S-038-2012 (Consultant)

M E M O R A N D U M

TO: Mark Hite, P.E.
Director
Division of Structural Design

FROM: Bart Asher, P.E., L.S.
TEBM, Geotechnical Branch

BY: Daryl J. Greer, P.E.
Geotechnical Branch

DATE: September 24, 2015

SUBJECT: **Garrard/Mercer Counties**
FD52 040 0152 000-001
FD52 084 0152 018-019
BRO 5129 (012)
MARS No. 8469001D
KY 152 Bridge over Herrington Lake
Item No. 7-1116.00
Geotechnical Engineering Structure Foundation Report

The geotechnical engineering report for the subject project has been completed by Stantec Consulting Services, Inc. We have reviewed and concur with the recommendations as presented in this report.

A copy of the report is attached. If you have any questions, please contact this office at 502-564-2374.

Attachments

cc: W. McKinney
R. Powell
R. Sprague
M. Simpson
K. Caudill
R. Gossom
N. Ridgway
C. Raymer (WMB)
A. Crace (Stantec)
B. Greene

Report of Geotechnical Exploration

KY 152 over Herrington Lake
Item No. 7-1116.00
Garrard and Mercer Counties, Kentucky
Project ID: S-038-2012

Prepared for:
WMB, Inc.
Lexington, Kentucky

September 18, 2015

Stantec Consulting Services Inc.
Design with community in mind
www.stantec.com

Stantec

Stantec Consulting Services Inc.
1409 North Forbes Road, Lexington KY 40511-2050

September 18, 2015

rpt_002_175562020

Charlie Raymer, PE
WMB, Inc.
1950 Haggard Court
Lexington, Kentucky 40505

Re: Report of Geotechnical Exploration
KY 152 over Herrington Lake
Item No. 7-1116.00
Garrard and Mercer Counties, Kentucky
Project ID: S-038-2012

Dear Mr. Raymer:

Stantec Consulting Services Inc. (Stantec) is submitting the geotechnical engineering report for the referenced project with this letter. Also included are the subsurface data sheets presenting the boring layout and logs of borings for the bridge and approach roadways, as well as pertinent engineering analyses.

This bridge replacement project also includes relocating/reconstructing portions of roadway at either end of the bridge. Currently, there are two retaining walls proposed as well. The geotechnical considerations for the approach roadways and retaining walls will be addressed under separate cover. This report presents results of the field exploration along with our recommendations for the design and construction of the substructure elements proposed for the referenced bridge. As always, we enjoy working with your staff and if we can be of further assistance, please contact our office.

Sincerely,

STANTEC CONSULTING SERVICES INC.

Derek J. Gerdeman
Project Engineer

Adam Crace, PE
Senior Associate

/hnh

Report of Geotechnical Exploration

KY 152 over Herrington Lake
Item No. 7-1116.00
Garrard and Mercer Counties, Kentucky
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Report of Geotechnical Exploration

KY 152 over Herrington Lake
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1. Introduction

1.1. Project Overview

The Kentucky Transportation Cabinet (KYTC) is planning to replace the Kennedy Bridge, KY 152 over Herrington Lake. The existing bridge has been in service since 1933 and is currently operating under a reduced service load of 15 tons. Since the completion of the existing bridge in 1924, the pier nearest the Mercer County side has risen vertically approximately 30 inches and tilted upstream and toward Mercer County approximately 12 inches. The cause of this movement has never been determined.

It is proposed that a new bridge will be constructed just downstream of the existing bridge. As part of the bridge replacement project, short pieces of roadway will be relocated and/or reconstructed at either end of the bridge. Currently there are two retaining walls proposed as well. The geotechnical considerations for the approach roadways and retaining walls will be addressed under separate cover. This report addresses the geotechnical considerations associated with the proposed bridge over Herrington Lake. The map provided in Appendix A illustrates the proposed bridge location.

1.2. Structure Location and Description

Structure plans indicate the proposed 3-span structure will be 825 feet in length beginning at KY 152 station 18+35 and ending at station 26+60. Table 1 presents a summary of approximate planned locations of the substructure elements as referenced to KY 152 stationing.

Table 1.Approximate Stationing of Bridge Substructure Elements

Element	KY 152 Station
Abutment 1	18+35
Pier 1	21+85
Pier 2	25+35
Abutment 2	26+60

Appendix B presents structure drawings received from the project designer, WMB Inc. (WMB) which depicts the proposed plan layout and profile of the bridge.

2. Site Topography and Geologic Conditions

The project area lies within the Bluegrass Physiographic Region of Kentucky. The Bluegrass Region is characterized by gently rolling hills with rich fertile soils. Weathering of the underlying limestone bedrock has produced caves, sinkholes, and springs. The proposed bridge is located close to the Kentucky River Palisades, which formed when the Kentucky River and its tributaries cut through the limestone bedrock to form high cliffs and steep gorges within the study area. Existing topographic relief at the site varies from approximate elevation 790 feet at the abutments to approximate elevation 550 feet below Herrington Lake.

Available geologic mapping (USGS Geologic Map of Bryantsville (1971) Quadrangle, Kentucky) indicates the site is underlain by limestone and possibly dolomite bedrock of the Middle Ordovician age. According to the USGS Quadrangle, the limestones are predominantly light gray to gray, micro-crystalline to fine grained, thin to medium bedded, with shale stringers. The dolomite is described as light gray to gray, micro-crystalline grained, and thick bedded.

Karst activity exists with the Bluegrass Physiographic Region of Central Kentucky. However, based on USGS Geologic mapping, no known karstic features are present in the project vicinity. Stantec encountered small voids in the upper approximately 20 feet of bedrock in several borings at the substructure locations. These voids indicate that minor karstic features may be present within the project vicinity.

Based on USGS Geologic mapping, several unnamed faults are present within approximately one mile of the proposed bridge location. The unnamed faults fall to the north, southwest and south of the bridge location. The Kentucky River Fault Zone is also located near the bridge location. At the closest point, the Kentucky River Fault Zone is approximately 3.25 miles to the southeast of the bridge location. None of these faults are known to have been active within recent history.

Residual clayey and silty soils are the predominant soil type mapped within the approach areas of the bridge. Soils can become very thin to very deep in karst areas within a relatively short distance.

3. Summary of Borings

Fourteen borings were drilled during the 2014 field exploration of the proposed structure. A previous geotechnical exploration was completed in 2013 and included two rock core borings at the abutment 1 location. The borings of the 2014 exploration consisted of four rockline soundings, one undisturbed sample boring, two undisturbed sample borings with rock coring, and seven rock core borings. The borings were staked in the field by WMB survey personnel. The locations and logs of borings are shown on the Subsurface Data Sheets located in Appendix C. Table 2 presents a summary of the borings drilled. All measurements are expressed in feet.

Table 2. Summary of Borings

Substructure Element	Hole No.	Station, Offset	Surface Elevation	Top of Rock Elevation	Refusal/Begin Core Elevation	Length of Core[b]	Bottom of Hole Elevation
Abutment 1	B-1[c]	18+42, 26.0’ Lt.	786.0	779.5	779.5	319.2	460.3
	B-2[c]	17+80, 16.0’ Lt.	786.6	782.2	782.2	62.3[d]	731.1
	B-3	18+18, 38.0’ Lt.	790.0	788.9[a]	788.9	N/C	788.9
	B-4[e]	18+32, 16.0’ Rt.	786.1	780.5[a]	780.5	N/C	780.5
	B-5	18+18, 38.0’ Rt.	786.1	779.6[a]	779.6	N/C	779.6
Pier 1	B-6	21+71, 11.8’ Lt.	739.0[f]	546.4	546.4	100.3	446.1
	B-7	21+75, 9.6’ Rt.	729.8[f]	545.4	547.2	91.5	455.7
	B-8	21+95, 10.9’ Lt.	736.3[f]	547.0	547.0	104.2	442.8
	B-9	21+96, 9.5’ Rt.	730.4[f]	547.3	550.8	103.7	447.1
Pier 2	B-10	25+-24, 8.4’ Lt.	738.0[f]	711.2	711.2	70.5	640.7
	B-11	25+24, 8.8’ Rt.	738.2[f]	710.9	710.9	69.8	641.1
	B-12	25+40, 7.6’ Lt.	738.6[f]	723.2	723.2	71.7	651.5
	B-13	25+44, 8.0’ Rt.	738.4[f]	725.8	725.8	69.5	656.3
Abutment 2	B-14[e]	26+60, 48.0’ Lt.	782.3	779.4[a]	779.4	N/C	779.4
	B-16	26+60, 15.0’ Rt.	792.4	790.5	790.5	30.6	759.9
	B-17	26+60, 41.0’ Rt.	792.2	790.4[a]	790.4	N/C	790.4

a. Top of rock in this case indicates rock-like resistance to augering. An exact determination cannot be made without performing rock coring.
b. N/C denotes no rock coring performed.
c. Boring Nos. B-1 and B-2 were previously drilled in 2013.
d. Boring was drilled at a 35 degree angle. Length of core recorded is along the 35 degree angle.
e. Boring advanced with a 3” hand-auger due to access.
f. Borings were drilled from a floating plant. The surface elevation recorded is referenced to the top of the casing.

Stantec personnel performed drilling and sampling operations in the summer of 2014. The drill crews operated track-mounted and truck-mounted drill rigs equipped with hollow-stem and flight augers as well as wire line rock coring tools. The field personnel generally performed soil sampling at approximately five-foot intervals of depth to obtain in situ strength data and specimens for subsequent laboratory strength and/or classification testing.

The Pier 1 and Pier 2 borings were completed from a floating plant on Herrington Lake. Due to deep water (180 feet +) at the Pier 1 location and subsequently long unsupported lengths of drill steel, HQ rock coring tools encased in 6-inch steel Flush Joint (FJ) casing were utilized for the borings drilled from the floating plant. Also due to the deep water, a traditional spud system was not feasible to anchor the barge. Stantec utilized a system of cables attached to four anchor points drilled into bedrock approximately 40 feet below the water surface. The anchor points were positioned on either bank, upstream and downstream of the proposed bridge location in an “X” pattern to allow movement of the barge over the different boring locations by lengthening and shortening of the cables.

Due to variations of the water level in the lake during drilling, the surface elevation recorded is referenced to the top of the 6-inch FJ casing seated into bedrock, and was determined based on the current lake elevation at the time the casing was seated. Lake elevations were obtained through the USGS National Water Information System for Herrington Lake.

Standard penetration testing (SPT) was performed within granular (non-cohesive) materials and thin wall (Shelby) tube samples were taken in cohesive materials as applicable. The drill crews checked each boring for the presence of groundwater prior to backfilling. The Subsurface Data Sheets in Appendix C provide a boring layout that depicts the locations of the borings in relation to the planned structure as well as graphical logs presenting the results of the drilling, sampling, and laboratory testing programs. Refer to Appendix D for the Coordinate Data Submission Form summarizing the as-drilled boring locations, surface elevations, and associated latitudes and longitudes.

The drill rigs utilized for the sampling operations were equipped with automatic hammers to perform SPT testing in accordance with Section 302-5 of the current KYTC Geotechnical Manual. The use of automatic hammers provides for a more efficient and consistent transfer of energy than traditional SPT testing with a safety hammer/rope/cat-head system. Thus, blowcounts observed from automatic hammers are lower than those observed with the safety hammer system. Typical correlations for SPT results used in geotechnical engineering are based on the safety hammer system and require that blowcounts from SPT testing using an automatic hammer be corrected for efficiency.

4. Soil and Bedrock Conditions

Soils encountered in the borings drilled near the abutments consist of silty clays with varying amounts of chert and gravel. The abutment borings indicate that soils tend to be shallow, varying from approximately 1 to 8 feet in thickness. Soils encountered in the borings drilled in Herrington Lake consist of silts and clays and vary in depth up to approximately 10 feet.

The rock core specimens obtained in the borings consist primarily of limestone with zones that have interbedded shale. The limestones were described as light gray to gray in color, thin- to thick-bedded, fine- to microcrystalline-grained, and having shale stringers. The interbedded shales were described as gray in color.

The project engineer determined the location of the base of weathered rock for each rock core boring, and selected samples of the rock cores for Unconfined Compression testing. The percent recovery and rock quality designation (RQD) were also determined for each core run.

The RQD is defined as the sum of all core pieces longer than four inches, divided by the total length of the coring run. KYTC modifies the RQD by excluding from the sum those portions of core which can be broken by hand pressure. The resultant is multiplied by 100 to express the RQD in percent. The RQD provides a simple quantitative indication of rock competency. Detailed graphical logs of the borings are presented on the Subsurface Data Sheets in Appendix C.

5. Laboratory Testing and Results

5.1. General

All laboratory tests were performed in accordance with the applicable AASHTO or Kentucky Methods soil and rock testing specifications. Laboratory testing consisted of natural moisture content, grain size-sieve analyses (silt plus clay determinations), soil classification index testing, and unconfined compression testing of rock.

Engineering staff used the test results to establish material properties for subsequent engineering analyses. The following paragraphs provide discussions of the laboratory testing program and its results.

5.2. Laboratory Testing of Standard Penetration Test Samples

Laboratory testing of the SPT samples included natural moisture content, grain-size sieve analysis (silt plus clay determination), and standard engineering classification testing. The SPT soil samples tested classify as CL and GC according to USCS and as A-6 and A-7-6 based on the AASHTO classification system.

5.3. Unconfined Compression Testing on Rock

Several rock core samples were tested for unconfined compressive strength for use in foundation analyses. The results varied from a low of 247 tons per square foot (tsf) in a shale layer at the Abutment 1 location to a high of 2,528 tsf in limestone. The laboratory test results are shown on the Subsurface Data Sheets in Appendix C.

6. Foundation Analyses

6.1. General

Stantec understands that the new bridge will be supported by spread footings and drilled shaft foundations. Spread footings will be designed at the service limit state using presumptive values of allowable bearing pressures found in NAVFAC DM 7.2. Drilled Shaft foundations in this project will be designed using the Load and Resistance Factor Design (LRFD) methodology. LRFD is a design approach in which applicable failure and serviceability conditions can be evaluated considering the uncertainties associated with loads and materials resistances. Where applicable, the following engineering analyses followed the current AASHTO LRFD guidelines. This report provides recommendations for spread footings on bedrock as well as drilled shaft foundations for support of the abutments and piers of the subject structure where applicable.

6.2. Bearing Capacity for Spread Footings on Bedrock

In accordance with NAVFAC DM 7.2, page 7.2-142, a presumptive value of 40 ksf is being recommended for the allowable bearing capacity of competent limestone bedrock. The allowable bearing capacity of 40 ksf shall be used for spread footing elements on the project as outlined in Section 8 of this report.

6.3. Drilled Shaft Analyses

Drilled shaft options are being evaluated as the foundation type for Abutment 1, Pier 1 and Pier 2. A geotechnical engineer performed axial analyses for a 6.0-foot diameter shaft (5.5-foot diameter rock socket) at the abutment 1 location and various shaft sizes ranging from 5.5-foot to 13.5-foot diameter rock sockets at the pier locations. Stantec utilized the procedures outlined in the Federal Highway Administration Publication No. FHWA-IF-99-025 and 2014 AASHTO LRFD Bridge Design Specifications to estimate axial capacities of drilled shafts.

The selection of LRFD resistance factors for drilled shaft capacities involves an evaluation of the type of loading (axial compression versus uplift) and the variability and reliability of models or methodologies used to determine nominal resistance capacities. Table 3 summarizes the applicable analysis methodologies as well as the resistance factors recommended by the 2014 Edition of the AASHTO LRFD Bridge Design Specifications.

Table 3. LRFD Resistance Factors for Drilled Shaft Analyses

Loading Condition	Resistance Mechanism	Analysis Methodology	Resistance Factor[a] (φ)
Nominal Axial Compressive Resistance of Single Drilled Shafts	Side Resistance in Rock	O'Neill and Reese, 1999	0.55
	End Bearing in Rock	O'Neill and Reese, 1999	0.50
Uplift Resistance of Single Drilled Shafts	Rock	Carter and Kulhway, 1988	0.40
Horizontal Geotechnical Resistance of Single Shaft or Shaft Group	All Material		1.0

a. 2014 Edition of the AASHTO LRFD Bridge Design Specifications, portion of Table 10.5.5.2.4-1.

6.3.1. End Bearing and Side Resistance of Shafts in Bedrock

Stantec utilized the procedures outlined in the Federal Highway Administration Publication No. FHWA-IF-99-025 and 2014 AASHTO LRFD Bridge Design Specifications to estimate axial capacities of drilled shafts. Refer to Appendix E for drilled shaft nominal axial capacity estimates for the Pier locations.

It shall be noted that no side resistance from the upper approximately 20 feet of rock was contributed to the nominal axial capacity estimates for the Pier 1 shafts. Due to intermittent voids in boring B-7 between elevations 541 feet and 526 feet and the void that is present in all of the Pier 1 borings near elevation 524 feet, the bedrock above elevation 523.5 feet was discounted in the drilled shaft capacity analyses. Remediation of the noted voids and cavities will likely be necessary as part of the construction process. Refer to Section 8.3 of this report for recommendations on cavity remediation for drilled shafts.

At the pier 2 location, the foundation system sits on a shelf scenario. The axial capacity contributions from side resistance begin at the base of weathered rock elevation in the lowest boring.

