PRELIMINARY ENGINEERING REPORT

FOR

QUEENS LAKE DAM
YORK COUNTY, VIRGINIA

AMT PROJECT #20-0081.001

October 23, 2020

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QUEENS LAKE COMMUNITY ASSOCIATION
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WILLIAMSBURG, VA 23185
757-323-4442

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100 GATEWAY CENTER PARKWAY, SUITE 200
RICHMOND, VIRGINIA 23235
804-276-6231

Preliminary Engineering Report for the Queens Lake Dam

Introduction

Queens Lake Dam (Dam Inventory #199016) is an earthen embankment under West Queens Drive (Route 716) in York County, Virginia, that is owned and operated by the Queens Lake Community Association (QLCA). The dam is approximately 580-feet long and twelve (12) feet tall, with a dam crest that is approximately eighteen (18) feet wide to support an approximately sixteen (16) foot wide, two-way asphalt roadway. The downstream and upstream slopes vary greatly, and the dam drains directly into the marshes of Queens Creek, as shown on the existing conditions plan (C1.0) contained in this preliminary engineering report (PER).

The dam is classified by the Virginia Department of Conservation and Recreation (DCR) as a Special Low Hazard Dam, not requiring many of the detailed engineering studies required for other hazard classes. Details of the requirements for a special low hazard dam can be found in the Virginia Impounding Structure Regulations (4VAC50-20-51).

The purpose of this preliminary engineering report (PER) is to make recommendations based on the current hazard class, improve the emergency preparedness plan, and recommend dam repairs or upgrades as necessary to maintain the useful life of this dam for the foreseeable future. A path towards a 50-year maintenance and repair plan is desired by the QLCA for the Queens Lake Dam.

Dam Issues and Identified Concerns

The following identified issues, concerns, and deficiencies were noted for the dam at the start of this PER and known concerns have been expanded upon through the enclosed dam inspection and geotechnical investigation as part of this study.

1. Based on an evaluation of the concrete spillway by TAM Consultants in April 2018, construction work is planned to rehabilitate the existing concrete spillway and extend its useful life. TAM Consultant's recommendations are paraphrased below for convenience.
    a. Remove tree roots coming through cracks in the concrete structure or underneath it.
    b. Clean barnacles and remove loose concrete or other deleterious materials from the exposed surfaces.
    c. Repair all damaged concrete, fill cracks, and replace joint materials.
2. Based on previous geotechnical investigations and overly steep side slopes, the factor of safety for slope stability is a major concern for this dam. This report includes a geotechnical investigation of slope stability, and recommendations to achieve a 1.3 factor of safety on the dam embankment.
3. QLCA is also concerned about the holes forming in the dam, that are being marked by pink pin flags or white paint as they are encountered. Three (3) possible reasons for the holes are noted below:

a. Depressions are forming from eleven (11) trees that were planted on this dam, as part of the original dam construction work in 1959. Several of these trees fell during Hurricane Isabel in 2003, but the stumps were left in the dam during the clean-up work, when the remaining trees were removed. This has resulted in seventeen (17) years of rotting tree stumps and roots in the dam, that may be forming holes and pathways for water through the dam, slowly over time.

b. The QLCA noted the possibility of small rodents or muskrats creating burrows in this dam. Rodent and animal burrowing will additionally contribute to dam stability concerns from tree stumps and roots and should be further evaluated if encountered on this dam.

c. There are holes forming around the guard rail posts near the concrete spillway that VDOT has tried to fill twice, unsuccessfully. There are also some holes around the VDOT traffic signs on the dam.

Dam Topographic Survey

The Queens Lake Dam was surveyed by a professional land surveyor for A. Morton Thomas and Associates, Inc. (AMT) as a basis for this engineering study - with fieldwork and a Miss Utility Ticket in July 2020. Results of that topographic survey are noted on the Existing Conditions Plan (C1.0) in this report. Queens Creek mean tidal data and other information on the dam survey are provided in the North American Vertical Datum 1988 (NAVD 88). To convert to the older NGVD 29 datum for a comparison to previous mapping and reports, add 1.03-feet to the elevations depicted on this survey.

Property Ownership

The Queens Lake Dam appears to have a 50’ wide public Right-of-Way crossing it, that is maintained by the Virginia DOT, based on the 1959 record drawing (or subdivision plat) for Queens Lake Club, Inc. that is recorded in York County Plat Book 6, Pages 30/31. County parcel mapping in GIS shows the owner is Queens Lake Club, Inc. care-of (C/O) the Queens Lake Community Association, Inc. This ownership covers the dam and at least 25’ additionally on all sides, except where a permanent easement may be required from an adjacent property owner (GPIN G16d-4915-2463) to perform vegetation clearing as required for dam safety or to improve boat launching capabilities onto Queens Lake from that location. Further coordination with the property owner for any planned construction or maintenance work in this area is recommended for the QLCA prior to proposed easement acquisition and related work.

Additional easements for utilities owned by York County, Dominion Virginia Power, and others in the vicinity of the dam are separate from the QLCA property rights and are not necessarily noted in this report or shown on the topographic survey. Additional easements, however, could be researched and shown by way of a formal title report or boundary survey should the need arise for additional investigations of land rights associated with this dam.

Geotechnical Investigation

The Queens Lake Dam was evaluated by a professional engineer for ECS Mid-Atlantic as part of this engineering study based on a review of previous geotechnical studies and recommendations, three (3) additional borings in the dam for this study (B-1, B-2, and B-3) and a slope stability analysis of the dam. Recommendations to address structural concerns and improve the overall factor of safety for slope stability to 1.3 or greater, are described in ECS Mid-Atlantic's engineering report (see report appendices). No internal drains or water management retrofits are recommended or required for this dam, except as necessary to lower the water table during construction.

Dam Inspection

The Queens Lake Dam was inspected by a professional engineer for A. Morton Thomas and Associates, Inc. (AMT) as part of this engineering study in September 2020. Results of that inspection are noted on DCR Form 199-098 in the report appendices, as summarized below.

1. Trees and other woody vegetation within 25-feet of the dam on both sides of the dam should be removed as shown on the conceptual improvement plan (C2.0) including the 30" conifer and 36" maple tree on the north side of the dam. Trees stumps can remain within the 25' offset for tree removals required for dam safety, if tree stumps are outside of the dam groin areas.

2. Any remaining tree stumps or larger roots in the dam itself should be removed from the dam, and then the dam embankment can be rehabilitated in accordance with the geotechnical engineering recommendations from ECS Mid-Atlantic (see report appendices) in this report.

3. Fill material and a rock key should be installed on the downstream side of the dam to improve slope stability in accordance with the geotechnical engineering recommendations from ECS Mid-Atlantic (see report appendices) in this report.

4. QLCA is already rehabilitating the concrete spillway in accordance with the structural evaluation by TAM Consultants (September 2018) that is included in the report appendices, but AMT additionally recommends that QLCA backfill scour holes that have formed on the downstream side of the concrete spillway and under the spillway apron, then armor the slopes on both sides of the concrete spillway with filter fabric and riprap.

5. QLCA should also install a 3' tall, color-coded staff gage to monitor depth of flow in the concrete spillway during an extreme storm event for observation from a location near Traverse Point #1 (TRV #1). Dam overtopping occurs at a spillway flow depth of 3.64-feet for this dam.

These recommended dam improvements are generally depicted on the enclosed Conceptual Improvement Plan (C2.0) with an associated budgetary estimate of $360,000 construction costs, with cost estimating details as shown in the report appendices.

Environmental Considerations

During the course of this engineering study, environmental concerns were noted including the following environmental considerations for this study:

1. Any work below ordinary high water (OHW) or Mean High Water (MHW) to improve or rehabilitate this dam will likely require a permit for impacts to Waters of the United States (WoUS) such as wetland and stream impacts. Further investigation of these impacts would typically follow a 2-step process of a jurisdictional determination request (JDR) to the U.S. Army Corps of Engineers, followed by a permit application for avoidance, minimization and mitigation of any impacts to WoUS through the Joint Permit Application (JPA) process. Related permit requirements and costs should be part of the engineering design and permitting phase.

2. Any land disturbing activities will likely require a permit for erosion and sediment control measures during construction, based on the local permitting requirements for York County. A pre-application meeting for a determination of county-related permit requirements and costs should be part of the engineering design and permitting phase.

No lake water quality issues were identified during this study.

Operation and Maintenance Plan

Continued routine maintenance is recommended for this dam with the following key points:

1. Dam mowing should be performed at least twice annually with grassy vegetation cut to an approximate height of 3-4 inches to promote deep root growth.

2. Annual dam inspections by the QLCA should include coordination of woody vegetation removal within 25-feet of the dam on all sides, and over-seeding and stabilizing any bare patches encountered to establish and maintain a full, thick stand of grass cover crop on this dam.

3. The concrete spillway should also be inspected and repaired on a regular basis, at least every five (5) to ten (10) years for this dam.

VDOT routine inspections and maintenance of the paved roadway is also strongly recommended as it relates to this dam. VDOT maintained assets on the dam include the asphalt roadway, wooden bridge, metal guard-rails, edge of pavement delineator signs, and other VDOT traffic signage as also noted on the survey. QLCA should coordinate these needs directly with VDOT for annual inspections and maintenance requirements. Additionally, VDOT is coordinating with QLCA to repair and fill holes around the guard-rail posts at this time. VDOT previously tried filling these holes with crusher run and pavement millings but the holes have quickly resurfaced after both VDOT spot repairs. We recommend VDOT's use of a low strength grout for the repairs generally matching the geotechnical recommendations in the ECS Mid-Atlantic report.

The existing wooden bridge is designated as Federal Bridge ID Number 19883 and it is currently posted by VDOT with an eleven (11) ton weight limit for vehicles, which is a consideration during construction for the type of construction equipment, as well as access and staging areas.

Emergency Preparedness Plan (EPP)

The previously prepared Emergency Action Plan (EAP) for this dam on DCR Form 199-103 has been reviewed and then updated as an Emergency Preparedness Plan (EPP) for this dam going forward, using DCR Form 199-103. QLCA should review the proposed EPP report, contact all emergency services agencies noted in the EPP to advise them as to the recommended actions for this dam during a sunny day breach or extreme flood event, and keep their contact information updated at least annually by copy to all parties noted in the EPP document including York County, Virginia Department of Transportation (VDOT), Virginia Department of Emergency Management (VDEM), and the Virginia Department of Conservation and Recreation (Virginia DCR).

Other Dam Discussion

During this engineering study, other things have been discussed for the QLCA to consider:

1. Dam armoring using ACB's, Riprap, Gabions or similar hard armoring materials was evaluated and determined initially to be a more expensive alternative than the recommended slope repairs described in this report. Should the QLCA want to more carefully consider a concrete armoring and repair alternative, we can reach-out to ACF Environmental for a value engineering study to compare to the recommendations in this report. It is believed that up to 50,000 square feet of ACB's will be needed for an estimated budget of $20 per square foot, or a $1 million budget.

2. We briefly discussed driving sheet piles into the dam on the upstream slope, to essentially replace the earthen embankment as the regulated impounding structure, but this was not recommended for further study by the QLCA lake committee during our kickoff meeting. It is estimated that 12' long vinyl sheet piling would be necessary over the length of the dam with two-thirds embedment for an estimated budget of $100/sf, or a $700,000 budget.

3. If DCR requires the QLCA to provide a low flow drain, or if the QLCA wants the ability to lower the lake level more easily below the concrete spillway invert elevation, AMT can provide the design of a self-priming PVC siphon for installation on your dam to meet these goals with an estimated budget of $30,000. AMT has been told that QLCA abandoned the dam's concrete sluice that is buried behind the south abutment wall of the concrete spillway in approximately 1990, by filling it with 15 cubic yards of concrete.

4. We understand that the QLCA marina committee might want to remove additional vegetation near the marina on the south side of the dam, beyond the 25' limits required per the dam regulations. Once AMT has established the dam clearing limits, work can get underway by the QLCA lake committee with additional tree clearing for the marina, as required by others. Cost sharing and other details should be worked out internally by the QLCA leadership team.

5. The QLCA Lake Committee has discussed providing improvements in the vicinity of the north groin for this dam that would allow a small boat to launch into the lake for shoreline maintenance and dock related construction work and equipment (such as a small dredge or barge) that may be desired by lakefront property owners for access to the lake. Currently, the north groin area is covered with riprap that could be blended with #3 stone or similar to inexpensively improve boat launching capabilities. Alternatively, a concrete or ACB armored boat launch could be installed in this area, for an additional construction cost. AMT can provide additional for a boat launch that meets these goals, should the QLCA decide to include it in the planned dam construction work to follow this study.

Dam Hazard Class

The Queens Lake Dam hazard class of **SPECIAL LOW HAZARD** remains unchanged as a result of this preliminary engineering report in agreement with the recommendations by URS Corporation in an engineering report, dated August 2014.

AMT recommends no change in hazard class because there is no new development within the immediate vicinity of this dam nor any significant changes to the upstream watershed or dam itself. Also, it is AMT's opinion that the impounding structure will cause no expected loss of human life or economic damage except possibly to property owned by the dam owner (such as the QLCA marina).

In the case of roadway damages, VDOT has advised QLCA that they would not repair this roadway or continue its current use as a state maintained public road, in the case of roadway problems as a result of a dam failure, making dam maintenance and repairs the community's responsibility as a private road at that time (e.g. Lake Powell, etc.). Also, York County reportedly does not currently allow county vehicles to drive across the dam (buses, fire trucks, etc.) and VDOT has posted a weight limit of 11 tons on the wooden bridge which is 16' wide for 2-way traffic (Federal Bridge ID Number 19883). These limitations would continue for a privately maintained roadway on this dam, should that situation arise.

Further notes about the special low hazard dam classification can be taken from 4VAC50-20-51.

- No dam break inundation map is required per 4VAC50-20-54.
- No specific spillway design flood (SDF) is required however the URS report on dam hazard class determined that the existing concrete spillway has a 10-year spillway capacity (August 2014).
- No emergency preparedness plan (EPP) is required; however, one is included in this report to help inform notifications to the local emergency services coordinator, VDOT and others in case of an emergency condition at the dam. AMT also recommends closing the road when the flow depth in the concrete spillway is three (3) feet and the installation of a staff gage to measure depth.
- No PE dam inspections are required; however one is included in this report to help inform the necessary improvements to remove woody vegetation and old tree stumps from the dam, and then re-build the downstream slope to establish a 1.3 factor of safety for slope stability. Annual dam owner inspections started by the QLCA Lake Committee three (3) years ago and should also continue in 2021 and beyond for this dam.
- No O&M certificate or permit fees are typically required for a special low hazard dam, should the DCR regional dam safety engineer agree with the findings of this AMT Preliminary Engineering Report (PER). QLCA is required however to immediately notify the department (DCR) in case of a change in conditions that may affect the recommended dam hazard class described in this report. Additionally, the current O&M certificate for this dam expires, July 2021, and an application for renewal is due at least 90-days prior to the expiration date (April 2021). Planned construction work may not be completed by April 2021 and a coordination meeting with the DCR regional dam safety engineer is recommended at the conclusion of this study to further coordinate dam permit requirements and recommendations going forward.

QUEENS LAKE DAM REHABILITATION PROJECT

CONCEPTUAL COST ESTIMATE

28-Sep-20

#	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	SOFT COSTS				
1	Constuction Stakeout / Layout	$4,500.00	1	LS	$4,500.00
2	Dam As-Built Updates	$2,500.00	1	LS	$2,500.00
	SUBTOTAL =				**$7,000.00**
	GENERAL CONDITIONS				
3	Mobilization & Temporary Facilities	$20,000.00	1	LS	$20,000.00
4	Bonds, Taxes, Permits, and Insurance	$10,000.00	1	LS	$10,000.00
5	Traffic Control Measures- **CLOSE THE ROAD**	$5,000.00	1	LS	$5,000.00
	SUBTOTAL =				**$35,000.00**
	DEMOLTION & SITE PREPARATION				
6	Erosion & Sediment Control Measures	$10,000.00	1	LS	$10,000.00
7	Remove and Replace VDOT Signs	$2,000.00	1	LS	$2,000.00
8	Vegetation and Stump Removals w/ 2 Trees	$15,000.00	1	LS	$15,000.00
9	Excavation / Disposal of Unsuitable Material	$30.00	400	CY	$12,000.00
10	Install Color-Coded Staff Gage (3' Tall)	$5,000.00	1	LS	$5,000.00
	SUBTOTAL =				**$44,000.00**
	SLOPE REPAIRS				
11	#3 Rock Key w/ Geotextile & Dewatering	$100.00	400	CY	$40,000.00
12	Grouting Plan & Budget	$18,000.00	1	LS	$18,000.00
13	Fill Holes with Clay Soils, compacted	$50.00	120	CY	$6,000.00
14	Re-Build Downstream Slope on Rock Key	$50.00	1000	CY	$50,000.00
15	Biaxial Geogrid at 2' vertical spacing	$2.00	12,000	SF	$24,000.00
16	Fine Grading with Seed & Mulch	$3.50	3,300	SY	$11,550.00
	SUBTOTAL =				**$149,550.00**
	CONCRETE SPILLWAY REPAIRS				
17	Concrete Cleaning & Repairs	$50,000.00	1	LS	$50,000.00
18	Fix and Rip-Rap Slopes on both sides	$15,000.00	1	LS	$15,000.00
	SUBTOTAL =				**$65,000.00**
	TOTAL COST =				**$307,550.00**
	CONTINGENCY BUDGET =	**15%**			**$46,133.00**
	CONSTRUCTION COST =				**$360,000.00**

Cost Estimate Notes:

1) Design and Permitting Costs are estimated as part of the AMT contract separately
2) A permanent easement is required for the Reams Property prior to the work in that area.
3) Boat launch improvements near the Reams Property are not included.
4) The use of temporary sheet piles for the construction ramp into the creek is not included.
5) Concrete cleaning and repair costs are being separately contracted by QLCA at this time.

