'_{v_0} + \Delta\sigma_v}{\sigma'_{v_0}}$$

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where

C_{cr} = recompression index

H_o = initial thickness of ash layer

e_o = initial void ratio

σ'_{vo} = initial effective stress (@ middle of layer)

$\Delta\sigma_v$ = additional stren applied by add. ash

$$\therefore \quad S_{cr} = 0.02\left(\frac{43'}{1+1}\right)\log\frac{0.41+2.5}{0.41}$$

$$\underline{\underline{S_{cr} = 0.37 \text{ ft. or } 4.4 \text{ inches}}}$$

SUBJECT VEPCO Chesterfield Ash Disposal Pond Settlement

BY NCBA DATE 9/25/97 PROJ. NO. 96-410-33

CHKD. BY KCC DATE 10/28/97 SHEET NO. 5 OF 7

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Settlement - Phase II

Vertical stress due to weight of embankment is approx.

$$130 - 32 = 98' \text{ of ash @ } \gamma = 100 \text{ pcf} = 9800 \text{ psf}$$

$$= 4.9 \text{ tsf}$$

$$\text{say } 5.0 \text{ tsf} = \Delta\sigma_v$$

$$C_{cr} = 0.02$$

$$\therefore \quad S_{cr} = 0.02\left(\frac{98'}{2}\right) \log \frac{0.41 + 5.0}{0.41}$$

S_{cr} = 1.10 ft or 13 inches

Conclusions:

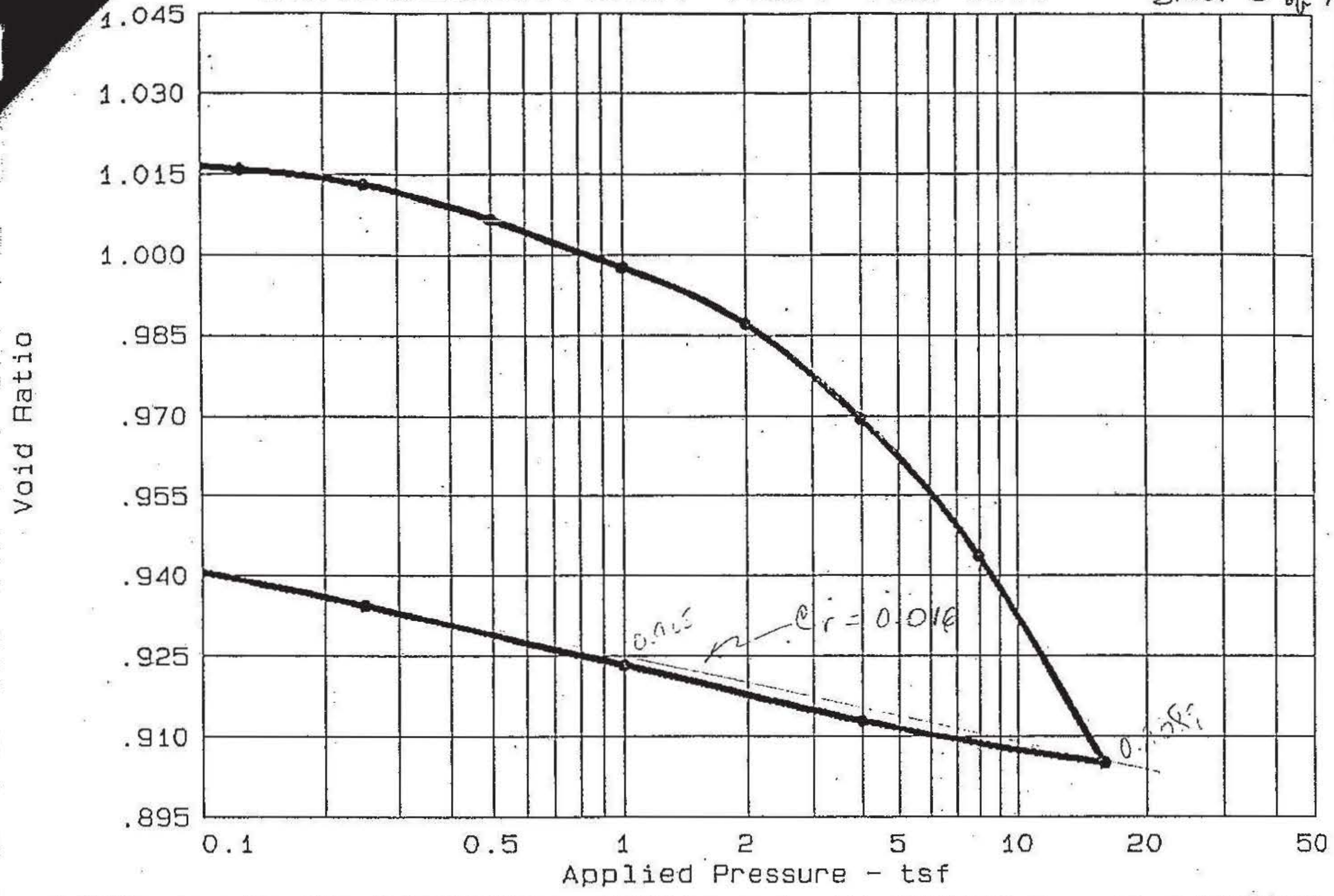
The existing ash layer will settle 4.4 inches due to the first phase embankment loading & up to a total of 13 inches due to second phase embankment loading.

