GEOTECHNICAL DATA REPORT
PILLAR SECTION

Louisville-Southern Indiana Ohio River Bridges Project
Section 4 – East End Approach Twin Tunnels
Jefferson County, Kentucky
Project No. 1831-10-5629

Prepared For:

Kentucky Transportation Cabinet
Geotechnical Branch
1236 Wilkinson Boulevard
Frankfort, Kentucky

Prepared By:

S&ME
422 Codell Drive
Lexington, Kentucky 40509

August 31, 2011

August 31, 2011

Kentucky Transportation Cabinet
Geotechnical Branch
1236 Wilkinson Boulevard
Frankfort, Kentucky 40601

Attention: Mr. Daryl Greer, P.E.

Subject: **Geotechnical Data Report**
Louisville Tunnel Project
Pillar Section
Jefferson County, Kentucky
Project No. 1831-10-5629

Dear Mr. Greer:

S&ME, Inc. is pleased to submit the following *Geotechnical Data Report* for the Pillar Section conducted along the proposed alignment of Louisville Tunnel in Jefferson County, Kentucky. The following report presents the data generated from our horizontal directional core drilling and laboratory testing. Should you have any questions regarding this report, or if we can be of any further assistance, please contact us at your convenience.

Respectfully Submitted,

S&ME, Inc.

Nathan J. Peterson, P.G.
Geotechnical Professional

Craig S. Lee, P.E
Senior Engineer

William A. Leake, P.E., P.L.S.
Project Manager

Attachments: Geotechnical Data Report

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1. PROJECT INFORMATION

The Louisville-Southern Indiana Ohio River Bridges Project is a "priority" national transportation project which addresses long-term, cross-river transportation needs in Louisville, Kentucky and Southern Indiana. It is one of the largest transportation projects in the country and will result in safer travel, less congestion and improved access to destinations in the region. The overall project consists of six segments:

1. Kennedy Interchange
2. New Downtown Bridge
3. Downtown Indiana Approach
4. East End River Bridge
5. Kentucky East End Approach
6. Indiana East End Approach

The tunnel project is part of the Kentucky East End Approach segment. The approximate 2,000 foot twin tunnels begins about 1,000 feet east of the intersection of Highway 841 North and Route 42. The original design of the I-265 extension proposed a conventional open cut roadway through the hillside that includes the Drumanard Estate. The Drumanard Estate was recently placed in the National Registry of Historic Places and must be preserved. This forced the alignment underground into twin tunnels, a northbound and a southbound tunnel. As of this date, the tunnels have an inside finished width of approximately 60 feet with an inside finished height of approximately 41 feet.

The objectives of our subsurface exploration were to advance horizontal directional core borings through the crown of each tunnel and in the pillar section between the tunnel openings and perform laboratory testing on the recovered rock core to assess the engineering properties of the rock.

An assessment of site environmental conditions for the presence or absence of pollutants in the soil, bedrock, surface water, or groundwater along the alignment or on adjacent properties was beyond the scope of this exploration.

The geotechnical exploration involved field exploration and laboratory testing. The following sections of this report present discussions of the field exploration and laboratory testing programs. The boring logs and laboratory test results are provided in the Appendices to this report. Our scope of work included the following:

- Drilling a total of 2,337 feet along the Pillar section of the tunnel alignment.
- Providing a brief review of our field exploration and the results of the laboratory testing conducted.
- Review of subsurface soil and rock stratigraphy with pertinent available physical properties.
- Providing boring logs and laboratory data sheets

2. GEOLOGY

The project site lies within the Bluegrass Physiographic Province of central Kentucky, which is located near the center of the state and is bordered by the Ohio River in the north and west and a ring of hills known as the Knobs in the west, south, and east. It is a rolling plateau that becomes more rugged near the edges. The Bluegrass Region is characterized by gently rolling hills and fertile soils created by weathering of thick-bedded limestone from the Ordovician and Silurian strata along the crest of the Cincinnati Arch. The soils are fertile because the Ordovician limestones contain phosphate minerals which are natural fertilizers.

The Louisville Bridges Twin Tunnels will encounter three rock formations along the alignment. The Silurian aged Louisville Limestone is the uppermost formation at the project site and is comprised of soluble limestone. The Louisville Limestone is mostly thin-bedded gray dolomitic limestone and gray calcitic dolomite, commonly in lumpy or irregular beds. Shale, in partings and very thin beds, constitutes a few percent, and very sparse chert is present in nodules and thin layers. In the project site, the Louisville Limestone is finely crystalline calcitic dolomite; the sparse fossils are dolomitized and include crinoid columnals, brachiopods, horn corals, and colonial corals.

From an engineering perspective, the Louisville Limestone is characterized by solution enlarged joints and bedding planes. The enlarged joints and bedding plane discontinuities can be either clay filled or open voids. Deep weathering and sinkhole formation are common. The primary impact for conventional building and roadway construction is the presence of latent drop-outs and a highly variable top of rock profile. The residuum derived from the Louisville Limestone is predominantly fat clay with limestone slabs and can exhibit problematic shrink and swell characteristics. For the tunnel, the Louisville Limestone presents several potential problems most associated with the discontinuities such as solution enlarged joints (both horizontal and vertical), solutioning along bedding planes, voids, and sinkholes. The Louisville Limestone can also produce significant groundwater flows after rain events. Water flow is largely along open joints, fractures and bedding planes.

The Waldron Shale is immediately below the Louisville Limestone. The Waldron Shale is composed of greenish-gray shale and minor gray dolomite; probably at least 95 percent is shale. The shale is dolomitic and weathers with angular fracture or crude fissility, eventually producing a plastic clay. The dolomite is clayey and occurs in irregular masses, lumps, and thin discontinuous beds. Fossils, which are sparse in both the shale and the dolomite, include brachiopods, crinoid columnals, gastropods, and bryozoans. At the tunnel site, previous vertical drilling suggests the Waldron Shale ranges in thickness from 9 to 15 feet. The basal contact with the underlying Laurel Dolomite is conformable and sharp.

The Waldron Shale degrades when exposed to water and air. This formation is problematic in conventional earthwork construction as those unfamiliar with its properties, mistakenly place the shale as a durable shot rock fill. Over time the shale will degrade causing structurally significant settlement of buildings and roadways. The Waldron Shale presents a

challenge to the construction of the tunnel as the shale is prone to delaminating and degrading during construction of the tunnel. In addition, the Shale will undergo a change in it physical properties over time after exposure to the elements.

The Laurel Dolomite underlies the Waldron Shale. The Laurel Dolomite is composed 95 percent or more of gray dolomite with minor greenish-gray shale and sparse gray limestone.

3. LABORATORY GEOTECHNICAL TESTING PROGRAM

The following strength and index tests were performed on selected rock core specimens in general conformance with ASTM International Standards, Kentucky Methods Manual, or other standards where applicable. The laboratory tests were conducted in the S&ME Knoxville, Tennessee Rock Mechanics laboratory and at the Geotechnical Engineering Center at the University of Texas at Austin.

- Axial and Diametrial Point Load Test (D5731)
- Unconfined compressive strength (D7012)
- Direct Shear (D5607)
- Brazilian Stress/Splitting Tensile Strength (D3967)
- Slake Durability (D4644)
- Cerchar Abrasivity (D7625)
- Huder-Amberg Test (W.Wittke, Rock Mechanics, 1991)
- Thin Section Petrographic Analysis
- pH
- Saturation and void ratio
- Sulfur Testing

The samples collected for testing were selected from the proposed alignment starting at the tunnel face to the termination of the Pillar Boring. The point load, unconfined compressive strength, and Brazilian Split Tensile tests were selected approximately every 60 feet along the boring starting at a distance of 400 feet, from the boring collar (which is the distance to the tunnel face) to the termination of the boring at 2,337.5 feet.

The direct shear samples were selected in the field by the S&ME geologist along discontinuities within the recovered rock core.

The slake durability samples were selected from the Waldron Shale. These samples were collected approximately every 35 feet along the boring starting at the contact of the Waldron Shale to the contact with the Laurel Dolomite (1170.0 feet to 2110.0 feet). Samples collected for the Cerchar Abrasivity, Huder-Amberg, and petrographic analysis were also selected from the Waldron Shale and then sent to the University of Texas at Austin. The pH, saturation and void ratio, and sulfur testing were also selected from the Waldron Shale. The locations of these samples along the alignment were selected by the S&ME geologist in the field based on visual observations and characteristics of the shale.

4. SUBSURFACE CONDITIONS

4.1 GENERAL

Subsurface conditions along the proposed Pillar section of the tunnel alignment were explored with a single horizontal directional core boring. The coordinates for the Pillar Boring alignment were provided by Parsons and used by S&ME in our boring plan. The Pillar Boring was advanced using HQ size core tools to a distance of 122.0 feet. The HQ tools cut a 2.5 inch diameter core and a 3.7 inch diameter boring. From a distance of 122 feet NQ size core equipment was advanced the remainder of the boring. The NQ tools cut a 1.8 inch diameter core and a 3 inch diameter boring. After coring 100 feet of NQ core, HQ casing was advanced to case the boring. This process was continued out to a distance of 1,140 feet. From this distance only the NQ size tools were advanced.

Continuous core samples were collected along the Pillar Boring during both the conventional and directional phases. Our boring logs, laboratory test sheets, and core boxes reference the location of the core with respect to "distance" from the boring collar instead of depth. The report also includes a table of distance from the collar as well as project datum coordinates for each rock core sample interval. The field logging was performed by an S&ME geologist and consisted of:

- Measuring and logging the core and describing the physical appearance and lithology of the rock.
- Identifying and documenting the discontinuities, and bedding planes within the formations.
- Measuring the core recovery and Rock Quality Designation (RQD)
- Selecting specimens for laboratory testing
- Photographing the core after placing the recovered core in the labeled core boxes. The rock core photographs are included in Appendix A of this report.
- Assigning project coordinates of the selected rock core specimens

The Devico System used at the Louisville Bridges tunnel job consists of the DeviDrill, the PeeWee tool, and the DeviFlex. The DeviDrill is the steerable core barrel while both the PeeWee and DeviFlex are used to measure the physical parameters of the borehole. The principle behind the DeviDrill core barrel is a drive shaft running through a bushing, offset from the center line of the tool. Expanding pads operated by a differential pressure is keeping the DeviDrill in a fixed tool face while drilling in a curve. The inner assembly carries an inner tube collecting the core, a mule shoe system, and an instrument barrel with the survey tool recording inclination and tool orientation. Data is stored inside the tool and downloaded wirelessly to a PDA after each run.

The PeeWee is a miniature electronic multishot based on the same technology as the DeviTool Standard. The PeeWee uses three high-accuracy magnetometers and accelerometers. It records inclination, azimuth, tool face, temperature, gravity vector, magnetic field vector, magnetic dip angle, and battery status.

DeviFlex is a non- magnetic electronic multishot for surveying inside casings and drill strings by simply using the wireline system. The DeviFlex is less prone to magnetic disturbances. The DeviFlex tool consists of two independent measuring systems. Three accelerometers and four strain gauges are used to calculate inclination and change in azimuth. In addition, the DeviFlex records and stores gravity vector, temperature, and battery capacity

Subsurface conditions encountered at the Pillar Boring location are shown on the boring log. The boring log represents our interpretation of the subsurface conditions, based on the field log and visual examination of the field samples by a geotechnical professional.

4.2 BEGINNING OF PILLAR SECTION TO TUNNEL FACE

The Pillar Boring was located within an abandoned exit ramp from Highway 841. From the hole collar to the face of the tunnel is a distance of 400 feet. In this 400 foot interval the boring encountered shot rock fill for the first 12 feet then gray, slightly weathered, hard, crystalline limestone (Louisville Limestone). The recovered core was logged, photographed, and boxed; however, laboratory testing was not performed on the core from this portion of the alignment as it was not within the tunnel.

4.3 LOUISVILLE LIMESTONE

In the pillar boring the tunnel face begins at a distance of 400 feet from the hole collar and at an elevation of 528.1 feet. The Louisville Limestone is present from the boring collar to a distance of 1,170 feet. The Louisville Limestone consisted of gray, very slightly weathered, hard, crystalline limestone with occasional joint sets and fossils. Samples were collected along the alignment at equally spaced intervals of 60 feet. The samples along this section of the alignment were tested for Brazilian Stress, Diametrial and Axial Point Load, and Unconfined Compression. The results of these laboratory tests can be found in Appendix B.

4.4 WALDRON SHALE

The Waldron Shale formation was encountered at a distance of 1,170 feet along the alignment. The Waldron Shale consists of light gray calcareous shale, very slightly weathered, hard, with calcite crystals and pyrite along the upper portion of the formation. This portion of the Waldron Shale strongly resembles limestone in appearance, but contains thin, dark gray shale partings and pyrite which are indentifying characteristics of the Waldron Shale.

At a distance of 1,350 feet the Waldron Shale transitions from moderately hard to soft with near horizontal fractures along bedding planes. The shale contains calcite and occasional thin white calcite veins which can be observed in the recovered core. From a distance of approximately 1,350 feet to 1,615 feet the Waldron Shale becomes fine grained and soft with Rock Quality Designation (RQD) values ranging from 40 to 60 percent. The Waldron Shale continues to degrade from a distance of 1,615 feet to 1,930 feet. The shale along this distance

is very soft and can be broken by hand. The core recovery values along this distance ranged from 45 to 100 percent and RQD values ranged from 0 to 60 percent. The low RQD values reflect the fractures that were occurring horizontal to the rock core. The recovered shale was platy and occasionally friable along these fractures.

The Waldron Shale improved in quality and becomes slightly fractured to sound at a distance of 1,930 feet to 2,110 feet. Within this interval short sections of the shale are moderately hard to soft with areas of severe fracturing and clay filled fractures. The fractures observed were occurring horizontal to the rock core. The RQD values along this portion of the alignment ranged from 40 to 100 percent.

Samples were collected for laboratory analysis within the Waldron Shale formation and were tested for Brazilian Stress, Diametrial and Axial Point Load, Unconfined Compression, slake durability, saturation and void ratio, and pyritic testing. Additional samples were collected and sent to the University of Texas at Austin under chain of custody and were analyzed for Cerchar Abrasivity, Huder-Amber (Axial Swelling), and petrographic analysis. The results of these laboratory tests can be found in Appendix B.