Quotation

To: ECS, Williamsburg
At: Queens Lake Dam

CJGeo WO#: SF1921
Revision #: Original Date:9/9/2020

Item	Quantity	Unit Price	Total
Mobilize manpower and equipment to site. Furnish and install CJGrout 35NHV61 to fill (50) 8” average diameter holes running horizontally across the dam with a limit of 1837 Lbs.	1 LS	$17,693.00	$17,693.00
		Total	$17,693.00

CJGeo
3402 Acorn St #202
Williamsburg, VA 23188
office: (800) 428-5690
fax: (757) 566-3025
Division of Preston H. Roberts, Inc
Virginia (H/H, RBC, CBC, LSC) #2705-106435A
West Virginia Contractor WV048953
Maryland MHIC 104379
District of Columbia GC 410512000255
North Carolina GC HWY 73978
South Carolina GC121002
Delaware 2013101276

Terms & Conditions:

General:

Contracts, subcontracts and/or purchase orders should be made to "Preston H. Roberts, Inc dba CJGeo". This quotation must be referenced in your contract, subcontract and/or purchase order. Quoted price is based on customer providing CJGeo at least 14 hours of consecutive work time per calendar day. $350/hour short shift charged if less than 14 hours of work time provided per day.

Insurance & Bonding:

Quoted price is based on insurance coverage detailed in bidding COI available at www.cjgeo.com/COI. No bond is included in quoted price; bond billed at cost if desired, on AIA forms. Payment in full is due within 30 days of completion, with 30 day draws if project is phased.

Payment:

Payment in full is due within 30 days of completion. Interest will accrue at 1.5% per month after 30 days. Customer shall pay all costs and expenses of collection incurred by Preston H. Roberts, Inc., including reasonable attorneys' fees.

Taxes:

Quoted prices reflect CJGeo paying sales tax on project-specific materials. Quoted prices do not include capital improvement or other sales taxes on services; these will be billed separately, as required by municipality and/or state.

Customer Responsibilities:

1. Provide a safe, hazard free work environment.
2. Provide and maintain construction entrance, sanitary facilities & all erosion/sediment control.
3. Provide access for CJGeo's equipment onsite, with onsite storage/laydown area for equipment and materials.
4. Surface restoration such as seed & straw, sodding, pavement replacement, flooring, etc.
5. Perform all dewatering and/or bypass pumping unless explicitly stated
6. Provide utility locating for all private utilities within work area/zone of influence
7. Facilitate access for CJGeo-initiated 811 public utility marking

Safety:

Quoted price includes up to 3 hours of attendance per CJGeo employee in site-specific safety training. No additional safety training is included in quoted price; $40/hour per employee in attendance beyond 3 hours. Customer to notify CJGeo of OSHA 10 or 30 hour trained employee requirements at least 2 weeks prior to mobilization.

Permitting:

Building or other permits are not included in quoted price. Permits are billed at cost plus $50.00

Inspections & Engineering:

CJGeo will coordinate with customer's testing agency, third party engineers, municipal inspectors, etc. to facilitate testing and inspections, but costs associated with those parties are not covered by CJGeo, unless explicitly stated in writing.

Polyurethane Grouting:

Method:

CJGeo proposes to furnish & install CJGrout 35NHV61 geotechnical polyurethane grout immediately into voids running horizontally across the dam structure. Quoted price includes up to 1837 pounds 35NHV61 (525 cubic feet). Quoted quantity is based on 8 inch diameter burrows over 1500 Lin. feet.

Material Limit:

Additional material, if required, is $5.50/pound.

Testing:

No independent testing, engineering or other incidentals are included.

Obstructions:

If sacrificial grouting tubes cannot be installed due to obstructions, grouting will be performed at achievable depth. Tubing installation as quoted is based on percussion driven installation.

Customer Responsibilities:

Customer to locate all private utilities within the work area prior to arrival of CJGeo. Any non-pressurized pipes such as storm drains, sanitary sewers, etc, should be video inspected prior to arrival of CJGeo. Utility markings should be capable of tolerating normal foot and vehicle traffic for duration of repair. Repair of utilities, including those fouled by polyurethane grout, are responsibility of customer.

Surface Restoration:

CJGeo will leave work are broom finish clean, and break off any bulk extrusions of grout off flush with surface and dispose of offsite.

DCP Testing:

NA

When Lifting Will Be Stopped:

No planned lifting.

This quotation was prepared by:
Mike Chattin
c: (804) 543-3063
kirk@cjgeo.com

This quote expires 30 days from 9/8/2020

To accept this quotation:
Initial all pages, sign below and return to offiice@cjgeo.com . By signing below, you acknowledge and accept this quotation and its attachment(s) in their entirety, and agree to pay within 30 days of completion. Signed quotations must be accompanied by purchase order.

Sign: _____

Print & Title: _____

Date: _____

Please provide contact info below for your organization for this project.

Name: _____

Title: _____

Phone: _____

Email: _____

( ) scheduling ( ) billing ( ) project manager ( ) superintendent ( ) contracts ( ) other:

Name: _____

Title: _____

Phone: _____

Email: _____

( ) scheduling ( ) billing ( ) project manager ( ) superintendent ( ) contracts ( ) other:

Name: _____

Title: _____

Phone: _____

Email: _____

( ) scheduling ( ) billing ( ) project manager ( ) superintendent ( ) contracts ( ) other:

Virginia Department of Conservation & Recreation

Date Prepared: September 14, 2020
Prepared By: D. Rissmeyer

ANNUAL INSPECTION REPORT FOR VIRGINIA REGULATED IMPOUNDING STRUCTURES

Reference: Impounding Structures Regulations, 4VAC 50-20-10 et seq., including 4VAC 50-20-105, Virginia Soil and Water Conservation Board

Owner's Information

Name of Dam: Queens Lake Dam
Inventory Number: 199016
Owner's Name: Queens Lake Community Association, Inc. (QLCA)
Location-County/City: York County
Contact Person (if different from above): QLCA President, Leah Duckworth
Owner's Address: 234 East Queens Drive, Williamsburg, VA 23185
Hazard Classification: Special Low
Name of reservoir: Queens Lake
Purpose of reservoir: Recreational
Telephone No.: (Residential) (757) 323-4442 (Business) (757) 229-0973
Other means of communication: qlca@widomaker.com

Owner's Engineer

Name of Engineering Firm and Engineer: A. Morton Thomas and Associates, Inc. / Don Rissmeyer, PE, CFM
Professional Engineer Virginia License Number: 026104
Mailing Address: 100 Gateway Center Parkway, Suite 200, Richmond, VA 23235

Telephone No.: (Business) (804) 276-6231 or (804) 916-9476 - Cell

Directions: Make note of all pertinent conditions and changes since the last inspection, or, if this is the first inspection, since the filing of a design report.

Date of This Inspection 9/10/2020
Date of Last Inspection 4/8/2020

1. EMBANKMENT

a. Any alteration made to the embankment? Pink pin flags are now marking holes due to rodent burrows and/or rotting roots from trees that were removed after Hurricane Isabel (September 2003).
b. Erosion on embankment? Banks and sloughing were noted.
c. Settlement, misalignment or cracks in embankment? Holes were noted throughout the embankment. Also, there is some alligator cracking on the edges of VA Route 716 (East Queens Drive) which goes across the top of the dam.
d. Seepage? If so, seepage flow rate and location (describe any turbidity and observed color within the flow): None

2. UPSTREAM SLOPE

a. Woody vegetation discovered? Yes – requires regular maintenance to control due to re-growth
b. Rodent burrows discovered? Rodent burrows or holes from rotting roots near where tree stumps were removed.
c. Remedial work performed? Holes near the guard rail have been filled by VDOT. Also, a new contractor for clearing and mowing was hired in March 2020.

3. INTAKE STRUCTURE – Same as Concrete Emergency Spillway

a. Deterioration of concrete? Cracks noted in the 2018 engineering study
b. Exposure of rebar reinforcement? None
c. Is there a need to repair or replace the trash rack? It is a concrete spillway with no trash rack
d. Any problems with debris? None
e. Was the drawdown valve operated? The low flow drain was a 3'x3' sluice behind the east abutment that was filled with concrete and abandoned on the Queens Lake Marina side of the dam.

4. ABUTMENT CONTACTS

a. Any seepage? If so, estimate the flow rate and describe the location of the seep or damp areas (describe any turbidity and observed color within the flow):
None

5. EARTHEN EMERGENCY SPILLWAY – Not Applicable (N/A)

a. Obstructions to flow? If so, describe plans to correct:

b. Rodent burrows discovered?

c. Any deterioration in the approach or discharge channel?

6. CONCRETE EMERGENCY SPILLWAY – Same as Intake Structure

a. Deterioration of concrete? Cracks noted in the 2018 engineering study.

b. Exposed steel reinforcement? None

c. Any leakage below concrete spillway? None

d. Obstructions to flow? If so, lists plans to correct: Dam Owner is planning to rehabilitate the concrete spillway based on the recommendations in the structural evaluation report by TAMS Consultants (February 2018). A repair contract was initiated in April 2020 by QLCA.

7. DOWNSTREAM SLOPE

a. Woody vegetation discovered? Rotting wood stumps are suspected from trees removed after Isabel.

b. Rodent burrows discovered? Rodent burrows or holes from rotting roots near where tree stumps were removed.

c. Are seepage drains flowing? N/A

d. Any seepage or wet areas? Animal burrows were noted on bare earth slopes at the outlet end of the spillway on both sides.

8. OUTLET PIPE – Not Applicable (N/A)

a. Any water flowing outside of discharge pipe through the Impounding Structure?

b. Describe any deflection or damage to the pipe:

9. STILLING BASIN – Not Applicable (N/A)

a. Deterioration of concrete structures?

b. Exposure of rebar reinforcement?

c. Deterioration of the basin slopes?

d. Repairs made?

e. Any obstruction to flow?

10. GATES – Not Applicable (N/A)

a. Gate malfunctions or repairs?

b. Corrosion or damage?

c. Were any gates operated? If so, how often and to what extreme?

11. RESERVOIR/WATERSHED

a. New developments upstream of dam? The shoreline is fully developed with residential back yards. No new development.

b. Slides or erosion of lake banks around the rim? None

c. General comments to include silt, algae or other influence factors: Water quality is generally believed to be good.

12. INSTRUMENTS – Not Applicable (N/A)

a. List all instruments

b. Any readings of instruments?

c. Any installation of new instruments?

13. DOWNSTREAM/HAZARD ISSUES

a. New development in downstream inundation zone?
The dam drains directly into Queens Creek and there are no downstream hazards.

b. Note the maximum storm water discharge or peak elevation during the previous year. Elevation 11.25' (NGVD '29)

c. Was general maintenance performed on dam? If so, when? Mowing has been performed monthly since March 2020.

d. List actions that need to be accomplished before the next inspection: See Below.

14. OVERALL CONDITION ASSESSMENT OF IMPOUNDING STRUCTURE AND APPURTENANCES

(Check one) ☐ **SATISFACTORY** ☐ **FAIR** ☒ **POOR** ☐ **UNSATISFACTORY** ☐ **NOT RATED**

1. SATISFACTORY
No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.
2. FAIR
No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.
3. POOR
A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.
4. UNSATISFACTORY
A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
5. NOT RATED
The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated.

General Comments: Two projects are planned for rehabilitation of this dam. One involves the rehabilitation of the concrete spillway per the recommendations in the structural evaluation by TAMS Consultants (February 2018). The second will be based on a Preliminary Engineering Report (PER) that is currently underway by AMT to make recommendations as a result of this dam inspection to be addressed prior to dam recertification. Dam inspection results are summarized below.

Recommendations:

1. Remove all woody vegetation within 25-feet of the dam on both sides, as shown on the recently developed dam as-built survey and PER Report by AMT Engineering.
2. Remove all tree stumps and rotting wood roots in the dam leftover from tree removals after Hurricane Isabel (September 2003) then backfill voids with a low strength grout per ECS geotechnical engineering recommendations.
3. Cap grout with clayey soils to form a more consistent upstream side slope, then stabilize with grass and EC-2 matting.
4. Extend the downstream embankment 10' into Queens Creek, to then build an approximately 2.5:1 or flatter side slope, with a 24" deep x 10' wide rock key underneath to improve the slope stability safety factor to 1.3 or better, as noted in the ECS geotechnical engineering recommendations. Then stabilize the downstream slope with grass and EC-2 matting.
5. Install rip-rap armoring to protect exposed slopes on both sides of the concrete spillway at the outlet end.

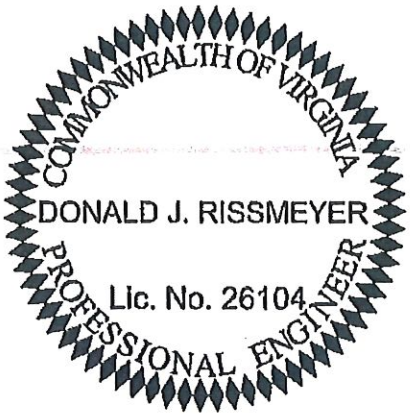
CERTIFICATION BY OWNER'S ENGINEER (required only when an inspection by an engineer is required)

I hereby certify that the information provided in this report has been examined by me and found to be true and correct in my professional judgment.

Signed: _____ Donald J. Rissmeyer, PE, CFM Virginia Number: 026104
Professional Engineer's Signature Print Name

This 14th day of September , 20 20 .

Engineer's Virginia Seal:



CERTIFICATION BY OWNER

I hereby certify that the information provided in this report has been examined by me.

Signed: Bruce Keener QLCA Bruce C. Keener
Owner's Signature Print Name

This 23 day of OCTOBER , 20 20 .