It shall also be noted that the contribution from end bearing is not considered in the estimated nominal axial capacity of the shafts. In hard limestone of this nature, it is assumed that there would not be enough movement to mobilize end bearing.

6.3.2. Strength Limit State

Stantec estimated allowable bearing capacities for the strength limit state by deriving nominal end bearing and side resistance of drilled shafts in bedrock based on the results of the drilling, sampling, and laboratory testing programs conducted. The methodology used to calculate the nominal end bearing (q_p) and side resistance (q_s) of drilled shafts in bedrock is presented in the 2014 Edition of the AASHTO LRFD Bridge Design Specifications, Section 10.8.3.5.4. Using the referenced procedures and design unconfined compressive strength of 5,000 psi for concrete, the nominal end bearing resistance (q_p) and the nominal side resistance (q_s) are presented in Table 4 based on the different rock stratigraphy. A resistance factor as shown in Table 3 was then applied to the nominal axial capacity in order to arrive at the total factored axial resistance. Refer to the drilled shaft capacity tables presented in Appendix E.

Table 4. Summary of Drilled Shaft Parameters

Substructure Element	Rock Mass Type	Rock Mass Rating	Maximum Side Shear (ksf)	Maximum End Bearing (ksf)
Abutment 1	Upper Limestone	49	22.6	213
	Shale	39	11.1	22
	Lower Limestone	71	25.4[a]	1950
Pier 1	Upper Limestone	49	24.5	292
	Lower Limestone	76	25.4[a]	2378
Pier 2	Upper Limestone	54	25.4[a]	383
	Lower Limestone	71	25.4[a]	1928

a. Limited by the strength of the concrete.

6.3.3. Service Limit State

Stantec determined capacity values for the service limit state using the same procedures outlined above except a Factor of Safety (FS) of three was applied to the nominal axial capacity in order to arrive at the service limit state total allowable bearing capacity. The Service Limit State capacities will be used by the designer for the evaluation of lateral deflection.

6.3.4. Extreme Limit State

Stantec also determined capacity values for the extreme limit state using the same procedures outlined above except a resistance factor of 1.0 (2014 Edition of the AASHTO LRFD Bridge Design Specifications, Section 10.5.5.3.2) was applied to the nominal axial capacity in order to arrive at the extreme limit state total factored axial resistance. Refer to the drilled shaft capacity tables presented in Appendix E for specific capacities with respect to depth.

6.3.5. Lateral Analyses of Shafts

The lateral analyses for the drilled shafts are being performed by the designer. Appendix F provides Idealized Subsurface Profiles that outline the recommended soil and rock parameters for use in lateral load analyses.

6.3.6. Uplift

Uplift analyses were determined for the strength limit state and utilized a resistance factor of 0.4 as described in Table 3. In accordance with AASHTO, the resistance factor used for the socket friction for uplift loading was 0.4, corresponding to uplift resistance of single-drilled shafts. Uplift analysis was also determined for the extreme limit state and utilized a resistance factor of 0.8 (2014 Edition of the AASHTO LRFD Bridge Design Specifications, Section 10.5.5.3.2). Refer to Appendix E for tables showing the total factored uplift resistance.

7. Seismic Design Considerations

The 2014 AASHTO LRFD Bridge Design Specifications provide guidelines for determining the seismic hazard at a bridge site. The seismic hazard for a bridge site is characterized by the acceleration response spectrum and the site factors for the relevant site classification. Based on the results of the exploration and the geology of the area, the subsurface profile in the vicinity of the bridge should be classified as site classification B, as per Table 3.10.3.1.1 - Site Class Definitions, and used for design purposes.

8. Conclusions and Recommendations

Stantec developed the following recommendations based upon reviews of available data, information obtained during the field exploration, results of laboratory testing and engineering analyses, and discussions with WMB and KYTC personnel. The recommendations are also based on the structure configuration presented in drawings provided by WMB.

8.1. General

8.1.1. Based on a review of the existing subsurface conditions and anticipated structural loads, it is recommended that rock bearing foundation systems be used for all bridge substructure elements. The following table provides possible foundation alternates using the following notations:

1 = Spread Footings

2 = Drilled Shafts

The foundation alternates shown below are those Stantec considers being most practical. However, other structural and/or economic considerations may dictate which option is most preferable.

Substructure Element and Boring No.	Station, Offset	Foundation Alternate	Top of Rock (Feet)	Estimated Bearing Elevation (Feet)	Service I Bearing Pressure (psf)
Abutment 1					
B-1	18+42, 26.0’ Lt.	1, 2[b]	779.5	749.5	40,000
B-2	17+80, 16.0’ Lt.	1, 2[b]	782.2	749.5	40,000
B-3	18+18, 38.0’ Lt.	1, 2[b]	788.9[a]	749.5	40,000
B-4	18+32, 16.0’ Rt.	1, 2[b]	780.5[a]	749.5	40,000
B-5	18+18, 38.0’ Rt.	1, 2[b]	779.6[a]	749.5	40,000
Pier 1					
B-6	21+71, 11.8’ Lt.	2	546.4	See Capacity Tables – Appendix F	
B-7	21+75, 9.6’ Rt.	2	545.4		
B-8	21+95, 10.9’ Lt.	2	547.0		
B-9	21+96, 9.5’ Rt.	2	547.3		
Pier 2					
B-10	25+24, 8.4’ Lt.	2	711.2	See Capacity Tables – Appendix F	
B-11	25+24, 8.8’ Rt.	2	710.9		
B-12	25+40, 7.6’ Lt.	2	723.2		
B-13	25+44, 8.0’ Rt.	2	725.8		
Abutment 2					
B-14	26+60, 48.0’ Lt.	1	779.4[a]	773.5	40,000
B-16	26+60, 15.0’ Rt.	1	790.5	773.5	40,000
B-17	26+60, 41.0’ Rt.	1	790.4	773.5	40,000

a. Top of rock in this case indicates rock-like resistance to augering. An exact determination cannot be made without performing rock coring.

b. See capacity tables in Appendix F for Foundation Alternate 2 bearing and capacity information.

8.1.2. Foundation excavations should be properly braced/shored to provide adequate safety to people working in or around the excavations. Bracing should be performed in accordance with applicable federal, state and local guidelines.

8.1.3. **A plan note should be included by the designer** that indicates that temporary shoring, sheeting, cofferdams, and/or dewatering methods may be required to facilitate foundation construction.

8.1.4. **A plan note should be included by the designer:** Structure excavation shall be completed just prior to structure foundation construction in order to prevent the bedrock from being exposed for an extended period of time and deteriorating. Rock excavation will be required at the Abutment locations. The contractor shall take care during blasting and other excavation methods to avoid over-breakage and damage to the bedrock beneath the footings.

8.2. Spread Footings on Bedrock

8.2.1. Rock-bearing spread footing options are being provided for the abutment substructure elements. Foundation excavations for footings at the structure locations should be level and free of loose, water softened material, etc. Additional rock excavation to achieve suitable bearing conditions may be required depending upon topography and bedrock weathering conditions.

8.2.2. It is recommended that spread footings should be embedded a minimum of 2 feet. All footing excavations should be neatly cut so that no forming or backfilling is necessary in the construction of the portions of the footing located in rock. Concrete should be placed directly against the cut rock faces.

8.2.3. The bearing surfaces of spread footings should be level, and any soft compressible materials should be removed prior to placement of reinforcing steel and concrete.

8.2.4. Foundation excavations should not be left open to allow the accumulation of water or extended exposure to other climatic conditions. Foundation excavations should be concreted and backfilled immediately after excavation is complete, or if this cannot be done, the last four to six inches of foundation material should not be removed until preparations for placing concrete are ready.

8.2.5. It is recommended that any over-excavation into bedrock be filled to the top of the excavation with mass concrete.

8.3. Drilled Shaft Foundations

8.3.1. The Contractor should use a permanent casing from the top of shaft to the top of unweathered bedrock and use an uncased rock socket which is 6 inches smaller than the inside diameter of the permanent casing.

8.3.2. Unless otherwise specified, it is recommended that construction methods and materials used for drilled shaft installations be in accordance with the current KYTC "Special Note for Drilled Shafts".

8.3.3. **A plan note should be included by the Designer:** Construction cores will not be required at the Pier 1 and Pier 2 drilled shaft locations. Rock cores obtained during the geotechnical exploration were drilled at the center of each shaft and extend deep enough to cover the embedment length.

8.3.4. Drilled Shaft Integrity Testing will be required for each drilled shaft. An appropriate number of Crosshole Sonic Logging (CSL) access tubes, consisting of two (2) inch nominal diameter schedule 40 steel pipe, will be required. These tubes should be shown on the drilled shaft details.

8.3.5. Drilled shaft foundations at Pier 1 will be constructed in deep (180 feet +) water. Traditional spud anchoring systems may not be feasible for drilling and construction operations performed from a barge deck. Special consideration should be taken by the Contractor to establish a sufficient anchoring system for support barges.

8.3.6. Small voids and cavities are present in the upper 20 feet of bedrock at the Pier 1 location. Pier 1 drilled shafts will require cavity remediation using one of the following recommended techniques. A plan note should be included by the designer which indicates: The contractor shall submit a drilled shaft cavity remediation plan for approval prior to beginning drilled shaft construction.

Cavity Remediation Option 1: Drill the rock socket to one foot below the lowest cavity. Perform sonic caliper testing to ensure that cavities aren't on the edge of a cavern. Fill the rock socket with lean concrete to a depth that is five feet above the highest cavity. Allow two day set on the concrete. Re-drill that portion of the shaft and perform sonic caliper testing again to confirm that the cavities have been sealed. Continue drilling of the shaft to the specified bearing elevation.

Cavity Remediation Option 2: Drill a slightly oversized rock socket to one foot below the lowest cavity. Insert a permanent steel casing that extends from one foot below the lowest cavity to the top of rock. Inside of this steel casing, advance the shaft to the specified bearing elevation with the design rock socket diameter.

9. Closing

9.1. The conclusions and recommendations presented herein are based on data and subsurface conditions from the borings drilled during the geotechnical exploration using that degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. No warranties can be made regarding the continuity of conditions between borings.

9.2 General soil and rock descriptions and indicated boundaries are based on an engineering interpretation of all available subsurface information and may not necessarily reflect the actual variation in subsurface conditions between borings and samples. Collected data and field interpretation of conditions encountered in individual borings are shown on the drafted sheets in Appendix C.

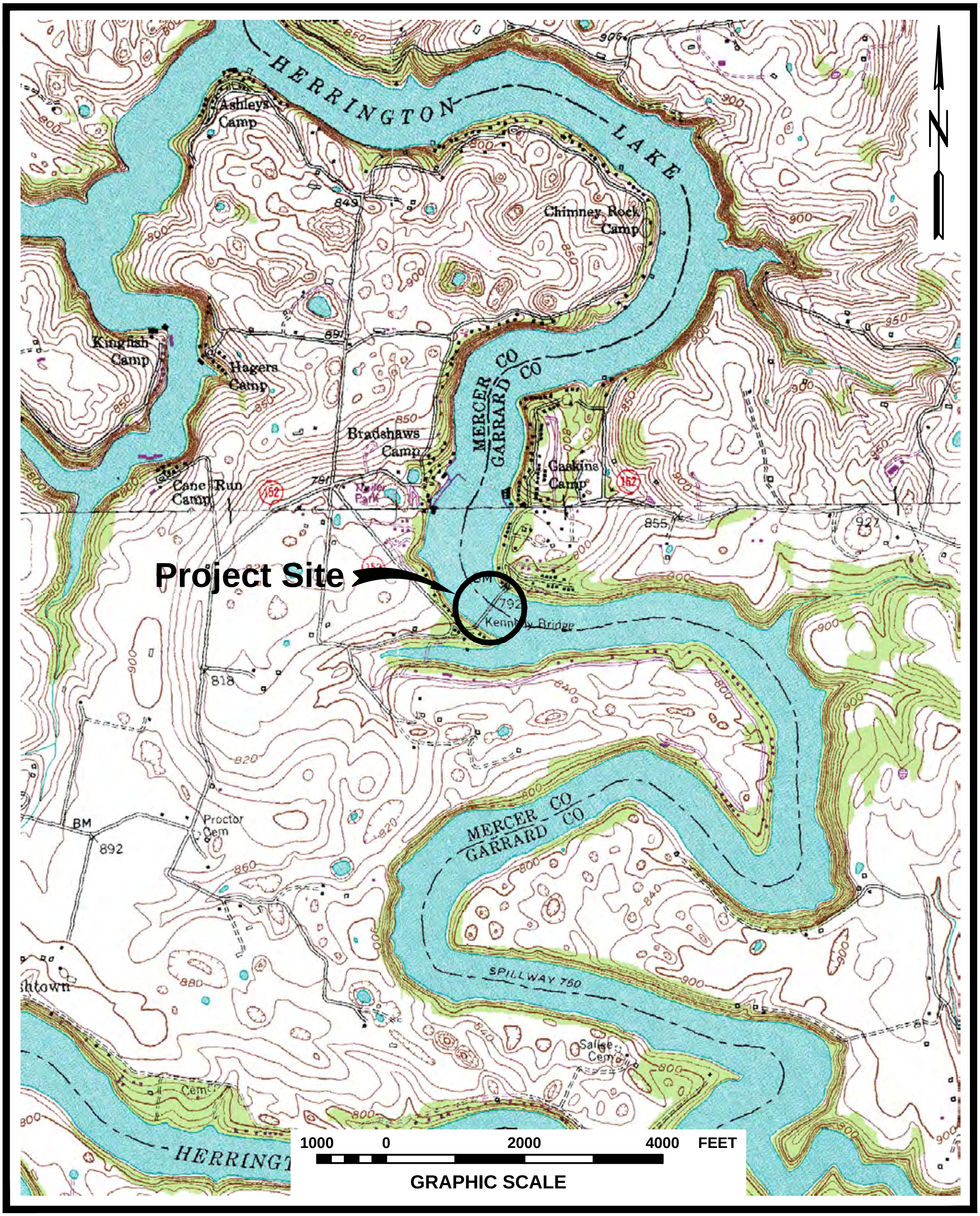
9.3. The observed water levels and/or conditions indicated on the boring logs are as recorded at the time of exploration. These water levels and/or conditions may vary considerably, with time, according to the prevailing climate, rainfall, tail water elevations and/or other factors and are otherwise dependent on the duration of and methods used in the exploration program.

9.4. Stantec exercised sound engineering judgment in preparing the subsurface information presented herein. This information has been prepared and is intended for design and estimating purposes. Its presentation on the plans or elsewhere is for the purpose of providing intended users with access to the same information. This subsurface information interpretation is presented in good faith and is not intended as a substitute for independent interpretations or judgments of the Contractor.

9.5. All structure details shown herein are for illustrative purposes only and may not be indicative of the final design conditions shown in the contract plans.