Differential settlements should be gradual.

Copy ref. 2

Sheet 6 of 7

CONSOLIDATION TEST REPORT



Coefficients of Consolidation (sq.in./min.)								
No.	Load	Cv	No.	Load	Cv	No.	Load	Cv
1	0.06	0.201	9	16.00	0.205			
2	0.13	0.138						
3	0.25	0.152						
4	0.50	0.159						
5	1.00	0.148						
6	2.00	0.199						
7	4.00	0.220						
8	8.00	0.201						

Natural Saturation	Natural Moisture	Dry Density	LL	PI	Sp.Gr.	C_c	e_o
74.9 %	33.8	69.8			2.26	0.13	1.0199

TEST RESULTS

Compression Index = 0.13

MATERIAL DESCRIPTION

POND ASH

Project No.: 97-071-01
Project: VIRGINIA POWER
Location: CF #1

Date: 3 MARCH 1997

Remarks:

TESTED BY DDK
ENTERED BY DDK
CHECKED BY KM

CONSOLIDATION TEST REPORT

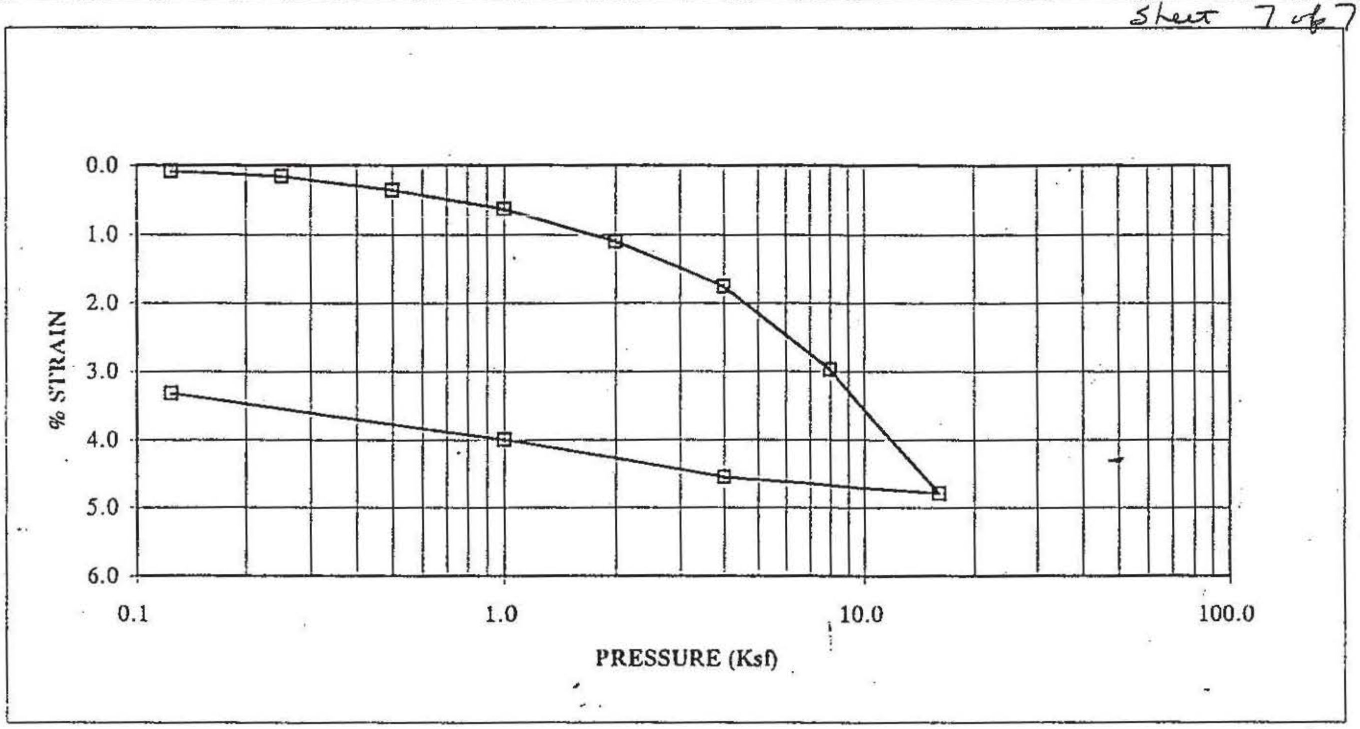
GAI Consultants, Inc.