4.5 LAUREL DOLOMITE

The Waldron Shale formation terminates at a distance of approximately 2,110 feet and the Laurel Dolomite formation begins. The Laurel Dolomite is sound, moderately hard to hard, very slightly weathered, with occasional calcite vugs. The dolomite continues to the end of the boring at a distance of 2,337.5 feet. The recovery and RQD values within the dolomite were 90 to 100 percent. Samples along this section of the alignment were tested for Brazilian Stress, Diametrial and Axial Point Load, and Unconfined Compression. The results of these laboratory tests can be found in Appendix B.

4.6 DISCONTINUITIES

The Louisville Limestone can be observed at road cuts along Highway 181 and Highway 42. The Limestone is weathered to light gray with substantial fossils throughout. Solutional weathering can be observed in the exposed rock extending ten to twenty feet deep into the rock. Reddish brown clay exists within the solution channels.

The features observed within the road cut were not observed within the Pillar Boring rock core. The Louisville Limestone along the alignment was observed to be sound to slightly fractured, hard, and crystalline. No solutional weathering or features were observed within the limestone portion of the alignment.

Water circulation was lost during the drilling process through small fractures and bedding features within the Louisville Limestone and Waldron Shale. The fractures and bedding features encountered in these formations were communicating down and to the southeast towards the North Bound Boring. Water gain of approximately 5 to 10 percent was observed during the drilling of the North Bound Boring. This water gain was interpreted to be coming

from the Pillar Boring through the fractures and bedding features. At the termination of the Pillar Boring the water gain in the North Bound Boring was lost.

4.7 GROUNDWATER

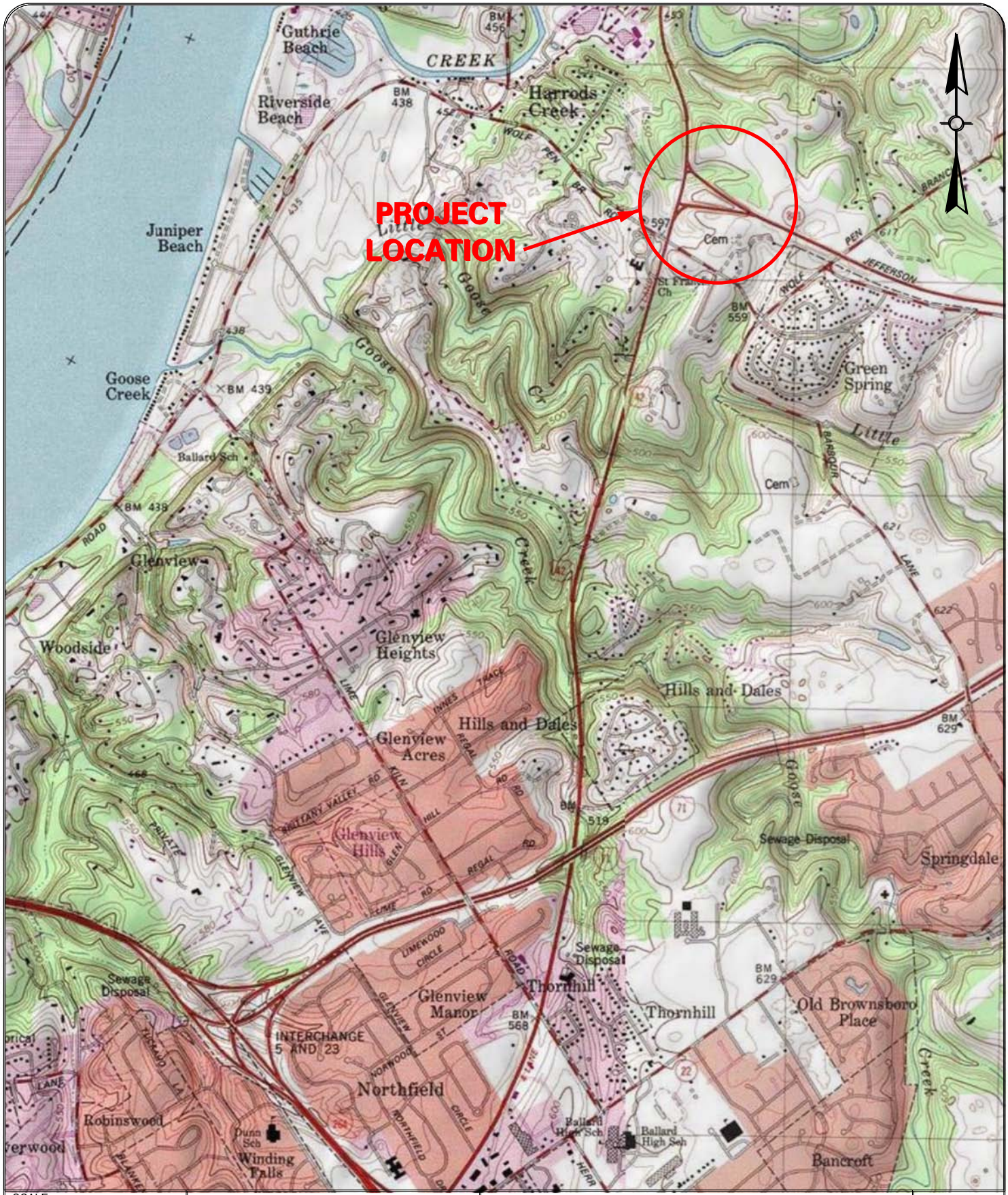
During the drilling of the Pillar Boring subsurface water was not encountered. Water circulation was gradually lost through the Louisville Limestone either through small fractures encountered or across bedding planes. At the transition from the Louisville Limestone to the Waldron Shale at 1,170.0 feet, all water return was lost and was not regained during the remainder of the boring.

5.0 LIMITATIONS

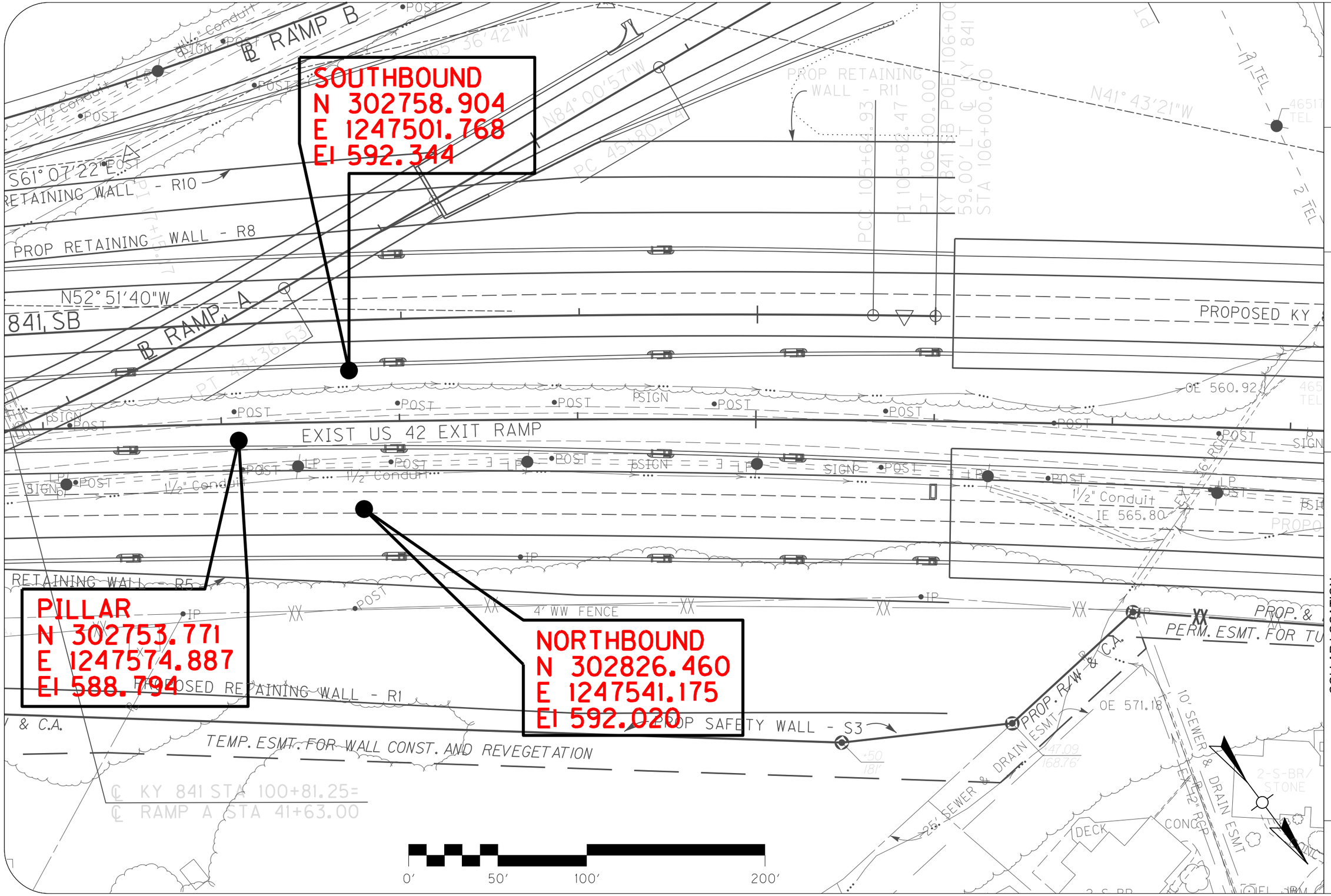
The geotechnical date report (GDR) provides a compilation of field and laboratory data collected and reviewed for use by the design and construction teams for the Louisville-Southern Indiana Ohio River Bridges Project. No analyses, conclusions, or design recommendations are contained in this report.

The report was prepared for the exclusive use of the Kentucky Transportation Cabinet. It should be made available to the prospective contractors for use as factual data only, and not as a warranty of subsurface conditions such as those interpreted from the boring log. The GDR should not be taken as a contract document.

The GDR was prepared within the limitations of our scope, schedule and budget. The data contained in the GDR are compiled and presented in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. S&ME makes no warranty, either expressed or implied.



SCALE: 1" = 2000'	S&ME WWW.SMEINC.COM 422 CODELL DRIVE, LEXINGTON, KY 40509 PHONE: 859.293.5518	COLLAR LOCATION HORIZONTAL DIRECTIONAL BORING GEOTECHNICAL DATA REPORT LOUISVILLE SOUTHERN INDIANA OHIO RIVER BRIDGES PROJECT KENTUCKY EAST END APPROACH TUNNEL	FIGURE NO. 1
DATE: 8/26/11			
DRAWN BY: CAC			
PROJECT NO: 24305629			



DATE:	8/25/11
DRAWN BY:	CAC
CHECKED BY:	
SCALE:	1" = 50'
PROJECT NUMBER:	24305629
DRAWING NUMBER:	

S&ME
WWW.SMEINC.COM
422 CODELL DRIVE, LEXINGTON, KY 40509
PHONE: 859.293.5518

COLLAR LOCATION
HORIZONTAL DIRECTIONAL BORING
GEOTECHNICAL DATA REPORT

LOUISVILLE SOUTHERN INDIANA
OHIO RIVER BRIDGES PROJECT
KENTUCKY EAST END APPROACH TUNNEL

FIGURE NO.
2

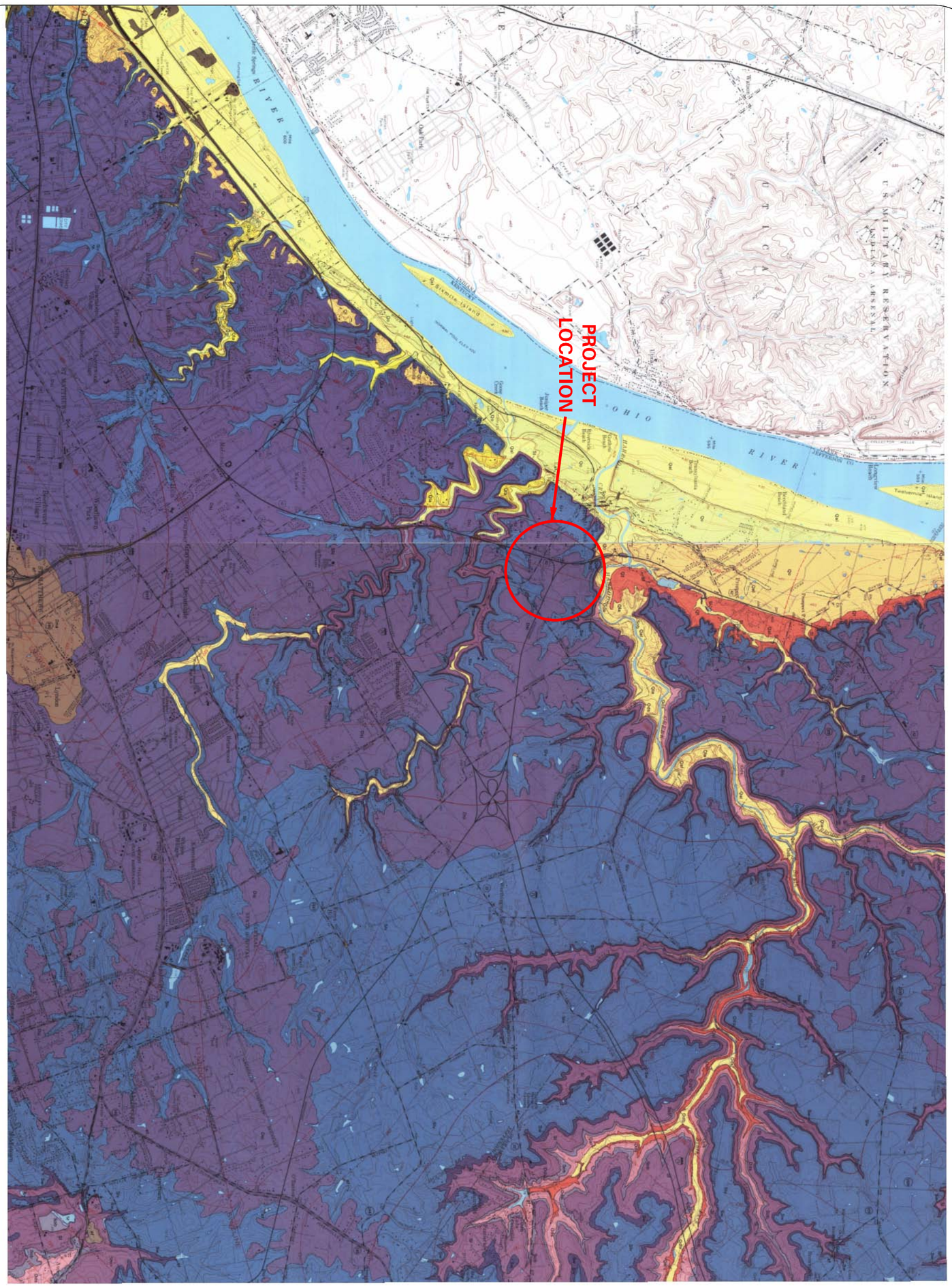


FIGURE NO. 3

PROJECT AREA GEOLOGIC MAP
HORIZONTAL DIRECTIONAL BORING
GEOTECHNICAL DATA REPORT

LOUISVILLE SOUTHERN INDIANA
OHIO RIVER BRIDGES PROJECT
KENTUCKY EAST END APPROACH TUNNEL

S&ME
WWW.SMEINC.COM
422 CODELL DRIVE, LEXINGTON, KY 40509
PHONE: 859.293.5518

SCALE: 1' = 50'	DATE: 8/25/11
PROJECT NUMBER: 24305629	DRAWN BY: CAC
DRAWING NUMBER:	CHECKED BY:

APPENDIX A

BORING LOGS

ROCK CORE PHOTOGRAPHS

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 1 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		PAVEMENT SURFACE														
		0.0 ft to 4.6 ft (Run No. 1): Reddish brown clay (FILL)		588.0	1											
5		**4.6 ft to 9.0 ft (Run No. 2):** Reddish brown clay with crushed stone (FILL) to a distance of 7.0'. At this distance concrete was encountered to a distance of 7.5'. From 7.5' to 9.0' clay fill material was encountered.		4.6 / 587.3	2											
		9.0 ft to 12.0 ft (Run No. 3): **LIMESTONE** - From a distance of 9.0' to 10.3' rock is slightly weathered; slightly fractured with fractures occuring at horizontal; moderately hard. Note: This limestone is rock FILL with clay fill beneath from a distance of 10.3' to 12.0'.		9.0 / 586.8	3											
10		**12.0 ft to 17.0 ft (Run No. 4):** **LIMESTONE** - light gray; slightly weathered; slightly fractured; moderately hard; fossiliferous; calcite matrix; horizontal fractures.		12.0 / 586.0	4											
15	HQ Core	**17.0 ft to 22.0 ft (Run No. 5):** **LIMESTONE** - light gray; slightly weathered; slightly fractured with fractures occuring at horizontal with fracture at solution feature at 18.0'; fossiliferous; with calcite matrix; joints are close (0.5' average). Iron staining present on outside surface of core.		17.0 / 585.2	5											
20		**22.0 ft to 27.0 ft (Run No. 6)** **LIMESTONE** - light gray; slightly weathered; slightly fractured to sound; moderately close joint spacing; pressure solution features throughout rock core.		22.0 / 584.3	6			585								
25		**27.0 ft to 32.0 ft (Run No. 7)** **LIMESTONE** - Same as previous run with high angle joint at 28.3'.		27.0 / 583.5	7								Azimuth: 304.4 Inclination: -10.0			
30		*--- CONTINUED NEXT PAGE ---*														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
35	HQ Core	**32.0 ft to 35.0 ft (Run No. 8)** **LIMESTONE** - Same as previous run; slightly weathered with solution features.		32.0 / 583.0	8											
		35.0 ft to 37.0 ft (Run No. 9) **LIMESTONE** - Same as previous run		35.0 / 582.7	9											
40		**37.0 ft to 42.0 ft (Run No. 10)** **LIMESTONE** - Same as previous run with moderately close joint spacing.		37.0 / 581.9	10											
45		**42.0 ft to 47.0 ft (Run No. 11)** **LIMESTONE** - Same as previous run; very slight weathering		42.0 / 581.0	11											
50		**47.0 ft to 52.0 ft (Run No. 12)** **LIMESTONE** - Same as previous run with pressure solution features and solution weathering features at 48.0'.		47.0 / 580.2	12											
55		**52.0 ft to 57.0 ft (Run No. 13)** **LIMESTONE** - Same as previous run; rock matrix becoming more crystalline. Note: Stopped drilling at 57 ft on 3/28/2011		52.0 / 579.4	13			580								
60		**57.0 ft to 62.0 ft (Run No. 14)** **LIMESTONE** - light gray; slightly weathered; slightly fractured to sound; moderately close joint spacing; pressure solution features throughout rock core.		57.0 / 578.6	14											
				62.0	15									Azimuth: 304.9 Inclination: -10.24		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 3 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
65	HQ Core	**62.0 ft to 67.0 ft (Run No. 15)** **LIMESTONE** - Same as previous run; rock matrix becoming more crystalline with depth; 30 degree fracture along pressure solution feature at a distance of 62.0' to 63.0'.		577.7	15											
		67.0 ft to 72.0 ft (Run No. 16) **LIMESTONE** - Light gray; very slight weathering; slightly fractured to sound; moderately close joint spacing; hard; pressure solution features throughout. Fractures occur along pressure solution features at approximately 30 degrees; crystalline matrix.		67.0 / 576.9	16											
70		**72.0 ft to 77.0 ft (Run No. 17)** **LIMESTONE** - Same as previous run; all breaks mechanical.		72.0 / 576.1	17											
75		**77.0 ft to 82.0 ft (Run No. 18)** **LIMESTONE** - Same as previous run with black pressure solution features occuring at approximately 30 degrees. Fractures occur along these features.		77.0 / 575.3	18											
80		**82.0 ft to 87.0 ft (Run No. 19)** **LIMESTONE** - light gray; very slight weathering; slightly fractured to sound; moderately close joint spacing; hard; pressure solution features throughout. Fractures occur along pressure solution features; crystalline matrix; with fossils present.		82.0 / 574.4	19			575								
85		**87.0 ft to 92 ft (Run No. 20)** **LIMESTONE** - Same as previous run with pressure solution features present to 88.2' and with fossils present to this distance.		87.0 / 573.6	20											
90		**92.0 ft to 97.0 ft (Run No. 21)** **LIMESTONE** - Same as previous run. Pressure solution features present throughout run.		92.0	21									Azimuth: 303.94 Inclination: -10.7		
95		*--- CONTINUED NEXT PAGE ---*														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
95	HQ Core	**92.0 ft to 97.0 ft (Run No. 21)** **LIMESTONE** - Same as previous run. Pressure solution features present throughout run.		572.8 / 97.0	21											
100	HQ Core	**97.0 ft to 102.0 ft (Run No. 22)** **LIMESTONE** - Same as previous run.		572.0 / 102.0	22											
105	HQ Core	**102.0 ft to 107.0 ft (Run No. 23)** **LIMESTONE** - Same as previous run.		571.1 / 107.0	23											
110	HQ Core	**107.0 ft to 112.0 ft (Run No. 24)** **LIMESTONE** - Light gray; very slight weathering; slightly fractured to sound; moderately close joint spacing; hard; crystalline with pressure solution features; with calcite vugs at 109.7 ft and fossils in joint (90 degrees) at same distance. Fractures occur at pressure solution features at approximately 30 degrees or less.		570.3 / 112.0	24											
115	HQ Core	**112.0 ft to 117.0 ft (Run No. 25)** **LIMESTONE** - Light gray; very slight weathering; slightly fractured to sound; moderately close joint spacing; hard; crystalline with pressure solution features.		569.5 / 117.0	25			570								
120	HQ Core / 3/30/2011	**117.0 ft to 122.0 ft (Run No. 26)** **LIMESTONE** - Same as previous run. Note: Stopped drilling at 122.0 ft on 3/29/2011		568.7 / 122.0	26											
125	NQ Core	**122 ft to 127 ft (Run No. 27)** **LIMESTONE** - Light gray; very slight weathering; sound; moderatley close to wide joint spacing; hard; crystalline. Note: Begin NQ size sore at 122.0 feet			27									Azimuth: 303.94 Inclination: -10.7		
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
	NQ Core			567.9	27											
		127 ft to 132 ft (Run No. 28) **LIMESTONE** - Same as previous run.		127.0	28											
130				567.0												
		132 ft to 137 ft (Run No. 29) **LIMESTONE** - Same as previous run with single break in rock core being mechanical.		132.0	29											
135	4/5/2011			566.2												
		137 ft to 141 ft (Run No. 30) **LIMESTONE** - Light gray; very slight weathering; sound; moderatley close to wide joint spacing; hard; crystalline; Recovered 4.0 feet intact. Note: Begin AQ size core at 137.0 feet.		137.0	30											
140				565.5												
	AQ Core	**141 ft to 151 ft (Run No. 31)** **LIMESTONE** - Same as previous run with fractures at 148.8 and 149.2 feet. Fractures occur at approximately 60 degrees along pressure solution features.		141.0	31			565								
145																
150				563.9												
		151 ft to 161 ft (Run No. 32) **LIMESTONE** - Same as previous run.		151.0	32									Azimuth: 304.39 Inclination: -11.11		
155																
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
160	AQ Core	**151 ft to 161 ft (Run No. 32)** **LIMESTONE** - Same as previous run.		562.2	32											
165	AQ Core	**161 ft to 171 ft (Run No. 33)** **LIMESTONE** - Light gray; very slight weathering; sound; moderatley close to wide joint spacing; hard; crystalline.		161.0 560.6	33											
170	AQ Core	**171 ft to 175.5 (Run No. 34)** **LIMESTONE** - light gray; very slight weathering; sound; moderately close joint spacing with joint at 173.8, joint is rough; hard. Note: Stopped AQ directional core to adjust turn. Begin NQ core at 175.5 feet.		171.0 559.9	34			560						J, R		
175	AQ Core	**175.5 ft to 180.5 ft (Run No. 35)** **LIMESTONE** - Same as previous run; no fractures or joints observed; pressure solution features throughout core. Note: Stop NQ core at 180.5 feet and resume AQ directional core.		175.5 559.0	35											
180	AQ Core	**180.5 ft to 190.5 ft (Run No. 36)** **LIMESTONE** - Same as previous run; joint set at 181.0 to 182.1 feet, joint is planar, rough, no infilling; joint at 183.7 feet is same as previous joint set.		180.5	36									J, R J, R J, R Azimuth: 305.0 Inclination: -10.0		
185		*--- CONTINUED NEXT PAGE ---*														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 7 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
190	AQ Core			557.4	36											
		190.5 ft to 200.5 ft (Run No. 37) **LIMESTONE** - light gray; very slight weathering; sound; moderately close joint spacing; joint is rough; hard; fractures occur along pressure solution features at 191.6 feet; joint set at 197.3 to 198.8 feet, rough.		190.5	37									J, R		
195														J, R		
200				555.7												
		200.5 ft to 210.5 ft (Run No. 38) **LIMESTONE** - Same as previous run with joint set at 204.9 to 205.1 feet, rough, no infilling; remaining breaks in run are mechanical or occur along pressure solution features; crystalline rock.		200.5	38			555						J, R J, R		
205																
210				554.1												
		210.5 ft to 220.5 ft (Run No. 39) **LIMESTONE** - light gray; very slight weathering; sound; moderately close joint spacing; hard; all breaks mechanical.		210.5	39									Azimuth: 306.4 Inclination: -10.02		
215																
220				552.4												
				220.5	40											
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 8 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
	AQ Core													J, R		
225		**220.5 ft to 230.5 ft (Run No. 40)** **LIMESTONE** - Same as previous run; joints at 222.4 and 226.2 feet with very close spacing, rough. Fractures occur at low angles along pressure solution features.			40									J, R		
230				550.8 / 230.5												
235		**230.5 ft to 240.5 ft (Run No. 41)** **LIMESTONE** - Same as previous run; fracture at 231.9 feet occured along pressure solution feature; all other breaks are mechanical.			41			550								
240				549.1 / 240.5												
245		**240.5 ft to 250.5 ft (Run No. 42)** **LIMESTONE** - Light gray, very slight weathering; slightly fractured to sound; close to moderately close joints; joints at 244.1', 244.5', 245.5', 246.3', 248.5', 249.1' (rough); hard; crystalline; with pressure solution features and occasional fractures along these features.			42									J, R J, R J, R J, R		
250				547.5 / 250.5										J, R J, R		
		250.5 ft to 260.5 ft (Run No. 43) **LIMESTONE** - Same as previous run; no joints observed; fractures occur along pressure solution features. All other breaks are mechanical.			43									Azimuth: 306.4 Inclination: -10.02		
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 9 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
255	AQ Core	**250.5 ft to 260.5 ft (Run No. 43)** **LIMESTONE** - Same as previous run; no joints observed; fractures occur along pressure solution features. All other breaks are mechanical.		545.8	43											
260		**260.5 ft to 270.5 ft (Run No. 44)** **LIMESTONE** - Same as previous run; joints at 261.7', 265.6', 266.0', 266.1', 267.4' (all joints rough).		260.5	44			545						J, R J, R J, R J, R J, R		
265																
270		**270.5 ft to 280.5 ft (Run No. 45)** **LIMESTONE** - Light gray; very slight weathering; close to moderately close joint spacing; sound from 270.5' to 277.9'; fractures occur along pressure solution features; pressure solution features present throughout; crystalline; hard.		544.2 270.5	45											
275																
280		**280.5 ft to 290.5 ft (Run No. 46)** **LIMESTONE** - Light gray; very slight weathering; sound; close to moderately close joint spacing; joints at 293.9', 294.2', 294.6', 294.8' (all joints rough); pressure solution features present throughout; crystalline; hard.		542.5 280.5	46									Azimuth: 306.94 Inclination: -5.8		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 10 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
285	AQ Core	**280.5 ft to 290.5 ft (Run No. 46)** **LIMESTONE** - Light gray; very slight weathering; sound; close to moderately close joint spacing; joints at 293.9', 294.2', 294.6', 294.8' (all joints rough); pressure solution features present throughout; crystalline; hard.		540.9	46											
290				290.5												
295		**290.5 ft to 300.5 ft (Run No. 47)** **LIMESTONE** - Same as previous run; sound rock from 290.5' to 299.6' then is slightly fractured at pressure solution features.			47			540						J, R J, R J, R J, R		
300				539.2												
				300.5												
305		**300.5 ft to 310.0 ft (Run No. 48)** **LIMESTONE** - Same as previous run; joints at 305.5', 306.9' with rough surfaces.			48									J, R J, R		
310				537.6										Azimuth: 306.94 Inclination: -5.8		
				310.5										J, R, FE		
		310.5 ft to 320.5 ft (Run No. 49) **LIMESTONE** - Same as previous run; joints at 310.9', 311.5', 312.2', 313.0'. Joints are rough with iron staining above and below joints.			49									J, R, FE J, R, FE J, R, FE		
315		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 11 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
320	AQ Core	**310.5 ft to 320.5 ft (Run No. 49)** **LIMESTONE** - Same as previous run; joints at 310.9', 311.5', 312.2', 313.0'. Joints are rough with iron staining above and below joints.		535.9	49											
325	AQ Core	**320.5 ft to 330.5 ft (Run No. 50)** **LIMESTONE** - Light gray; very slight weathering; sound; close to moderately close joint spacing; joints at 326.4', 326.8', 327.2', 327.9', 328.4' with rough joint surfaces; pressure solution features present throughout; crystalline; hard.		320.5	50			535						J, R J, R J, R J, R J, R		
330	4/9/2011 AQ Core	**330.5 ft to 332.8 ft (Run No. 51)** **LIMESTONE** - Same as previous run. Note: Cored standard NQ to clear out boring for HQ casing advancement.		534.3 330.5	51											
335	4/13/2011 NQ Core	**332.8 ft to 333.2 ft (Run No. 52)** **LIMESTONE** - Same as previous run. **333.2 ft to 337.0 ft (Run No. 53)** **LIMESTONE** - Same as previous run. Note: Both runs drilled with standard NQ core to clear boring for HQ casing advancement.		533.9 332.8 533.2	52 53											
340	AQ Core	**337.0 ft to 339.6 ft (Run No. 54)** **LIMESTONE** - Same as previous run. Note: Resume AQ size directional core at 337.0 feet. **339.6 ft to 341.3 ft (Run No. 55)** **LIMESTONE** - Same as previous run.		337.0 532.8 339.6 532.5	54 55											
345	AQ Core	**341.3 ft to 351.3 ft (Run No. 56)** **LIMESTONE** - Light gray; very slight weathering; sound; moderately close joint spacing with all breaks being mechanical in this run; hard; crystalline; pressure solution features present throughout.		341.3	56									Azimuth: 308.41 Inclination: -3.8		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
350	AQ Core	**341.3 ft to 351.3 ft (Run No. 56)** **LIMESTONE** - Light gray; very slight weathering; sound; moderately close joint spacing with all breaks being mechanical in this run; hard; crystalline; pressure solution features present throughout.		530.9	56											
355	AQ Core	**351.3 ft to 361.3 ft (Run No. 57)** **LIMESTONE** - Same as previous run. Joints at 351.9' and 352.5' with iron staining.		351.3 / 529.2	57			530						J, R, FE J, R, FE		
360	AQ Core															
365	AQ Core	**361.3 ft to 371.3 ft (Run No. 58)** **LIMESTONE** - Same as previous run. All breaks in run are mechanical.		361.3 / 527.6	58											
370	AQ Core															
375	AQ Core	**371.3 ft to 381.3 ft (Run No. 59)** **LIMESTONE** - Light gray to dark gray; very slight weathering; sound; moderately close joint spacing; moderately hard to a distance of 375.9 feet. From 375.9 feet to 377.7 feet rock is dark gray; moderately weathered with areas weathered to gray clay; interbedded thin shale partings at approximately 10 degrees; pressure solution features throughout; moderately hard. From 377.7 feet to 381.3 feet Limestone is gray with very slight weathering; sound; moderately close joint spacing; crystalline; hard.		371.3	59									Azimuth: 308.41 Inclination: -3.8		
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 13 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
380				525.9	59											
		381.3 ft to 390.9 ft (Run No. 60) **LIMESTONE** - Gray; fine grained; very slight weathering; sound; moderately close joint spacing with joint at 385.4 feet with iron staining. From 385.9 feet to 390.9 feet rock is light gray; very slight weathering; sound; moderately close joint spacing; moderately hard; with fossils and rip-up clasts. Note: Run stopped at 390.6 feet because inner barrel blocked off.		381.3												
385					60			525						J, R, FE		
390				524.3												
		390.9 ft to 400.9 ft (Run No. 61) **LIMESTONE** - Gray; very slight weathering; sound; moderately hard; moderately close joint spacing; trace fossils; fine grained with pressure solution features throughout. **Note: Tunnel face begins at 400.0 feet.**		390.9												
395	AQ Core				61											
400				522.7												
		400.9 ft to 410.9 ft (Run No. 62) **LIMESTONE** - Gray; very slight weathering out to a distance of 408.9 feet then is moderately to severly weathered and soft to moderately hard to a distance of 409.6 feet. From 409.6 feet rock is hard, sound, and slightly weathered. Entire run is fine grained with pressure solution features and occasional thin shale partings.		400.9												4522 976
405					62											
														Azimuth: 308.17 Inclination: -3.3		
410		*--- CONTINUED NEXT PAGE ---*														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 14 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
410				521.0	62											
		410.9 ft to 420.9 ft (Run No. 63) **LIMESTONE** - Gray; very slight weathering; moderately hard; sound; moderately close joint spacing with joint at 418.9' with iron staining; fine grained with pressure solution features throughout.		410.9	63			520						J, R, FE		
420				519.4												
	AQ Core	**420.9 ft to 430.9 ft (Run No. 64)** **LIMESTONE** - Gray; very slight weathering; hard; sound; moderately close joint spacing with joint at 426.5'; crystalline matrix; occasional thin calcite veins present.		420.9	64									J, R		
430				517.7												
		430.9 ft to 440.9 ft (Run No. 65) **LIMESTONE** - Same as previous run. Joint at 435.5 with iron staining.		430.9	65									J, R, FE Azimuth: 308.85 Inclination: -2.83		
440				516.1												
				440.9	66											
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 15 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
445	4/14/2011 AQ Core	**440.9 ft to 450.9 ft (Run No. 66)** **LIMESTONE** - Same as previous run. Note: Rock core has several mechanical fractures caused by too great of a turn with the directional tools. Begin NQ size core to correct over steer at 450.9 feet. **443.5 ft to 452.7 ft (Run No. 67)** **LIMESTONE** - Rock core was cut below existing angle cut of Run No. 66. Rock is same as previous.			66 67			515								
450				514.2												
455	NQ Core	**452.7 ft to 462.7 ft (Run No. 68)** **LIMESTONE** - Same as previous run. Joint at 455.2 feet with slight weathering.		452.7	68									J, R		
460				512.5												7011
465	4/16/2011	**462.7 ft to 468.4 ft (Run No. 69)** **LIMESTONE** - Gray; very slight weathering; sound; moderately hard; fine grained; moderately close joint spacing; occasional thin calcite veins.		462.7	69											
470	AQ Core	**468.4 ft to 478.4 ft (Run No. 70)** **LIMESTONE** - Same as previous run. Note: Begin AQ Directional Core at 468.4 feet.		511.6 468.4	70									Azimuth: 308.07 Inclination: -2.4		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 16 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
475		**468.4 ft to 478.4 ft (Run No. 70)** **LIMESTONE** - Same as previous run. Note: Begin AQ Directional Core at 468.4 feet.		509.9	70			510								
480	AQ Core	**478.4 ft to 488.5 ft (Run No. 71)** **LIMESTONE** - Gray; very slight weathering; sound; moderately hard; fine grained; close to moderately close joint spacing with the majority of breaks being mechanical because of directional drilling; with dark gray pressure solution features.		478.4	71											
485	4/17/2011															
490	NQ Core			508.2 488.5	73									J, R J, R J, R J, R		
495	4/22/2011				74 72											
500	HQ Core			506.9	75 80 81									J, R Azimuth: 308.07 Inclination: -2.4 J, R J, R		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	FLUSH	COLOR % RETURN	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---															
505	4/17/2011 HQ Core	**488.5 ft to 498.6 ft (Run No. 72)** **LIMESTONE** - Same as previous run with joints at 489.5', 489.7', 491.6', and 493.0'. Note: Begin over steer correction with NQ core at 488.5 feet.			75 82 82				505								
	AQ Core	**488.5 ft to 492.4 ft (Run No. 73)** **LIMESTONE** - Same as previous run.															
		492.4 ft to 496.7 ft (Run No. 74) **LIMESTONE** - Same as previous run.			83 76												
510	4/22/2011	Note: Run Numbers 73 and 74 drilled in standard NQ core to correct over steer. Over lap of rock core from Run 72.															
		496.7 ft to 506.8 ft (Run No. 75) **LIMESTONE** - Gray; very slight weathering; moderately hard with soft zones at pressure solution features at 504.7' and 505.7'. Moderately close joint spacing with joints at 497.7', 503.1', 503.7'; sound (breaks are mechanical); fine grained; with pressure solution features.															
515		**506.8 ft to 511.0 ft (Run No. 76)** **LIMESTONE** - Same as previous run; all breaks are mechanical resulting from the directional barrel.			77 84												
		511.0 ft to 521.0 ft (Run No. 77) **LIMESTONE** - Gray; very slight weathering; sound with breaks being mechanical; moderately close joint spacing; moderately hard; fine grained with dark gray pressure solution features.															
520		**521.0 ft to 531.0 ft (Run No. 78)** **LIMESTONE** - Same as previous run. Note: NQ Cored from 521.0 ft to 531.0 ft to correct for over steer of directional barrel.															1105
	NQ Core	**531.0 ft 541.0 ft (Run No. 79)** **LIMESTONE** - Gray; very slight weathering; moderately hard; sound; moderately close joint spacing; crystalline; greenish gray pressure solution features which are softer than the surrounding gray limestone. Note: This run was recovered during casing advancement. The NQ core barrel was advanced without the inner barrel. The rock was fractured during retrieval.			78 85												
525		**496.0 ft to 500.4 ft (Run No. 80)** **LIMESTONE** - Light gray; very slight weathering; sound; moderately close joint spacing; crystalline with fine grained pressure solution features. Note: While advancing the HQ casing encountered directional NQ cut off at 488.5 feet and casing could not advance past cut off. Begin HQ core at 496 feet after going between cut off borings between 488.5 and 498.6 feet.															
530		**500.8 ft to 502.1 ft (Run No. 81)** **LIMESTONE** - Same as previous run.															
		502.1 ft to 507.4 ft (Run No. 82) **LIMESTONE** - Same as previous run. Becomes more crystalline with depth.			86										Azimuth: 308.96 Inclination: -2.6		
535		**507.4 ft to 510.9 ft (Run 83)**															
		--- CONTINUED NEXT PAGE ---															