Mail the executed form to the appropriate
Department of Conservation and Recreation
Division of Dam Safety and Floodplain Management
Regional Engineer

Photo 1 – Photo along the Top of Dam from Concrete Spillway

Photo 2 – Holes under the Guard Rail Posts (being addressed by VDOT)

Photo 3 – Existing concrete spillway under the wooden bridge (bare slopes on both sides)

Photo 4 –Small crabs and holes in the embankment near the concrete spillway

Photo 5 – Buried Stump near downstream toe of dam (rotting wood is forming holes)

Photo 6 – Buried Stump near downstream toe of dam (pink flags note holes forming)

Date Prepared: September 21, 2020
Prepared By: D. Rissmeyer

EMERGENCY PREPAREDNESS PLAN FOR LOW HAZARD VIRGINIA REGULATED IMPOUNDING STRUCTURES

Reference: Impounding Structures Regulations, 4VAC 50-20-10 et seq., including 4VAC 50-20-177, Virginia Soil and Water Conservation Board

1. Name of Impounding Structure: Queens Lake Dam
   Inventory Number: N/A City/County: York County
   Other Name (if any): N/A
   Stream Name: Queens Creek
   Latitude: 37º-17'-48" Longitude: 76º-39'-06"

2. Name of Owner: Queens Lake Community Association (QLCA)
   Address: 234 East Queens Drive, Williamsburg, VA 23185
   Telephone: (Residential) (757) 323-4442 (Business) (757) 229-0973
   Other means of communication: qlca@widomaker.com
   (Note: 24-hour telephone contact required) Bruce C. Keener, (757) 323-4442 (cell)

3. Name of Impounding Structure Operator: Queens Lake Community Association (QLCA)
   Address: 234 East Queens Drive, Williamsburg, VA 23185
   Telephone: (Residential) (757) 323-4442 (Business) (757) 229-0973
   Other means of communication: qlca@widomaker.com
   (Note: 24-hour telephone contact required)

   Name of Alternate Operator: Bruce C. Keener, QLCA Lake Committee Chairman
   Telephone: (Residential) N/A (Business) (757) 323-442 (cell)
   Other means of communication: bckeener3@gmail.com
   (Note: 24-hour telephone contact required)

4. Name of Rainfall and Staff Gage Observer for Dam: Queens Lake Community Association (QLCA)
   Address: 234 East Queens Drive, Williamsburg, VA 23185
   Telephone: (Residential) (757) 323-4442 (Business) (757) 229-0973
   Other means of communication: qlca@widomaker.com
   (Note: 24-hour telephone contact required)

   Name of Alternate Rainfall and Staff Gage Observer: Bruce C. Keener, QLCA Lake Committee Chairman
   Telephone: (Residential) N/A (Business) (757) 323-442 (cell)
   Other means of communication: bckeener3@gmail.com
   (Note: 24-hour telephone contact required)

5. 24-Hour Dispatch Center Nearest Impounding Structure – Police/Fire/Sheriff's Department:
   York County Sheriff's Department
   Address: 301 Goodwin Neck Road, Yorktown, VA 23692

   24-Hour Telephone: (757) 890-3621 or 911

6. Name of City/County Emergency Services Coordinator(s): Stephen Kopczynski

Address: 301 Goodwin Neck Road, Yorktown, VA 23692

Telephone: (757) 890-3600

Other means of communication (757) 890-3621 or 911

(Note: 24-hour telephone contact required)

7. Describe the procedure and the responsible parties for notifying to the extent possible any known local occupants, owners, or lessees of downstream properties potentially impacted by the dam's failure.

(1) There are no downstream properties impacted by the dam's failure except the Queen's Lake Marina which is jointly owned and operations by the QLCA. It will be closed by QLCA immediately in the case of potential dam overtopping or failure. See above for contact information for the QLCA.

(2) West Queens Drive sits atop the dam and would also need to be closed in case or potential dam overtopping or failure. See below for VDOT contact information.

8. Discuss the procedures for timely and reliable detection, evaluation, and classification of emergency situations considered to be relevant to the project setting and impounding features. Each relevant emergency situation is to be documented to provide an appropriate course of action based on the urgency of the situation

This low head and special low hazard dam is monitored by the QLCA before, during and after any extreme storm events or any detected concerns for a sunny dam breach. Responsibilities are with the QLCA Lake Committee Chairperson or their designee for any detectable event.

9. Attach a simple dam break inundation map, demonstrating the general inundation that would result from an impounding structure failure. No dam break inundation map is required for a special low hazard dam, however the previous EAP noted that hydraulic modeling using SWMM Version 5.0 estimated a localized rise in Queens Creek just downstream of this dam of 0.48-feet for a dam sunny day break event, depending on current tidal conditions. The impoundment is 700 acre-feet, estimated.

10. If there are public roads downstream from the impounding structure, identify by highway number and distance below dam:

Route # 716 , 0.0 Miles Route # _____ , _____ Miles

Route # _____ , _____ Miles Route # _____ , _____ Miles

Provide name of resident engineer, VA Department of Transportation, (or City/County engineer):

Jim Brewer, Residency Administrator

Address: VDOT, 4451 Ironbound Road, Williamsburg, VA 23188-2621

Telephone: (Residential) (757) 253-4832 (Business) (757) 424-9903 and 511

Other means of communication: (757) 253-5138

(Note: 24-hour telephone contact required)

Definitions:

Stage I Condition – A flood watch, or heavy continuous rain or excessive flow of water from ice or snow melt.

Stage II Condition – A flood watch, or emergency spillway activation or dam overtopping/breach may be possible.

Stage III Condition – Emergency spillway activation, dam overtopping or imminent failure is probable.

11. Amount of rainfall that will initiate a:

Stage II Condition	4	Inches per 6 hrs.
	5	Inches per 12 hrs.
	6	Inches per 24 hrs.
Stage III Condition	6	Inches per 6 hrs.
	8	Inches per 12 hrs.
	10	Inches per 24 hrs.

The amount of flow in the emergency spillway that will initiate a:

Stage II Condition	2.0	Feet (depth of flow)
Stage III Condition	3.0	Feet (depth of flow)

Total depth of emergency spillway available before crest of dam is overtopped: 3.64 Feet

12. Does a staff gage exist? ____ Yes _X_ No
Staff Gage Location and Description:
N/A

Frequency of observations by rainfall/staff gage observer during a:

Stage I Condition	Every 12-Hours	
Stage II Condition	Every 4-Hours	
Stage III Condition	Continuous	(recommend continuous)

Clearly identify access route and means of monitoring during flood conditions at the dam.

Monitoring can be performed from either side of the dam, however in most cases monitoring will occur from a Staging area at the QLCA clubhouse and high ground adjacent to the clubhouse with a clear line of sight to the concrete spillway on the upstream side. At no time during flood conditions should anyone cross the dam (road closure); or go onto the docks in the marina (marina closure); or go into adjacent low-lying areas. Depending on conditions at the time, binoculars may be required to visual estimate the depth of flow in the upstream side of the concrete spillway, and if a staff gage is added in the future, it should have 3" lettering or larger with color coding of depth of flow in 1' increments (3' total depth of flow).

Note: It is recommended that the Observer remain on post until potentially serious or serious conditions subside.

13. Evacuation Procedures:
    a. The dam owner/operator should notify the local emergency services office (i.e., the city/county 24-hour dispatch center). Phone number should be listed in #5 above.
    b. Once the local emergency services office has been notified of any problem at a dam site, it should take appropriate protective measures in accordance with the local Emergency Operations Plan and this Emergency Preparedness Plan. Local emergency services actions will include:
        (1) Notify the individuals who own downstream property
        (2) Begin Alert, Notification, and Warning
        (3) Immediately evacuating the inundation areas, when stage III conditions warrant.
        (4) Begin Emergency Public Information procedures open emergency shelters.
        (5) Provide Situation Reports to the State Emergency Operations Center (804) 674-2400 or (800) 468-8892.

    c. Once the local government has been notified of a condition requiring evacuation, the dam owner/operator and local government are mutually responsible for effecting evacuation.
        (1) The dam owner/operator will: Inform VDOT and York County of the situation onsite. Assist with closing
            a. Inform VDOT and York County of the emergency situation recommendations.
            b. Close the Marina, as warranted and setup an incident command center (ICC) at the QLCA clubhouse
            c. Help VDOT and York County close West Queens Drive, or with other needs.
            d. Provide an Observed on-post until the incident subsides with regular reporting to VDOT and York County.

        (1) Local emergency services will:
            a. Provide coordinated direction to the QLCA observer for public safety in accordance with this EPP.
            b. Close West Queens Drive, as warranted.
            c. Maintain communications until the incident subsides.
            d. Help conduct a post-incident report with lessons learned.
            e. Provide hourly SCADA reporting on rainfall amounts near the dam site.

    e. Methods for notification and warning to evacuate include:
    Check appropriate method(s)

    _____ (1) Telephone – Per Telephone Numbers in this EPP
    _____ (2) Police/fire/sheriff radio dispatch vehicles with loudspeakers, bullhorns, etc. – As directed by local emergency services and this EPP.
    _____ (3) ~~Personal runners for door-to-door alerting~~
    _____ (4) Radio/television broadcasts for areas involved – As directed by local emergency services at this EPP

CERTIFICATION BY OWNER

I certify that a copy of this plan has been filed with York County (City/County) and Stephen P Kopczynski, Fire Chief (Name), the local Emergency Services Coordinator. Also, that a copy of this form has been filed with the State Department of Emergency Management; that this plan shall be adhered to during the life of the project; and that the information contained herein is current to the best of my knowledge.

Signed: Bruce C Keener QLCA BRUCE C KEENER

Owner's Signature Print Name

This 23 day of October, 20 20.

Please fill out and mail to:

Virginia Department of Emergency Management (VDEM)
Plans Division
10501 Trade Court
Richmond, Virginia 23236

CC:

Virginia Department of Transportation (VDOT), Resident Administrator

York County, Emergency Services Coordinator

Mail the executed form to the appropriate
Department of Conservation and Recreation
Division of Dam Safety and Floodplain Management
Regional Engineer

ECS Mid-Atlantic, LLC

Geotechnical Engineering Report

Queen Lake Dam Exploration

West Queens Drive
Williamsburg, Virginia

ECS Project No. 07:15207R1

September 23, 2020

September 23, 2020

Mr. Donald J. Rissmeyer
A. Morton Thomas & Associates, Inc.
100 Gateway Center Parkway, Suite 200
Richmond, VA 23235

ECS Project No. 07:15207R1

Reference: Report of Subsurface Exploration & Geotechnical Analysis
Queens Lake Dam Exploration
East/West Queens Road
York County, Virginia

Dear Mr. Rissmeyer:

ECS Mid-Atlantic, LLC (ECS) has completed the subsurface exploration and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our Proposal No. 07:20673-R1-GP, dated July 1, 2020. This report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration and laboratory testing conducted as well as our design and construction recommendations.

Project Information

The project site is located along West Queens Drive in York County, Virginia. It is understood that the existing dam embankment was constructed more than 20 years ago and West Queens Drive (asphalt paved roadway) lies along the crest of the dam embankment. The entire embankment is approximately 600-feet long, approximately 10-feet in height, with an approximate crest of 22-feet in width. The dam has experienced some erosion (sloughing of portions of the downslope embankment) and animal burrows on both sides of the existing embankment. You have requested soil borings and an embankment evaluation to aid in the remediation of the existing dam embankment.

Previous studies have been performed on the embankment in 2013 during the sewer and pedestrian bridge project. The reports were supplied to ECS for review and were performed by ETS (dated June 1, 2013) and URS (dated March 15, 2013). These reports were reviewed as a part of our work for this project. In addition, we met with representatives of CJ Geo to discuss the animal burrows and prospective methods for remediating the burrows during the renovation of the embankment.

Scope of Work

A total of three (3) 30-foot deep soil borings were performed at the site. The number and general location of the boring performed for the subsurface exploration were located in the field by ECS Mid-Atlantic, LLC personnel. Our borings were located with a handheld GPS unit and their approximate locations are shown on the Boring Location Diagram in Appendix I.

Subsurface Exploration Procedures

The soil borings were performed by Fishburne Drilling, Inc. using an all-terrain vehicle (ATV) mounted CME 55 drilling rig, utilizing continuous flight, rotary wash "mud" drilling techniques. An automatic hammer was utilized in the performance of Standard Penetration Testing (SPT). Following drilling operations, the boreholes were backfilled with grout.

Representative soil samples were obtained by means of the split-barrel sampling procedure in accordance with ASTM Specification D-1586. In this procedure, a 2-inch O.D., split-barrel sampler is driven into the soil a distance of 24 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through a 12-inch interval is termed the SPT N-value and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of non-cohesive soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the standard penetration resistance value preventing a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies.

The drill crew maintained a field log of the soils encountered in the borings. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each sample were sealed and brought to our laboratory for further visual examination and laboratory testing.

Laboratory Testing Program

Representative soil samples were tested in our laboratory to verify the field classification and determinate pertinent engineering properties. The laboratory testing program included visual sample classifications, moisture content testing, Atterberg Limits testing, grain size, and analysis. All data that was obtained from the laboratory tests are included on the soil boring logs attached in Appendix II and the laboratory testing summary sheet in Appendix III.

Each soil sample was classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS). The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. A brief explanation of the USCS is included with this report. The various soil types were grouped into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring log is approximate; in situ, the transitions may be gradual, rather than distinct. The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded unless other instructions are received as to their disposition.

Soil Conditions

Initially, the exploration encountered asphalt ranging from 4 to 6-inches and gravel ranging from 4.5 to 6-inches at the existing grades. Beneath the surficial materials, the exploration encountered Embankment FILL materials consisting of interbedded layers of Silty SAND (SM FILL), Clayey SAND (SC FILL), and Sandy LEAN CLAY (CL) containing trace gravel, organics, and marine shell fragments. The SPT N-values for the fill ranged between 8 and 11 blows per foot (bpf). Beneath the Embankment FILL materials, natural Silty SANDS (SM), Clayey SAND (SC), Sandy LEAN CLAY (CL), and FAT CLAY (CH) were encountered that extended to the deepest exploration depth of approximately 30 feet below existing grade. SPT N-values

for the granular materials ranged between 1 and 18 bpf, indicating a very loose to medium dense relative density. SPT N-values for the cohesive materials ranged from 1 to 18 bpf, indicating very soft to very stiff relative density.

The subsurface conditions encountered were generally consistent with published geological mapping. The following sections provide generalized characterizations of the soil. Please refer to the boring logs in Appendix II.

Approximate Depth (ft)	**Elevation (1) (ft)**	***Stratum***	***Description***	**Ranges of SPT(2) N-values (bpf)**
0-1 ft (Surface cover)	EL. + 12 to + 11	n/a	Asphalt ranging from 4 to 6-inchces Gravel ranging from 4.5 to 6-inches	N/A
1-4.5 ft	EL. +11 to + 7.5	I	Very Loose to Loose SAND (SM, SC-FILL) with interbedded stiff CLAY (CL-FILL), containing, gravel, organics, and marine shell fragments	5-11
4.5-13 ft	EL. + 7.5 to -1	II	Very loose to Medium Dense, SAND (SM and SC) Very soft to Firm, Clay (CL and CH)	3-18
13-28 ft	EL. - 1 to -16	III	Very Loose, Clayey Sand (SC) Very soft to very stiff clay (CL, CL/ML and CH)	1-18
28-30 ft	EL. - 16 to -18	IV	Very loose, Sand (SC and SM)	3-7

Notes:
(1) Please note that the ground surface elevations were surveyed by a licensed surveyor provided by AMT.
(2) Standard Penetration Testing

Groundwater Observations

The groundwater table was encountered at a depth of 13- feet below the existing site elevations. Please note that groundwater levels are influenced by seasonal conditions and by periods of significant precipitation or prolonged drought. If ground water is encountered, we recommend it be pumped from sumps located below the bottom of foundation elevation. However, work that is performed below the groundwater table will likely require well pointing.

The location of the groundwater table can vary as a result of seasonal fluctuations in precipitation, evaporation, surface water runoff, local topography, and other factors not immediately apparent at the time of the exploration. Groundwater fluctuations of 2 to 4 feet are possible.

Slope Stability

Slope Design Parameters: Based on the results of the borings, it appears that the materials which are present in the existing slopes include both cohesive and granular materials. In order to characterize the soils of the cut and fill slopes, we have evaluated the results of the moisture content, and classification testing and have modeled the existing slopes using shear strength values shown below.

SOIL PARAMETERS FOR SLOPE STABILITY ANALYSES			
Material Description	**Unit Weight (pcf)**	**Cohesion (psf)**	**Friction Angle**
Existing FILL	115	5	32°
Loose Clayey SAND	105	50	28°
Stiff Sandy CLAY	105	500	--
Soft CLAY	95	250	--
Silty SAND (Yorktown Formation)	110	0	32°

Slope Stability Analyses: The global stability analyses were performed using the commercially produced two-dimensional computer slope stability program SLIDE. A factor of safety of 1.3 was considered to be the minimum adequate factor of safety for long term conditions. The factors of safety were calculated based on potential circular/block failure surfaces using Modified Bishops Method/Janbu, etc. A summary of the slope stability analyses are presented below.

SUMMARY OF SLOPE STABILITY ANALYSES			
Approximate Location	**Description**	**Lowest Factor of Safety**	**Remarks**
A-A Upstream	Existing Slope	**1.697**	SF Acceptable
A-A Downstream	Existing Slope	**1.226**	**1.342** After Slope Extended and Reinforced
B-B Upstream	Existing Slope	**1.649**	SF Acceptable
B-B Downstream	Existing Slope	**1.113**	**1.342** After Slope Extended and Reinforced 1.5:1 with shoulder
B-B Downstream	Existing Slope	**1.113**	**1.677** After Slope Extended and Reinforced 2:1 no shoulder

Based on the results above, the existing slope on the upstream side exceeded a minimum factor of safety of 1.3 for global stability. However, the downstream slope did not meet the required safety factor. The factor of safety can be increased to 1.3 minimum by extending the toe of the slope 10 feet and reinforcing the slope with geogrid. Slope analysis sections are included in Appendix IV. Additional recommendations regarding the slope extension and reinforcing are included below.