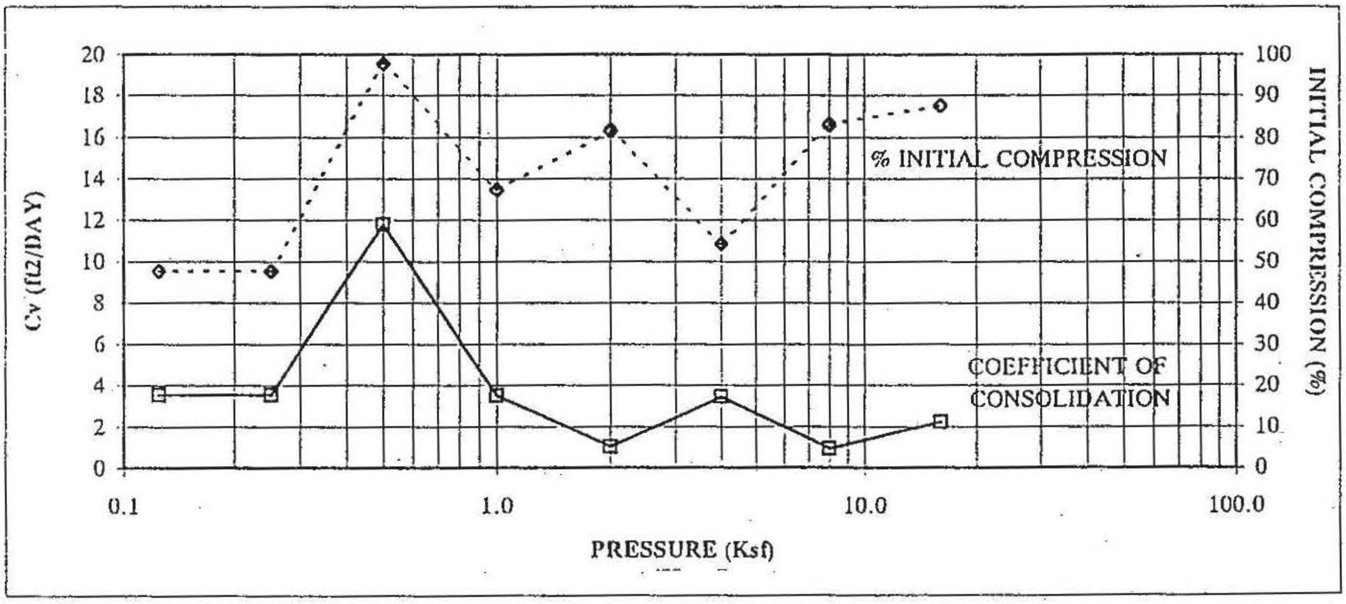
Fig. No.________

ONE - DIMENSIONAL CONSOLIDATION
ASTM D 2435

COPY ref. 4

Sheet 7 of 7





SAMPLE ID	COAL ASH
SAMPLE TYPE	Bulk
SAMPLE DEPTH	-

LL	-
PL	-
PI	-
Gs	2.25

	Initial	Final
Dry Unit Weight (pcf)	75.2	78.0
Wet Unit Weight (pcf)	94.7	106.6
Moisture Content	26.0%	36.6%
Void Ratio	0.8677	0.8000
Degree of Saturation	67.4%	103.0%

DESCRIPTION Coal Ash

USCS -

$$C_\alpha = \frac{\Delta \varepsilon}{\Delta P} = \frac{0.048-0.03}{\log 16 - \log 8} = \frac{0.018}{0.30} = 0.06$$

TECH	PWM
DATE	8/5/97
CHECK	
REVIEW	

VIRGINIA / CHESTERFIELD COAL ASH TESTING / VA
977-8032

Golder Construction Services, Inc.