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 18 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
	NQ Core 4/24/2011	LIMESTONE **- Same as previous.** 510.9 ft to 520.9 ft (Run 84) LIMESTONE **- Light gray; very slight weathering; sound; crystalline; with pressure solution features; moderately hard; all breaks within core are mechanical.** **Note: Begin standard NQ core at 510.9 feet.** 520.9 ft to 531.1 ft (Run No. 85) LIMESTONE **- Same as previous run. All breaks mechanical.**			86 79 79			500					J, R J, R J, R		
540				499.5												
		531.1 ft to 541.3 ft (Run No. 86) **LIMESTONE** - (From a distance of 531.1 feet to 535.3 feet) Light gray; very slight weathering; sound; crystalline; hard. **From 535.3 ft to 540.4 ft LIMESTONE** - Light gray; very slight weathering; sound; close joint spacing with joints at 536.1', 536.7', 537.9'; pressure solution features become more frequent from 535.3' and are dark gray, fine grained and softer than the surrounding gray crystalline rock. **From 540.4 ft to 541.3 ft LIMESTONE** - Light gray with dark gray pressure solution features; moderately hard; moderately fractured with fracture occuring at low angle to horizontal along pressure solution feature; moderately weathered with rock weathered to clay along some areas of the fracture. Note: Begin AQ directional core at 541.3 feet.		541.3										
545					87											
550				497.9												
	AQ Core	**541.3 ft to 551.3 ft (Run No. 87)** **LIMESTONE** - Light gray; very slight weathering; sound; moderately close joint spacing; moderately hard with dark gray, fine grained, pressure solution features surrounded by gray crystalline limestone.		551.3												
555		**551.3 ft to 561.3 ft (Run No. 88)** **LIMESTONE** - Same as previous run. All breaks are mechanical.			88											
560				496.2												
				561.3												
		561.3 ft to 571.3 ft (Run No. 89) **LIMESTONE** - Same as previous run. Joint at 562.8', 564.0', 567.8'. Horizontal pressure solution feature, soft, with fracture occuring along feature from 569.3' to 569.9'.			89									J, R J, R Azimuth: 309.06 Inclination: -1.77		
565																
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
570	AQ Core	**561.3 ft to 571.3 ft (Run No. 89)** **LIMESTONE** - Same as previous run. Joint at 562.8', 564.0', 567.8'. Horizontal pressure solution feature, soft, with fracture occuring along feature from 569.3' to 569.9'.		494.6	89			495						J, R		
575		**571.3 ft to 581.3 ft (Run No. 90)** **LIMESTONE** - Same as previous run with pressure solution features becoming less frequent. Joints at 571.8', 574.3', 576.3', 577.1', 579.3', 580.5'.		571.3	90									J, R J, R J, R J, R J, R J, R		
580				492.9												
585		**581.4 ft to 591.4 ft (Run No. 91)** **LIMESTONE** - Light gray; very slight weathering; sound; moderately close joint spacing; moderately hard; crystalline with very thin dark gray pressure solution features.		581.4	91											31353
590				491.3												
595		**591.4 ft to 601.5 ft (Run No. 92)** **LIMESTONE** - Same as previous run.		591.4	92									Azimuth: 308.69 Inclination: -1.07		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER FT (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 250 500 750)	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
600	AQ Core	**591.4 ft to 601.5 ft (Run No. 92)** **LIMESTONE** - Same as previous run.		489.6	92			490								
605	AQ Core	**601.5 ft to 611.5 ft (Run No. 93)** **LIMESTONE** - Same as previous run. Dark gray pressure solution feature at 604.7', soft, fine grained, moderately fractured at 608.1'.		601.5 488.0	93											
610	AQ Core															
615	AQ Core	**611.5 ft to 621.5 ft (Run No. 94)** **LIMESTONE** - Same as previous run. From 615.9' to 617.1' dark gray pressure solution feature, severly weathered, soft, fractured.		611.5 486.3	94											
620	4/26/2011															
625	HQ Core	**621.5 ft to 626.9 ft (Run No. 95)** **LIMESTONE** - Light gray; slightly weathered; moderately hard; crystalline with dark gray thin shale parting starting at 620.2' to 624.1'. Shale is soft, clayey and fractures easily. At 624.1' crystalline limestone is encountered. Note: Begin HQ Core at 621.5 feet.		621.5 485.4	95											
630	HQ Core	**626.9 ft to 632.0 ft (Run No. 96)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; crystalline with large calcite crystals visible at fresh breaks; with pressure solution features.		626.9	96			485						Azimuth: 308.56 Inclination: -0.46		
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 21 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
				484.6	96											
		632.0 ft to 635.9 ft (Run No. 97) **LIMESTONE** - Same as previous run.		632.0 / 483.9	97											
635																
		635.9 ft to 640.9 ft (Run No. 98) **LIMESTONE** - Same as previous run; from 640.6' to 640.9' weathered fracture with clay; Joints at 637.3', 638.6', 638.9', 639.1', 645.1', 640.8'.		635.9 / 483.1	98									J, R J, R J, R J, R		
640																
		640.9 ft to 646.3 ft (Run No. 99) **LIMESTONE** - Gray; very slight weathering; slightly fractured with fractures occuring along pressure solution feature at 640.9' to 643.3'. Fracture contains gray clay and iron staining; limestone beyond fracture is gray, crystalline, moderately hard.		640.9 / 482.2	99									J, R		19774
645	HQ Core															
		646.3 ft to 651.3 ft (Run No. 100) **LIMESTONE** - Light gray; very slight weathering; sound; hard; crystalline; stylolitic features.		646.3 / 481.4	100											
650																
		651.3 ft to 656.7 ft (Run No. 101) **LIMESTONE** - Same as previous run; Fracture at 653.9' (approximately 40 degrees).		651.3 / 480.5	101				<<							
655																
		656.7 ft to 661.9 ft (Run No. 102) **LIMESTONE** - Same as previous run.		656.7 / 479.7	102			480						Azimuth: 309.36 Inclination: -0.47		
660																
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 22 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	FLUSH	COLOR % RETURN	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---															
665	HQ Core	**661.9 ft to 667.0 ft (Run No. 103)** **LIMESTONE** - Same as previous run.		661.9 / 478.8	103												
670	HQ Core	**667.0 ft to 672.0 ft (Run No. 104)** **LIMESTONE** - Same as previous run; Fracture at 668.4' to 668.6'; Joint at 671.0'.		667.0 / 478.0	104										J, R		
675	HQ Core	**672.0 ft to 677.0 ft (Run No. 105)** **LIMESTONE** - Gray; very slight weathering; moderately hard; sound; crystalline; occasional thin white calcite veins; weathered fracture at 676.5' to 676.6'.		672.0 / 477.2	105												
680	HQ Core	**677.0 ft to 682.0 ft (Run No. 106)** **LIMESTONE** - Same as previous run. All breaks mechanical.		677.0 / 476.3	106												
685	HQ Core	**682.0 ft to 687.0 ft (Run No. 107)** **LIMESTONE** - Same as previous run. Joint at 685.0'.		682.0 / 475.5	107										J, R		
690	HQ Core	**687.0 ft to 692.0 ft (Run No. 108)** **LIMESTONE** - Same as previous run. Joint at 689.8' occurs along calcite vein; Fracture at 690.5' occurs along stylolitic feature.		687.0 / 474.7	108				475						J, SM		
	HQ Core	**692.0 ft to 697.0 ft (Run No. 109)** **LIMESTONE** - Same as previous run. Joint at 694.3'.		692.0	109										Azimuth: 309.36 Inclination: -0.47		
		--- CONTINUED NEXT PAGE ---															