Appendix A

Location Map

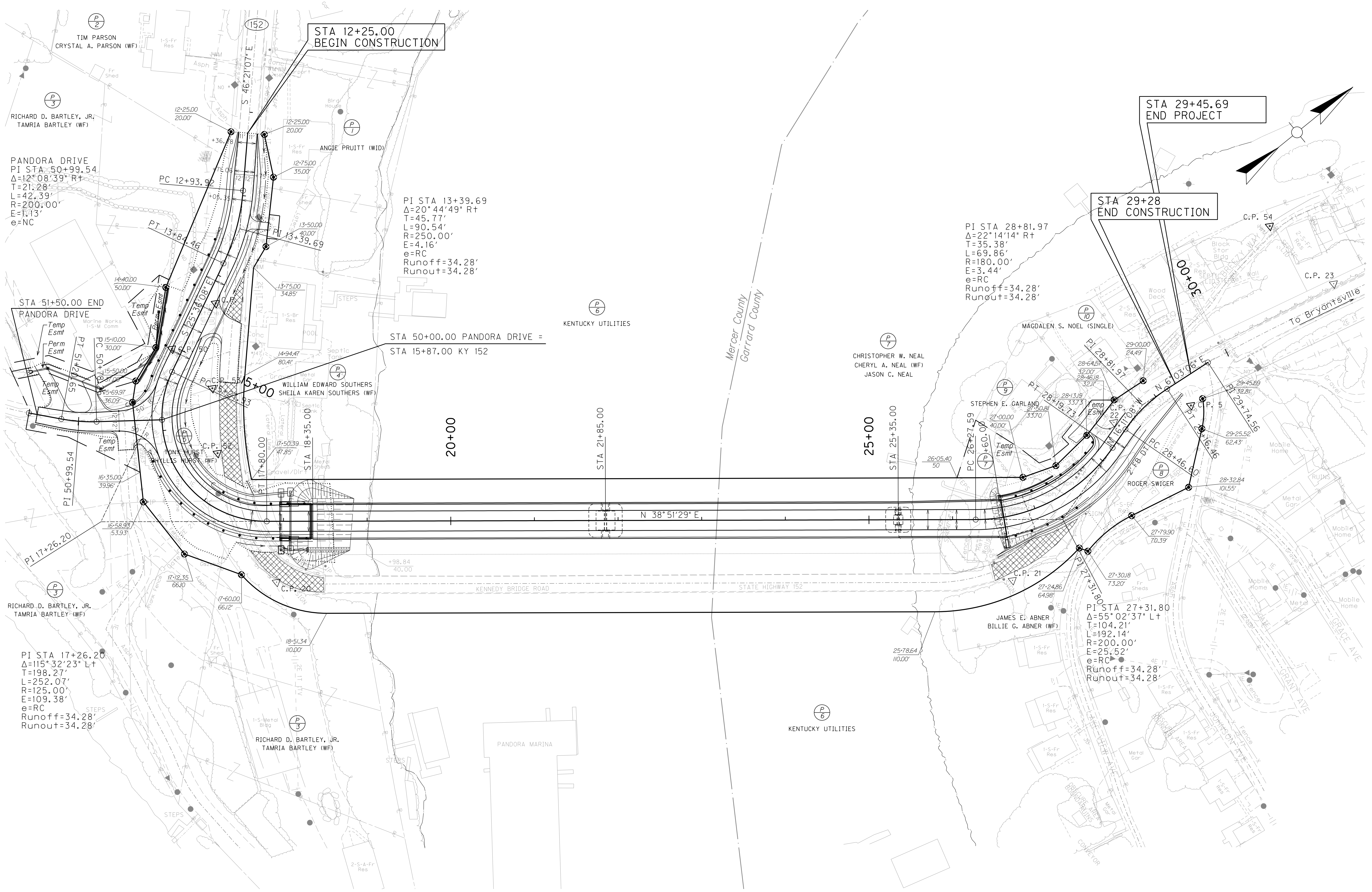


PLOT DATE: 02/05/2015 USER: ELLISON, DOC
V:\1755\ACTIVE\175562020\GEOTECHNICAL\DRAWING\SHEET_FILES\2020_LOCMAP.DWG

LOCATION MAP
KY 152 OVER HERRINGTON LAKE
GARRARD/MERCER COUNTIES, KENTUCKY
Portions of USGS 7 1/2-minute Topographic Maps
(BRYANTSVILLE, WILMORE QUADRANGLES) SHOWING PROJECT SITE

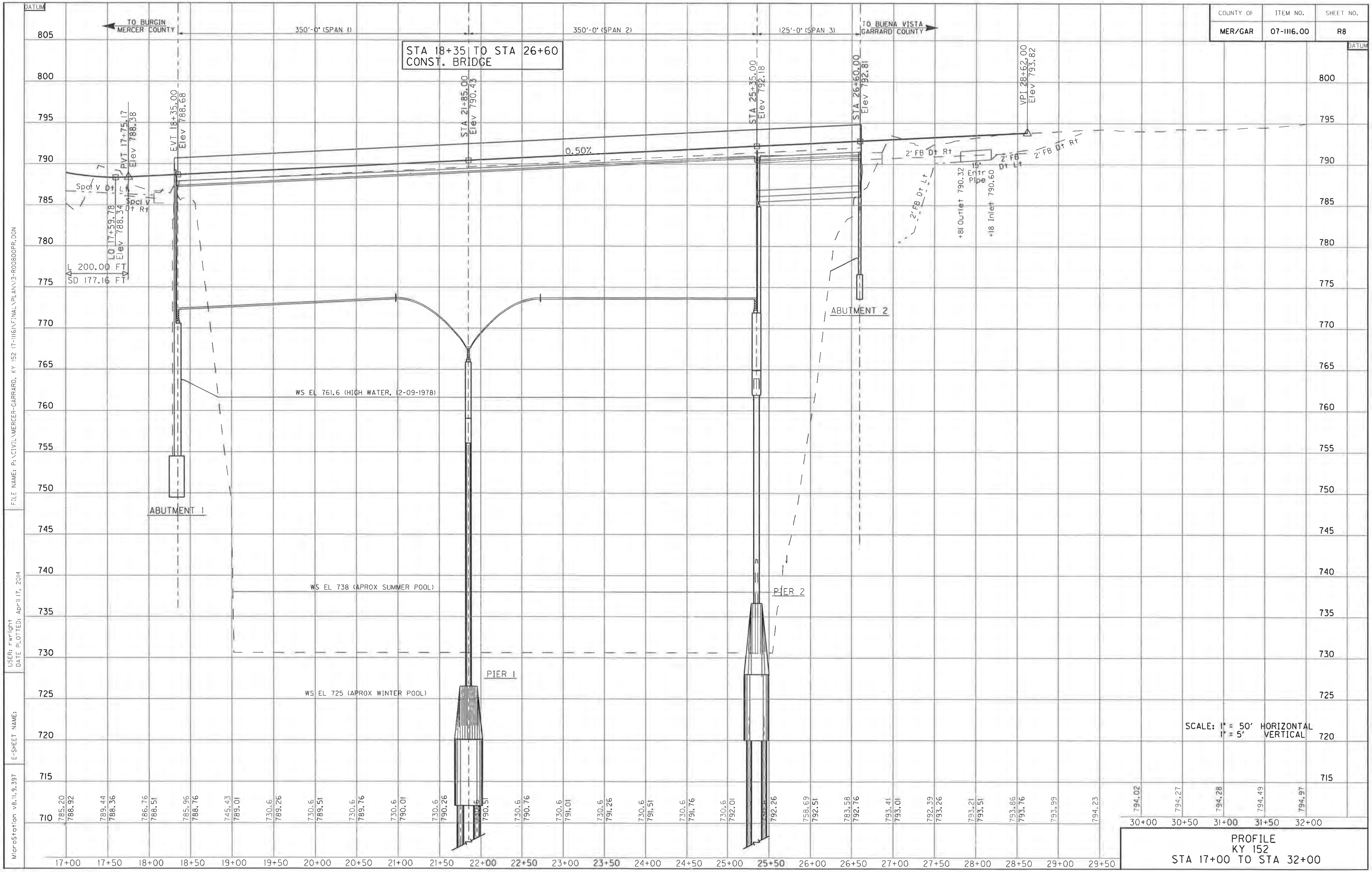
Appendix B

Designer Drawings



STA 12+25.00
BEGIN CONSTRUCTION
STA 29+45.69
END PROJECT
STA 29+28
END CONSTRUCTION
152
S 46°21'07" E
TIM PARSON
CRYSTAL A. PARSON (WF)
RICHARD D. BARTLEY, JR.
TAMRIA BARTLEY (WF)
ANGIE PRUITT (WID)
PANDORA DRIVE
PI STA 50+99.54
Δ=12°08'39" Rt
T=21.28'
L=42.39'
R=200.00'
E=1.13'
e=NC
12+25.00
20.00'
12+25.00
20.00'
12+75.00
35.00'
PC 12+93.92
PT 13+84.46
PI 13+39.69
13+50.00
40.00'
13+75.00
34.85'
14+40.00
50.00'
PI STA 13+39.69
Δ=20°44'49" Rt
T=45.77'
L=90.54'
R=250.00'
E=4.16'
e=RC
Runoff=34.28'
Runout=34.28'
STA 51+50.00 END
PANDORA DRIVE
Temp Esmt
Perm Esmt
Marine Works
1-S-M Comm
PT 51+20.65
PC 50+78
15+10.00
30.00'
15+50.00
37.00'
15+69.97
36.09'
S 25°36'08" E
C.P. 1
C.P. 50
C.P. 53
C.P. 52
PC 15+27.93
15+00
STA 50+00.00 PANDORA DRIVE =
STA 15+87.00 KY 152
14+94.47
80.41'
WILLIAM EDWARD SOUTHERS
SHEILA KAREN SOUTHERS (WF)
TONY HURST
PHYLLIS HURST (WF)
PI 50+99.54
16+35.00
39.96'
16+58.93
53.93'
PI 17+26.20
PT 17+80.00
17+50.39
47.85'
STA 18+35.00
17+12.35
66.10
17+60.00
66.12'
18+51.34
110.00'
+98.84
40.00
C.P. 20
RICHARD D. BARTLEY, JR.
TAMRIA BARTLEY (WF)
PI STA 17+26.20
Δ=115°32'23" Lt
T=198.27'
L=252.07'
R=125.00'
E=109.38'
e=RC
Runoff=34.28'
Runout=34.28'
RICHARD D. BARTLEY, JR.
TAMRIA BARTLEY (WF)
PANDORA MARINA
20+00
STA 21+85.00
N 38°51'29" E
KENTUCKY UTILITIES
Mercer County
Garrard County
KENNEDY BRIDGE ROAD
STATE HIGHWAY 152
25+00
STA 25+35.00
25+78.64
110.00'
KENTUCKY UTILITIES
CHRISTOPHER W. NEAL
CHERYL A. NEAL (WF)
JASON C. NEAL
PI STA 28+81.97
Δ=22°14'14" Rt
T=35.38'
L=69.86'
R=180.00'
E=3.44'
e=RC
Runoff=34.28'
Runout=34.28'
MAGDALEN S. NOEL (SINGLE)
STEPHEN E. GARLAND
PI 28+81.97
PT 28+19.73
29+00.00
24.49'
28+64.57
32.00'
28+46.18
32.11'
28+13.19
33.73
27+50.81
33.70
27+00.00
40.00'
26+05.40
50
PC 26+27.59
+60.00
C.P. 22
C.P. 5
C.P. 54
C.P. 23
C.P. 21
N 6°03'06" E
N 16°11'08" W
30+00
To Bryantsville
PI 29+74.56
29+45.69
32.81'
PT 29+16.46
29+25.52
62.43'
PC 28+46.60
2' FB DT
ROGER SWIGER
28+32.84
101.55'
27+79.90
70.39'
27+30.18
73.20'
27+24.86
64.98'
PI 27+31.80
JAMES E. ABNER
BILLIE G. ABNER (WF)
PI STA 27+31.80
Δ=55°02'37" Lt
T=104.21'
L=192.14'
R=200.00'
E=25.52'
e=RC
Runoff=34.28'
Runout=34.28'
GRACE AVE
GRANT AVE
Mobile Home
Metal Gar
RUINS

COUNTY OF	ITEM NO.	SHEET NO.
MER/GAR	07-1116.00	R8



SCALE: 1" = 50' HORIZONTAL
1" = 5' VERTICAL

PROFILE
KY 152
STA 17+00 TO STA 32+00

FILE NAME: P:\CIVIL\MERCER-GARRARD, KY 152 (7-1116)\FINAL\PLAN\13-R00800PR.DGN

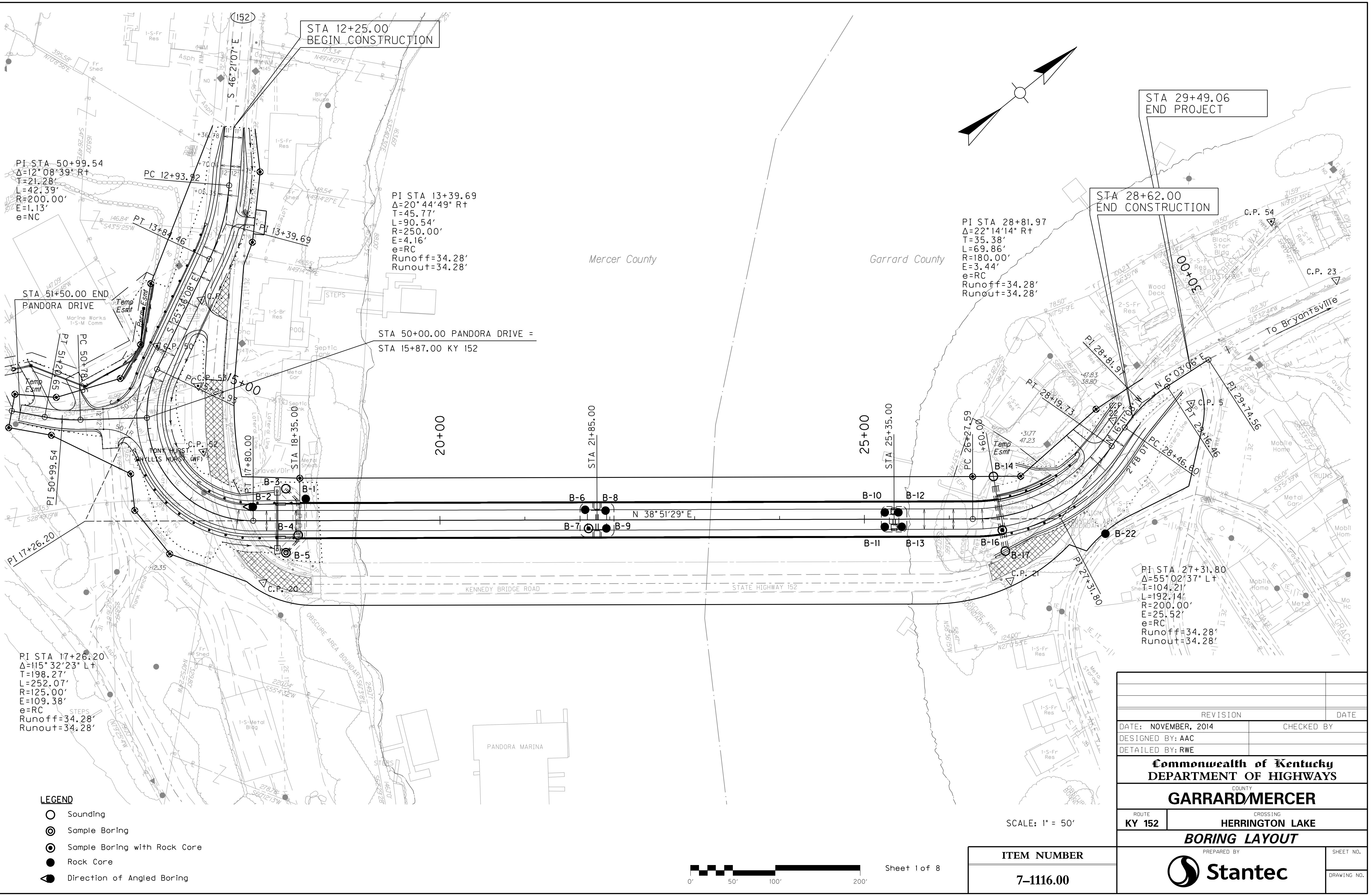
USER: rwright
DATE PLOTTED: April 17, 2014

E-SHEET NAME:

MicroStation v8.11.9.397

Appendix C

Subsurface Data Sheets



LEGEND

- ○ Sounding
- ◎ Sample Boring
- ⊙ Sample Boring with Rock Core
- ● Rock Core
- ◀● Direction of Angled Boring

SCALE: 1" = 50'

Sheet 1 of 8

FILE NAME: V:\1755\ACTIVE\175562020\GEOTECHNICAL\DRAWING\SHEET_FILES\62020B-101-BL1.DGN

USER: dellison
DATE PLOTTED: November 19, 2014

E-SHEET NAME:

MicroStation v8.11.7.443

REVISION	DATE

DATE: NOVEMBER, 2014 — CHECKED BY
DESIGNED BY: AAC
DETAILED BY: RWE

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
GARRARD/MERCER

ROUTE: KY 152
CROSSING: HERRINGTON LAKE

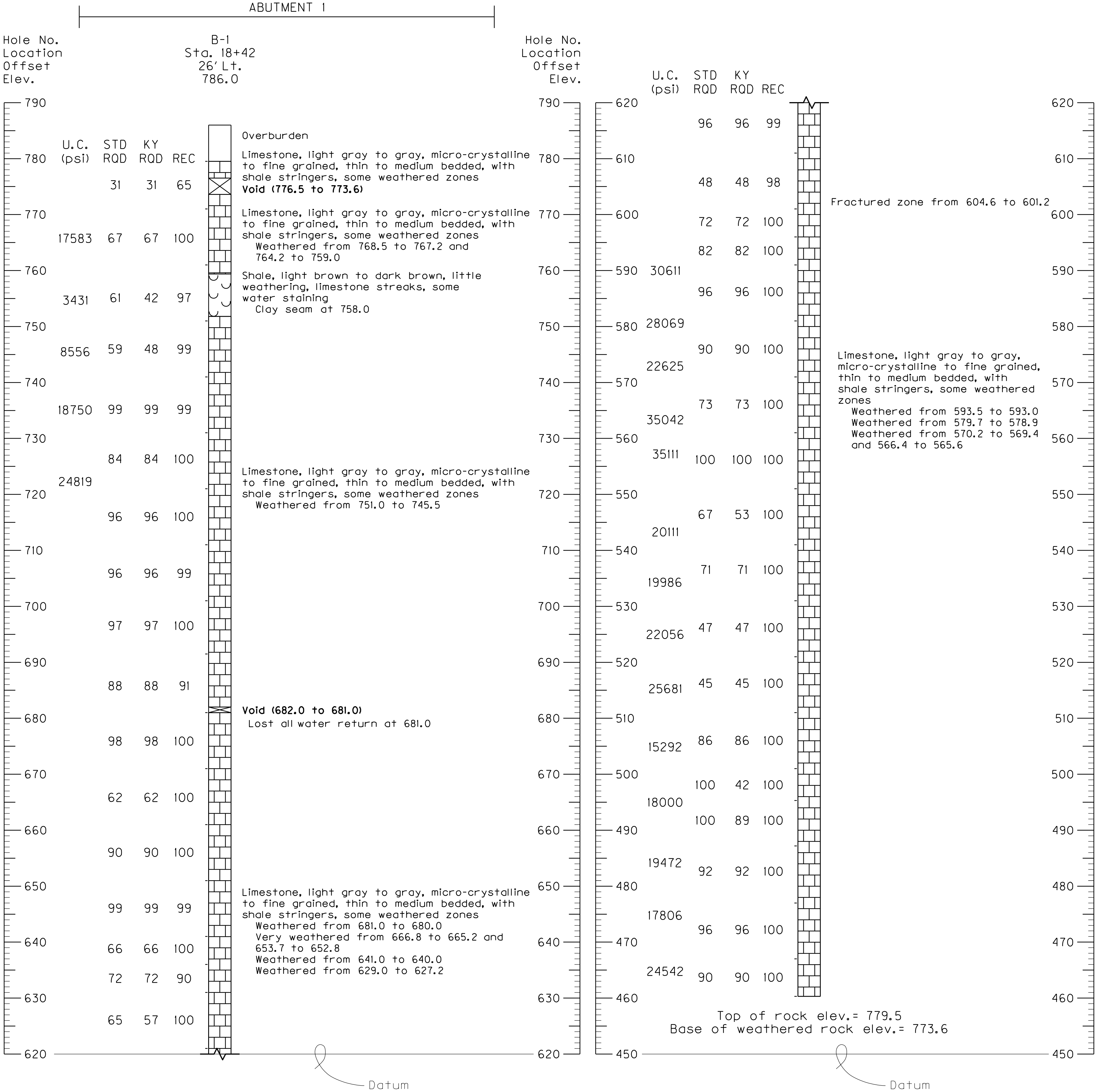
BORING LAYOUT

ITEM NUMBER
7–1116.00

PREPARED BY
Stantec

SHEET NO.