SUBJECT Virginia Power – Chesterfield Closure
USLE

BY MRL DATE 9/10/97 PROJ. NO. 96-410-33

CHKD. BY RHD DATE 23 SEP 97 SHEET NO. 4 OF 8

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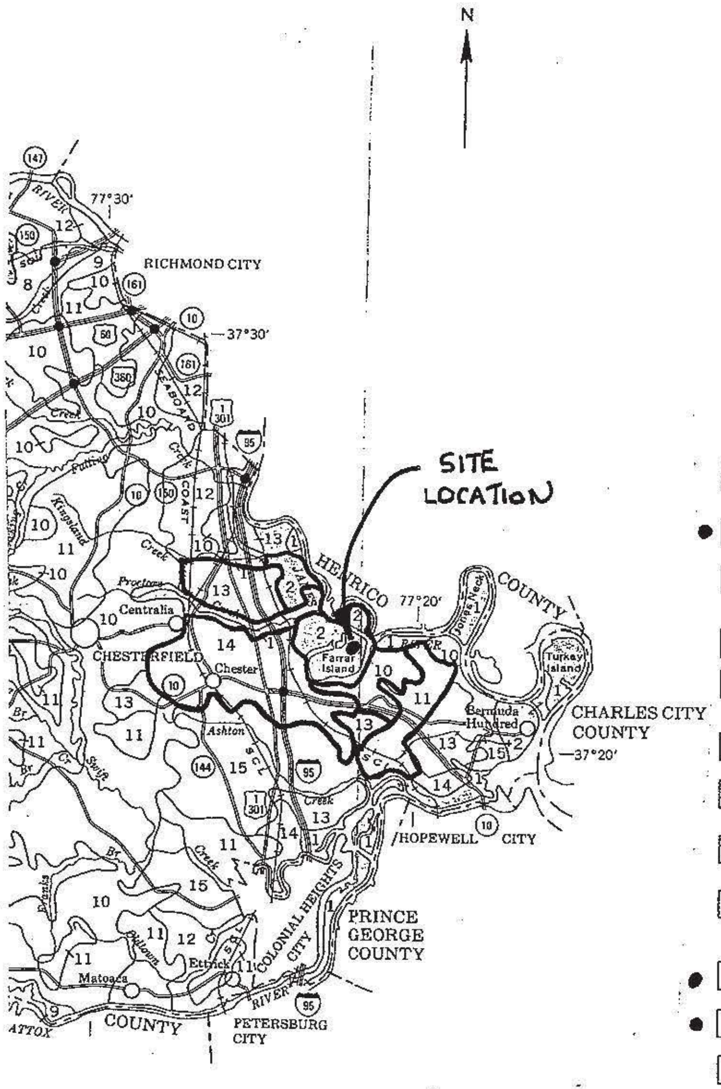

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

GENERAL SOIL MAP

CHESTERFIELD COUNTY, VIRGINIA

Scale 1:253,440
1 0 1 2 3 4 Miles

SOIL ASSOCIATIONS

SOILS ON FLOOD PLAINS AND TERRACES

1 Fluvaquents-Hydraquents association: Deep, poorly drained and very poorly drained soils that are frequently flooded and that have a sandy, loamy, or clayey substratum; along drainageways and streams

● 2 Pamunkey-Lenoir-Dogue association: Deep, well drained, moderately well drained, and somewhat poorly drained soils that have a dominantly loamy or clayey subsoil; on terraces

3 Masada-Edgehill-Turbeville association: Deep, well drained soils that have a dominantly clayey or gravelly clayey subsoil; on high terraces

SOILS ON TRIASSIC BASIN MATERIAL

4 Creedmoor-Mayodan association: Deep, well drained and moderately well drained soils that have a dominantly clayey subsoil; on uplands

5 Mayodan-Creedmoor association: Deep, well drained and moderately well drained soils that have a dominantly clayey or gravelly clayey subsoil; on uplands

SOILS ON THE PIEDMONT PLATEAU

6 Cecil-Appling association: Deep, well drained soils that have a dominantly clayey subsoil; on uplands

7 Cullen-Appling-Colfax association: Deep, well drained and somewhat poorly drained soils that have a dominantly clayey subsoil or that have a fragipan; on uplands

8 Appling-Worsham-Colfax association: Deep, well drained, somewhat poorly drained, and poorly drained soils that have a dominantly clayey subsoil or that have a fragipan; on uplands and upland flats