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 23 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
695	HQ Core	**692.0 ft to 697.0 ft (Run No. 109)** **LIMESTONE** - Same as previous run. Joint at 694.3'.		473.9	109									J, R		
700	HQ Core	**697.0 ft to 702 ft (Run No. 110)** **LIMESTONE** - Light gray; very slight weathering; hard; sound; crystalline; occasional white calcite veins; thin dark gray pressure solution features present.		697.0 / 473.0	110											
705	HQ Core	**702.0 ft to 707.0 ft (Run No. 111)** **LIMESTONE** - Light gray; very slight weathering; hard; sound; crystalline; occasional white calcite veins; thin dark gray pressure solution features present; Joint at 703.3'.		702.0 / 472.2	111									J, R		25285
710	HQ Core	**707.0 ft to 711.9 ft (Run No. 112)** **LIMESTONE** - Same as previous run. Joint at 708.3'.		707.0 / 471.4	112									J, R		
715	HQ Core	**711.9 ft to 717.0 ft (Run No. 113)** **LIMESTONE** - Same as previous run. All breaks are mechanical.		711.9 / 470.6	113											
720	HQ Core	**717.0 ft to 722.0 ft (Run No. 114)** **LIMESTONE** - Same as previous run. Joint at 721.1'. Note: Terminate HQ core at 722.0' and begin AQ directional core.		717.0 / 469.7	114			470						J, R		
725	NQ Core	**722.0 ft to 732.0 ft (Run No. 115)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; moderately close to wide joint spacing; occasional white calcite veins. All breaks are mechanical.		722.0	115									Azimuth: 309.36 Inclination: -0.47		
		--- CONTINUED NEXT PAGE ---														

4/27/2011

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 24 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
725	NQ Core	**722.0 ft to 732.0 ft (Run No. 115)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; moderately close to wide joint spacing; occasional white calcite veins. All breaks are mechanical.		468.1	115											
730				732.0												
735		**732.0 ft to 741.6 ft (Run No. 116)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; moderately close to wide joint spacing with joint at 740.1 feet; occasional white calcite veins.			116									J, SM		
740	4/29/2011			466.5												
745	AQ Core	**741.6 ft to 751.6 ft (Run No. 117)** **LIMESTONE** - Same as previous run. Joint at 745.0'. Note: Begin AQ core directional drilling at 741.6 feet.		741.6	117			465						J, R		
750				464.9												
755		**751.6 ft to 761.6 ft (Run No. 118)** **LIMESTONE** - Same as previous run. Joint at 753.0'.		751.6	118									J, R Azimuth: 309.89 Inclination: -1.12		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 25 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
760	AQ Core	**751.6 ft to 761.6 ft (Run No. 118)** **LIMESTONE** - Same as previous run. Joint at 753.0'.		463.2	118											
765		**761.6 ft to 771.6 ft (Run No. 119)** **LIMESTONE** - Same as previous run. All breaks are mechanical.		461.6	119											32633
770																
775		**771.6 ft to 781.6 ft (Run No. 120)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; moderately close to wide joint spacing with joints at 775.2', 775.4', 776.4', 781.2'; occasional white calcite veins.		459.9	120			460						J, R J, R J, R J, R		
780																
785		**781.6 ft to 791.6 ft (Run No. 121)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; moderately close to wide joint spacing; occasional thin white calcite veins; crystalline.		781.6	121									Azimuth: 310.25 Inclination: -0.63		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 26 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
790	AQ Core	**781.6 ft to 791.6 ft (Run No. 121)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; moderately close to wide joint spacing; occasional thin white calcite veins; crystalline.		458.3	121											
				791.6												
795		**791.6 ft to 801.6 ft (Run No. 122)** **LIMESTONE** - Same as previous run. Joints at 797.2' and 799.9'.			122									J, R		
800				456.6										J, R		
				801.6										J, R		
805		**801.6 ft to 811.6 ft (Run No. 123)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; moderately close to wide joint spacing with joints at 802.9' and 809.4'; Fracture at 810.6'; occasional white calcite veins.			123											
810				455.0				455						J, R		
				811.6												
815		**811.6 ft to 821.6 ft (Run No. 124)** **LIMESTONE** - Same as previous run; Joint at 816.6' Note: Begin HQ core at 821.6'			124									J, R		
														Azimuth: 309.43 Inclination: -0.6		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 27 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
820	5/3/2011 AQ Core			453.4	124											
		821.0 ft to 827.6 (Run No. 125) **LIMESTONE** - Gray; very slight weathering; hard; sound; moderately close joint spacing with joint at 822.2'; cyrstalline; with occasional thin white calcite veins.		821.0									J, R		25693
825					125											
				452.3												
		827.6 ft to 837.5 ft (Run No. 126) **LIMESTONE** - Same as previous run. All breaks mechanical.		827.6	126											
830																
835	HQ Core															
				450.7												
		837.5 ft to 847.5 ft (Run No. 127) **LIMESTONE** - Gray; very slight weathering; hard; sound; moderately close joint spacing; cyrstalline; with occasional thin white calcite veins. All breaks mechanical.		837.5	127			450								
840																
845				449.1												
		847.5 ft to 857.5 ft (Run No. 128) **LIMESTONE** - Same as previous run; Joint at 854.4'		847.5	128								Azimuth: 309.43 Inclination: -0.6			
850		*--- CONTINUED NEXT PAGE ---*														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 28 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
855	HQ Core	**847.5 ft to 857.5 ft (Run No. 128)** **LIMESTONE** - Same as previous run; Joint at 854.4'		447.4 / 857.5	128									J, R		
860	HQ Core	**857.5 ft to 867.5 ft (Run No. 129)** **LIMESTONE** - Same as previous run; Joints at 859.1', 859.2' occuring at approximately 60 degrees.		445.8 / 867.5	129									J, R J, R		
870	HQ Core	**867.5 ft to 877.1 ft (Run No. 130)** **LIMESTONE** - Same as previous run; Joints at 874.8' and 875.5'.		444.2 / 877.1	130			445						J, R J, R		
880	HQ Core	**877.1 ft to 887.3 ft (Run No. 131)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; crystalline; wide joint spacing; All breaks mechanical.			131									Azimuth: 309.00 Inclination: -2.2		16610
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
885	HQ Core	**877.1 ft to 887.3 ft (Run No. 131)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; crystalline; wide joint spacing; All breaks mechanical.		442.5	131											
890		**887.3 ft to 897.3 ft (Run No. 132)** **LIMESTONE** - Same as previous run; Joints at 889.5' (with black oxide staining), 891.5'.		440.8	132									J, FE, R J, R		
895																
900		**897.3 ft to 907.3 ft (Run No. 133)** **LIMESTONE** - Same as previous run; Joints at 901.3' and 902.9'.		439.2	133			440						J, R J, R		
905																
910		**907.3 ft to 917.3 ft (Run No. 134)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; crystalline; wide joint spacing; All breaks mechanical.		907.3	134									J, R Azimuth: 309.08 Inclination: -2.24		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 30 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER FT (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 250 500 750)	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
915	HQ Core	**907.3 ft to 917.3 ft (Run No. 134)** **LIMESTONE** - Light gray; very slight weathering; sound; hard; crystalline; wide joint spacing; All breaks mechanical.		437.5	134											
				917.3												
920		**917.3 ft to 927.5 (Run No. 135)** **LIMESTONE** - Same as previous run. Joints at 923.3', 923.8', 925.3'.			135									J, R J, R		
925				435.9										J, R		
				927.5												
930		**927.5 ft to 937.5 ft (Run No. 136)** **LIMESTONE** - Same as previous run; All breaks are mechanical.			136			435								
935				434.2												
				937.5												
940		**937.5 ft to 947.5 ft (Run No. 137)** **LIMESTONE** - Light gray; very slight weathering; hard; sound; crystalline; with occasional thin white calcite veins; wide joint spacing with fracture at 938.4 feet.			137									Azimuth: 308.82 Inclination: -2.82		
945																13701
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 31 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														13701
	HQ Core	**937.5 ft to 947.5 ft (Run No. 137)** **LIMESTONE** - Light gray; very slight weathering; hard; sound; crystalline; with occasional thin white calcite veins; wide joint spacing with fracture at 938.4 feet.		432.6 / 947.5	137											
950	HQ Core	**947.5 ft to 957.5 ft (Run No. 138)** **LIMESTONE** - Light gray; very slight weathering; hard; sound; crystalline; with occasional thin white calcite veins; close to moderately close joint spacing, joints at 951.1' and 954.5' both occuring along calcite veins.			138									J, SM J, SM		
955	HQ Core			430.9 / 957.5												
960	HQ Core	**957.5 ft to 967.5 ft (Run No. 139)** **LIMESTONE** - Same as previous run; Joint at 963.5'; Fracture at 965.2' to 965.4'. Note: Terminate HQ core at 967.5 ft and begin directional AQ core.			139			430						J, R		
965	HQ Core			429.3 / 967.5												
970	NQ Core	**967.5 ft to 977.0 ft (Run No. 140)** **LIMESTONE** - Same as previous run; Fracture at 976.6' along calcite vein.			140											
975	NQ Core			427.7										Azimuth: 308.82 Inclination: -2.82		
		--- CONTINUED NEXT PAGE ---														