DRAWING NO.



Overburden

Limestone, light gray to gray, micro-crystalline to fine grained, thin to medium bedded, with shale stringers, some weathered zones

Void (776.5 to 773.6)

Limestone, light gray to gray, micro-crystalline to fine grained, thin to medium bedded, with shale stringers, some weathered zones
Weathered from 768.5 to 767.2 and 764.2 to 759.0

Shale, light brown to dark brown, little weathering, limestone streaks, some water staining
Clay seam at 758.0

Limestone, light gray to gray, micro-crystalline to fine grained, thin to medium bedded, with shale stringers, some weathered zones
Weathered from 751.0 to 745.5

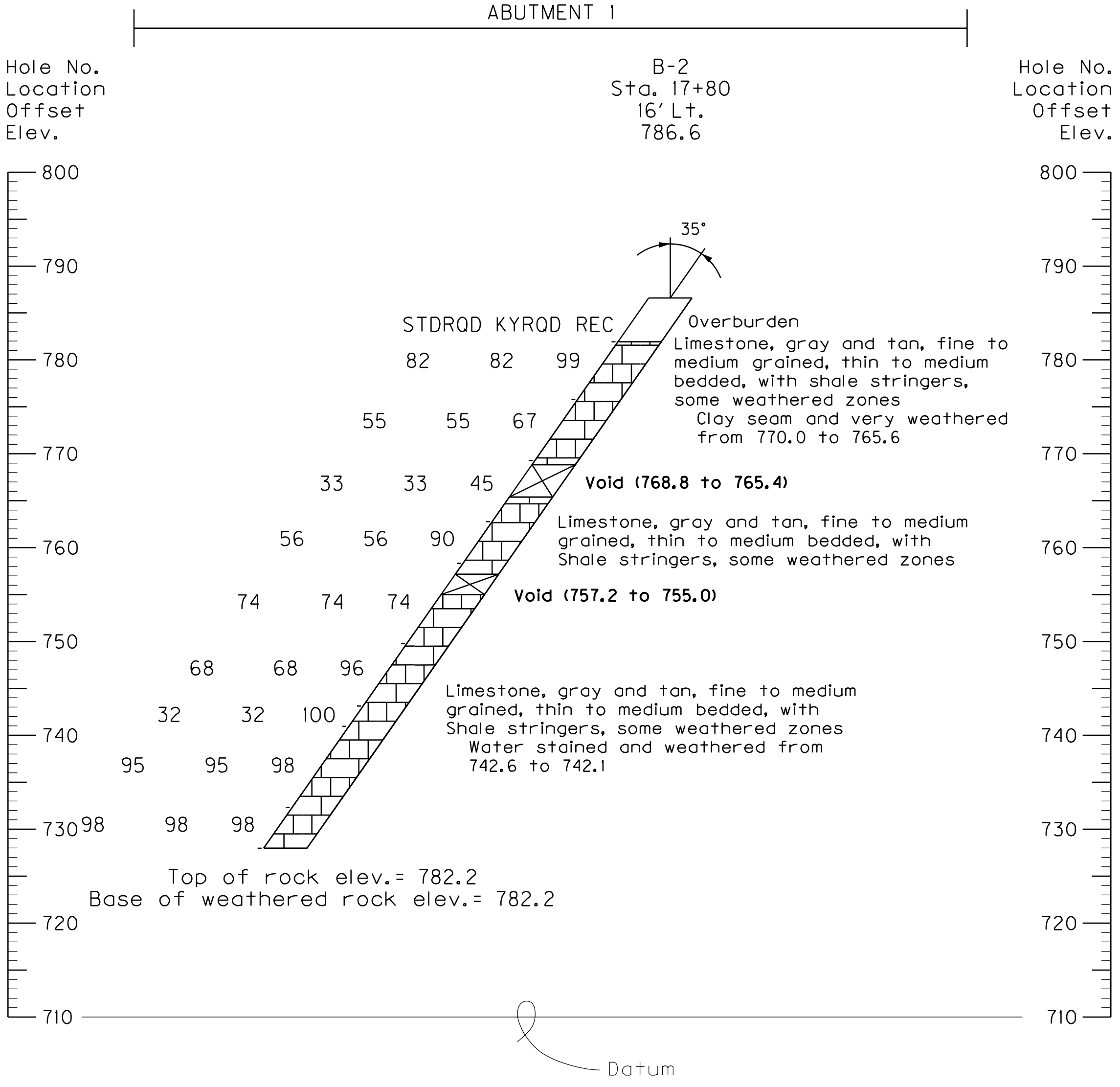
Void (682.0 to 681.0)
Lost all water return at 681.0

Limestone, light gray to gray, micro-crystalline to fine grained, thin to medium bedded, with shale stringers, some weathered zones
Weathered from 681.0 to 680.0
Very weathered from 666.8 to 665.2 and 653.7 to 652.8
Weathered from 641.0 to 640.0
Weathered from 629.0 to 627.2

Fractured zone from 604.6 to 601.2

Limestone, light gray to gray, micro-crystalline to fine grained, thin to medium bedded, with shale stringers, some weathered zones
Weathered from 593.5 to 593.0
Weathered from 579.7 to 578.9
Weathered from 570.2 to 569.4 and 566.4 to 565.6

Top of rock elev.= 779.5
Base of weathered rock elev.= 773.6



Overburden

Limestone, gray and tan, fine to medium grained, thin to medium bedded, with shale stringers, some weathered zones
Clay seam and very weathered from 770.0 to 765.6

Void (768.8 to 765.4)

Limestone, gray and tan, fine to medium grained, thin to medium bedded, with Shale stringers, some weathered zones

Void (757.2 to 755.0)

Limestone, gray and tan, fine to medium grained, thin to medium bedded, with Shale stringers, some weathered zones
Water stained and weathered from 742.6 to 742.1

Top of rock elev.= 782.2
Base of weathered rock elev.= 782.2

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.

SCALE: 1" = 10'
(Vertical Only)

Sheet 2 of 8

ITEM NUMBER
7–1116.00

REVISION | DATE
DATE: NOVEMBER, 2014 | CHECKED BY
DESIGNED BY: AAC
DETAILED BY: PJB

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
GARRARD/MERCER

ROUTE
KY 152

CROSSING
HERRINGTON LAKE

LOGS OF BORING

PREPARED BY
Stantec

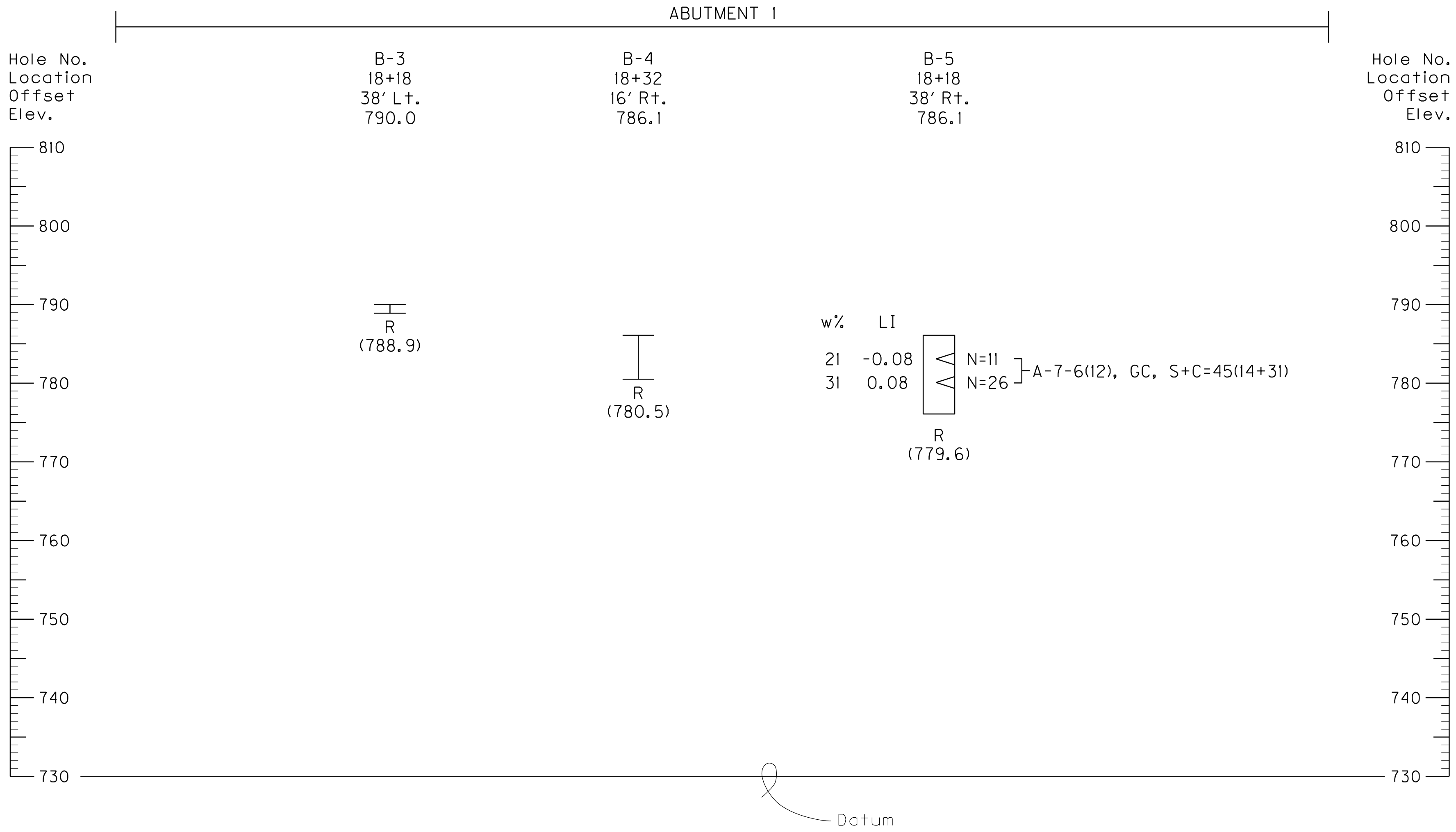
SHEET NO.
DRAWING NO.

FILE NAME: V:\1755\ACTIVE\175562020\GEOTECHNICAL\DRAWING\SHEET_FILES\62020B-301-B02.DGN

USER: rflynn
DATE PLOTTED: November 19, 2014

E-SHEET NAME:

MicroStation v8.11.7.443



NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.

SCALE: 1" = 10′
(Vertical Only)

Sheet 3 of 8

ITEM NUMBER
7–1116.00

REVISION	DATE

DATE: NOVEMBER, 2014
CHECKED BY
DESIGNED BY: AAC
DETAILED BY: PJB

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
GARRARD/MERCER

ROUTE
KY 152

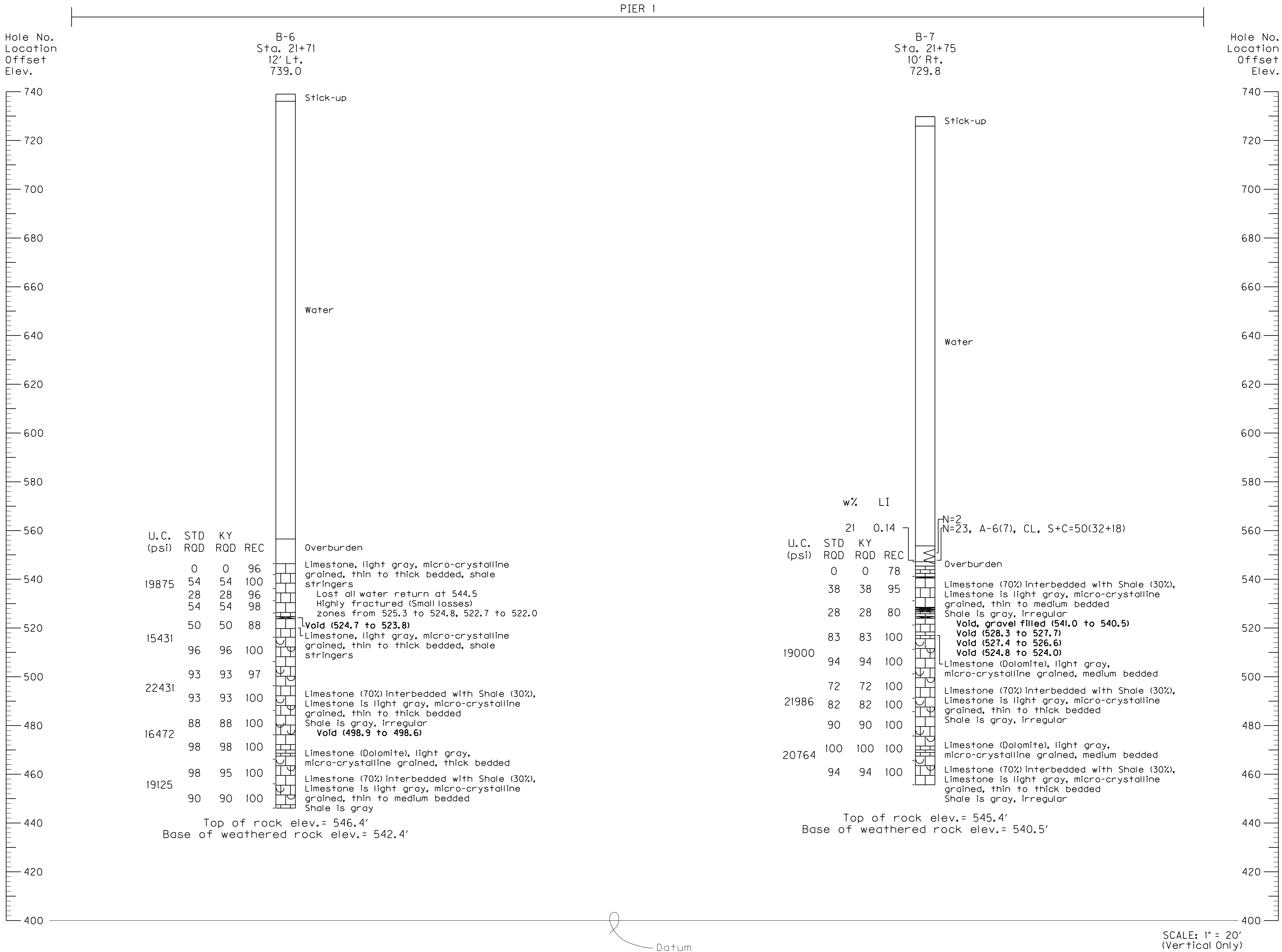
CROSSING
HERRINGTON LAKE

LOGS OF BORING

PREPARED BY
Stantec

SHEET NO.

DRAWING NO.