OBSERVATIONS AND RECOMMENDATIONS

Discussion

ECS performed a visual observation of the existing dam embankment. Queens Road traverses the top of the dam embankment. The surface of the side slopes is primarily grass covered with old existing stumps throughout both the upstream and downstream slopes. Additionally, there are rodent burrows that exist within the embankment at isolated areas as well. ECS met with representatives of CJ Geo to determine methods to deal with filling the existing animal burrows.

The upstream side of the dam was observed to be covered with tall grass vegetation, with a slope ranging from approximately 2H to 3H:1V or steeper. Large trees and residential areas lie just north of the end of the upstream embankment.

The downstream side of the dam embankment was observed to be covered with tall grass vegetation, with a slope of 2H:1V or steeper. Several erosion areas (sloughing) were observed on the downstream side of the dam embankment.

The existing roadway pavement was observed to exhibit distresses in the form of subsidence and alligator cracking, particularly above the embankment pipes.

The existing dam embankment is generally comprised of Silty SAND (SM FILL) and Clayey SAND (SC FILL) materials. These granular materials (SM FILL and SC FILL) generally have a higher than desired permeability for dam embankments due to their low fines content. However, this is discussed in more detail below with corresponding recommendations. The N-values obtained from the granular materials blow counts ranged from 1 to 19 bpf, indicating very loose to medium dense relative density. SPT N-values for the cohesive materials indicate that the soils have a very soft to very stiff relative density.

The elevations from the north to the south of the embankment undulate, with the lowest surface elevations present in the middle. The highest surface elevations are present along the north and south portions.

Dam Recommendations

We understand that this dam embankment has been in place for several decades. Previous geotechnical explorations have been performed by others and we were supplied these reports to review. Based on the results of our field exploration and the discussion above, the dam embankment visually appears to be in a fair condition. The soil materials that currently make up the dam are typically not used for a homogenous dam, due to the lack of fines content in the granular soils. However, these soils have been in place for several decades and other than the mentioned erosion issues which are addressed in our recommendations below. The embankment has weathered numerous large storm and hurricane events with minimal damage or issues. The N-values from the granular materials ranged from 1 to 18 bpf,

indicating very loose to medium dense sandy soils. SPT N-values for the cohesive materials indicated predominately very soft to very stiff relative density.

Based on the results of our slope stability analysis, we are recommending minor repairs and erosion stabilization on the upstream side. The slope stability analysis showed that the existing slope on this side meets the minimum Factor of Safety requirement. However, the downstream slope did not meet the minimum safety factor in its current condition. We are recommending that the toe of the downstream slope be extended out 10 feet and that the slope be rebuilt at a minimum of 1.5H:1V and stabilized with geogrid. We recommend the following sequence of repairs:

1. All stumps should be removed from the upstream and downstream faces of the dam. It is likely that this will need to be accomplished with a long boom excavator to minimize damage to the existing slopes.
2. The stump holes and animal burrows should be injected with grout to fill any voids that are extending into the existing embankment.
3. Once the voids have been backfilled with grout the upstream slope should be stabilized with erosion control mat.
4. We recommend the grout consist of a low strength grout (CJ Grout 35NHV61) or equivalent. A technical sheet for this grout product is attached in Appendix V.
5. We recommend that the items contained in numbers 1, 2, and 3 be performed in short enough sections such that the area can be stabilized at the end of each day's work.
6. Once the stumps and animal burrows have been filled on the downstream slope, the toe of the downstream slope of the dam is recommended to be extended 10 feet. In order to provide a stable platform to begin the slope re-construction, we recommend a 2 foot deep by 10 feet wide key be installed in the subgrade soils. The key should consist of #3 stone wrapped in woven stabilization geotextile.
7. Once the key is in place new soil material should be placed to build the new slope extension.
8. We have included two options for re-grading the slope. The first is re-grading the slope to 1.5:1 which will allow for a small shoulder at the top of the slope. The second option is to grade back to 2:1 which will tie into existing grades without a shoulder.
9. It is recommended that the proposed structural fill material be submitted for approval prior to bringing the material on-site.
10. The material that is used to re-build the slope should be benched into the remaining existing slope as it is placed in lifts in accordance with Section 303 of VDOT's 2007 Road and Bridge Specification requirements.
11. At 2 foot intervals geogrid (10 feet in length for 1.5:1 slope and 7 feet length for 2:1 slope) will need to be placed to stabilize the new slope. The geogrid should be a minimum Miragrid 10 XT or better. For the 1.5:1 slope, the grid should extend to the top of the slope. For the 2:1 slope, the grid only needs to extend as far up the slope as the 7 foot lengths can be placed without cutting into the existing slope.
12. The slope repair should be observed by a VDOT certified testing technician and compaction testing should be performed as required by VDOT specifications.
13. The slope should be graded back to 1.5H:1V or 2:1 as necessary and should be stabilized with vegetation.
14. Engineered Fill to replace any removed soils or erosion affected areas should be a Sandy CLAY or CLAY (CL, CH) and should be compacted to at least 95 percent of maximum dry density as determined per ASTM D698-07 Standard Test Methods for Laboratory Compaction Characteristics

of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)). Loose lifts should not exceed 8 inches. Compaction should be accomplished with a sheepsfoot roller for predominately clayey soil materials.

15. Hand operated equipment should be employed around and immediately above pipes and foundations. Soils should be compacted at moisture contents within 3% above and 1% below optimum moisture content for the material used.

The following is an assessment of the fill materials considered suitable for use on this project:

Imported Engineered Fill (Embankment FILL): Soil material classified as Sandy CLAY or CLAY (CL or CH) containing a minimum of 50% by weight passing the No. 200 Sieve. Imported Engineered Fill should be free of organics, debris, rubble, and other unsuitable material.

Soils intended to be used as backfill should be thoroughly evaluated by the Geotechnical Engineer prior to placement. The evaluation should be performed per ASTM D2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

Drying and compaction of wet soils is typically difficult during the cold, winter months. Accordingly, earthwork should be performed during the warmer, drier times of the year, if practicable. Proper drainage should be maintained during the earthwork phases of construction to prevent ponding of water which has a tendency to degrade soil subgrades.

Dam Maintenance

The dam embankment should be protected from erosion. Slope protection can best be attained by seeding with heavy grass. Trees should not be planted on or allowed to re-vegetate dam embankments. Routine maintenance should be provided for the dam. This should include annual inspections for removal of bushes and trees; filling of animal burrows; inspection for surface erosion, vertical cracks, or seepage in the embankment; etc.

All backfill materials should be placed, compacted, and tested in accordance with the recommendations contained in this report. We recommend that all cut and fill operations be observed on a full-time basis by the Geotechnical Engineer or their qualified representative to determine if minimum earthwork and compaction requirements are being met.

Construction Considerations

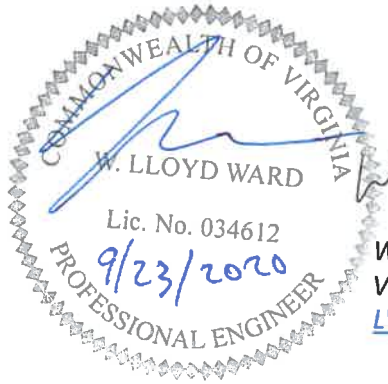
It is imperative to maintain positive site drainage during earthwork operations to help maintain the integrity of the surface soils. The surface of the site should be kept properly graded to enhance drainage of surface water away from the proposed construction areas during the earthwork phase of this project. It should be the earthwork contractor's responsibility to maintain the site soils within a workable moisture content range to obtain the required in-place density and maintain a stable subgrade.

Closing

We appreciate this opportunity to be of service to you in preparing this geotechnical evaluation. If there are any questions regarding the information and recommendations presented in this report, please do not hesitate to contact us.

Respectfully,

ECS MID-ATLANTIC, LLC



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APPENDIX:

i. Drawings and Reports
ii. Field Operations
iii. Laboratory Testing
iv. Supplemental Report Documents and Calculations
v. Technical Grout Data Sheet

APPENDIX I- Drawings and Reports

Site/Boring location Diagram

Site Location Diagram
QUEENS LAKE DAM EXPLORATION

W QUEENS DRIVE, WILLIAMSBURG, VIRGINIA
A. MORTON THOMAS & ASSOCIATES, INC

ENGINEER	WLW
SCALE	1 " = 200 '
PROJECT NO.	07:15207
SHEET	1 OF 1
DATE	7/8/2020

Boring Location Diagram
QUEENS LAKE DAM EXPLORATION

W QUEENS DRIVE, WILLIAMSBURG, VIRGINIA
A. MORTON THOMAS & ASSOCIATES, INC

ENGINEER	WLW
SCALE	1 " = 200 '
PROJECT NO.	07:15207
SHEET	1 OF 1
DATE	7/9/2020

APPENDIX II- Field Operations

Reference Notes for Boring Logs
Reference Notes for SPT Testing
Boring Logs B-1 through B-3

REFERENCE NOTES FOR BORING LOGS

MATERIAL[1,2]	
	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	FILL[3] MAN-PLACED SOILS
GW	**WELL-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GP	**POORLY-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GM	**SILTY GRAVEL** gravel-sand-silt mixtures
GC	**CLAYEY GRAVEL** gravel-sand-clay mixtures
SW	**WELL-GRADED SAND** gravelly sand, little or no fines
SP	**POORLY-GRADED SAND** gravelly sand, little or no fines
SM	**SILTY SAND** sand-silt mixtures
SC	**CLAYEY SAND** sand-clay mixtures
ML	**SILT** non-plastic to medium plasticity
MH	**ELASTIC SILT** high plasticity
CL	**LEAN CLAY** low to medium plasticity
CH	**FAT CLAY** high plasticity
OL	**ORGANIC SILT or CLAY** non-plastic to low plasticity
OH	**ORGANIC SILT or CLAY** high plasticity
PT	**PEAT** highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS			
SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION		
DESIGNATION		**PARTICLE SIZES**
Boulders		12 inches (300 mm) or larger
Cobbles		3 inches to 12 inches (75 mm to 300 mm)
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")		<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS		
UNCONFINED COMPRESSIVE STRENGTH, Q_P[4]	**SPT[5] (BPF)**	**CONSISTENCY[7] (COHESIVE)**
<0.25	<3	Very Soft
0.25 - <0.50	3 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS	
SPT[5]	**DENSITY**
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

RELATIVE AMOUNT[7]	COARSE GRAINED (%)[8]	FINE GRAINED (%)[8]
Trace	≤5	≤5
Dual Symbol *(ex: SW-SM)*	10	10
With	15 - 20	15 - 25
Adjective *(ex: "Silty")*	≥25	≥30

WATER LEVELS[6]		
	WL	Water Level (WS)(WD)
		(WS) While Sampling
		(WD) While Drilling
	SHW	Seasonal High WT
	ACR	After Casing Removal
	SWT	Stabilized Water Table
	DCI	Dry Cave-In
	WCI	Wet Cave-In

[1] Classifications and symbols per ASTM D 2488-09 (Visual-Manual Procedure) unless noted otherwise.

[2] To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.

*[3] Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-**FILL**)].*

[4] Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).

[5] Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf).

[6] The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.

[7] Minor deviation from ASTM D 2488-09 Note 16.

[8] Percentages are estimated to the nearest 5% per ASTM D 2488-09.

SUBSURFACE EXPLORATION PROCEDURE: STANDARD PENETRATION TESTING (SPT) ASTM D 1586 Split-Barrel Sampling

Standard Penetration Testing, or **SPT**, is the most frequently used subsurface exploration test performed worldwide. This test provides samples for identification purposes, as well as a measure of penetration resistance, or N-value. The N-Value, or blow counts, when corrected and correlated, can approximate engineering properties of soils used for geotechnical design and engineering purposes.

SPT Procedure:

- Involves driving a hollow tube (split-spoon) into the ground by dropping a 140-lb hammer a height of 30-inches at desired depth
- Recording the number of hammer blows required to drive split-spoon a distance of 12 inches (in 3 or 4 Increments of 6 inches each)

- Auger is advanced* and an additional SPT is performed
- One SPT test is typically performed for every two to five feet

- Obtain two-inch diameter soil sample

**Drilling Methods May Vary—* The predominant drilling methods used for SPT are open hole fluid rotary drilling and hollow-stem auger drilling.

CLIENT	Job #:	BORING #	SHEET
A. Morton Thomas & Associates, Inc	07:15207	B-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Queens Lake Dam Exploration	

SITE LOCATION: W Queens Drive, Williamsburg, James City, VA

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

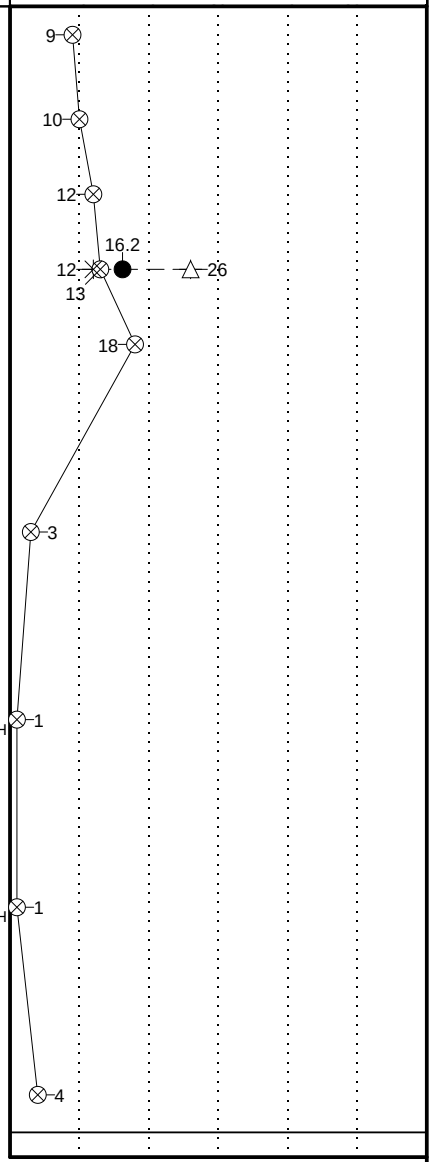
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 12

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Asphalt Thickness [4.00"]			
	S-1	SS	18	16	Gravel Thickness [5.00"]			6 5 4
					(SC FILL) FILL, CLAYEY FINE TO MEDIUM SAND, trace gravel, trace organics, orange mottled tan, moist, loose, contains marine shell fragments		10	4 5 5 6
	S-2	SS	24	14				
5	S-3	SS	24	20	(CL FILL) FILL, SANDY LEAN CLAY, trace gravel, trace organics, tan mottled gray and orange, moist, stiff			5 5 7 8
	S-4	SS	24	22	(SC FILL) FILL, CLAYEY FINE TO MEDIUM SAND, trace organics, trace gravel, tan mottled gray, moist, medium dense		5	5 7 6 7
	S-5	SS	24	22	(SC) CLAYEY FINE TO MEDIUM SAND, tan mottled gray and orange, moist to wet, medium dense			7 9 9 8
10							0	
	S-6	SS	24	24	(CL/CH) LEAN TO FAT CLAY, greenish gray, wet, very soft			2 1 2 3
15							-5	
	S-7	SS	24	24	(SC) CLAYEY FINE TO MEDIUM SAND, greenish gray mottled orange, wet, very loose			2 1 WOH 1
20							-10	
	S-8	SS	24	24				1 1 WOH 1
25							-15	
	S-9	SS	24	20	(SM) SILTY FINE TO MEDIUM SAND, trace clay, greenish gray, wet, very loose			3 2 2 5
30					END OF BORING @ 30'			



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 13 WS ☐ WD ☒	BORING STARTED 07/17/20	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 07/17/20	HAMMER TYPE Auto
WL	RIG CME 55 FOREMAN FDI	DRILLING METHOD RWMD

CLIENT	Job #:	BORING #	SHEET
A. Morton Thomas & Associates, Inc	07:15207	B-2	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Queens Lake Dam Exploration	

SITE LOCATION: W Queens Drive, Williamsburg, James City, VA

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING ▶ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 12

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	18	12	Asphalt Thickness [6.00"] Gravel Thickness [6.00"]			11 5 5
	S-2	SS	24	14	(SM FILL) FILL, SILTY FINE TO MEDIUM SAND, trace clay, trace gravel, orange brown, moist, medium dense to loose		10	6 4 4 5
5	S-3	SS	24	14	(CL) SANDY LEAN CLAY, trace clay, trace gravel, orange mottled tan, moist, firm to soft			5 4 3 3
	S-4	SS	24	22			5	2 2 2 2
	S-5	SS	24	20	(CL/CH) LEAN TO FAT CLAY, tan brown, moist to wet, very soft			2 2 1 2
10							0	
	S-6	SS	24	16				1 WOH 1 1
15							-5	
	S-7	SS	24	24	(CL/ML) SILTY CLAY, dark gray, wet, very soft to stiff			1 WOH 1 1
20							-10	
	S-8	SS	24	24				WOH 12 1 1
25							-15	
	S-9	SS	24	24	(SC) CLAYEY FINE TO MEDIUM SAND, dark gray, wet, very loose			1 1 2 2
30					END OF BORING @ 30'			