5/4/2011

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 32 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
980	5/7/2011 NQ Core	**977.0 ft to 983.1 ft (Run No. 141)** **LIMESTONE** - Same as previous run. Note: Terminate NQ core and begin AQ directional core.		977.0 426.7	141											
985		**983.1 ft to 991.1 ft (Run No. 142)** **LIMESTONE** - Light gray; very slight weathering; moderately hard; moderately close joint spacing with joints at 983.5' and 988.3'; with pressure solution features throughout.		983.1 425.4	142									J, R		
990														J, R		
995	AQ Core	**991.1 ft to 1001.1 ft (Run No. 143)** **LIMESTONE** - Same as previous run; Joints at 995.4'; Fracture at 996.8'; Calcite vugs at 997.0' and 997.9'.		991.1 423.7	143			425						J, R		
1000		**1001.1 ft to 1011.1 ft (Run No. 144)** **LIMESTONE** - Light gray; very slight weathering; slightly fractured with fractures at 1006.4' and 1008.7'. The fracture at 1008.7' occured along dark gray pressure solution feature. Limestone is hard, crystalline, with dark gray, fine grained, moderately hard pressure solution features.		1001.1	144									Azimuth: 309.00 Inclination: -2.37		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 33 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1010	AQ Core			422.1	144											15948
1015		**1011.1 ft to 1021.1 ft (Run No. 145)** **LIMESTONE** - Light gray; very slight weathering; hard; moderately close to close joint spacing with joints at 1018.7', 1019.1', and 1020.1'. Joint at 1020.1' has moderate weathering and clay. Limestone is hard, crystalline, with dark gray, fine grained pressure solution features that are moderately hard.		1011.1 / 420.4	145									J, R J, R J, R		
1020																
1025		**1021.1 ft to 1025.2 ft (Run No. 146)** **LIMESTONE** - Same as previous run with less frequent pressure solution features. Joints at 1021.3', 1022.0', 1022.4', and 1022.6'.		1021.1 / 419.8	146			420						J, R J, R J, R J, R		
1030		**1025.2 ft to 1031.1 ft (Run No. 147)** **LIMESTONE** - Same as previous run. Joints at 1027.8', 1029.9'.		1025.2 / 418.8	147									J, R J, R		
1035		**1031.1 ft to 1041.3 ft (Run No. 148)** **LIMESTONE** - Same as previous run. Calcite crystals present at 1033.4'; Fractures at 1034.8' and 1038.4'.		1031.1	148									Azimuth: 309.28 Inclination: -1.78		
1040		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 34 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
1040		*--- CONTINUED FROM PREVIOUS PAGE ---*														
	AQ Core			417.1	148											
		1041.3 ft to 1051.3 ft (Run No. 149) **LIMESTONE** - Light gray, very slight weathering; moderately hard; sound; moderately close joint spacing; crystalline; with pressure solution features increasing with distance.		1041.3	149											
1045																
1050				415.5												
		1051.3 ft to 1061.3 ft (Run No. 150) **LIMESTONE** - Gray; very slight weathering; moderately hard with moderately close to wide joint spacing; fine grained with dark gray pressure solution features. Note: Terminate AQ directional core and begin NQ core at 1061.3 feet.		1051.3	150			415								
1055																
1060	5/8/2011			413.8												
	NQ Core			1061.3												
1065		**1061.3 ft to 1071.2 ft (Run No. 151)** **LIMESTONE** - Light gray; very slight weathering; moderately hard; with wide joint spacing; crystalline with fine grained pressure solution features; occasional thin white calcite veins.			151									Azimuth: 309.29 Inclination: -1.34		
1070				412.2												
				1071.2	152											
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 35 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1075	NQ Core 5/13/2011	**1071.2 ft to 1077.2 ft (Run No. 152)** **LIMESTONE** - Light gray; very slight weathering; moderately hard; wide joint spacing; fine grained with dark gray pressure solution features and occasional thin, white calcite veins. Note: Terminate NQ core and begin AQ directional core at 1077.2 feet.		411.2	152											19101
1080	AQ Core	**1077.2 ft to 1081.4 ft (Run No. 153)** **LIMESTONE** - Light gray; very slight weathering; moderately hard; wide joint spacing; crystalline; with thin, dark gray, fine grained pressure solution features.		1077.2 410.5	153											
1085		**1081.4 ft to 1091.4 ft (Run No. 154)** **LIMESTONE** - Same as previous run. All breaks mechanical.		1081.4	154			410								
1090				408.8												
1095		**1091.4 ft to 1101.3 ft (Run No. 155)** **LIMESTONE** - Same as previous run. All breaks mechanical.		1091.4	155									Azimuth: 309.90 Inclination: -1.13		
1100				407.2												
				1101.3	156											
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 36 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1105	AQ Core	**1101.3 ft to 1111.3 ft (Run No. 156) LIMESTONE** - Gray; very slight weathering; moderately hard; fine grained; with dark gray pressure solution features; moderately close joint spacing; fracture at 1102.1' to 1102.4'. Muliple mechanical breaks caused by high water pressure during drilling.		405.6	156			405								
1110				1111.3										J, R, CL		
1115		**1111.3 ft to 1121.3 ft (Run No. 157) LIMESTONE** - Light gray to gray; very slight weathering; close joint spacing with joints at 1112.8', 1114.1', and 1120.8'. Joints are weathered to clay at openings; moderately hard limestone with slightly softer dark gray pressure solution features; fine grained.			157								J, R, CL		
1120				403.9										J, R, CL		
1125		**1121.3 ft to 1131.3 ft (Run No. 158) LIMESTONE** - Light gray; very slight weathering; wide joint spacing; moderately hard; fracture at 1121.6' along pressure solution feature; limestone is crystalline with evidence of turbid deposition.		1121.3	158											
1130				402.3										Azimuth: 309.72 Inclination: -0.81		
		1131.3 ft to 1141.3 ft (Run No. 159) LIMESTONE - Same as previous run. All breaks mechanical. Note: Terminate AQ directional core at 1141.3 feet and begin NQ size core.		1131.3	159											
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1135	AQ Core 5/16/2011	**1131.3 ft to 1141.3 ft (Run No. 159)** **LIMESTONE** - Same as previous run. All breaks mechanical. Note: Terminate AQ directional core at 1141.3 feet and begin NQ size core.		400.6	159											18778
1140				1141.3												
1145		**1141.3 ft to 1147.2 ft (Run No. 160)** **LIMESTONE** - Light gray; very slight weathering; wide joint spacing; moderately hard; fine grained with thin crystalline lenses and dark gray pressure solution features.		399.6	160			400								
1150	NQ Core			1147.2												
1155		**1147.2 ft to 1157.2 ft (Run No. 161)** **LIMESTONE** - Same as previous run.		398.0	161											
1160				1157.2												
1165		**1157.2 ft to 1167.3 ft (Run No. 162)** **LIMESTONE** - Same as previous run.			162									Azimuth: 310.47 Inclination: 0.24		
		1157.2 ft to 1167.3 ft (Run No. 162) **LIMESTONE** - Same as previous run.														
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
				396.3	162											
		1167.3 ft to 1177.4 ft (Run No. 163) **LIMESTONE** - Same as previous run out to a distance of 1170.0 feet. At 1170.0 feet rock begins to transition into light gray, fine grained, moderately hard, sound, calcareous shale **(Waldron Shale)**		1167.3												
1170				395.9 1170.0	163											
1175								395								
		1177.4 ft to 1187.4 ft (Run No. 164) **SHALE** - Light gray; fine grained; calcareous; pyrite at 1189.6'; moderately hard; sound; wide joint spacing; fracture at 1184.5 feet.														
1180	NQ Core				164											
1185				393.0												
				1187.4												
1190		**1187.4 ft to 1197.2 ft (Run No. 165)** **SHALE** - Light gray; very slight weathering; sound; wide joint spacing; moderately hard; fine grained; with darker gray shale partings.			165									Azimuth: 311.09 Inclination: -0.1		10330
1195				391.4												
				1197.2	166											
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1200	NQ Core	**1197.2 ft to 1207.2 ft (Run No. 166)** **SHALE** - Same as previous run.		389.8	166			390								
1205	NQ Core	**1207.2 ft to 1217.2 ft (Run No. 167)** **SHALE** - Same as previous run; Fracture at 1208.4 feet.		1207.2 / 388.1	167											
1210	NQ Core	**1217.2 ft to 1227.0 ft (Run No. 168)** **SHALE** - Same as previous run; Fracture at 1220.8 feet along stylolitic feature.		1217.2 / 386.5	168									Azimuth: 311.09 Inclination: -0.1		
1215	NQ Core	**1227.0 ft to 1237.1 ft (Run No. 169)** **SHALE** - Same as previous run; All breaks mechanical.		1227.0	169											
1220		*--- CONTINUED NEXT PAGE ---*														
1225																

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 40 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1230	NQ Core	**1227.0 ft to 1237.1 ft (Run No. 169)** **SHALE** - Same as previous run; All breaks mechanical.			169											
1235				384.8				385								
1240		**1237.1 ft to 1247.1 ft (Run No. 170)** **SHALE** - Light gray; very slight weathering; sound; wide joint spacing; fine grained; moderately hard; calcareous; with darker gray thin shale partings, thin white calcite veins, and occasional thin crystalline lenses.		1237.1	170											
1245				383.2												
1250		**1247.1 ft to 1257.1 ft (Run No. 171)** **SHALE** - Same as previous run; All breaks mechanical		1247.1	171											15860
1255				381.5												
1260		**1257.1 ft 1267.0 ft (Run No. 172)** **SHALE** - Same as previous run; All breaks mechanical		1257.1	172									Azimuth: 311.09 Inclination: -0.41		
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1265	NQ Core	**1257.1 ft 1267.0 ft (Run No. 172)** **SHALE** - Same as previous run; All breaks mechanical		379.9	172			380								
1270	NQ Core	**1267.0 ft to 1277.2 ft (Run No. 173)** **SHALE** - Same as previous run. All breaks mechanical.		1267.0 / 378.2	173											
1280	NQ Core	**1277.2 ft to 1287.2 ft (Run No. 174)** **SHALE** - Light gray; very slight weathering; sound; moderately hard; wide joint spacing; fine grained; calcareous; occasional thin crystalline lenses; with darker gray thin shale partings. Thin shale partings are softer than surrounding calcareous shale and rock breaks mechanically along these features.		1277.2 / 376.6	174											
1290	NQ Core	**1287.2 ft to 1297.2 ft (Run No. 175)** **SHALE** - Light gray; very slight weathering; sound; moderately hard; wide joint spacing; fine grained; calcareous; with thin dark gray shale partings which are softer than the surrounding shale; all breaks mechanical.		1287.2	175									Azimuth: 309.51 Inclination: -0.55		
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 42 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1295	NQ Core	**1287.2 ft to 1297.2 ft (Run No. 175)** **SHALE** - Light gray; very slight weathering; sound; moderately hard; wide joint spacing; fine grained; calcareous; with thin dark gray shale partings which are softer than the surrounding shale; all breaks mechanical.		374.9	175			375								
1300	NQ Core	**1297.2 ft to 1302.5 ft (Run No. 176)** **SHALE** - Same as previous run. All breaks mechanical.		1297.2 / 374.0	176											
1305	AQ Core	**1302.5 ft to 1311.2 ft (Run No. 177)** **SHALE** - Same as previous run; All breaks mechanical.		1302.5 / 372.6	177											
1310	AQ Core	**1311.2 ft to 1320.4 ft (Run No. 178)** **SHALE** - Same as previous run with close joint spacing; Joints at 1312.5', 1313.0', 1313.2', 1316.0', 1319.7'; Joint at 1319.7' is weathered and soft.		1311.2 / 371.1	178									J, R J, R J, R J, R J, R, CL Azimuth: 310.77 Inclination: -0.88		10364
1315	AQ Core	**1320.4 ft to 1330.3 ft (Run No. 179)** **SHALE** - Same as previous run; All breaks mechanical.		1320.4	179											
		--- CONTINUED NEXT PAGE ---														