9 Appling-Grover-Colfax association: Deep, well drained and somewhat poorly drained soils that have a dominantly clayey or loamy subsoil or that have a fragipan; on uplands and upland flats

SOILS ON THE COASTAL PLAIN

● 10 Faceville-Gritney-Kempsville association: Deep, well drained soils that have a dominantly clayey or loamy subsoil; on uplands

● 11 Bourne-Aquults-Tetotum association: Deep, moderately well drained and poorly drained soils that have a fragipan or that have a loamy or clayey subsoil; on uplands and upland flats

12 Tetotum-Bourne association: Deep, moderately well drained soils that have a dominantly loamy subsoil or that have a fragipan; on uplands

● 13 Gritney-Atlee-Lenoir association: Deep, well drained, moderately well drained, and somewhat poorly drained soils that have a clayey or loamy subsoil; on uplands

● 14 Lucy-Orangeburg-Rumford association: Deep, well drained and somewhat excessively drained soils that have a dominantly loamy subsoil; on uplands

15 Ochrepts and Udults-Vaucluse association: Deep, excessively drained, well drained, and moderately well drained soils that have a sandy, loamy, clayey, or gravelly subsoil or that have a fragipan; on uplands

Compiled 1976

Reference: USDA Soil Survey of Chesterfield County, Virginia, July 1978

APPENDIX C

SCHEDULE AND CHEKLIST FOR FACILITY INSPECTIONS

APPENDIX C

SCHEDULE AND CHECKLIST FOR FACILITY INSPECTIONS

Table C-1

GENERAL INSPECTION SCHEDULE

Item	Possible Deficiency	Inspection Frequency[1]
CCB Placement Areas[2]	Surface breaks or slides, erosion, settlement, displacement	M/Q
Vegetated Cover[2]	Brush, trees, gaps in cover, erosion	M/Q
Existing Perimeter Dike[2]	Slides, sloughs, scarps, displacements, seepage, erosion	Q
Surface Water Drainage System[2]	Accumulated sediment, ponding, erosion	M/Q
Monitoring Wells	Misc. damage	Q
Locking Site Gate	Misc. damage	M/Q

Notes:

(1) M/Q - monthly for first 12 months, quarterly thereafter; Q - quarterly.

(2) Additionally, the integrity of the CCB placement area, cover, vegetation, existing perimeter dike, and surface water drainage system will be inspected after the spring thaw, after any rainfall exceeding two inches or any major rainfall event resulting in localized flooding.

SITE INSPECTION CHECKLIST
UPPER (EAST) CLOSURE
CHESTERFIELD POWER STATION

Date of Inspection: ______________________________

Temperature: ______________________________

Weather Conditions on Date of Inspection: ______________________________

General Weather Conditions During Previous Week: ______________________________

Persons Present at Inspection:

Name	Title/Position	Representing

General Comments:

Name of Inspector: ______________________ Site: ______________ Inspection Date: ____________

AREA INSPECTED	CONDITION	ACTION REQUIRED		OBSERVATIONS/LOCATION (Note on Attached Site Plan)
		Yes	No	
CCB PLACEMENT AREAS AND EXISTING PERIMETER DIKE	Wet Areas, Seepage			
	Surface Cracking			
	Slide, Slough, Scarp			
	Sinkhole, Animal Burrow			
	Erosion			
	Unusual Movement			
	Vegetation Control			
VEGETATED COVER	Surface Cracking			
	Sinkhole, Animal Burrow			
	Low Areas(s)			
	Ruts and/or Puddles			
	Vegetation Condition (Trees, brush, gaps)			

ADDITIONAL COMMENTS:

Name of Inspector: ______________________ Site: ______________ Inspection Date: ____________

AREA INSPECTED	CONDITION	ACTION REQUIRED		OBSERVATIONS/LOCATION (Note on Attached Site Plan)
		Yes	No	
LOCKING GATE	Miscellaneous Damage			
SURFACE WATER DRAINAGE SYSTEM	Drainage Channels			
	- Accumulated Sediment			
	- Erosion			
	- Vegetation/Riprap/Lining Condition			
	- Ponding			
	Culverts			
	- Accumulated Sediment			
	- Structural Integrity			
	- Inlet Condition			
	- Outlet Condition			
MONITORING WELLS	Miscellaneous Damage (e.g, damaged casing, cover, lock, etc.)			

ADDITIONAL COMMENTS:

Post-Hearing Exhibit 6
Page 184 of 184