B-6
Sta. 21+71
12′ Lt.
739.0

U.C. (psi)	STD RQD	KY RQD	REC
	0	0	96
19875	54	54	100
	28	28	96
	54	54	98
15431	50	50	88
	96	96	100
22431	93	93	97
	93	93	100
16472	88	88	100
	98	98	100
19125	98	95	100
	90	90	100

Overburden

Limestone, light gray, micro-crystalline grained, thin to thick bedded, shale stringers
Lost all water return at 544.5
Highly fractured (Small losses)
zones from 525.3 to 524.8, 522.7 to 522.0

Void (524.7 to 523.8)

Limestone, light gray, micro-crystalline grained, thin to thick bedded, shale stringers

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to thick bedded
Shale is gray, irregular
Void (498.9 to 498.6)

Limestone (Dolomite), light gray, micro-crystalline grained, thick bedded

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to medium bedded
Shale is gray

Top of rock elev.= 546.4′
Base of weathered rock elev.= 542.4′

B-7
Sta. 21+75
10′ Rt.
729.8

w%	LI
21	0.14

N=2
N=23, A-6(7), CL, S+C=50(32+18)

U.C. (psi)	STD RQD	KY RQD	REC
	0	0	78
	38	38	95
	28	28	80
	83	83	100
19000	94	94	100
	72	72	100
21986	82	82	100
	90	90	100
20764	100	100	100
	94	94	100

Overburden

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to medium bedded
Shale is gray, irregular
Void, gravel filled (541.0 to 540.5)
Void (528.3 to 527.7)
Void (527.4 to 526.6)
Void (524.8 to 524.0)

Limestone (Dolomite), light gray, micro-crystalline grained, medium bedded

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to thick bedded
Shale is gray, irregular

Limestone (Dolomite), light gray, micro-crystalline grained, medium bedded

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to thick bedded
Shale is gray, irregular

Top of rock elev.= 545.4′
Base of weathered rock elev.= 540.5′

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.

SCALE: 1" = 20′
(Vertical Only)

REVISION	DATE

DATE: NOVEMBER, 2014
CHECKED BY
DESIGNED BY: AAC
DETAILED BY: RWE

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
GARRARD/MERCER

ROUTE
KY 152

CROSSING
HERRINGTON LAKE

LOGS OF BORING

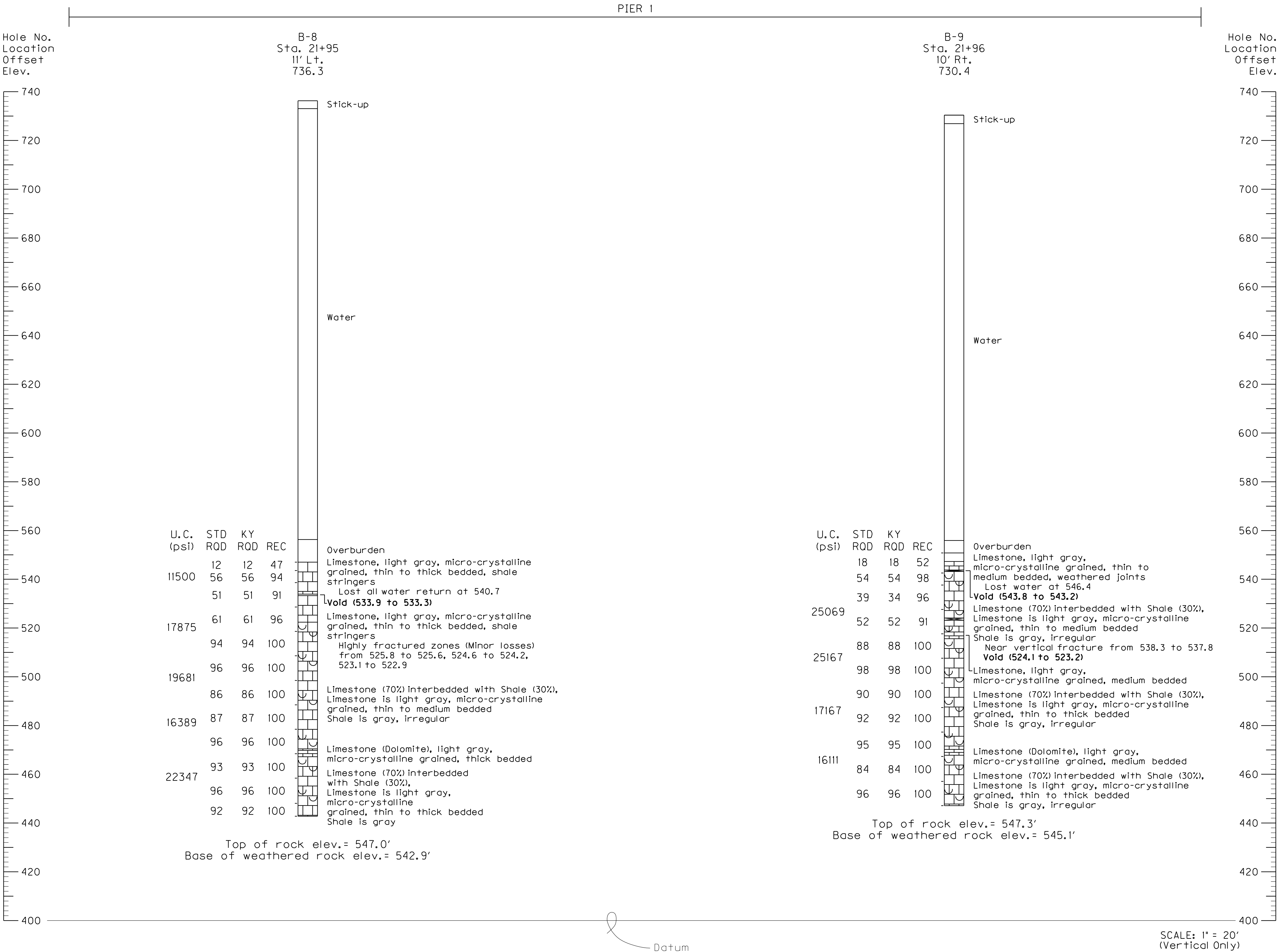
PREPARED BY
Stantec

SHEET NO.
DRAWING NO.

ITEM NUMBER
7-1116.00

MicroStation v8.11.7.443
E-SHEET NAME:
USER: dellison
DATE PLOTTED: November 19, 2014
FILE NAME: V:\1755\ACTIVE\175562020\GEOTECHNICAL\DRAWING\SHEET_FILES\62020B-301-B03.DGN

PIER 1



Hole No.	B-8	B-9
Location	Sta. 21+95	Sta. 21+96
Offset	11′ Lt.	10′ Rt.
Elev.	736.3	730.4

B-8

U.C. (psi)	STD RQD	KY RQD	REC
	12	12	47
11500	56	56	94
	51	51	91
	61	61	96
17875			
	94	94	100
	96	96	100
19681			
	86	86	100
16389	87	87	100
	96	96	100
	93	93	100
22347			
	96	96	100
	92	92	100

Overburden

Limestone, light gray, micro-crystalline grained, thin to thick bedded, shale stringers
Lost all water return at 540.7
Void (533.9 to 533.3)

Limestone, light gray, micro-crystalline grained, thin to thick bedded, shale stringers
Highly fractured zones (Minor losses) from 525.8 to 525.6, 524.6 to 524.2, 523.1 to 522.9

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to medium bedded Shale is gray, irregular

Limestone (Dolomite), light gray, micro-crystalline grained, thick bedded

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to thick bedded Shale is gray

Top of rock elev.= 547.0′
Base of weathered rock elev.= 542.9′

B-9

U.C. (psi)	STD RQD	KY RQD	REC
	18	18	52
	54	54	98
	39	34	96
25069			
	52	52	91
	88	88	100
25167			
	98	98	100
	90	90	100
17167			
	92	92	100
	95	95	100
16111			
	84	84	100
	96	96	100

Overburden

Limestone, light gray, micro-crystalline grained, thin to medium bedded, weathered joints
Lost water at 546.4
Void (543.8 to 543.2)

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to medium bedded Shale is gray, irregular
Near vertical fracture from 538.3 to 537.8
Void (524.1 to 523.2)

Limestone, light gray, micro-crystalline grained, medium bedded

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to thick bedded Shale is gray, irregular

Limestone (Dolomite), light gray, micro-crystalline grained, medium bedded

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to thick bedded Shale is gray, irregular

Top of rock elev.= 547.3′
Base of weathered rock elev.= 545.1′

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.

SCALE: 1" = 20′
(Vertical Only)

Sheet 5 of 8

REVISION	DATE

DATE: NOVEMBER, 2014 CHECKED BY
DESIGNED BY: AAC
DETAILED BY: RWE

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
GARRARD/MERCER

ROUTE
KY 152
CROSSING
HERRINGTON LAKE

LOGS OF BORING

ITEM NUMBER
7-1116.00

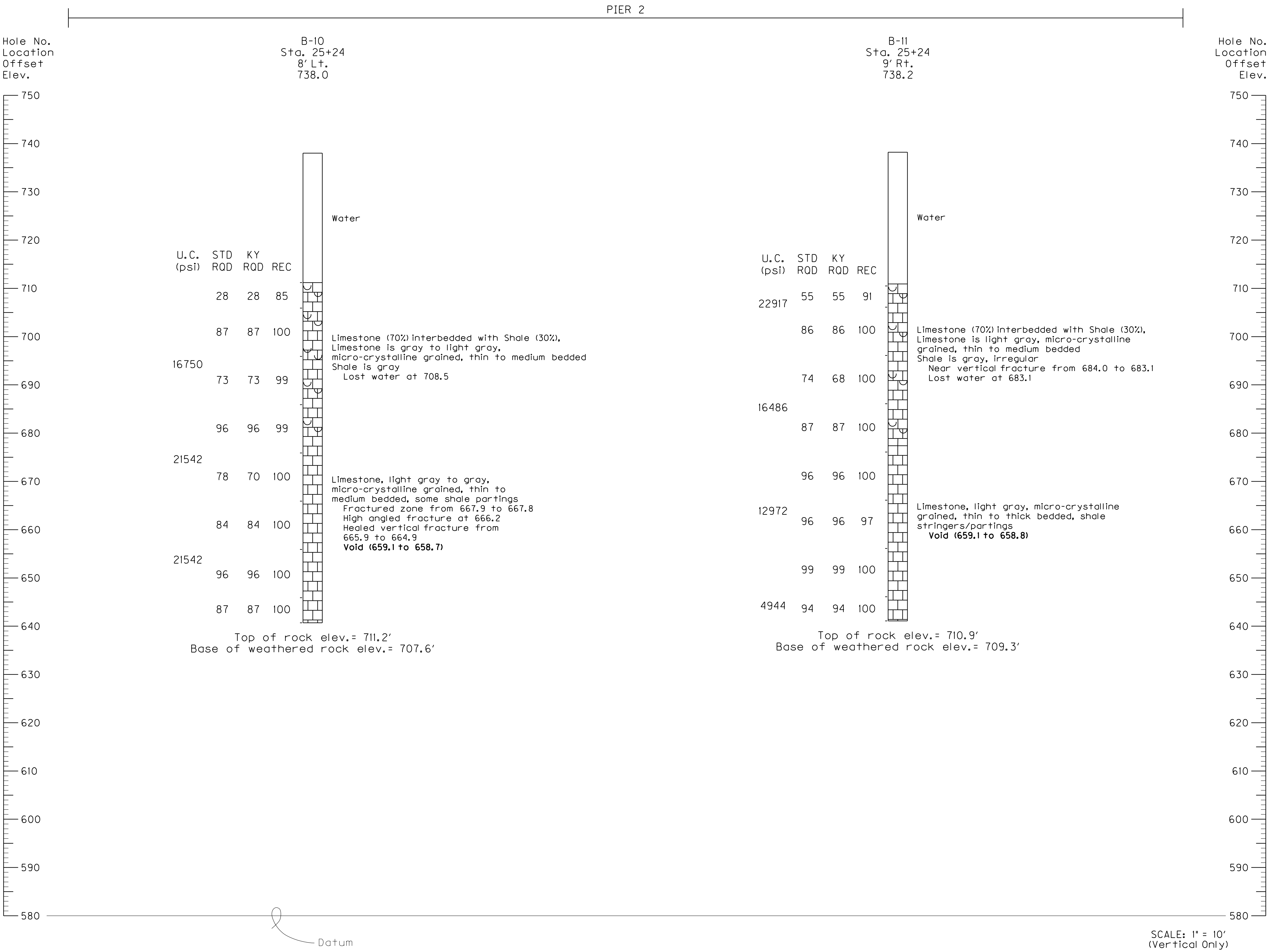
PREPARED BY
Stantec

SHEET NO.
DRAWING NO.

FILE NAME: V:\1755\ACTIVE\175562020\GEOTECHNICAL\DRAWING\SHEET_FILES\62020B-301-B04.DGN
USER: dellison
DATE PLOTTED: November 19, 2014
E-SHEET NAME:
MicroStation v8.11.7.443

PIER 2

Hole No.	B-10	B-11
Location	Sta. 25+24	Sta. 25+24
Offset	8′ Lt.	9′ Rt.
Elev.	738.0	738.2



B-10

U.C. (psi)	STD RQD	KY RQD	REC
	28	28	85
	87	87	100
16750			
	73	73	99
	96	96	99
21542			
	78	70	100
	84	84	100
21542			
	96	96	100
	87	87	100

Limestone (70%) interbedded with Shale (30%), Limestone is gray to light gray, micro-crystalline grained, thin to medium bedded
Shale is gray
Lost water at 708.5

Limestone, light gray to gray, micro-crystalline grained, thin to medium bedded, some shale partings
Fractured zone from 667.9 to 667.8
High angled fracture at 666.2
Healed vertical fracture from 665.9 to 664.9
Void (659.1 to 658.7)

Top of rock elev.= 711.2′
Base of weathered rock elev.= 707.6′

B-11

U.C. (psi)	STD RQD	KY RQD	REC
22917	55	55	91
	86	86	100
	74	68	100
16486			
	87	87	100
	96	96	100
12972	96	96	97
	99	99	100
4944	94	94	100

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to medium bedded
Shale is gray, irregular
Near vertical fracture from 684.0 to 683.1
Lost water at 683.1

Limestone, light gray, micro-crystalline grained, thin to thick bedded, shale stringers/partings
Void (659.1 to 658.8)

Top of rock elev.= 710.9′
Base of weathered rock elev.= 709.3′

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.

SCALE: 1" = 10′
(Vertical Only)

REVISION	DATE

DATE: NOVEMBER, 2014
CHECKED BY
DESIGNED BY: AAC
DETAILED BY: RWE

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
GARRARD/MERCER

ROUTE
KY 152
CROSSING
HERRINGTON LAKE

LOGS OF BORING

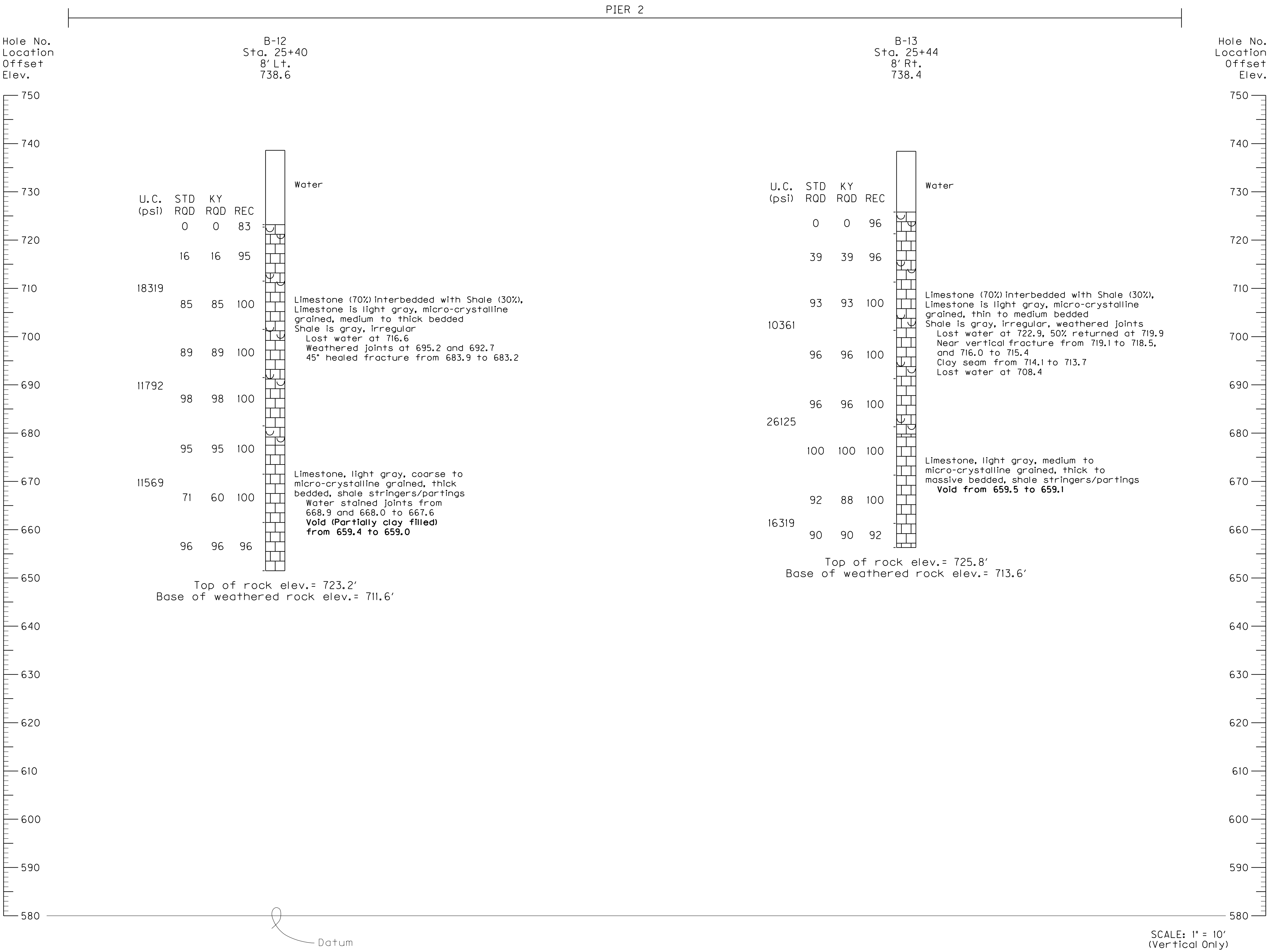
PREPARED BY
Stantec

SHEET NO.
DRAWING NO.