5/20/2011

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 43 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE; F-FAULT; SM-SMOOTH; FL-FLEXURED; BC-BROKEN CORE
CL-CLEAVAGE; J-JOINT; R-ROUGH; UE-UNEVEN; MB-MECH. BREAK
SH-SHEAR; P-POLISHED; ST-STEPPED; W-WAVY; B-BEDDING
VN-VEIN; S-SLICKENSIDED; PL-PLANAR; C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER FT (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec (10^{-6} 10^{-5} 250 500 750)	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1325	AQ Core	**1320.4 ft to 1330.3 ft (Run No. 179)** **SHALE** - Same as previous run; All breaks mechanical.		369.5	179			370								
1330				1330.3										J, R		
1335		**1330.3 ft to 1340.3 ft (Run No. 180)** **SHALE** - Same as previous run; Joint at 1332.3'.		367.8	180											
1340				1340.3												
1345		**1340.3 ft to 1350.1 ft (Run No. 181)** **SHALE** - Light gray; very slight weathering; sound; moderately hard; wide joint spacing; fine grained; with dark gray soft shale partings; calcareous.			181											
1350				366.2												
		1350.1 ft to 1360.1 ft (Run No. 182) **SHALE** - Gray; moderately weathered; soft; moderately fractured. Shale is fractured along dark gray shale partings. Severly fractured at 1355.8' to 1357.3' and at 1357.9' to 1360.1' with areas weathered to clay. Both fractures are parallel to core (0 degrees) and both fractures are very soft shale.		1350.1	182									Azimuth: 311.47 Inclination: -1.8		
1355		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 44 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
1355		*--- CONTINUED FROM PREVIOUS PAGE ---*														
	AQ Core	**1350.1 ft to 1360.1 ft (Run No. 182)** **SHALE** - Gray; moderately weathered; soft; moderately fractured. Shale is fractured along dark gray shale partings. Severly fractured at 1355.8' to 1357.3' and at 1357.9' to 1360.1' with areas weathered to clay. Both fractures are parallel to core (0 degrees) and both fractures are very soft shale.			182			365								
1360				364.5												
	5/22/2011	**1360.1 ft to 1362.5 ft (Run No. 183)** **SHALE** - Gray; slightly weathered; moderately hard with soft dark gray shale partings; fine grained; sound. Note: Over cut with directional core and will cut out 10 feet with standard NQ. Begin NQ core at 1362.5 feet.		1360.1 / 364.1	183											
				1362.5												
1365		**1362.5 ft to 1372.7 ft (Run No 184)** **SHALE** - Dark gray; slightly weathered; moderately hard with soft dark gray thin shale partings; sound; fine grained.			184											
1370																
				362.5												
1375	NQ Core	**1372.2 ft to 1383.0 ft (Run No. 185)** **SHALE** - Same as previous run.			185											6614
1380				360.8												
				1383.0												
1385		**1383.0 ft to 1393.1 ft (Run No. 186)** **SHALE** - Same as previous run.			186									Azimuth: 312.17 Inclination: -1.6		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 45 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
	5/26/2011 NQ Core	**1383.0 ft to 1393.1 ft (Run No. 186)** **SHALE** - Same as previous run.		359.1	186			360								
1390																
	5/26/2011 AQ Core	**1393.1 ft to 1401.0 ft (Run No. 187)** **SHALE** - Light gray; slightly weathered; moderately fractured with fractures occuring at 1393.1' to 1396.1' and 1399.6' to 1400.4'. Fractures occur along thin soft dark gray shale partings. Shale is fine grained; moderately hard to soft.		1393.1	187											
1395																
1400				357.8												
		1401.0 ft to 1411.0 ft (Run No. 188) **SHALE** - Same as previous run. Fractures at 1402.9' to 1402.9' and 1405.9' to 1407.6'. Fractures occur along dark gray, thin, soft shale partings.		1401.0	188											
1405																
1410				356.2												
		1411.0 ft to 1421.1 ft (Run No. 189) **SHALE** - Light gray; slightly weathered; slightly fractured with fractures at 1411.0' to 1411.2', 1411.8' to 1412.2', and 1418.3' to 1418.6'. Fractures occur along dark gray, soft, thin shale partings. Shale is fine grained; moderately hard with soft, thin, dark gray shale partings.		1411.0	189									Azimuth: 311.73 Inclination: -1.94		
1415								355								
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1420	AQ Core	**1411.0 ft to 1421.1 ft (Run No. 189)** **SHALE** - Light gray; slightly weathered; slightly fractured with fractures at 1411.0' to 1411.2', 1411.8' to 1412.2', and 1418.3' to 1418.6'. Fractures occur along dark gray, soft, thin shale partings. Shale is fine grained; moderately hard with soft, thin, dark gray shale partings.		354.5	189											
				1421.1												
1425		**1421.1 ft to 1426.3 ft (Run No. 190)** **SHALE** - Gray; moderately weathered; soft; moderately to severly fractured throughout with fractures occuring horizontal to 60 degrees with fractures containing weathered shale and clay; Shale is soft; fine grained.		353.6	190											
				1426.3												
1430		**1426.3 ft to 1431.3 ft (Run No. 191)** **SHALE** - Gray; slightly weathered; moderately fractured from 1426.3' to 1428.0' then becomes sound rock. Shale is moderately hard to soft along fractures; fine grained.		352.8	191											9597
				1431.3												
1435		**1431.3 ft to 1441.2 ft (Run No. 192)** **SHALE** - Gray; slightly weathered; moderately hard; fine grained; sound.		351.2	192											
				1441.2												
1440		**1441.2 ft to 1451.2 ft (Run No. 193)** **SHALE** - Dark gray; slightly weathered; fine grained; soft to very soft; slightly fractured with fractures occuring parallel with core at 1441.2' to 1441.9' and at 1446.2' to 1451.2'.			193			350						Azimuth: 313.26 Inclination: -2.67		
1445		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 47 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1450				349.5	193											
		1451.2 ft to 1459.5 ft (Run No. 194) **SHALE** - Dark gray; moderately weathered with portions weathered to clay; very soft to soft; moderately fractured.		1451.2 / 348.2	194											
1455																
1460		**1459.9 ft to 1465.8 ft (Run No. 195)** **SHALE** - Same as previous run; clay seams at 1460.4', 1462.5', 1462.9'; From 1464.3' to 1465.8' rock is severly fractured with clay seams and very soft.		1459.5 / 347.1	195									CL CL CL Severly fractured with clay Severly fractured with clay		
1465	AQ Core															
1470		**1465.8 ft to 1472.1 ft (Run No. 196)** **SHALE** - Dark gray; slightly weathered and sound from 1465.8' to 1467.4'. From 1467.4 to 1472.1 shale is moderately weathered with some areas weathered to clay; moderately to severly fractured; soft.		1465.8 / 346.1	196											
		1472.1 ft to 1475.7 ft (Run No. 197) **SHALE** - Dark gray; slightly weathered; slightly fractured with fracture at 1475.1' to 1475.5'; moderately hard.		1472.1 / 345.5	197											
1475		**1475.7 ft to 1482.7 ft (Run No. 198)** **SHALE** - Dark gray; slightly weathered; moderately hard; slightly fractured with fractures at 1476.0' to 1476.3' and 1477.2' to 1478.0'; shale at fractures is soft; shale becomes more sound towards end of run.		1475.7	198			345						Azimuth: 315.27 Inclination: -2.49		
1480		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 48 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
				344.3	198											8949
1485		**1482.7 ft to 1491.2 ft (Run No. 199)** **SHALE** - Dark gray; very slight weathering; sound; moderately hard; all breaks mechanical.		1482.7	199											
1490				342.9												
1495	AQ Core	**1491.2 ft to 1501.2 ft (Run No. 200)** **SHALE** - Same as previous run; all breaks mechanical.		1491.2	200											
1500				341.3												
1505		**1501.2 ft to 1511.2 ft (Run No. 201)** **SHALE** - Same as previous run; all breaks mechanical.		1501.2	201			340						Azimuth: 315.27 Inclination: -2.49		
1510				339.6												
		1511.2 ft to 1521.2 ft (Run No. 202) **SHALE** - Same as previous run; all breaks mechanical.		1511.2	202											
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 49 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1515	AQ Core	**1511.2 ft to 1521.2 ft (Run No. 202)** **SHALE** - Same as previous run; all breaks mechanical.			202											
1520				338.0												
1525		**1521.2 ft to 1531.2 ft (Run No. 203)** **SHALE** - Dark gray; slightly weathered; slightly fractured with fractures at 1522.7' to 1523.5' and at 1529.3' to 1530.8'. Fractures occur at low angles along thin, soft, dark gray shale partings; shale is moderately hard over all. Note: Terminate AQ directional core at 1531.2 feet and begin NQ core.		1521.2	203											
1530	5/27/2011			336.3												
1535	NQ Core	**1531.2 ft to 1537.1 ft (Run No. 204)** **SHALE** - Dark gray; slightly weathered; moderately hard; sound; calcareous; fine grained.		1531.2	204											
				335.4												
1540		**1537.1 ft to 1547.1 ft (Run No. 205)** **SHALE** - Same as previous; all breaks mechanical.		1537.1	205			335						Azimuth: 315.79 Inclination: -0.28		5773
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1545	NQ Core 5/28/2011	**1537.1 ft to 1547.1 ft (Run No. 205)** **SHALE** - Same as previous; all breaks mechanical.		333.7	205											
1550	NQ Core	**1547.1 ft to 1557.4 ft (Run No. 206)** **SHALE** - Gray; very slight weathering; moderately fractured from 1547.3' to 1552.3' then becomes sound from 1552.3' to 1557.4'. Shale is moderately hard; fine grained; calcareous.		1547.1 / 332.0	206											
1555																
1560	NQ Core	**1557.4 ft to 1567.4 ft (Run No. 207)** **SHALE** - Same as previous; moderately fractured at low angle from 1561.0' to 1562.5' with clay.		1557.4 / 330.4	207											
1565																
1570		**1567.4 ft to 1574.8 ft (Run No. 208)** **SHALE** - Gray; slightly weathered; moderately hard; sound; fine grained; calcareous.		1567.4 / 329.1	208			330						Azimuth: 315.65 Inclination: 0.01		
1575				1574.8	209											
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	FLUSH	COLOR % RETURN	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---															
1580	NQ Core	**1574.8 ft to 1584.2 ft (Run No. 209)** **SHALE** - Same as previous run; all breaks mechanical.		327.6	209												
1585	NQ Core	**1584.2 ft to 1594.3 ft (Run No. 210)** **SHALE** - Same as previous run; all breaks mechanical.		1584.2 / 325.9	210												
1590	NQ Core	**1594.3 ft to 1604.3 ft (Run No. 211)** **SHALE** - Gray to light gray; very slight weathering; sound out to 1598.1'. From 1598.1' to 1600.5' severly weathered along low angle fracture. From 1600.5' to 1604.3' shale is slightly fractured; slightly weathered; moderately hard to soft.		1594.3 / 324.3	211				325								
1595	NQ Core	**1604.3 ft 1614.3 ft (Run No. 212)** **SHALE** - Gray; slightly weathered; moderately hard; sound; fine grained; calcareous.		1604.3	212										Azimuth: 315.65 Inclination: 0.01		6304
		--- CONTINUED NEXT PAGE ---															

5/29/2011

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1610	NQ Core	**1604.3 ft 1614.3 ft (Run No. 212)** **SHALE** - Gray; slightly weathered; moderately hard; sound; fine grained; calcareous.		322.6	212											
1615	NQ Core	**1614.3 ft to 1623.9 ft (Run No. 213)** **SHALE** - Same as previous run out to 1619.4'. From 1619.4' to 1621.6' shale is light gray; moderately weathered; moderately fractured at low angle. Fractured area is friable with clay. Shale is sound; soft from 1621.6' to 1622.8'. From 1622.8' to 1623.9' low angle fracture present; moderately weathered; friable with clay.		1614.3	213											
1620	NQ Core			321.0												
1625	NQ Core	**1623.9 ft to 1634.0 ft (Run No. 214)** **SHALE** - Light to dark gray; slightly weathered; moderately fractured with low angle fracture at 1623.9' to 1625.9' and at 1627.3' to 1627.9'. Shale at fractures is moderately hard to soft with clay. From 1627.9' to 1634.0' shale is sound; moderately hard.		1623.9	214			320								
1630	NQ Core			319.4												
1635	NQ Core	**1634.0 ft to 1643.2' (Run No. 215)** **SHALE** - Gray; slightly weathered; moderately fractured with low angle fractures at 1634.6' to 1648.1' and 1640.4' to 1643.2'. Fractures contain slightly weathered rock and pyrite. Shale surrounding fractures is moderately hard; fine grained.		1634.0	215									Azimuth: 315.65 Inclination: 0.01		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 53 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1640	NQ Core	**1634.0 ft to 1643.2' (Run No. 215)** **SHALE** - Gray; slightly weathered; moderately fractured with low angle fractures at 1634.6' to 1648.1' and 1640.4' to 1643.2'. Fractures contain slightly weathered rock and pyrite. Shale surrounding fractures is moderately hard; fine grained.		317.9	215											
1645	NQ Core	**1643.2 ft to 1653.0 ft (Run No. 216)** **SHALE** - Gray; slightly weathered; sound; moderately hard out to 1651.4'. Shale becomes moderately fractured with fracture occuring at low angle from 1651.4' to 1653.4' with rock being moderately hard; fine grained.		1643.2 / 316.3	216											
1650	5/30/2011															
1655	NQ Core	**1653.0 ft 1657.5 ft (Run No. 217)** **SHALE** - Gray; moderately weathered; moderately fractured with fracture occuring at low angle for length of the run. Fracture contains clay and stained shale visible along fracture; moderately hard; fine grained.		1653.0 / 315.5	217											
1660	NQ Core	**1657.5 ft to 1667.5 ft (Run No. 218)** **SHALE** - Gray; moderately weathered; severly fractured; moderately hard with soft shale along fractures. Fracture runs at low angle to horizontal with core for entire run. Shale at fracture is platy and easily broken. Trace amounts of clay are present along fracture.		1657.5 / 313.9	218			315								
1665				1667.5	219									Azimuth: 315.29 Inclination: 0.33		10051
1670		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1670	NQ Core	**1667.5 ft to 1677.5 ft (Run No. 219) SHALE** - Gray; slightly weathered; moderately fractured with low angle fracture from 1667.5' to 1670.5'; shale is platy along fracture with occasional clay. Fracture occurs along stylolite. From 1670.5' to 1677.5' shale is sound; fine grained; soft.		312.2	219											
1675				1677.5												
1680		**1677.5 ft to 1684.5 ft (Run No. 220) Shale** - Gray; slightly weathered; sound; soft out to 1680.6'. Becomes moderately weathered and severly fractured and platy.			220											
	5/31/2011			311.1												
1685		**1684.5 ft to 1687.5 ft (Run No. 221) SHALE** - Gray; moderately weathered; severly fractured with fracture occuring horizontally to core for length of run; soft to moderately hard; platy; trace clay at fracture.		1684.5	221											
				310.6												
1690	NQ Core	**1687.5 ft to 1697.5 ft (Run No. 222) SHALE** - Gray; severly to moderately weathered with portions weathered to clay. Moderately fractured with fractures containing clay at 1689.0'; moderately hard at competent shale sections (1687.8' to 1690.0' and 1691.0' to 1694.0') shale is soft and weathered along these sections.		1687.5	222			310								
1695				308.9												
1700		**1697.5 ft to 1704.1 ft (Run No. 223) SHALE** - Gray; severly to moderately weathered with clay seams at 1697.5' to 1698.2' and 1700.5' to 1701.0'. Moderately fractured with intact shale being soft and easily broken.		1697.5	223									Azimuth: 315.29 Inclination: 0.33		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE

1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling

DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP

CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1705	NQ Core	**1697.5 ft to 1704.1 ft (Run No. 223)** **SHALE** - Gray; severly to moderately weathered with clay seams at 1697.5' to 1698.2' and 1700.5' to 1701.0'. Moderately fractured with intact shale being soft and easily broken.		307.8	223											
				1704.1												
		1704.1 ft to 1712.8 ft (Run No. 224) **SHALE** - Gray; severly weathered; severly weatherd; soft with sections weathered to clay; platy at fractures; easily broken by hand. Sound, soft shale at 1704.1' to 1708.1'.		306.4	224											
1710				1712.8												
		1712.8 ft to 1718.3 ft (Run No. 225) **SHALE** - Gray; moderately weathered at 1712.8' to 1715.8' and moderately fractured; soft; trace clay. From 1715.8' to 1718.3 shale is severly weathered; severly fractured; soft; with clay.		305.5	225											
1715				1718.3												
		1718.3 ft to 1722.6 ft (Run No. 226) **SHALE** - Gray; slightly weathered; slightly fractured with fracture at 1718.3' to 1719.1'; becomes sound at 1719.1' to 1722.6' moderately hard; fine grained.		304.8	226			305								
1720	6/1/2011			1722.6												
		1722.6 ft to 1732.9 ft (Run No. 227) **SHALE** - Gray; from 1722.6' to 1730.6' shale has very slight weathering; sound; moderately hard to soft; fine grained. From 1730.6' to 1732.9' shale is severly weathered; severly fractured; soft; with clay.		303.1	227									Azimuth: 316.05 Inclination: -0.25		4431
1725	NQ Core															
1730																
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 56 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1735	NQ Core	**1732.9 ft to 1737.9 ft (Run No. 228)** **SHALE** - Gray; severly weathered; severly fractured; soft; with clay.		1732.9 / 302.3	228											
1740	NQ Core	**1737.9 ft to 1744.4 ft (Run No. 229)** **SHALE** - Gray; moderately weathered; severly fractured; soft; with clay.		1737.9 / 301.2	229											
1745	NQ Core	**1744.4 ft to 1752.4 ft (Run No. 230)** **SHALE** - Gray; moderately to severly weathered; severly fractured; soft; clay seam at approximately 1748.0' to 1751.0'.		1744.4 / 299.9	230			300								
1755	NQ Core	**1752.4 ft to 1758.1 ft (Run No. 231)** **SHALE** - Gray; moderately weathered; severly fractured; moderately hard to soft; fine grained; with clay at fractures.		1752.4 / 298.9	231											
1760	NQ Core	**1758.1 ft to 1767.5 ft (Run No. 232)** **SHALE** - Gray; slightly weathered; slightly fractured with fractures at 1760.1' to 1760.4', 1767.5' to 1763.6', and 1765.8' to 1766.0'. Fractures occur at approximately 60 degrees. Shale is moderately hard with fractures being soft and containing trace amounts of clay; calcareous shale with thin dark gray, soft, shale partings.		1758.1	232								Azimuth: 316.05 Inclination: -0.25			
		--- CONTINUED NEXT PAGE ---														