10 8 7 4 3 1 1 13 3 50.4

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 13 WS ☐ WD ☒	BORING STARTED 07/17/20	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 07/17/20	HAMMER TYPE Auto
WL	RIG CME 55 FOREMAN FDI	DRILLING METHOD RWMD

CLIENT	Job #:	BORING #	SHEET
A. Morton Thomas & Associates, Inc	07:15207	B-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Queens Lake Dam Exploration	

SITE LOCATION: W Queens Drive, Williamsburg, James City, VA

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

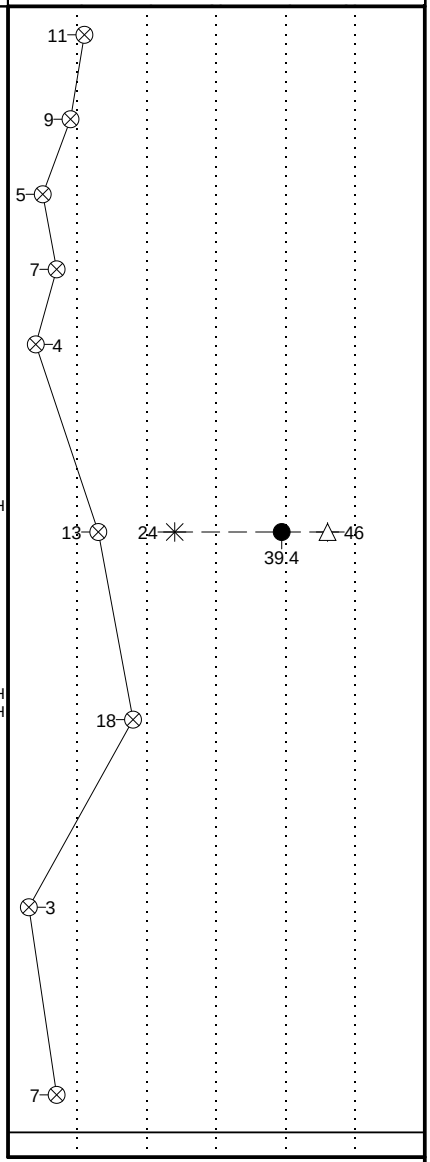
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 12

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Asphalt Thickness [6.00"]			8 6 5
	S-1	SS	18	12	Gravel Thickness [4.50"]			
					(SM FILL) FILL, SILTY FINE TO MEDIUM SAND, trace clay, trace gravel, orange brown, moist, medium dense		10	5 5 4 4
	S-2	SS	24	20				
					(SM FILL) FILL, SILTY FINE TO MEDIUM SAND, trace clay, trace gravel, dark orange brown, moist, loose to very loose			3 3 2 2
5	S-3	SS	24	10				
					(SM) SILTY FINE TO MEDIUM SAND, trace clay, orange brown, moist, loose			2 3 4 4
	S-4	SS	24	22	(SC) CLAYEY FINE TO MEDIUM SAND, tan orange brown, moist to wet, loose to very loose		5	2 2 2 2
	S-5	SS	24	10				
10							0	WOH 12 1 1
	S-6	SS	24	11	(CL) LEAN CLAY with Sand, tan mottled gray, wet, stiff to very stiff			
15							-5	
	S-7	SS	24	24				WOH WOH 18 2
20							-10	
	S-8	SS	24	8	(CL) SANDY LEAN CLAY, trace organics, greenish gray, wet, very soft, contains marine shell fragments			1 1 2 6
25							-15	
	S-9	SS	24	20	(SM) SILTY FINE TO MEDIUM SAND, trace clay, greenish gray, wet, loose, contains marine shell fragments			5 4 3 3
30					END OF BORING @ 30'			



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 13 WS ☐ WD ☒	BORING STARTED 07/17/20	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 07/17/20	HAMMER TYPE Auto
WL	RIG CME 55 FOREMAN FDI	DRILLING METHOD RWMD

APPENDIX III- Laboratory Testing

Laboratory Testing Summary

Laboratory Testing Summary

Boring Number	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
B-1												
	S-4	6.00 - 8.00	16.2	SC	26	12	14	44.0				
B-2												
	S-9	28.00 - 30.00	50.4	SC				45.8				
B-3												
	S-6	13.00 - 15.00	39.4	CL	46	24	22	72.3				

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 15207

Project Name: Queens Lake Dam Exploration

Client: A. Morton Thomas & Associates, Inc

Printed On: Wednesday, August 12, 2020

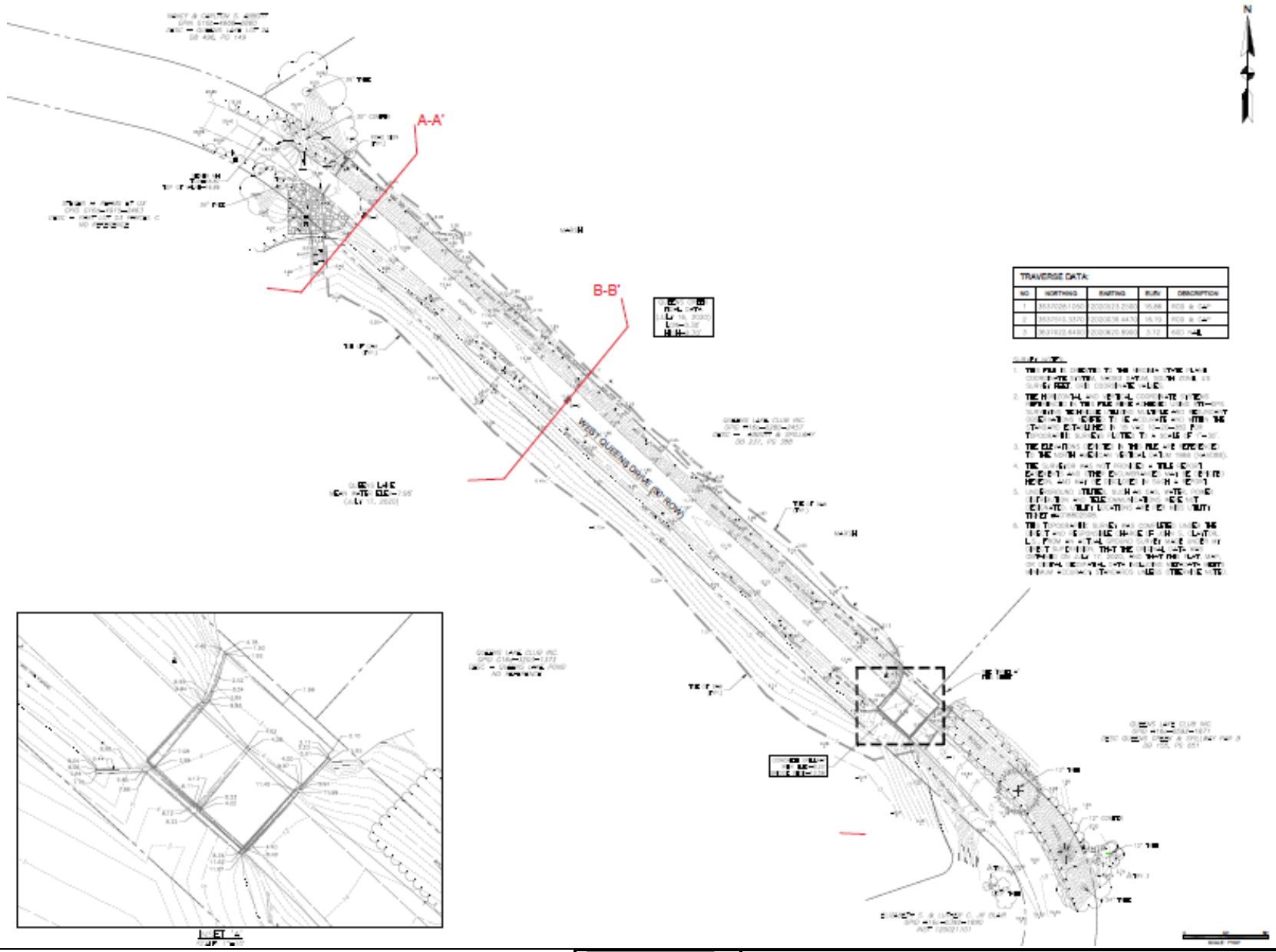
ECS Mid-Atlantic, LLC

Williamsburg, VA

APPENDIX IV- Supplemental Documents and Calculations

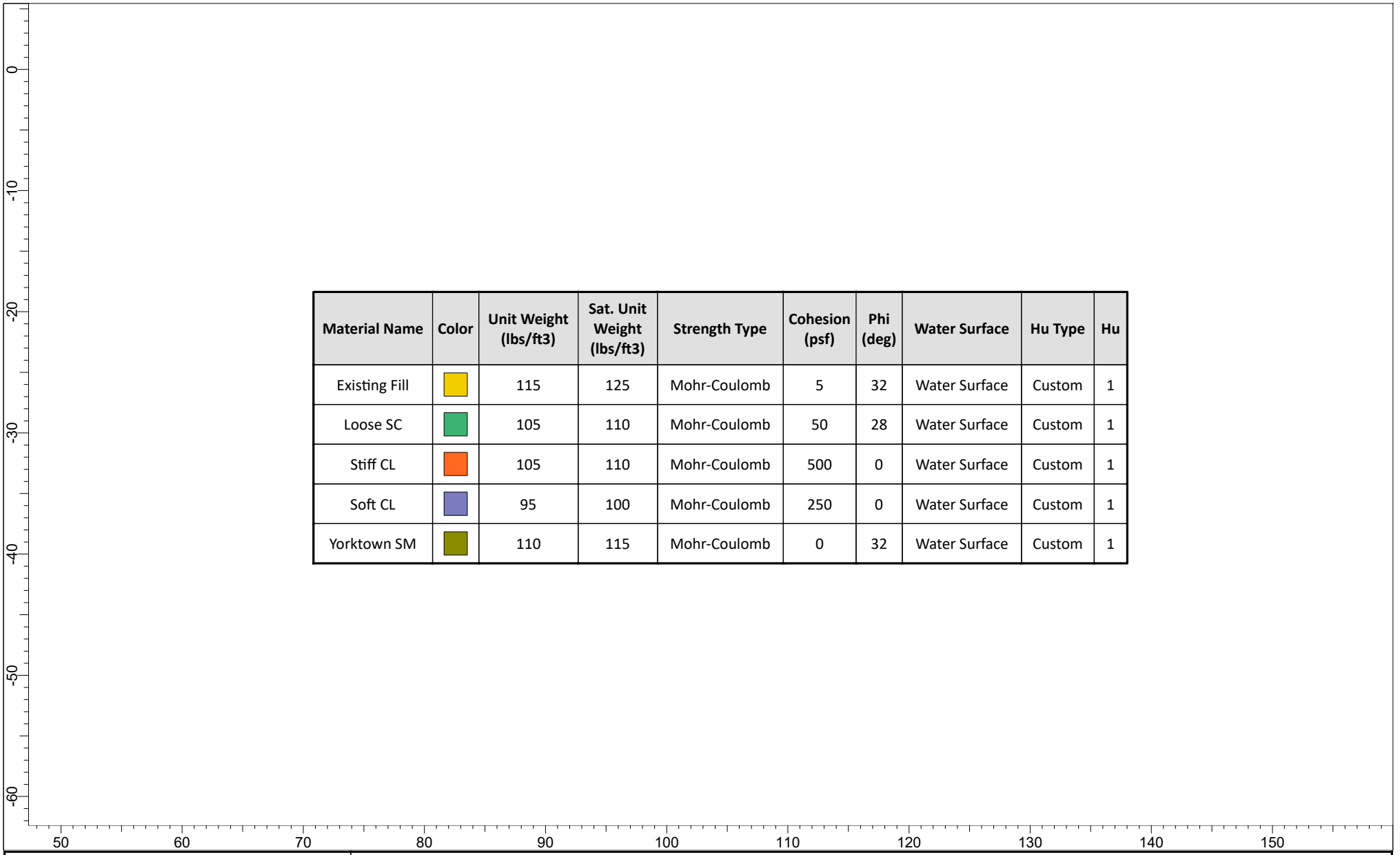
Slope Stability Map

Slope Stability Analysis Outputs



SLOPE STABILITY ANALYSIS LOCATION DIAGRAM

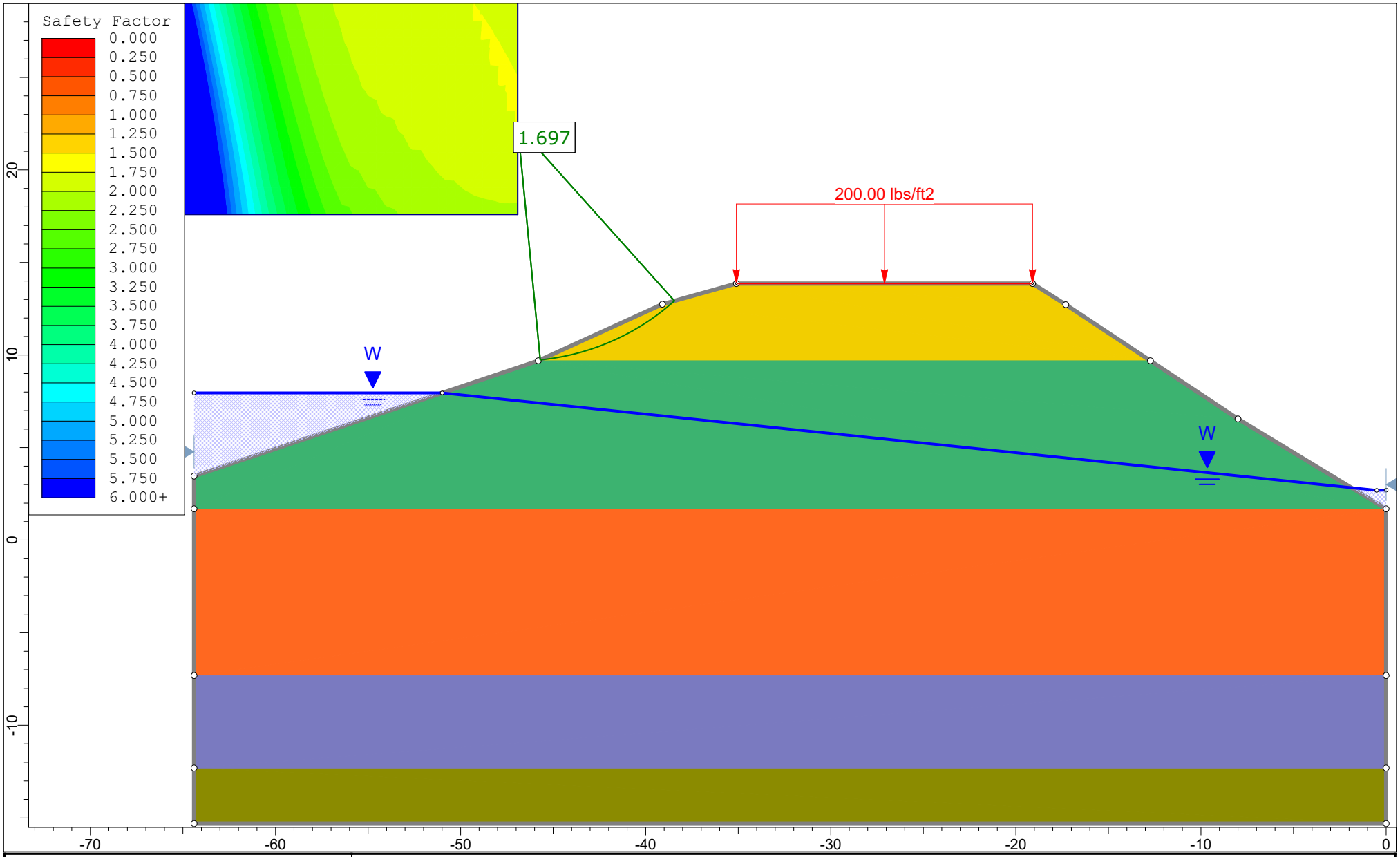
QUEENS LAKE DAM EXPLORATION
ECS PROJECT NO. 07-15207
WILLIAMSBURG, VA