ITEM NUMBER
7–1116.00

FILE NAME: V:\1755\ACTIVE\175562020\GEOTECHNICAL\DRAWING\SHEET_FILES\62020B-301-B05.DGN
USER: dellison
DATE PLOTTED: November 19, 2014
E-SHEET NAME:
MicroStation v8.11.7.443

PIER 2



B-12
Sta. 25+40
8′ Lt.
738.6

U.C. (psi)	STD RQD	KY RQD	REC
	0	0	83
	16	16	95
18319			
	85	85	100
	89	89	100
11792			
	98	98	100
	95	95	100
11569			
	71	60	100
	96	96	96

Water

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, medium to thick bedded
Shale is gray, irregular
Lost water at 716.6
Weathered joints at 695.2 and 692.7
45° healed fracture from 683.9 to 683.2

Limestone, light gray, coarse to micro-crystalline grained, thick bedded, shale stringers/partings
Water stained joints from 668.9 and 668.0 to 667.6
Void (Partially clay filled) from 659.4 to 659.0

Top of rock elev.= 723.2′
Base of weathered rock elev.= 711.6′

B-13
Sta. 25+44
8′ Rt.
738.4

U.C. (psi)	STD RQD	KY RQD	REC
	0	0	96
	39	39	96
	93	93	100
10361			
	96	96	100
	96	96	100
26125			
	100	100	100
	92	88	100
16319			
	90	90	92

Water

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin to medium bedded
Shale is gray, irregular, weathered joints
Lost water at 722.9, 50% returned at 719.9
Near vertical fracture from 719.1 to 718.5, and 716.0 to 715.4
Clay seam from 714.1 to 713.7
Lost water at 708.4

Limestone, light gray, medium to micro-crystalline grained, thick to massive bedded, shale stringers/partings
Void from 659.5 to 659.1

Top of rock elev.= 725.8′
Base of weathered rock elev.= 713.6′

NOTES:

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2. Surface elevations are referenced to Mean Sea Level.

SCALE: 1" = 10′
(Vertical Only)

REVISION	DATE

DATE: NOVEMBER, 2014
CHECKED BY
DESIGNED BY: AAC
DETAILED BY: RWE

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
GARRARD/MERCER

ROUTE
KY 152

CROSSING
HERRINGTON LAKE

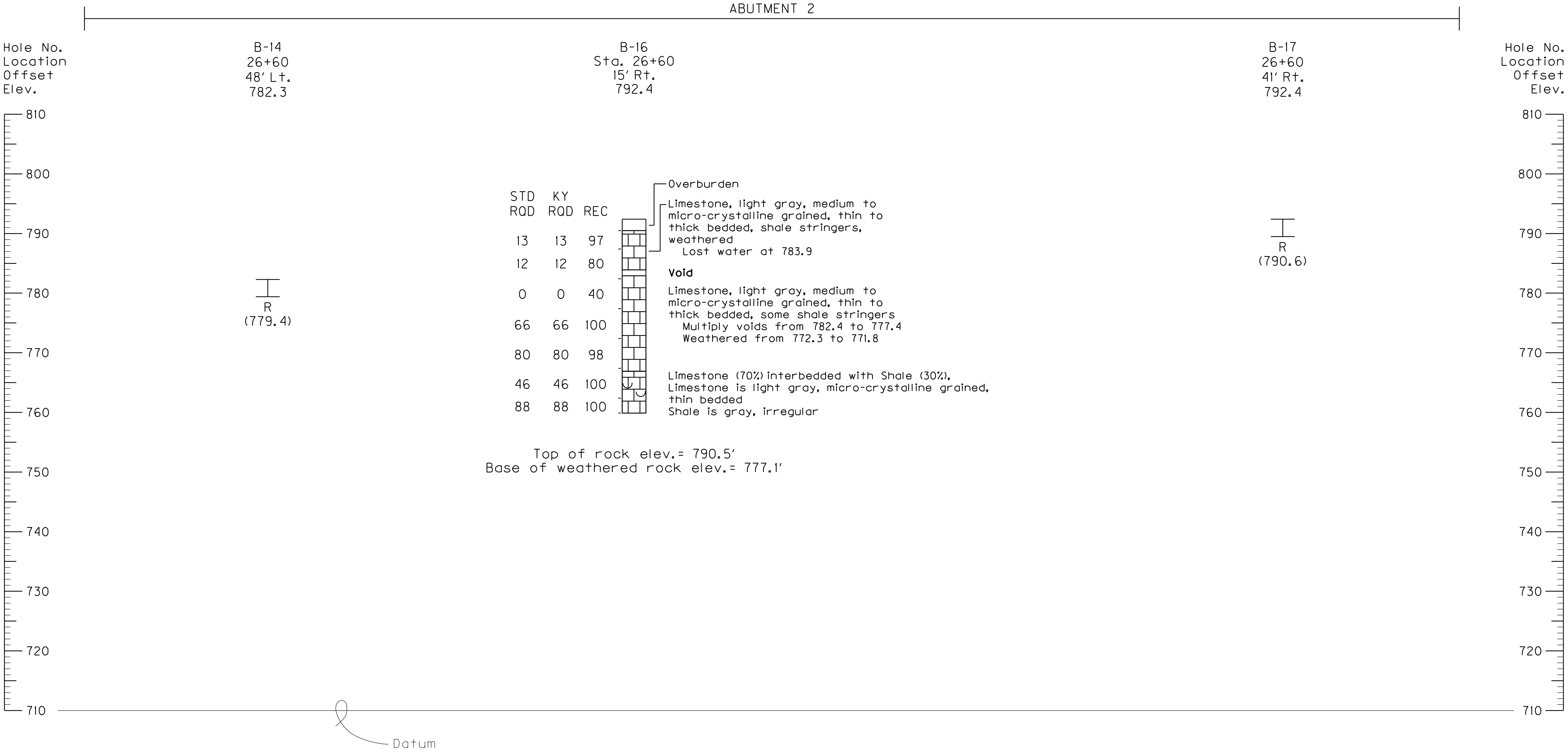
LOGS OF BORING

PREPARED BY
Stantec

SHEET NO.
DRAWING NO.

ITEM NUMBER
7-1116.00

FILE NAME: V:\1755\ACTIVE\175562020\GEOTECHNICAL\DRAWING\SHEET_FILES\62020B-301-B07.DGN
USER: dellison
DATE PLOTTED: November 19, 2014
E-SHEET NAME:
MicroStation v8.11.7.443



STD RQD	KY RQD	REC
13	13	97
12	12	80
0	0	40
66	66	100
80	80	98
46	46	100
88	88	100

Overburden

Limestone, light gray, medium to micro-crystalline grained, thin to thick bedded, shale stringers, weathered
Lost water at 783.9

Void

Limestone, light gray, medium to micro-crystalline grained, thin to thick bedded, some shale stringers
Multiply voids from 782.4 to 777.4
Weathered from 772.3 to 771.8

Limestone (70%) interbedded with Shale (30%), Limestone is light gray, micro-crystalline grained, thin bedded
Shale is gray, irregular

Top of rock elev.= 790.5′
Base of weathered rock elev.= 777.1′

NOTES:

1. This sheet presents geotechnical data and recommendations. Refer to project plans, profiles, and cross sections for final alignment and grade.
2. Surface elevations are referenced to Mean Sea Level.

SCALE: 1" = 10′
(Vertical Only)

Sheet 8 of 8

ITEM NUMBER
7-1116.00

REVISION	DATE

DATE: NOVEMBER, 2014 | CHECKED BY
DESIGNED BY: AAC
DETAILED BY: RWE

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
GARRARD/MERCER

ROUTE
KY 152

CROSSING
HERRINGTON LAKE

LOGS OF BORING

PREPARED BY
Stantec

SHEET NO.

DRAWING NO.

Appendix D

Coordinate Data Submission Form

COORDINATE DATA SUBMISSION FORM
KYTC DIVISION OF MATERIALS - GEOTECHNICAL BRANCH

County: Garrard/Mercer

Date: February 2015

Road Number: KY 152

Survey Crew / Consultant: WMB, Inc

Contact Person: James Napier, PE, PLS

Item No.: 7-1116.00

Mars No.: 84690

Project No.: BRO 5129, FD52 084 0152 018-019, FD 52 040 0152 000-001

Notes: All coordinates should be NAD-83. Latitude and Longitude in decimal degrees. Station and Offset in KY 152 Stationing. Borings B-1 and B-2 were drilled in 2013. All other borings drilled in 2014. Boring locations were staked by WMB personnel. All borings were drilled by Stantec.

(select one) **Elevation Datum** [✓ **Sea Level**] **Assumed**

HOLE NUMBER	STATION	OFFSET	ELEVATION (ft)	LATITUDE	LONGITUDE
B-1	18+42.00	26.00' Lt.	786.0	37.745447907	-84.704964842
B-2	17+80.00	16.00' Lt.	786.6	37.745299242	-84.705076896
B-3	18+18.00	38.00' Lt.	789.9	37.745418610	-84.705050110
B-4	18+32.00	16.00' Rt.	786.0	37.745353940	-84.704875200
B-5	18+18.00	38.00' Rt.	786.1	37.745285840	-84.704847280
B-6	21+70.81	11.84' Lt.	739.0*	37.746120580	-84.704204130
B-7	21+74.65	9.58' Rt.	729.8*	37.746091310	-84.704138510
B-8	21+95.12	10.87' Lt.	736.3*	37.746170400	-84.704148060
B-9	21+96.00	9.51' Rt.	730.4*	37.746136670	-84.704091750
B-10	25+23.84	8.37' Lt.	738.0*	37.746862670	-84.703418180
B-11	25+24.36	8.81' Rt.	738.2*	37.746833730	-84.703371190
B-12	25+40.12	7.55' Lt.	738.6*	37.746895740	-84.703380170
B-13	25+44.00	8.00' Rt.	738.4*	37.746876780	-84.703330140
B-14	26+60.00	48.00' Lt.	782.3	37.747207210	-84.703247180
B-16	26+60.00	15.00' Rt.	791.1	37.747120120	-84.703058760
B-17	26+60.00	41.00' Rt.	792.2	37.747083000	-84.702982000
B-22	27+50.00	60.00' Rt.	811.5	37.747362100	-84.702804770

* These borings were drilled from a floating plant in Herrington Lake. The elevation recorded is referenced to the top of casing seated into bedrock.

Appendix E

Drilled Shaft Capacity Tables

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Abutment 1

Drilled Shaft Diameter (ft) = 6 in overburden
Rock Socket Diameter (in) = 66
Rock Socket Diameter (ft) = 5.5

9/17/2015

							Service Limit State		Strength Limit State		Extreme Limit State	
Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Total Allowable Bearing Capacity FS = 2 (kips)**	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	779.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	779.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	778.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	777.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	776.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	775.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	774.0	22.6	213.0	390	0	390	**195**	**130**	**215**	**156**	**390**	**312**
	773.0	22.6	213.0	781	0	781	**390**	**260**	**430**	**312**	**781**	**625**
	772.0	22.6	213.0	1171	0	1171	**586**	**390**	**644**	**469**	**1171**	**937**
	771.0	22.6	213.0	1562	0	1562	**781**	**521**	**859**	**625**	**1562**	**1250**
	770.0	22.6	213.0	1952	0	1952	**976**	**651**	**1074**	**781**	**1952**	**1562**
	769.0	22.6	213.0	2343	0	2343	**1171**	**781**	**1289**	**937**	**2343**	**1874**
	768.0	22.6	213.0	2733	0	2733	**1367**	**911**	**1503**	**1093**	**2733**	**2187**
	767.0	22.6	213.0	3124	0	3124	**1562**	**1041**	**1718**	**1250**	**3124**	**2499**
	766.0	22.6	213.0	3514	0	3514	**1757**	**1171**	**1933**	**1406**	**3514**	**2812**
	765.0	22.6	213.0	3905	0	3905	**1952**	**1302**	**2148**	**1562**	**3905**	**3124**
	764.0	22.6	213.0	4295	0	4295	**2148**	**1432**	**2363**	**1718**	**4295**	**3436**
	763.0	22.6	213.0	4686	0	4686	**2343**	**1562**	**2577**	**1874**	**4686**	**3749**
	762.0	22.6	213.0	5076	0	5076	**2538**	**1692**	**2792**	**2031**	**5076**	**4061**
	761.0	22.6	213.0	5467	0	5467	**2733**	**1822**	**3007**	**2187**	**5467**	**4374**
	760.0	22.6	213.0	5857	0	5857	**2929**	**1952**	**3222**	**2343**	**5857**	**4686**
	759.0	11.1	22.0	6049	0	6049	**3025**	**2016**	**3327**	**2420**	**6049**	**4839**
	758.0	11.1	22.0	6241	0	6241	**3121**	**2080**	**3433**	**2496**	**6241**	**4993**
	757.0	11.1	22.0	6433	0	6433	**3216**	**2144**	**3538**	**2573**	**6433**	**5146**
	756.0	11.1	22.0	6625	0	6625	**3312**	**2208**	**3644**	**2650**	**6625**	**5300**
	755.0	11.1	22.0	6816	0	6816	**3408**	**2272**	**3749**	**2727**	**6816**	**5453**
	754.0	11.1	22.0	7008	0	7008	**3504**	**2336**	**3855**	**2803**	**7008**	**5607**
	753.0	11.1	22.0	7200	0	7200	**3600**	**2400**	**3960**	**2880**	**7200**	**5760**
	752.0	25.4	1950.0	7639	0	7639	**3819**	**2546**	**4201**	**3056**	**7639**	**6111**
	751.0	25.4	1950.0	8078	0	8078	**4039**	**2693**	**4443**	**3231**	**8078**	**6462**
	750.0	25.4	1950.0	8517	0	8517	**4258**	**2839**	**4684**	**3407**	**8517**	**6813**
	749.0	25.4	1950.0	8956	0	8956	**4478**	**2985**	**4926**	**3582**	**8956**	**7164**
	748.0	25.4	1950.0	9394	0	9394	**4697**	**3131**	**5167**	**3758**	**9394**	**7516**
	747.0	25.4	1950.0	9833	0	9833	**4917**	**3278**	**5408**	**3933**	**9833**	**7867**
	746.0	25.4	1950.0	10272	0	10272	**5136**	**3424**	**5650**	**4109**	**10272**	**8218**
	745.0	25.4	1950.0	10711	0	10711	**5356**	**3570**	**5891**	**4284**	**10711**	**8569**
	744.0	25.4	1950.0	11150	0	11150	**5575**	**3717**	**6132**	**4460**	**11150**	**8920**
	743.0	25.4	1950.0	11589	0	11589	**5794**	**3863**	**6374**	**4636**	**11589**	**9271**
	742.0	25.4	1950.0	12028	0	12028	**6014**	**4009**	**6615**	**4811**	**12028**	**9622**
	741.0	25.4	1950.0	12467	0	12467	**6233**	**4156**	**6857**	**4987**	**12467**	**9973**
	740.0	25.4	1950.0	12906	0	12906	**6453**	**4302**	**7098**	**5162**	**12906**	**10324**

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

** If shafts extend below elevation 740.0 feet, contact Stantec for additional capacity information.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 5.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 1

Drilled Shaft Diameter (ft) = 8 in overburden
Rock Socket Diameter (in) = 90
Rock Socket Diameter (ft) = 7.5

9/17/2015

							Service Limit State		**Strength Limit State**		**Extreme Limit State**	
Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Total Allowable Bearing Capacity FS = 2 (kips)**	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	545.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	544.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	543.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	542.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	541.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	540.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	539.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	538.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	537.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	536.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	535.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	534.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	533.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	532.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	531.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	530.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	529.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	528.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	527.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	526.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	525.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	524.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	523.5	24.5	292.0	577	0	577	**289**	**192**	**317**	**231**	**577**	**462**
	522.5	24.5	292.0	1155	0	1155	**577**	**385**	**635**	**462**	**1155**	**924**
	521.5	24.5	292.0	1732	0	1732	**866**	**577**	**952**	**693**	**1732**	**1385**
	520.5	24.5	292.0	2309	0	2309	**1155**	**770**	**1270**	**924**	**2309**	**1847**
	519.5	24.5	292.0	2886	0	2886	**1443**	**962**	**1587**	**1155**	**2886**	**2309**
	518.5	24.5	292.0	3464	0	3464	**1732**	**1155**	**1905**	**1385**	**3464**	**2771**
	517.5	24.5	292.0	4041	0	4041	**2020**	**1347**	**2222**	**1616**	**4041**	**3233**
	516.5	24.5	292.0	4618	0	4618	**2309**	**1539**	**2540**	**1847**	**4618**	**3695**
	515.5	25.4	2378.0	5217	0	5217	**2608**	**1739**	**2869**	**2087**	**5217**	**4173**
	514.5	25.4	2378.0	5815	0	5815	**2908**	**1938**	**3198**	**2326**	**5815**	**4652**
	513.5	25.4	2378.0	6414	0	6414	**3207**	**2138**	**3527**	**2565**	**6414**	**5131**
	512.5	25.4	2378.0	7012	0	7012	**3506**	**2337**	**3857**	**2805**	**7012**	**5610**
	511.5	25.4	2378.0	7611	0	7611	**3805**	**2537**	**4186**	**3044**	**7611**	**6088**
	510.5	25.4	2378.0	8209	0	8209	**4104**	**2736**	**4515**	**3284**	**8209**	**6567**
	509.5	25.4	2378.0	8807	0	8807	**4404**	**2936**	**4844**	**3523**	**8807**	**7046**
	508.5	25.4	2378.0	9406	0	9406	**4703**	**3135**	**5173**	**3762**	**9406**	**7525**
	507.5	25.4	2378.0	10004	0	10004	**5002**	**3335**	**5502**	**4002**	**10004**	**8004**

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 7.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 1

Drilled Shaft Diameter (ft) = 10 in overburden
Rock Socket Diameter (in) = 114
Rock Socket Diameter (ft) = 9.5

9/17/2015

Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Service Limit State**		**Strength Limit State**		**Extreme Limit State**	
							Total Allowable Bearing Capacity FS = 2 (kips)	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	545.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	544.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	543.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	542.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	541.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	540.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	539.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	538.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	537.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	536.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	535.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	534.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	533.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	532.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	531.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	530.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	529.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	528.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	527.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	526.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	525.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	524.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	523.5	24.5	292.0	731	0	731	**366**	**244**	**402**	**292**	**731**	**585**
	522.5	24.5	292.0	1462	0	1462	**731**	**487**	**804**	**585**	**1462**	**1170**
	521.5	24.5	292.0	2194	0	2194	**1097**	**731**	**1206**	**877**	**2194**	**1755**
	520.5	24.5	292.0	2925	0	2925	**1462**	**975**	**1609**	**1170**	**2925**	**2340**
	519.5	24.5	292.0	3656	0	3656	**1828**	**1219**	**2011**	**1462**	**3656**	**2925**
	518.5	24.5	292.0	4387	0	4387	**2194**	**1462**	**2413**	**1755**	**4387**	**3510**
	517.5	24.5	292.0	5118	0	5118	**2559**	**1706**	**2815**	**2047**	**5118**	**4095**
	516.5	24.5	292.0	5850	0	5850	**2925**	**1950**	**3217**	**2340**	**5850**	**4680**
	515.5	25.4	2378.0	6608	0	6608	**3304**	**2203**	**3634**	**2643**	**6608**	**5286**
	514.5	25.4	2378.0	7366	0	7366	**3683**	**2455**	**4051**	**2946**	**7366**	**5893**
	513.5	25.4	2378.0	8124	0	8124	**4062**	**2708**	**4468**	**3250**	**8124**	**6499**
	512.5	25.4	2378.0	8882	0	8882	**4441**	**2961**	**4885**	**3553**	**8882**	**7106**
	511.5	25.4	2378.0	9640	0	9640	**4820**	**3213**	**5302**	**3856**	**9640**	**7712**
	510.5	25.4	2378.0	10398	0	10398	**5199**	**3466**	**5719**	**4159**	**10398**	**8318**
	509.5	25.4	2378.0	11156	0	11156	**5578**	**3719**	**6136**	**4462**	**11156**	**8925**
	508.5	25.4	2378.0	11914	0	11914	**5957**	**3971**	**6553**	**4766**	**11914**	**9531**
	507.5	25.4	2378.0	12672	0	12672	**6336**	**4224**	**6970**	**5069**	**12672**	**10138**

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 9.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 1

Drilled Shaft Diameter (ft) = 12 in overburden
Rock Socket Diameter (in) = 138
Rock Socket Diameter (ft) = 11.5

9/17/2015

Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Service Limit State**		**Strength Limit State**		**Extreme Limit State**	
							Total Allowable Bearing Capacity FS = 2 (kips)	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	545.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	544.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	543.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	542.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	541.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	540.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	539.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	538.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	537.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	536.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	535.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	534.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	533.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	532.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	531.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	530.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	529.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	528.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	527.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	526.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	525.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	524.5	0.0	0.0	0	0	0	0	0	0	0	0	0
	523.5	24.5	292.0	885	0	885	443	295	487	354	885	708
	522.5	24.5	292.0	1770	0	1770	885	590	974	708	1770	1416
	521.5	24.5	292.0	2655	0	2655	1328	885	1460	1062	2655	2124
	520.5	24.5	292.0	3541	0	3541	1770	1180	1947	1416	3541	2832
	519.5	24.5	292.0	4426	0	4426	2213	1475	2434	1770	4426	3541
	518.5	24.5	292.0	5311	0	5311	2655	1770	2921	2124	5311	4249
	517.5	24.5	292.0	6196	0	6196	3098	2065	3408	2478	6196	4957
	516.5	24.5	292.0	7081	0	7081	3541	2360	3895	2832	7081	5665
	515.5	25.4	2378.0	7999	0	7999	3999	2666	4399	3200	7999	6399
	514.5	25.4	2378.0	8916	0	8916	4458	2972	4904	3567	8916	7133
	513.5	25.4	2378.0	9834	0	9834	4917	3278	5409	3934	9834	7867
	512.5	25.4	2378.0	10752	0	10752	5376	3584	5913	4301	10752	8601
	511.5	25.4	2378.0	11669	0	11669	5835	3890	6418	4668	11669	9336
	510.5	25.4	2378.0	12587	0	12587	6294	4196	6923	5035	12587	10070
	509.5	25.4	2378.0	13505	0	13505	6752	4502	7428	5402	13505	10804
	508.5	25.4	2378.0	14422	0	14422	7211	4807	7932	5769	14422	11538
	507.5	25.4	2378.0	15340	0	15340	7670	5113	8437	6136	15340	12272

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 11.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 1

Drilled Shaft Diameter (ft) = 14 in overburden
Rock Socket Diameter (in) = 162
Rock Socket Diameter (ft) = 13.5

9/17/2015

Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Service Limit State**		**Strength Limit State**		**Extreme Limit State**	
							Total Allowable Bearing Capacity FS = 2 (kips)	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	545.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	544.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	543.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	542.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	541.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	540.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	539.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	538.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	537.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	536.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	535.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	534.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	533.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	532.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	531.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	530.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	529.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	528.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	527.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	526.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	525.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	524.5	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	523.5	24.5	292.0	1039	0	1039	**520**	**346**	**571**	**416**	**1039**	**831**
	522.5	24.5	292.0	2078	0	2078	**1039**	**693**	**1143**	**831**	**2078**	**1663**
	521.5	24.5	292.0	3117	0	3117	**1559**	**1039**	**1714**	**1247**	**3117**	**2494**
	520.5	24.5	292.0	4156	0	4156	**2078**	**1385**	**2286**	**1663**	**4156**	**3325**
	519.5	24.5	292.0	5195	0	5195	**2598**	**1732**	**2857**	**2078**	**5195**	**4156**
	518.5	24.5	292.0	6234	0	6234	**3117**	**2078**	**3429**	**2494**	**6234**	**4988**
	517.5	24.5	292.0	7274	0	7274	**3637**	**2425**	**4000**	**2909**	**7274**	**5819**
	516.5	24.5	292.0	8313	0	8313	**4156**	**2771**	**4572**	**3325**	**8313**	**6650**
	515.5	25.4	2378.0	9390	0	9390	**4695**	**3130**	**5164**	**3756**	**9390**	**7512**
	514.5	25.4	2378.0	10467	0	10467	**5234**	**3489**	**5757**	**4187**	**10467**	**8374**
	513.5	25.4	2378.0	11544	0	11544	**5772**	**3848**	**6349**	**4618**	**11544**	**9236**
	512.5	25.4	2378.0	12622	0	12622	**6311**	**4207**	**6942**	**5049**	**12622**	**10097**
	511.5	25.4	2378.0	13699	0	13699	**6849**	**4566**	**7534**	**5480**	**13699**	**10959**
	510.5	25.4	2378.0	14776	0	14776	**7388**	**4925**	**8127**	**5910**	**14776**	**11821**
	509.5	25.4	2378.0	15853	0	15853	**7927**	**5284**	**8719**	**6341**	**15853**	**12683**
	508.5	25.4	2378.0	16931	0	16931	**8465**	**5644**	**9312**	**6772**	**16931**	**13545**
	507.5	25.4	2378.0	18008	0	18008	**9004**	**6003**	**9904**	**7203**	**18008**	**14406**

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 13.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 2

Drilled Shaft Diameter (ft) = 6 in overburden
Rock Socket Diameter (in) = 66
Rock Socket Diameter (ft) = 5.5

9/17/2015

Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Service Limit State**		**Strength Limit State**		**Extreme Limit State**	
							Total Allowable Bearing Capacity FS = 2 (kips)	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	711.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	710.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	709.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	708.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	707.0	25.4	383.0	439	0	439	**219**	**146**	**241**	**176**	**439**	**351**
	706.0	25.4	383.0	878	0	878	**439**	**293**	**483**	**351**	**878**	**702**
	705.0	25.4	383.0	1317	0	1317	**658**	**439**	**724**	**527**	**1317**	**1053**
	704.0	25.4	383.0	1756	0	1756	**878**	**585**	**966**	**702**	**1756**	**1404**
	703.0	25.4	383.0	2194	0	2194	**1097**	**731**	**1207**	**878**	**2194**	**1756**
	702.0	25.4	383.0	2633	0	2633	**1317**	**878**	**1448**	**1053**	**2633**	**2107**
	701.0	25.4	383.0	3072	0	3072	**1536**	**1024**	**1690**	**1229**	**3072**	**2458**
	700.0	25.4	383.0	3511	0	3511	**1756**	**1170**	**1931**	**1404**	**3511**	**2809**
	699.0	25.4	383.0	3950	0	3950	**1975**	**1317**	**2172**	**1580**	**3950**	**3160**
	698.0	25.4	383.0	4389	0	4389	**2194**	**1463**	**2414**	**1756**	**4389**	**3511**
	697.0	25.4	383.0	4828	0	4828	**2414**	**1609**	**2655**	**1931**	**4828**	**3862**
	696.0	25.4	383.0	5267	0	5267	**2633**	**1756**	**2897**	**2107**	**5267**	**4213**
	695.0	25.4	383.0	5705	0	5705	**2853**	**1902**	**3138**	**2282**	**5705**	**4564**
	694.0	25.4	383.0	6144	0	6144	**3072**	**2048**	**3379**	**2458**	**6144**	**4915**
	693.0	25.4	383.0	6583	0	6583	**3292**	**2194**	**3621**	**2633**	**6583**	**5267**
	692.0	25.4	383.0	7022	0	7022	**3511**	**2341**	**3862**	**2809**	**7022**	**5618**
	691.0	25.4	383.0	7461	0	7461	**3730**	**2487**	**4104**	**2984**	**7461**	**5969**
	690.0	25.4	383.0	7900	0	7900	**3950**	**2633**	**4345**	**3160**	**7900**	**6320**
	689.0	25.4	383.0	8339	0	8339	**4169**	**2780**	**4586**	**3335**	**8339**	**6671**
	688.0	25.4	383.0	8778	0	8778	**4389**	**2926**	**4828**	**3511**	**8778**	**7022**
	687.0	25.4	383.0	9216	0	9216	**4608**	**3072**	**5069**	**3687**	**9216**	**7373**
	686.0	25.4	383.0	9655	0	9655	**4828**	**3218**	**5310**	**3862**	**9655**	**7724**
	685.0	25.4	383.0	10094	0	10094	**5047**	**3365**	**5552**	**4038**	**10094**	**8075**
	684.0	25.4	383.0	10533	0	10533	**5267**	**3511**	**5793**	**4213**	**10533**	**8427**
	683.0	25.4	383.0	10972	0	10972	**5486**	**3657**	**6035**	**4389**	**10972**	**8778**
	682.0	25.4	383.0	11411	0	11411	**5705**	**3804**	**6276**	**4564**	**11411**	**9129**
	681.0	25.4	383.0	11850	0	11850	**5925**	**3950**	**6517**	**4740**	**11850**	**9480**
	680.0	25.4	383.0	12289	0	12289	**6144**	**4096**	**6759**	**4915**	**12289**	**9831**
	679.0	25.4	383.0	12728	0	12728	**6364**	**4243**	**7000**	**5091**	**12728**	**10182**
	678.0	25.4	383.0	13166	0	13166	**6583**	**4389**	**7242**	**5267**	**13166**	**10533**
	677.0	25.4	383.0	13605	0	13605	**6803**	**4535**	**7483**	**5442**	**13605**	**10884**
	676.0	25.4	383.0	14044	0	14044	**7022**	**4681**	**7724**	**5618**	**14044**	**11235**
	675.0	25.4	383.0	14483	0	14483	**7242**	**4828**	**7966**	**5793**	**14483**	**11586**
	674.0	25.4	383.0	14922	0	14922	**7461**	**4974**	**8207**	**5969**	**14922**	**11938**
	673.0	25.4	383.0	15361	0	15361	**7680**	**5120**	**8448**	**6144**	**15361**	**12289**

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 5.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 2

Drilled Shaft Diameter (ft) = 8 in overburden
Rock Socket Diameter (in) = 90
Rock Socket Diameter (ft) = 7.5

9/17/2015

							Service Limit State		**Strength Limit State**		**Extreme Limit State**	
Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Total Allowable Bearing Capacity FS = 2 (kips)**	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	711.0	0.0	0.0	0	0	0	0	0	0	0	0	0
	710.0	0.0	0.0	0	0	0	0	0	0	0	0	0
	709.0	0.0	0.0	0	0	0	0	0	0	0	0	0
	708.0	0.0	0.0	0	0	0	0	0	0	0	0	0
	707.0	25.4	383.0	598	0	598	299	199	329	239	598	479
	706.0	25.4	383.0	1197	0	1197	598	399	658	479	1197	958
	705.0	25.4	383.0	1795	0	1795	898	598	987	718	1795	1436
	704.0	25.4	383.0	2394	0	2394	1197	798	1317	958	2394	1915
	703.0	25.4	383.0	2992	0	2992	1496	997	1646	1197	2992	2394
	702.0	25.4	383.0	3591	0	3591	1795	1197	1975	1436	3591	2873
	701.0	25.4	383.0	4189	0	4189	2095	1396	2304	1676	4189	3351
	700.0	25.4	383.0	4788	0	4788	2394	1596	2633	1915	4788	3830
	699.0	25.4	383.0	5386	0	5386	2693	1795	2962	2155	5386	4309
	698.0	25.4	383.0	5985	0	5985	2992	1995	3292	2394	5985	4788
	697.0	25.4	383.0	6583	0	6583	3292	2194	3621	2633	6583	5267
	696.0	25.4	383.0	7182	0	7182	3591	2394	3950	2873	7182	5745
	695.0	25.4	383.0	7780	0	7780	3890	2593	4279	3112	7780	6224
	694.0	25.4	383.0	8379	0	8379	4189	2793	4608	3351	8379	6703
	693.0	25.4	383.0	8977	0	8977	4489	2992	4937	3591	8977	7182
	692.0	25.4	383.0	9576	0	9576	4788	3192	5267	3830	9576	7660
	691.0	25.4	383.0	10174	0	10174	5087	3391	5596	4070	10174	8139
	690.0	25.4	383.0	10773	0	10773	5386	3591	5925	4309	10773	8618
	689.0	25.4	383.0	11371	0	11371	5685	3790	6254	4548	11371	9097
	688.0	25.4	383.0	11969	0	11969	5985	3990	6583	4788	11969	9576
	687.0	25.4	383.0	12568	0	12568	6284	4189	6912	5027	12568	10054
	686.0	25.4	383.0	13166	0	13166	6583	4389	7242	5267	13166	10533
	685.0	25.4	383.0	13765	0	13765	6882	4588	7571	5506	13765	11012
	684.0	25.4	383.0	14363	0	14363	7182	4788	7900	5745	14363	11491
	683.0	25.4	383.0	14962	0	14962	7481	4987	8229	5985	14962	11969
	682.0	25.4	383.0	15560	0	15560	7780	5187	8558	6224	15560	12448
	681.0	25.4	383.0	16159	0	16159	8079	5386	8887	6464	16159	12927
	680.0	25.4	383.0	16757	0	16757	8379	5586	9216	6703	16757	13406
	679.0	25.4	383.0	17356	0	17356	8678	5785	9546	6942	17356	13885
	678.0	25.4	383.0	17954	0	17954	8977	5985	9875	7182	17954	14363
	677.0	25.4	383.0	18553	0	18553	9276	6184	10204	7421	18553	14842
	676.0	25.4	383.0	19151	0	19151	9576	6384	10533	7660	19151	15321
	675.0	25.4	383.0	19750	0	19750	9875	6583	10862	7900	19750	15800
	674.0	25.4	383.0	20348	0	20348	10174	6783	11191	8139	20348	16278
	673.0	25.4	383.0	20947	0	20947	10473	6982	11521	8379	20947	16757

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 7.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 2