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Existing Fill		115	125	Mohr-Coulomb	5	32	Water Surface	Custom	1
Loose SC		105	110	Mohr-Coulomb	50	28	Water Surface	Custom	1
Stiff CL		105	110	Mohr-Coulomb	500	0	Water Surface	Custom	1
Soft CL		95	100	Mohr-Coulomb	250	0	Water Surface	Custom	1
Yorktown SM		110	115	Mohr-Coulomb	0	32	Water Surface	Custom	1

SLIDEINTERPRET 8.010

Project	Queens Lake Dam		
Analysis Description	Slope Stability Section A-A'		
Drawn By	JMH	Scale 1:131	Company ECS Mid-Atlantic, LLC
Date	8/21/2020		File Name Cross Section A-A'.slmd



rocscience	Project	Queens Lake Dam		
	Analysis Description	Slope Stability Section A-A'		
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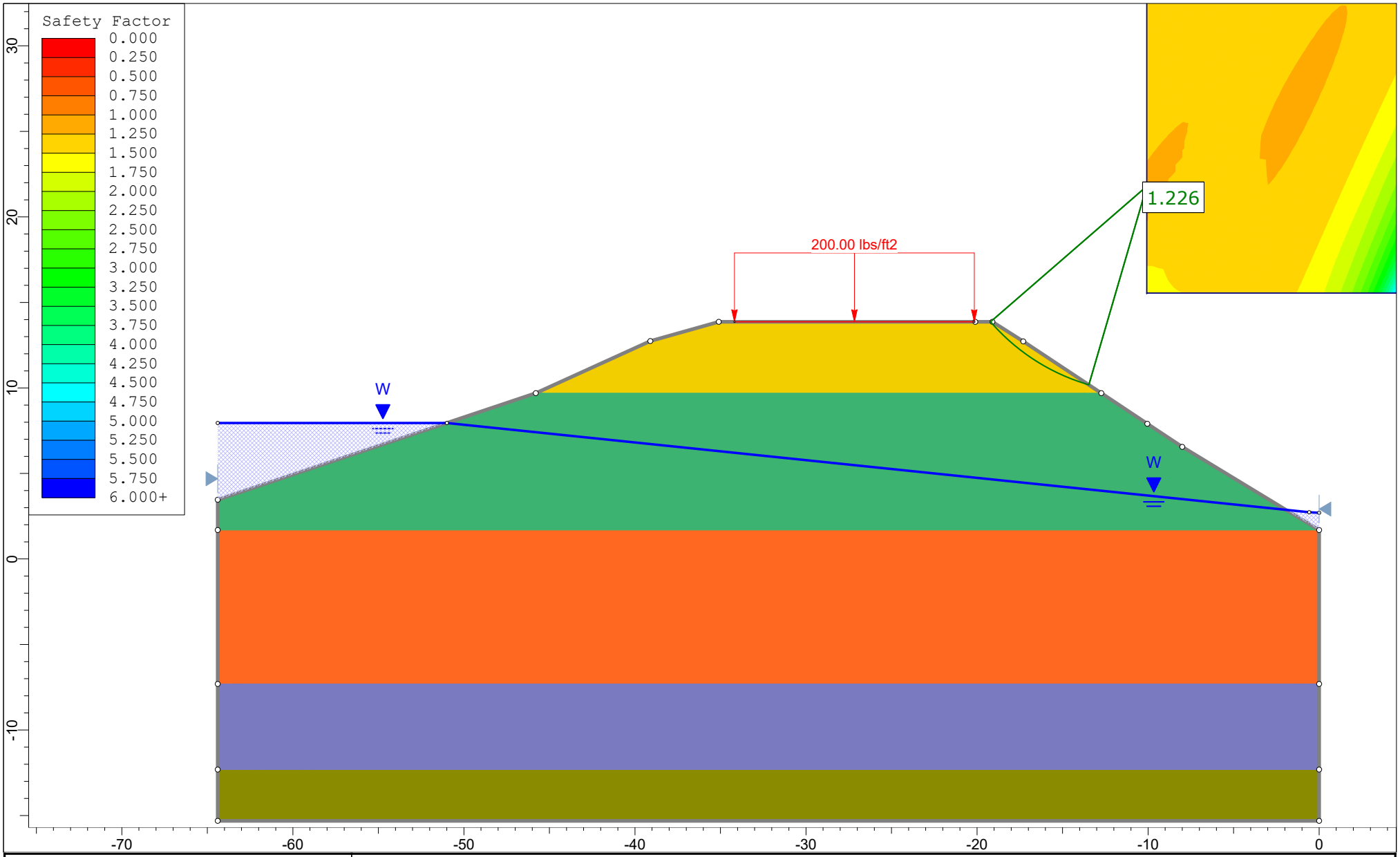
	Date	8/21/2020		File Name Cross Section A-A'.slmd

SLIDEINTERPRET 8.010



rocscience	Project	Queens Lake Dam		
	Analysis Description	Slope Stability Section A-A'		
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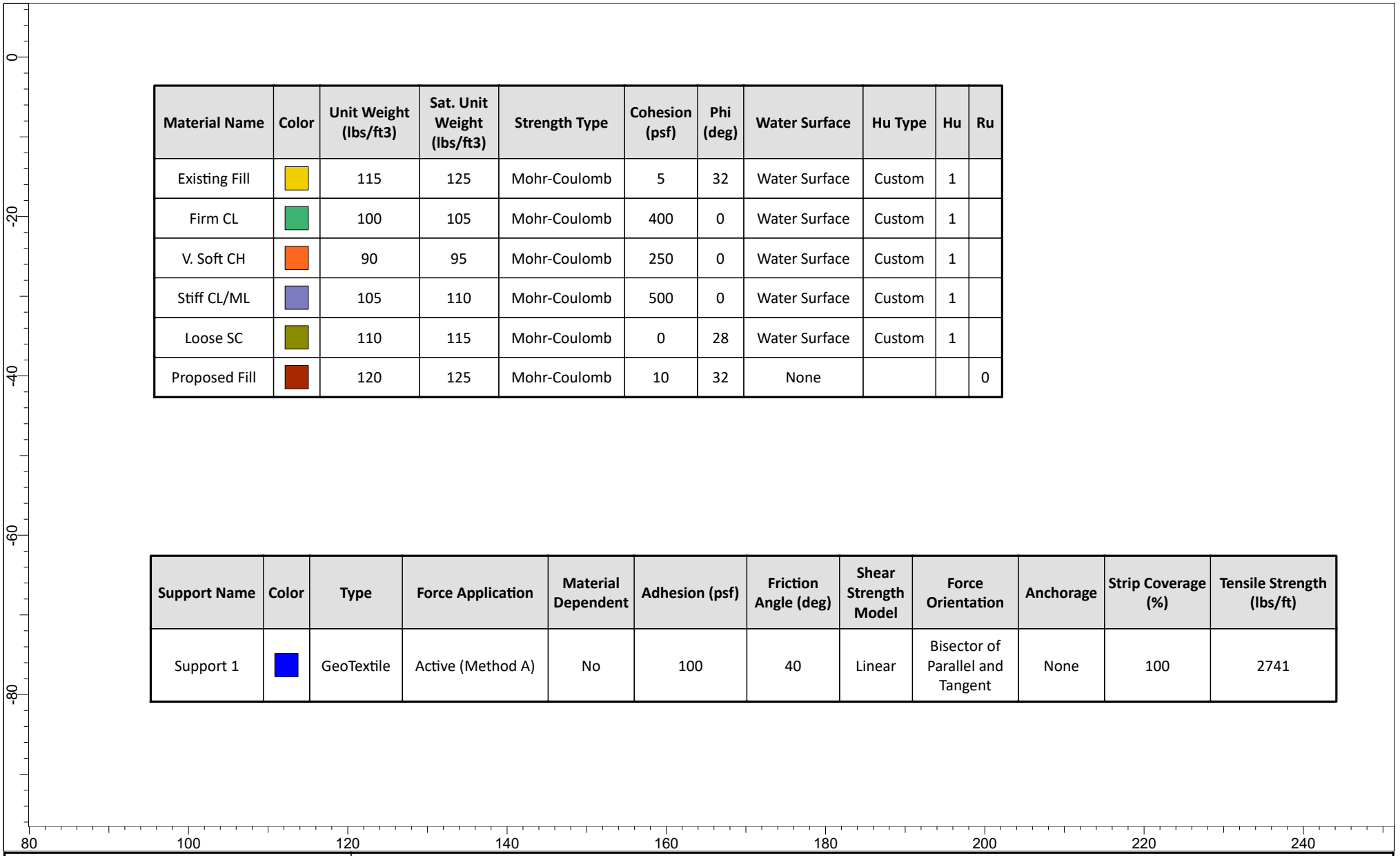
	Date	8/21/2020		File Name Cross Section A-A'.slmd

SLIDEINTERPRET 8.010

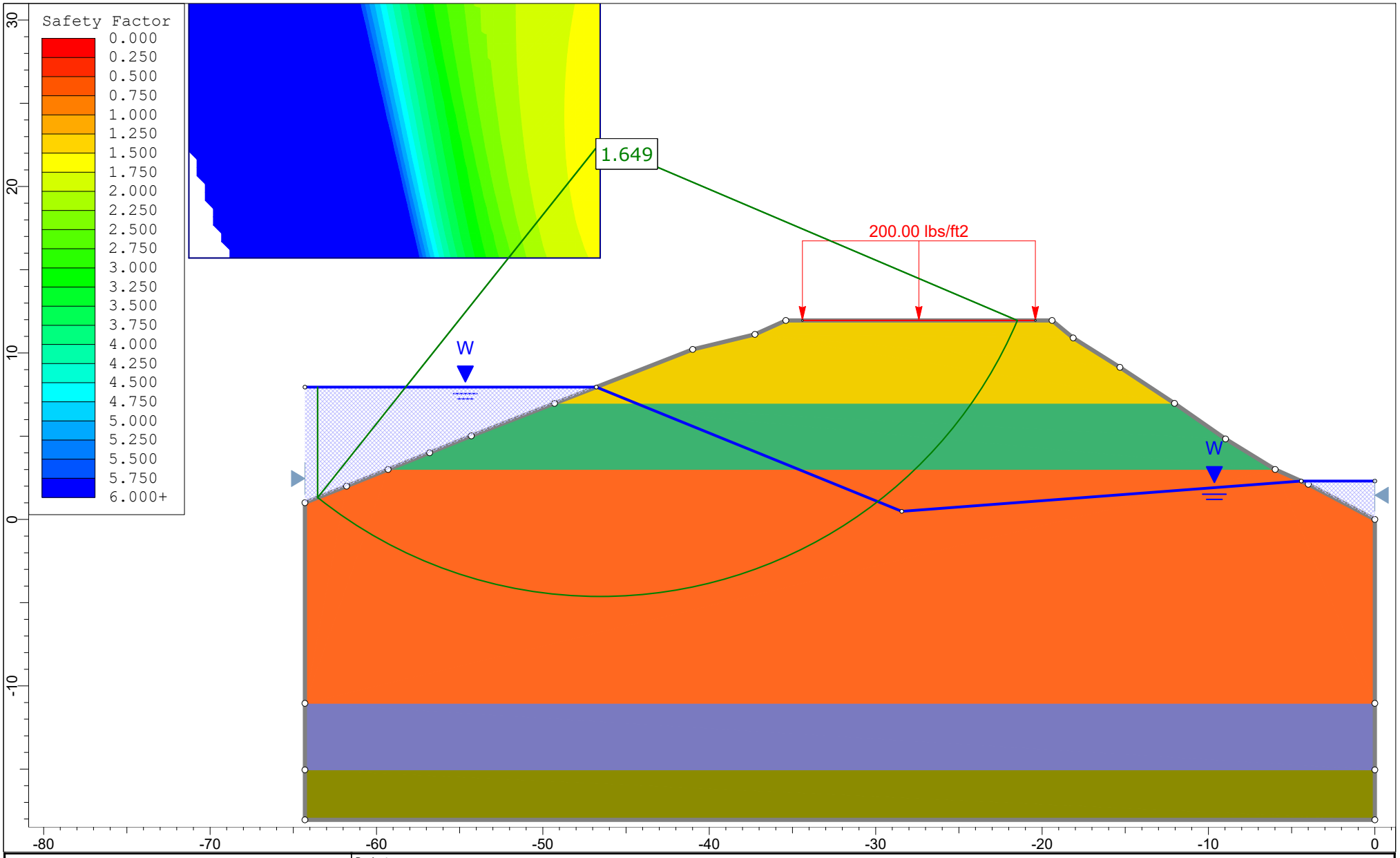


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Existing Fill		115	125	Mohr-Coulomb	5	32	Water Surface	Custom	1	
Firm CL		100	105	Mohr-Coulomb	400	0	Water Surface	Custom	1	
V. Soft CH		90	95	Mohr-Coulomb	250	0	Water Surface	Custom	1	
Stiff CL/ML		105	110	Mohr-Coulomb	500	0	Water Surface	Custom	1	
Loose SC		110	115	Mohr-Coulomb	0	28	Water Surface	Custom	1	
Proposed Fill		120	125	Mohr-Coulomb	10	32	None			0

Support Name	Color	Type	Force Application	Material Dependent	Adhesion (psf)	Friction Angle (deg)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (lbs/ft)
Support 1		GeoTextile	Active (Method A)	No	100	40	Linear	Bisector of Parallel and Tangent	None	100	2741

SLIDEINTERPRET 8.010

Project	Queens Lake		
Analysis Description	Slope Stability - Cross Section B-B'		
Drawn By	JMH	*Scale* 1:200	*Company* ECS Mid-Atlantic
Date	8/26/2020	*File Name*	Cross Section B-B' (Stabilized).slmd



rocscience	Project	Queens Lake		
	Analysis Description	Slope Stability - Cross Section B-B'		
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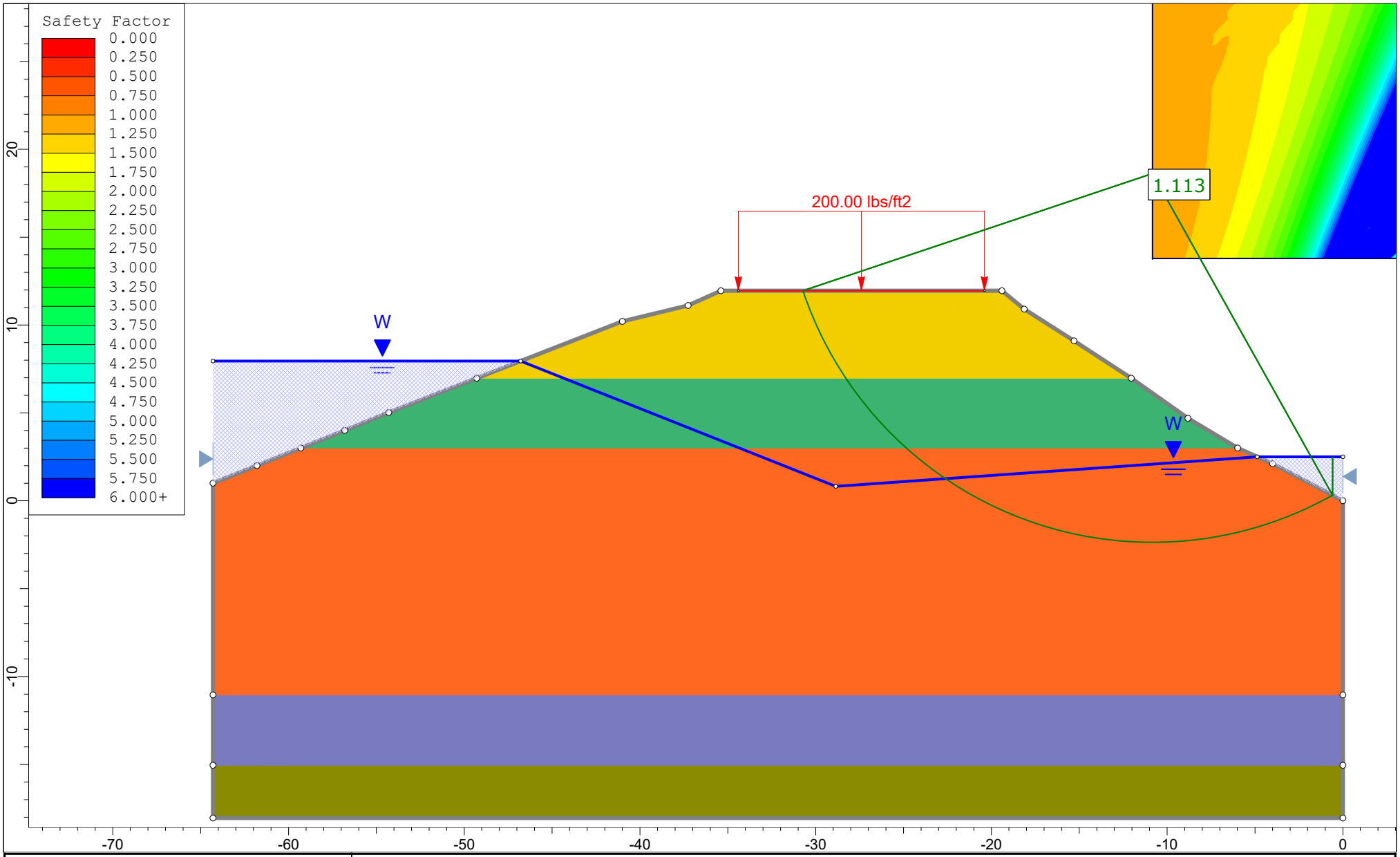
	Date	8/26/2020		File Name Cross Section B-B'.slmd

SLIDEINTERPRET 8.010



rocscience	Project	Queens Lake		
	Analysis Description	Slope Stability - Cross Section B-B'		
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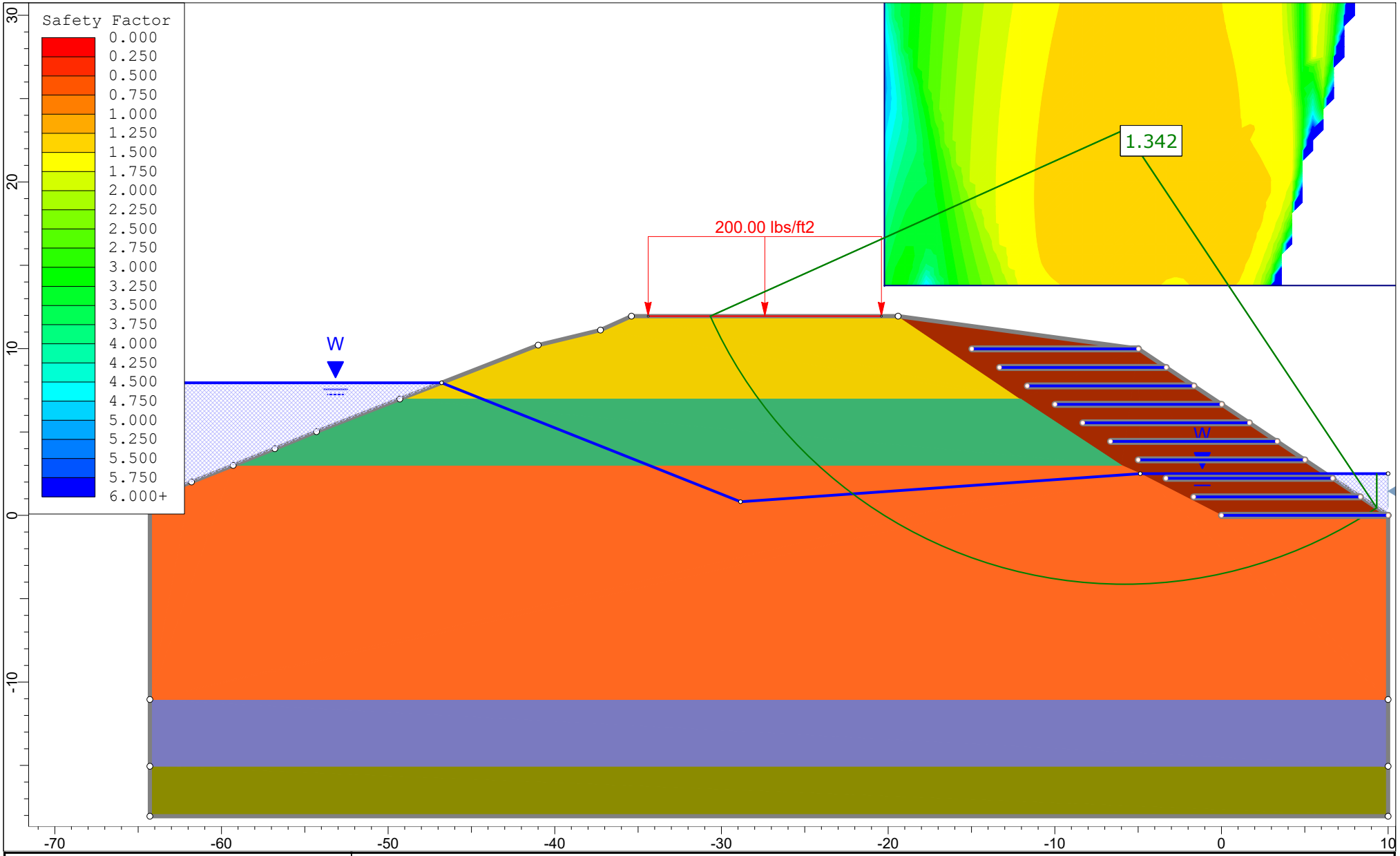
	Date	8/26/2020		File Name Cross Section B-B'.slmd

SLIDEINTERPRET 8.010



rocscience	Project	Queens Lake		
	Analysis Description	Slope Stability - Cross Section B-B'		
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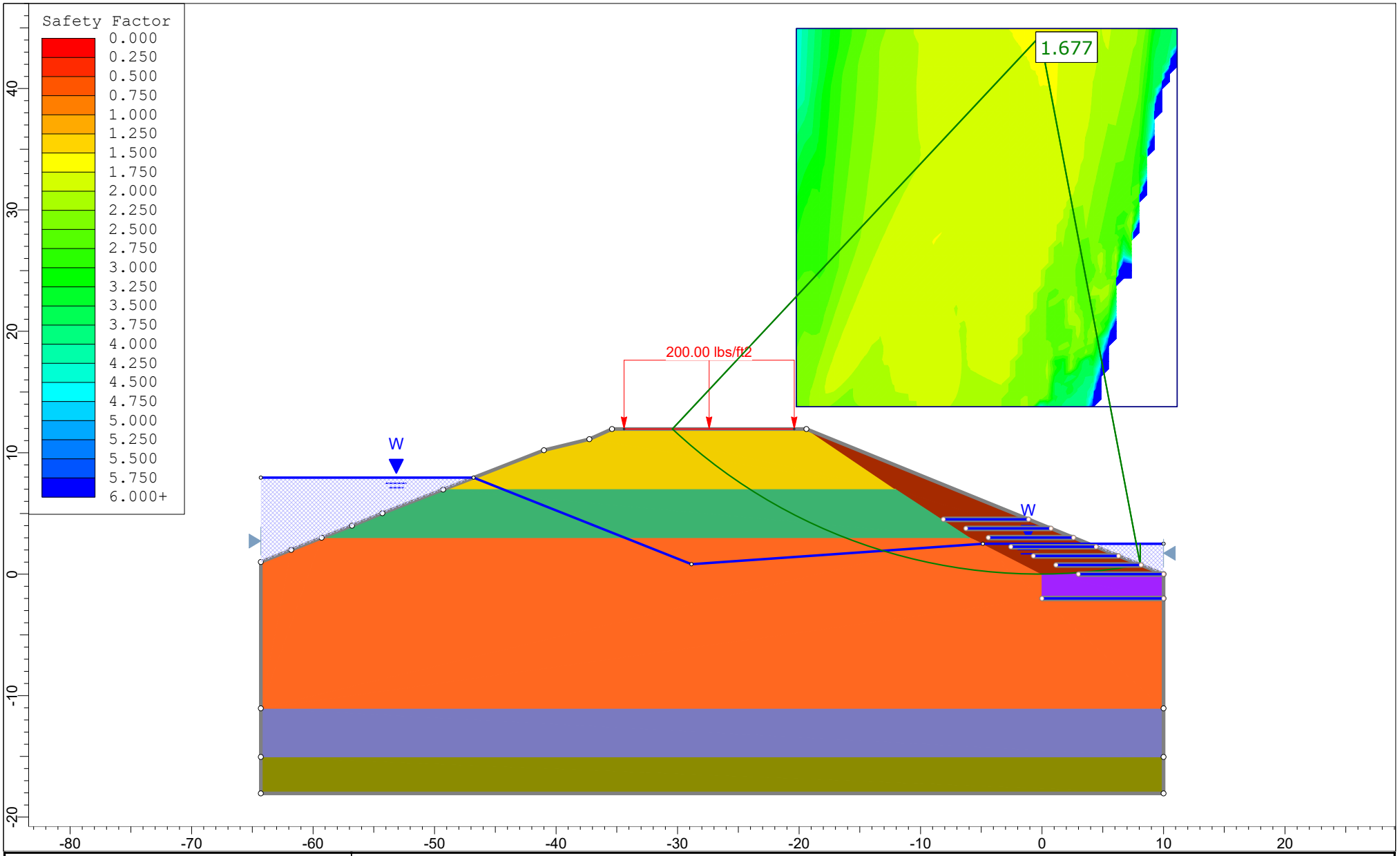
	Date	8/26/2020		File Name Cross Section B-B' (Stabilized).slmd

SLIDEINTERPRET 8.010



rocscience	Project	Queens Lake		
	Analysis Description	Slope Stability - Cross Section B-B'		
	Drawn By	JMH	Scale 1:131	Company ECS Mid-Atlantic
	Date	8/26/2020		File Name Cross Section B-B' (Stabilized)(9-18-20).slmd

SLIDEINTERPRET 8.010

APPENDIX V- Technical Grout Data Sheet

CJ Geo- CJGrout-35NHV61

CJGROUT
BY CJGEO

CJGrout-35NHV61

Technical Data Sheet

CJGrout 35NHV61 is a hydrophobic/hydro-insensitive 3.5lb/cuft free rise density two part polyurethane grout system formulated for moderate mobility grouting of pavement, structures and soils. CJGrout 35nhv61 is certified for potable water contact in excess of 5 gallons per NSF/ANSI 61 Section 5-2017.

Typical Applications

- Sub-slab void filling and non-differential settlement correction
- Compaction and permeation grouting of soils and voids
- Joint sealing, backgrouting and stabilization of buried structures and pipes

GEOTECHNICAL GROUT SYSTEM

Certified to NSF/ANSI 61

Typical Properties of Components

DENSITY (ASTM D-1622)	3.5lb/cuft FRC	Packed to 4.5lb/cuft
VOLUMETRIC EXPANSION OF LIQUIDS (ASTM C-1643)	24 times	16 times
COMPRESSIVE STRENGTH (ASTM D-1621)		
PARALLEL	45 psi	65 psi
PERPENDICULAR	27 psi	42 psi
COMPRESSIVE MODULUS (ASTM D-1621)		
PARALLEL	750 psi	1300 psi
PERPENDICULAR	600 psi	950 psi
GENERAL CHARACTERISTICS		
TENSILE STRENGTH	55 psi	78 psi
TENSILE MODULUS	800 psi	1200 psi
CLOSED CELL CONTENT (ASTM D-2856) (ASTM D-6226)	> 92%	> 94%
WATER ABSORPTION (ASTM D-2842)	< 0.08 lbs/ft^2	
NSF/ANSI 61 SECTION 5 - 2017	Certified	
RESISTANCE TO MOLD AND MILDEW	Excellent	
RESISTANCE TO SOLVENTS	Excellent	

DIMENSIONAL STABILITY, % VOLUME CHANGE (ASTM D-2126)			
	Heat age at 158°F	Freezer at -20°F	Humid age at 100%RH & 120°F
28 DAY AGING	-2%	-0.1%	-1.7%
MAXIMUM SERVICE TEMPERATURE	180°F		

Typical Properties of Components

COMPONENT	35NHV61-B	CJGrout-A
BROOKFIELD VISCOSITY @ 30 RPM	440 cps	200 cps
SPECIFIC GRAVITY	1.05	1.24

Mix Ratio

BY WEIGHT .....100 parts poly : 118 parts iso

BY VOLUME .....100 parts poly : 100 parts iso

Typical Properties of System

AT 120°F THRU EQUIPMENT	
CREAM TIME	6 seconds
TACK FREE TIME	60 seconds
RISE TIME	75 seconds
FREE RISE CORE DENSITY	3.5 lb/cuft

Process Parameters

ISO TEMPERATURE	100°F to 130°F
POLY TEMPERATURE	100°F to 130°F
MIXING PRESSURE	Minimum 1000 static, 800 dynamic psii

Storage and Handling

Store the poly from 50°F to 100°F. Avoid moisture contamination during storage, handling, and processing. For both components, pad containers and day tanks with either nitrogen or dry air (desiccant cartridge or air dryer @ -40°F dew point). For optimum shelf life, the recommended storage temperature for iso is 50°F to 110°F. Do not expose iso to lower temperatures – freezing may occur. Shelf life is 6 months for factory sealed containers.

CJGEO – DIV. OF PRESTON H. ROBERTS, INC

800-428-5690 info@cjgeo.com www.cjgeo.com

3402 Acorn St #202, Williamsburg, VA 23188

STRUCTURAL EVALUATION
OF THE
QUEENS LAKE SPILLWAY
FEBRUARY 2018

TAM Consultants Project No. 17496-W

Prepared for:

AES CONSULTING ENGINEERS
5248 Olde Towne Road, Suite 1
Williamsburg, VA 23188

By:

TAM Consultants
4350 New Town Avenue
Williamsburg, VA 23188
757-564-4434

TAM
CONSULTANTS

ATTACHMENT 26 MARCH 2018

TAM
CONSULTANTS
ENGINEERED SOLUTIONS
FOR OUR BUILT WORLD

February 5, 2018

AES Consulting Engineers
5248 Olde Towne Road, Suite 1
Williamsburg, VA 23188

Att: Howard Price

Re: Structural Evaluation of the
Queens Lake Spillway
York County, Virginia
TAM Project # 17496-W

Dear Howard:

Upon your authorization, TAM Consultants has performed a structural evaluation of the existing Queens Lake Dam and Spillway in York County, Virginia.

PROJECT DESCRIPTION

The Queens Lake Spillway is a poured in place concrete structure approximately 31'-9" wide, with a flow length of about 30 feet. On the lake side, the dam is approximately 5'-6" tall above the flow line. On each side of the spillway there are concrete abutment walls approximately 8'-5" tall, with an 8" wide divider wall in the center. The abutment walls, and the divider wall, provide support for a structural steel and heavy timber vehicular bridge carrying West Queens Drive over the spillway. The bridge is maintained by the Virginia Department of Transportation. No plans for the dam and spillway were available. The primary components of the spillway appear to have been constructed at different times, or perhaps major modifications were made from time to time. The Queens Lake residential development was begun in the 1950's. There are two thicknesses of concrete on the vertical dam wall. There are vertical cold joints between the abutment walls and the flared wing walls on the outfall. There appear to have been some patches and repair work done at some time.

OBSERVATIONS

In general, the dam and spillway are in Fair Condition. There are some areas that would benefit from repairs, but there is no obvious movement or signs of distress that would indicate structural failure. Areas that can be repaired:

1. There is a cold joint between the West abutment and wing wall (see photos 01.10 and 01.11). There are roots growing in the joint that have reached a size so that they are applying pressure that is causing a separation of the joint. This root, and all vegetation, should be removed. Once the vegetation is removed, the joint can be patched.

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2. At the top of the slope on the outfall slab there is a crack that begins at the East abutment wall and runs approximately 3/4 of the distance across the slab (see photos 01.12, 01.13 and 01.14). The crack varies in width from almost 1/4 inch down to a hairline, then disappears. This crack could be patched, but we do not feel patching is necessary at the present time. We might watch the crack over a period of time to see if it is continuing to move.

3. There is a crack and spall in the East abutment wall, that also appears to be a cold joint (see photos 01.15 and 01.16). The spall appears to have been patched previously, but the patch has failed. This could be patched as preventative maintenance. The wing wall at this location also needs to have vegetation removed.

4. At the outfall of the spillway there is a vertical concrete bulkhead. From a distance it appears the face is spalled and rough. Up close it is obvious the rough surface is from barnacles that have attached themselves to the face of the wall below the water line. The face of the wall above the water line is clean and smooth. Timber planks that are visible on the face of the bulkhead appear to be form boards used when the wall was first poured. These boards do not appear to have a structural function.

There was some concern expressed about water that possibly might be leaking through vertical joints at the dam intersection with the abutments. Water was flowing over the dam at the time of the field inspection and no noticeable flow through the joint was observed. This might be re-checked during drier weather. If water is flowing through the joint, that can be corrected by an expanding foam injected into the joint.