Drilled Shaft Diameter (ft) = 10 in overburden
Rock Socket Diameter (in) = 114
Rock Socket Diameter (ft) = 9.5

9/17/2015

Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Service Limit State**		**Strength Limit State**		**Extreme Limit State**	
							Total Allowable Bearing Capacity FS = 2 (kips)	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	711.0	0.0	0.0	0	0	0	0	0	0	0	0	0
	710.0	0.0	0.0	0	0	0	0	0	0	0	0	0
	709.0	0.0	0.0	0	0	0	0	0	0	0	0	0
	708.0	0.0	0.0	0	0	0	0	0	0	0	0	0
	707.0	25.4	383.0	758	0	758	379	253	417	303	758	606
	706.0	25.4	383.0	1516	0	1516	758	505	834	606	1516	1213
	705.0	25.4	383.0	2274	0	2274	1137	758	1251	910	2274	1819
	704.0	25.4	383.0	3032	0	3032	1516	1011	1668	1213	3032	2426
	703.0	25.4	383.0	3790	0	3790	1895	1263	2085	1516	3790	3032
	702.0	25.4	383.0	4548	0	4548	2274	1516	2502	1819	4548	3639
	701.0	25.4	383.0	5306	0	5306	2653	1769	2919	2123	5306	4245
	700.0	25.4	383.0	6065	0	6065	3032	2022	3335	2426	6065	4852
	699.0	25.4	383.0	6823	0	6823	3411	2274	3752	2729	6823	5458
	698.0	25.4	383.0	7581	0	7581	3790	2527	4169	3032	7581	6065
	697.0	25.4	383.0	8339	0	8339	4169	2780	4586	3335	8339	6671
	696.0	25.4	383.0	9097	0	9097	4548	3032	5003	3639	9097	7277
	695.0	25.4	383.0	9855	0	9855	4927	3285	5420	3942	9855	7884
	694.0	25.4	383.0	10613	0	10613	5306	3538	5837	4245	10613	8490
	693.0	25.4	383.0	11371	0	11371	5685	3790	6254	4548	11371	9097
	692.0	25.4	383.0	12129	0	12129	6065	4043	6671	4852	12129	9703
	691.0	25.4	383.0	12887	0	12887	6444	4296	7088	5155	12887	10310
	690.0	25.4	383.0	13645	0	13645	6823	4548	7505	5458	13645	10916
	689.0	25.4	383.0	14403	0	14403	7202	4801	7922	5761	14403	11523
	688.0	25.4	383.0	15161	0	15161	7581	5054	8339	6065	15161	12129
	687.0	25.4	383.0	15919	0	15919	7960	5306	8756	6368	15919	12736
	686.0	25.4	383.0	16677	0	16677	8339	5559	9173	6671	16677	13342
	685.0	25.4	383.0	17436	0	17436	8718	5812	9590	6974	17436	13948
	684.0	25.4	383.0	18194	0	18194	9097	6065	10006	7277	18194	14555
	683.0	25.4	383.0	18952	0	18952	9476	6317	10423	7581	18952	15161
	682.0	25.4	383.0	19710	0	19710	9855	6570	10840	7884	19710	15768
	681.0	25.4	383.0	20468	0	20468	10234	6823	11257	8187	20468	16374
	680.0	25.4	383.0	21226	0	21226	10613	7075	11674	8490	21226	16981
	679.0	25.4	383.0	21984	0	21984	10992	7328	12091	8794	21984	17587
	678.0	25.4	383.0	22742	0	22742	11371	7581	12508	9097	22742	18194
	677.0	25.4	383.0	23500	0	23500	11750	7833	12925	9400	23500	18800
	676.0	25.4	383.0	24258	0	24258	12129	8086	13342	9703	24258	19406
	675.0	25.4	383.0	25016	0	25016	12508	8339	13759	10006	25016	20013
	674.0	25.4	383.0	25774	0	25774	12887	8591	14176	10310	25774	20619
	673.0	25.4	383.0	26532	0	26532	13266	8844	14593	10613	26532	21226

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 9.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 2

Drilled Shaft Diameter (ft) = 12 in overburden
Rock Socket Diameter (in) = 138
Rock Socket Diameter (ft) = 11.5

9/17/2015

Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Service Limit State**		**Strength Limit State**		**Extreme Limit State**	
							Total Allowable Bearing Capacity FS = 2 (kips)	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	711.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	710.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	709.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	708.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	707.0	25.4	383.0	918	0	918	**459**	**306**	**505**	**367**	**918**	**734**
	706.0	25.4	383.0	1835	0	1835	**918**	**612**	**1009**	**734**	**1835**	**1468**
	705.0	25.4	383.0	2753	0	2753	**1376**	**918**	**1514**	**1101**	**2753**	**2202**
	704.0	25.4	383.0	3671	0	3671	**1835**	**1224**	**2019**	**1468**	**3671**	**2937**
	703.0	25.4	383.0	4588	0	4588	**2294**	**1529**	**2524**	**1835**	**4588**	**3671**
	702.0	25.4	383.0	5506	0	5506	**2753**	**1835**	**3028**	**2202**	**5506**	**4405**
	701.0	25.4	383.0	6424	0	6424	**3212**	**2141**	**3533**	**2569**	**6424**	**5139**
	700.0	25.4	383.0	7341	0	7341	**3671**	**2447**	**4038**	**2937**	**7341**	**5873**
	699.0	25.4	383.0	8259	0	8259	**4129**	**2753**	**4542**	**3304**	**8259**	**6607**
	698.0	25.4	383.0	9177	0	9177	**4588**	**3059**	**5047**	**3671**	**9177**	**7341**
	697.0	25.4	383.0	10094	0	10094	**5047**	**3365**	**5552**	**4038**	**10094**	**8075**
	696.0	25.4	383.0	11012	0	11012	**5506**	**3671**	**6057**	**4405**	**11012**	**8810**
	695.0	25.4	383.0	11930	0	11930	**5965**	**3977**	**6561**	**4772**	**11930**	**9544**
	694.0	25.4	383.0	12847	0	12847	**6424**	**4282**	**7066**	**5139**	**12847**	**10278**
	693.0	25.4	383.0	13765	0	13765	**6882**	**4588**	**7571**	**5506**	**13765**	**11012**
	692.0	25.4	383.0	14683	0	14683	**7341**	**4894**	**8075**	**5873**	**14683**	**11746**
	691.0	25.4	383.0	15600	0	15600	**7800**	**5200**	**8580**	**6240**	**15600**	**12480**
	690.0	25.4	383.0	16518	0	16518	**8259**	**5506**	**9085**	**6607**	**16518**	**13214**
	689.0	25.4	383.0	17436	0	17436	**8718**	**5812**	**9590**	**6974**	**17436**	**13948**
	688.0	25.4	383.0	18353	0	18353	**9177**	**6118**	**10094**	**7341**	**18353**	**14683**
	687.0	25.4	383.0	19271	0	19271	**9635**	**6424**	**10599**	**7708**	**19271**	**15417**
	686.0	25.4	383.0	20189	0	20189	**10094**	**6730**	**11104**	**8075**	**20189**	**16151**
	685.0	25.4	383.0	21106	0	21106	**10553**	**7035**	**11608**	**8442**	**21106**	**16885**
	684.0	25.4	383.0	22024	0	22024	**11012**	**7341**	**12113**	**8810**	**22024**	**17619**
	683.0	25.4	383.0	22941	0	22941	**11471**	**7647**	**12618**	**9177**	**22941**	**18353**
	682.0	25.4	383.0	23859	0	23859	**11930**	**7953**	**13123**	**9544**	**23859**	**19087**
	681.0	25.4	383.0	24777	0	24777	**12388**	**8259**	**13627**	**9911**	**24777**	**19821**
	680.0	25.4	383.0	25694	0	25694	**12847**	**8565**	**14132**	**10278**	**25694**	**20556**
	679.0	25.4	383.0	26612	0	26612	**13306**	**8871**	**14637**	**10645**	**26612**	**21290**
	678.0	25.4	383.0	27530	0	27530	**13765**	**9177**	**15141**	**11012**	**27530**	**22024**
	677.0	25.4	383.0	28447	0	28447	**14224**	**9482**	**15646**	**11379**	**28447**	**22758**
	676.0	25.4	383.0	29365	0	29365	**14683**	**9788**	**16151**	**11746**	**29365**	**23492**
	675.0	25.4	383.0	30283	0	30283	**15141**	**10094**	**16656**	**12113**	**30283**	**24226**
	674.0	25.4	383.0	31200	0	31200	**15600**	**10400**	**17160**	**12480**	**31200**	**24960**
	673.0	25.4	383.0	32118	0	32118	**16059**	**10706**	**17665**	**12847**	**32118**	**25694**

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) =	11.5
Side Resistance in Rock =	0.55
Tip Resistance in Rock =	0.50
Uplift Resistance in Rock =	0.40
Extreme Limit Side & Tip Resistance =	1.00
Extreme Limit Uplift Resistance =	0.80

DRILLED SHAFT AXIAL CAPACITY TABLE

KY 152 over Herrington Lake - Pier 2

Drilled Shaft Diameter (ft) = 14 in overburden
Rock Socket Diameter (in) = 162
Rock Socket Diameter (ft) = 13.5

9/17/2015

							Service Limit State		**Strength Limit State**		**Extreme Limit State**	
Shaft Tip Elevation (ft)		Nominal Unit Side Shear q_{ss} (ksf)	Nominal Unit End Bearing q_{eb} (ksf)	Nominal* Side Resistance R_{sr} (kips)	Nominal End Resistance R_{eb} (kips)	Total Nominal Axial Capacity Q_{ut} (kips)	**Total Allowable Bearing Capacity FS = 2 (kips)**	**Total Allowable Bearing Capacity FS = 3 (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**	**Total Factored Axial Resistance ϕR_t (kips)**	**Total Factored Uplift Resistance ϕR_{tu} (kips)**
Top of Rock >>>	711.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	710.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	709.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	708.0	0.0	0.0	0	0	0	**0**	**0**	**0**	**0**	**0**	**0**
	707.0	25.4	383.0	1077	0	1077	**539**	**359**	**592**	**431**	**1077**	**862**
	706.0	25.4	383.0	2155	0	2155	**1077**	**718**	**1185**	**862**	**2155**	**1724**
	705.0	25.4	383.0	3232	0	3232	**1616**	**1077**	**1777**	**1293**	**3232**	**2585**
	704.0	25.4	383.0	4309	0	4309	**2155**	**1436**	**2370**	**1724**	**4309**	**3447**
	703.0	25.4	383.0	5386	0	5386	**2693**	**1795**	**2962**	**2155**	**5386**	**4309**
	702.0	25.4	383.0	6464	0	6464	**3232**	**2155**	**3555**	**2585**	**6464**	**5171**
	701.0	25.4	383.0	7541	0	7541	**3770**	**2514**	**4147**	**3016**	**7541**	**6033**
	700.0	25.4	383.0	8618	0	8618	**4309**	**2873**	**4740**	**3447**	**8618**	**6894**
	699.0	25.4	383.0	9695	0	9695	**4848**	**3232**	**5332**	**3878**	**9695**	**7756**
	698.0	25.4	383.0	10773	0	10773	**5386**	**3591**	**5925**	**4309**	**10773**	**8618**
	697.0	25.4	383.0	11850	0	11850	**5925**	**3950**	**6517**	**4740**	**11850**	**9480**
	696.0	25.4	383.0	12927	0	12927	**6464**	**4309**	**7110**	**5171**	**12927**	**10342**
	695.0	25.4	383.0	14004	0	14004	**7002**	**4668**	**7702**	**5602**	**14004**	**11203**
	694.0	25.4	383.0	15082	0	15082	**7541**	**5027**	**8295**	**6033**	**15082**	**12065**
	693.0	25.4	383.0	16159	0	16159	**8079**	**5386**	**8887**	**6464**	**16159**	**12927**
	692.0	25.4	383.0	17236	0	17236	**8618**	**5745**	**9480**	**6894**	**17236**	**13789**
	691.0	25.4	383.0	18313	0	18313	**9157**	**6104**	**10072**	**7325**	**18313**	**14651**
	690.0	25.4	383.0	19391	0	19391	**9695**	**6464**	**10665**	**7756**	**19391**	**15512**
	689.0	25.4	383.0	20468	0	20468	**10234**	**6823**	**11257**	**8187**	**20468**	**16374**
	688.0	25.4	383.0	21545	0	21545	**10773**	**7182**	**11850**	**8618**	**21545**	**17236**
	687.0	25.4	383.0	22622	0	22622	**11311**	**7541**	**12442**	**9049**	**22622**	**18098**
	686.0	25.4	383.0	23700	0	23700	**11850**	**7900**	**13035**	**9480**	**23700**	**18960**
	685.0	25.4	383.0	24777	0	24777	**12388**	**8259**	**13627**	**9911**	**24777**	**19821**
	684.0	25.4	383.0	25854	0	25854	**12927**	**8618**	**14220**	**10342**	**25854**	**20683**
	683.0	25.4	383.0	26931	0	26931	**13466**	**8977**	**14812**	**10773**	**26931**	**21545**
	682.0	25.4	383.0	28009	0	28009	**14004**	**9336**	**15405**	**11203**	**28009**	**22407**
	681.0	25.4	383.0	29086	0	29086	**14543**	**9695**	**15997**	**11634**	**29086**	**23269**
	680.0	25.4	383.0	30163	0	30163	**15082**	**10054**	**16590**	**12065**	**30163**	**24130**
	679.0	25.4	383.0	31240	0	31240	**15620**	**10413**	**17182**	**12496**	**31240**	**24992**
	678.0	25.4	383.0	32318	0	32318	**16159**	**10773**	**17775**	**12927**	**32318**	**25854**
	677.0	25.4	383.0	33395	0	33395	**16697**	**11132**	**18367**	**13358**	**33395**	**26716**
	676.0	25.4	383.0	34472	0	34472	**17236**	**11491**	**18960**	**13789**	**34472**	**27578**
	675.0	25.4	383.0	35549	0	35549	**17775**	**11850**	**19552**	**14220**	**35549**	**28439**
	674.0	25.4	383.0	36627	0	36627	**18313**	**12209**	**20145**	**14651**	**36627**	**29301**
	673.0	25.4	383.0	37704	0	37704	**18852**	**12568**	**20737**	**15082**	**37704**	**30163**

NOTE: * It is assumed that in hard rock both side resistance and end bearing will not develop simultaneously.

From AASHTO LRFD, 2014 Edition
Table 10.5.5.2.4-1

D (ft.) = 13.5
Side Resistance in Rock = 0.55
Tip Resistance in Rock = 0.50
Uplift Resistance in Rock = 0.40
Extreme Limit Side & Tip Resistance = 1.00
Extreme Limit Uplift Resistance = 0.80

Appendix F

Idealized Subsurface Profiles

GENERAL SOIL AND BEDROCK PROFILE LEGEND SHEET

KY 152 over Herrington Lake

SUMMARY OF PARAMETERS DEVELOPED FOR SOIL PROFILES

Parameter	Units	Description
γ_t	lb/ft^3	Total Unit Weight
γ_e	lb/ft^3	Effective Unit Weight
q_U	lb/ft^2	Unconfined Compressive Strength (soil)
q_U	ton/ft^2	Unconfined Compressive Strength (rock)
C_U	lb/ft^2	Undrained Shear Strength
SDI	%	Slake Durability Index (Shale only)
ϕ	(^{o})	Angle of Internal Friction
c	lb/ft^2	Effective stress cohesion
K_S	lb/in^3	Soil Secant Modulus - Static (computer program LPILE^{PLUS}4.0)

GENERAL SOIL AND BEDROCK PROFILE

KY 152 over Herrington Lake
Pier 1
Based on Borings B-6, B-7, B-8, and B-9

Approximate			Description STRATA		
Elevation (ft)	Depth (ft)		Description (USCS Classification)	Parameters	
739.0	0.0		(Top of Casing)		
736.1	2.9	▽	Herrington Lake		
553.7	185.3				
			Silty Clay (CL)	γ_e (lb/ft^3) = 57.6 q_U (lb/ft^2) = 500 C_U (lb/ft^2) = 250	K_S (lb/in^3) = 30 E_{50} = 0.020
545.4	193.6		Top of Rock		
			Limestone * This zone to be discounted from lateral analysis due to poor rock quality		
524.0	215.0				
			Limestone	γ_t (lb/ft^3) = 168 q_u(ton/ft^2) = 1292	
515.6	223.4				
			Limestone	γ_t (lb/ft^3) = 169 q_u(ton/ft^2) = 1420	
442.8	296.2		Bottom of Hole		

GENERAL SOIL AND BEDROCK PROFILE

KY 152 over Herrington Lake
Pier 2
Based on Borings B-10, B-11, B-12, and B-13

Approximate		Description STRATA	
Elevation (ft)	Depth (ft)	Description (USCS Classification)	Parameters
738.2	0.0	(Top of Casing)	
735.1	3.1	∇ Herrington Lake	
710.9	27.3	Top of Rock	
		Limestone	γ_t (lb/ft^3) = 169 q_u(ton/ft^2) = 1212
658.6	79.6		
		Limestone	γ_t (lb/ft^3) = 168 q_u(ton/ft^2) = 1551
640.7	97.5	Bottom of Hole	