We hope these comments will be useful in planning for maintenance efforts for the spillway. We saw nothing that we feel required immediate corrective action. The items listed can be scheduled as weather and available funding might permit.

We appreciate this opportunity to serve AES and the Queens Lake Association. Please let us know if you have questions.

Very truly yours,

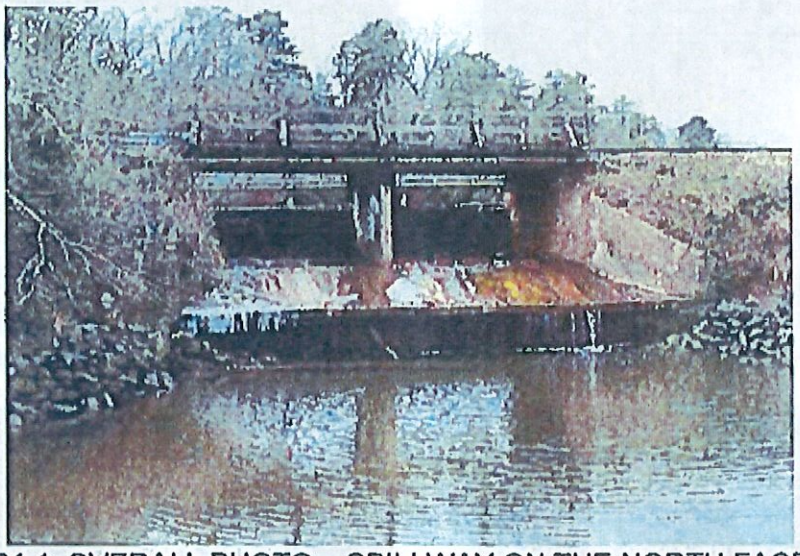
TAM CONSULTANTS

William D. Johnson, Jr., P.E.
Senior Project Manager

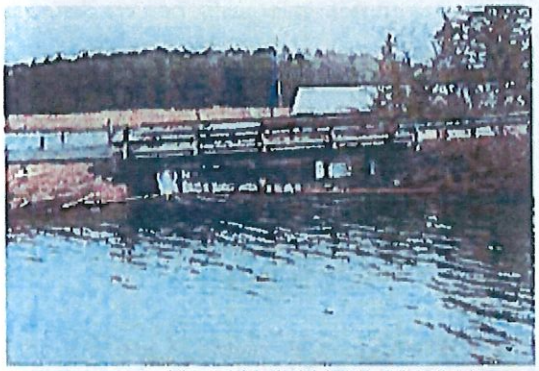
COMMONWEALTH OF VIRGINIA
WILLIAM D. JOHNSON, JR.
Lic. No. 7427
2/5/2018
PROFESSIONAL ENGINEER

TAM Consultants is a certified small/micro business,SWaM, a member of American Council of Engineering Companies, ACEC, the National Institute of Building Science, NIBS, the Building Enclosure Council, BEC, and Licensed American Air Barrier Association third party auditors, ABAA.

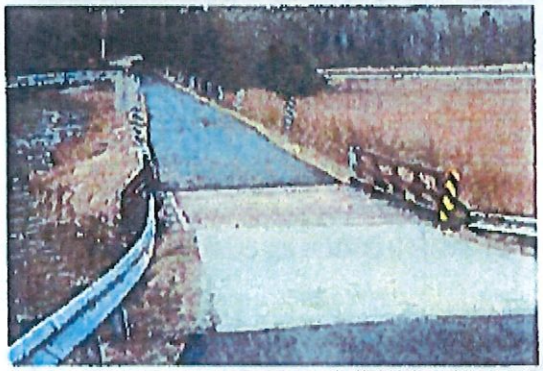
01.0 STRUCTURAL EVALUATION OF THE QUEENS LAKE SPILLWAY



01.1: OVERALL PHOTO – SPILLWAY ON THE NORTH FACE

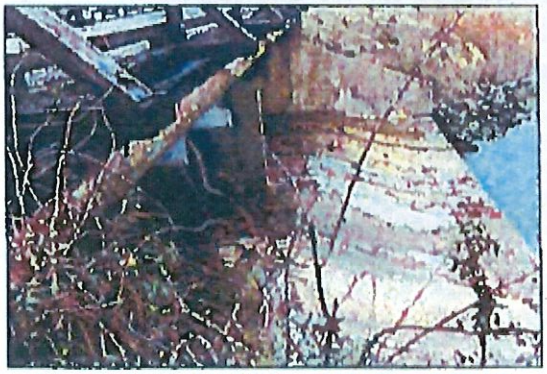


01.2: QUEENS LAKE DAM ON UPSTREAM SIDE



01.3: QUEENS LAKE DRIVE BRIDGE CROSSES THE SPILLWAY

01.4: SPILLWAY LOOKING TO THE EAST

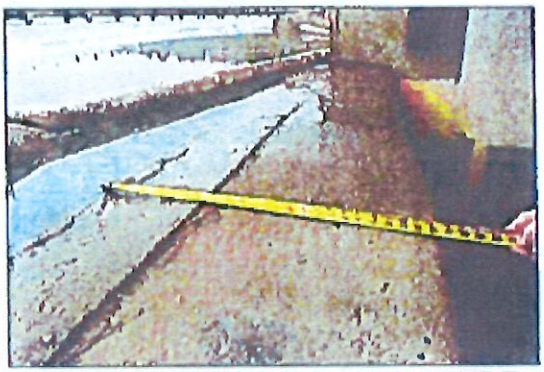


01.5: SPILLWAY LOOKING TO THE WEST

01.6: WEST ABUTMENT LOOKING TOWARDS THE DAM

01.7: WEST ABUTMENT LOOKING AT THE WINGWALL AT THE OUTFALL

01.8: HEAVY TIMBERS CAP THE CONCRETE ABUTMENTS TO SUPPORT BRIDGE STRUCTURE



01.9: THE CONCRETE STRUCTURE APPEARS TO HAVE BEEN CONSTRUCTED IN VARIOUS SECTIONS

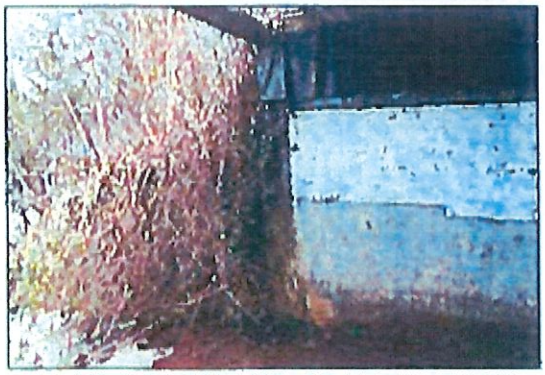
01.10: THERE IS A COLD JOINT BETWEEN THE WINGWALL AND THE ABUTMENT, AND ALSO AT THE BASE OF THE WINGWALL

01.11: LARGE ROOTS ARE FORCING THE COLD JOINT TO SEPARATE

01.12: CRACK ACROSS SPILLWAY

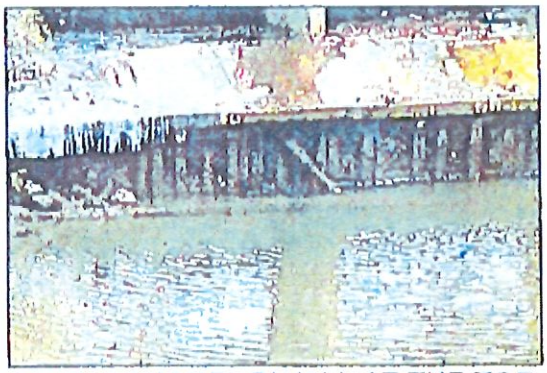
01.13: SPILLWAY CRACK VARIES FROM ABOUT ¼" TO HAIRLINE

01.14: SPILLWAY CRACK LOOKING TOWARDS THE EAST ABUTMENT



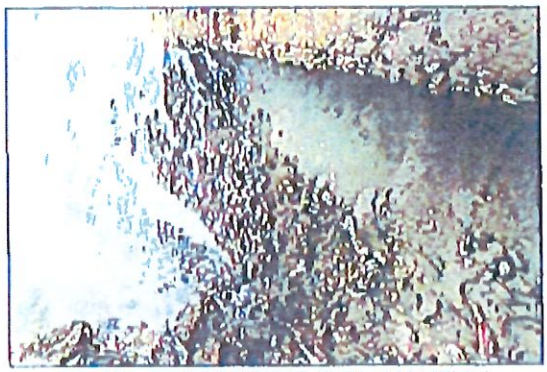
01.15: CRACK AND SPALL IN EAST ABUTMENT AT WING WALL

01.16: CRACK AND SPALL IN THE EAST ABUTMENT AT WING WALL



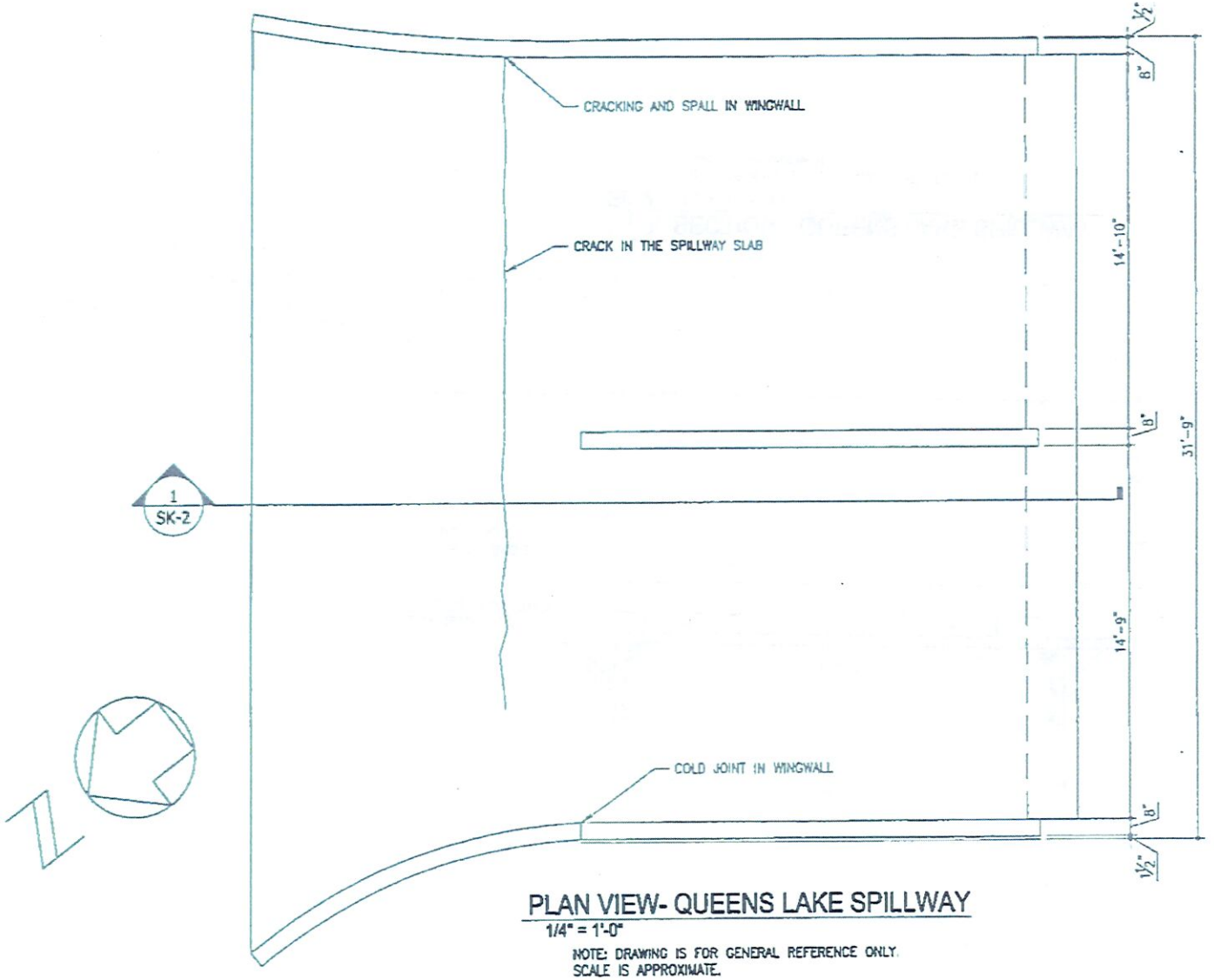
01.17: CONCRETE WALL AT THE TOE OF THE SPILLWAY

01.18: EXPOSED TIMBERS APPEAR TO BE PART OF FORMING FOR TOE



01.19: CONCRETE BELOW THE WATER LINE IS COVERED WITH BARNACLES

01.20: ABOVE THE WATER LINE THE CONCRETE IS CLEAN AND SMOOTH



PLAN VIEW- QUEENS LAKE SPILLWAY

1/4" = 1'-0"

NOTE: DRAWING IS FOR GENERAL REFERENCE ONLY.
SCALE IS APPROXIMATE.

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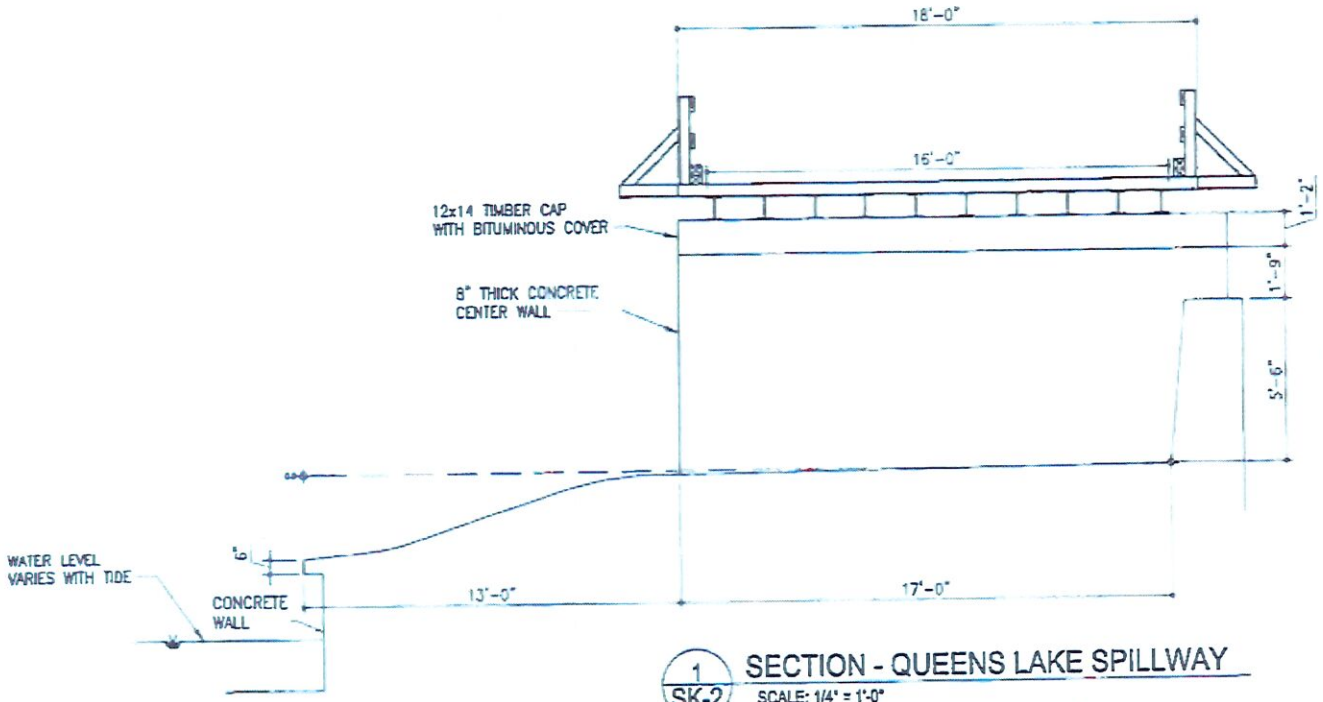
PROJECT MANAGER: WDJ
DESIGNED: BJ
DRAWN: GL
CHECKED: WDJ
DATE: 02/05/2018

STRUCTURAL EVALUATION
QUEENS LAKE SPILLWAY
AES CONSULTING ENGINEERS
YORK COUNTY, VIRGINIA

SHEET SK-1

CAD NO. 17496S1
JOB NO. 17496-W



1 / SK-2 SECTION - QUEENS LAKE SPILLWAY

SCALE: 1/4" = 1'-0"

NOTE: DRAWING IS FOR GENERAL REFERENCE ONLY. SCALE IS APPROXIMATE.

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