6/2/2011

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1765	NQ Core			297.4	232											
	NQ Core	**1767.5 ft to 1770.3 ft (Run No. 233)** **SHALE** - Gray; very soft; clay; 1767.5' to 1767.7' the becomes limestone at 1767.7' to 1769.1' which is very slightly weathered; sound; hard; fossiliferous. Shale resumes at 1769.1' to 1770.3' is moderately weathered; soft; severly fractured; platy; fine grained; trace clay.		1767.5	233											
1770	6/3/2011			296.9												
		1770.3 ft to 1780.3 ft (Run No. 234) **SHALE** - Dark gray; slight weathering; moderately fractured with fractures at 1772.1' to 1775.8' with clay at fracture. Shale is moderately hard to soft and can be broken by hand; clay seam at 1777.3'.		1770.3	234											
1775																
1780				295.3												7608
	NQ Core	**1780.3 ft to 1788.2 ft (Run No. 235)** **SHALE** - Dark gray; very slight weathering; slightly fractured with fractures at 1780.3' to 1780.8', 1781.3' to 1783.3'. Fractures occur at low angles to horizontal; shale is soft; fine grained out to 1783.8'. From 1783.8' to 1786.2' LIMESTONE - Gray; very slight weathering; slightly fractured; hard; oolitic; fossiliferous; clay seam within fracture at 1787.2'.		1780.3	235			295								
1785				294.0												
		1788.2 ft to 1796.3 (Run No. 236) **SHALE** - Dark gray; severly weathered; severly fractured; moderately hard at intact portions of shale to soft at fractured sections. Fractures contain clay.		1788.2	236									Azimuth: 314.79 Inclination: -0.85		
1790																
1795																
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 58 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
				292.6	236											
				1796.3												
1800	NQ Core 6/4/2011	**1796.3 ft to 1804.5 ft (Run No. 237)** **SHALE** - Gray; slightly weathered; slightly fractured; moderately hard; fine grained; calcareous.			237											
				291.3												
1805				1804.5												
		1804.5 ft to 1814.5 ft (Run No. 238) **SHALE** - Gray; slightly weathered; moderately to severly fractured with some fracturing occuring during removal from inner barrel. Clay present at fractures with fractures occuring at low angles to horizontal.			238			290								
1810																
				289.6												
1815	NQ Core			1814.5												
		1814.5 ft to 1821.2 ft (Run No. 239) **SHALE** - Gray; slightly weathered; slightly fractured; moderately hard; platy.			239											
1820				288.5												
				1821.2												
1825		**1821.2 ft to 1830.3 ft (Run No. 240)** **SHALE** - Same as previous run with clay at fractures.			240									Azimuth: 314.79 Inclination: -0.85		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1830	NQ Core 6/5/2011	**1821.2 ft to 1830.3 ft (Run No. 240)** **SHALE** - Same as previous run with clay at fractures.		287.0	240											
1835	NQ Core 6/5/2011	**1830.3 ft to 1840.3 (Run No. 241)** **SHALE** - Same as previous run with clay at fractures.		1830.3 285.4	241											
1840	NQ Core 6/6/2011	**1840.3 ft to 1845.9 ft (Run No. 242)** **SHALE** - Gray; slightly weathered; moderately hard; moderately fractured; trace clay at fractures; platy.		1840.3 284.4	242			285								
1845	NQ Core 6/6/2011	**1845.9 ft to 1848.3 ft (Run No. 243)** **SHALE** - Same as previous run.		1845.9 284.1	243											
1850	NQ Core 6/7/2011	**1848.3 ft to 1851.8 ft (Run No. 244)** **SHALE** - Gray; severly weathered; severly fractured; moderately hard at intact portions of shale to soft at weathered and fractured portions. Clay present at fractures. Fractures occur at low angles to horizontal.		1848.3 283.5	244											
1855	NQ Core	**1851.8 ft to 1861.8 ft (Run No. 245)** **SHALE** - Same as previous run.		1851.8	245									Azimuth: 315.37 Inclination: -0.79		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1860	NQ Core	**1851.8 ft to 1861.8 ft (Run No. 245)** **SHALE** - Same as previous run.		1861.8 / 281.8	245											
1865	NQ Core	**1861.8 ft to 1871.8 ft (Run No. 246)** **SHALE** - Gray; moderately weathered; slightly fractured; very soft and can be broken by hand; rock is clay like with some rock structure.		1871.8 / 280.2	246											
1870	NQ Core	**1871.8 ft to 1881.8 ft (Run No. 247)** **SHALE** - Gray; moderately weathered; severly fractured with fractures occuring at low angles; moderately hard; clay present at fractures.		1881.8 / 278.5	247			280								
1880	NQ Core	**1881.8 ft to 1887.5 ft (Run No. 248)** **SHALE** - Gray; moderately weathered; moderately fractured with fractures occuring at low angles and containing clay. Shale is moderately hard to soft. Shale can be broken by hand.		1887.5 / 277.6	248											
1885	NQ Core	**1887.5 ft to 1896.1 ft (Run No. 249)** **SHALE** - Gray; slightly weathered; sound from 1887.5' to 1889.0' then is moderately fractured with fractures occuring horizontally. Shale is sound again from 1889.0' to 1896.1'; moderately hard to soft at fractures.			249									Azimuth: 314.03 Inclination: -1.65		
1890	6/8/2011	*--- CONTINUED NEXT PAGE ---*														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 61 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1895	NQ Core	**1887.5 ft to 1896.1 ft (Run No. 249)** **SHALE** - Gray; slightly weathered; sound from 1887.5' to 1889.0' then is moderately fractured with fractures occuring horizontally. Shale is sound again from 1889.0' to 1896.1'; moderately hard to soft at fractures.		276.2	249											1689
1900	NQ Core	**1891.6 ft to 1906.1 ft (Run No. 250)** **SHALE** - Gray; moderately weathered; moderately fractured; soft; with clay. Note: Inner barrel blocked off but not the drill bit. Continued to advance drill tools which pulverized the soft shale in front of tools.		274.5	250			275								
1905	NQ Core	**1906.1 ft to 1911.5 ft (Run No. 251)** **SHALE** - Gray; moderately weathered; severly fractured with fractures occuring at low angles to horizontal; soft.		1906.1 / 273.6	251											
1910	NQ Core	**1911.5 ft to 1914.0 ft (Run No. 252)** **SHALE** - Gray; moderately weathered; slightly fractured to sound; fractures occur at horizontal and shale is platy along fractures; shale is soft and can be broken by hand.		1911.5 / 273.2	252											
1915	NQ Core	**1914.0 ft to 1919.6 ft (Run No. 253)** **SHALE** - Same as previous run.		1914.0 / 272.4	253											
1920	NQ Core	**1919.6 ft to 1922.0 ft (Run No. 254)** **SHALE** - Gray; moderately weathered; severly fractured with fracture occuring at horizontal for length of run; clay at fracture; soft; platy; fine grained.		1919.2 / 271.9	254									Azimuth: 314.03 Inclination: -1.65		
		--- CONTINUED NEXT PAGE ---														

6/9/2011

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	FLUSH	COLOR % RETURN	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---															
1925	6/10/2011 NQ Core	**1922.0 ft to 1927.5 ft (Run No. 254)** **SHALE** - Gray; moderately weathered; severly fractured with fractures occuring at horizontal for length of run; clay at fracture; soft; platy; fine grained.		1922.0 / 271.0	255				270								
1930	6/10/2011 NQ Core	**1927.5 ft to 1932.1 ft (Run No. 255)** **SHALE** - Gray; very slight weathering; sound; soft; fine grained.		1927.5 / 270.2	256												
1935	6/10/2011 NQ Core	**1932.1 ft to 1942.1 ft (Run No. 257)** **SHALE** - Gray; very slight weathering; moderately hard; slightly fractured; fine grained.		1932.1 / 268.6	257												
1940																	
1945		**1942.1 ft to 1952.1 ft (Run No. 258)** **SHALE** - Same as previous run.		1942.1 / 266.9	258										Azimuth: 314.33 Inclination: -2.18		8870
1950		**1952.1 ft to 1962.1 ft (Run No. 259)** **SHALE** - Same as previous run; fracture at 1952.4' to 1953.6'.		1952.1	259												
		--- CONTINUED NEXT PAGE ---															

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
1955	NQ Core 6/11/2011	**1952.1 ft to 1962.1 ft (Run No. 259)** **SHALE** - Same as previous run; fracture at 1952.4' to 1953.6'.		265.3	259											
1960				1962.1				265								
1965		**1962.1 ft to 1968.3 ft (Run No. 260)** **SHALE** - Same as previous run; all breaks mechanical.		264.3	260											
1970				1968.3												
1975	NQ Core	**1968.3 ft to 1977.5 ft (Run No. 261)** **SHALE** - Same as previous run; slightly fractured.		262.7	261											
1980		**1977.5 ft to 1987.5 ft (Run No. 262)** **SHALE** - Same as previous run; fractured at 1981.1' to 1982.3', 1985.0' to 1986.1' occuring at low angles.		1977.5	262									Azimuth: 314.33 Inclination: -2.18		
1985		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
1985		*--- CONTINUED FROM PREVIOUS PAGE ---*														
	6/12/2011 NQ Core	**1977.5 ft to 1987.5 ft (Run No. 262)** **SHALE** - Same as previous run; fractured at 1981.1' to 1982.3', 1985.0' to 1986.1' occuring at low angles.		261.1 / 1987.5	262											
1990		**1987.5 ft to 1997.5 ft (Run No. 263)** **SHALE** - Gray; very slight weathering; moderately fractured; moderately hard; fine grained; calcareous.		259.5 / 1997.5	263			260								
1995																
2000	NQ Core	**1997.5 ft to 2007.5 ft (Run No. 264)** **SHALE** - Same as previous run; slightly fractured.		257.8 / 2007.5	264											
2005																
2010		**2007.5 ft to 2017.5 ft (Run No. 265)** **SHALE** - Gray; slightly weathered; moderately to severly fractured; moderately hard; calcareous; thinly bedded; fine grained.			265									Azimuth: 313.80 Inclination: -2.50		
2015		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
	NQ Core			256.2	265											
	NQ Core	**2017.5 ft to 2020.5 ft (Run No. 266)** **SHALE** - Gray; slightly weathered; severly fractured with clay at fractures; very soft.		2017.5 / 255.7	266											
2020	6/13/2011 NQ Core	**2020.5 ft to 2031.0 ft (Run No. 267)** **SHALE** - Gray; very slight weathering; sound; moderately hard; fine grained; calcareous.		2020.5 / 253.9	267			255								
2030	NQ Core	**2031.0 ft to 2036.9 ft (Run No. 268)** **SHALE** - Gray; very slight weathering; sound; moderately hard; thinly bedded; fine grained; calcareous.		2031.0 / 253.0	268											
2040	NQ Core	**2036.9 ft to 2047.1 ft (Run No. 269)** **SHALE** - Same as previous run; all breaks mechanical.		2036.9 / 251.3	269									Azimuth: 313.80 Inclination: -2.50		
				2047.1	270											
		--- CONTINUED NEXT PAGE ---														

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
2050	NQ Core	**2047.1 ft to 2057.1 ft (Run No. 270)** **SHALE** - Same as previous run; all breaks mechanical.		249.6	270			250								
2055				2057.1												
2060		**2057.1 ft to 2067.2 ft (Run No. 271)** **SHALE** - Gray; slightly weathered; moderately hard; moderately fractured at 2065.1' and 2066.8'; remainder of shale is sound, calcareous, with dark gray, thin, soft shale partings along healed fractures.			271											
2065	6/14/2011			248.0												
2070	NQ Core	**2067.2 ft to 2075.9 ft (Run No. 272)** **SHALE** - Gray; severly weathered; severly fractured; very soft; fine grained with gray clay at fractures; fractures occur at horizontal.		2067.2	272											
2075				246.5												
		2075.9 ft to 2086.0 (Run No. 273) **SHALE** - Dark gray; moderately weathered; moderately fractured with horizontal fractures with clay at 2075.9' to 2077.9' and 2080.9' to 2082.9'; shale is moderately hard along intact sections and soft at fractured sections; fine grained; calcareous.		2075.9	273								Azimuth: 313.58 Inclination: -2.50			
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 67 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
2080	NQ Core	**2075.9 ft to 2086.0 (Run No. 273)** **SHALE** - Dark gray; moderately weathered; moderately fractured with horizontal fractures with clay at 2075.9' to 2077.9' and 2080.9' to 2082.9'; shale is moderately hard along intact sections and soft at fractured sections; fine grained; calcareous.		244.9	273			245								
2085				2086.0												
2090		**2086.0 ft to 2096.2 ft (Run No. 274)** **SHALE** - Dark gray; slightly weathered; sound; moderately hard; fine grained; calcareous.			274											
2095				243.2												
				2096.2												
2100		**2096.2 ft to 2106.3 ft (Run No. 275)** **SHALE** - Dark gray; very slight weathering; moderately hard; sound; fine grained; calcareous.			275											
2105				241.5												
				2106.3												
2110		**2106.3 ft to 2116.6 ft (Run No. 276)** **SHALE** - Gray; very slight weathering; sound; moderately hard; fine grained; calcareous out to a distance of 2109.8'. From 2109.8' to 2116.6' **DOLOMITE** - Gray; very slight weathering; sound; hard; fine grained.			276								Azimuth: 313.50 Inclination: -2.51			
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
2115	NQ Core 6/15/2011	**2106.3 ft to 2116.6 ft (Run No. 276) SHALE** - Gray; very slight weathering; sound; moderately hard; fine grained; calcareous out to a distance of 2109.8'. From 2109.8' to 2116.6' **DOLOMITE** - Gray; very slight weathering; sound; hard; fine grained.		239.8	276			240								
2120	NQ Core	**2116.6 ft to 2126.9 ft (Run No. 277) DOLOMITE** - Gray; very slight weathering; sound; hard; fine grained; trace fossils; rock discolored to tan at 2126.5' to 2126.9'. Rock becomes more crystalline towards end of run; all breaks mechanical.		2116.6 / 238.1	277											
2125																
2130	NQ Core 6/16/2011	**2126.9 ft to 2137.1 ft (Run No. 278) DOLOMITE** - Gray with tan discolored rock at 2126.9' to 2127.5' and 2130.0' to 2134.0'. Discoloration is depositional feature and not from weathering. Dolomite is very slightly weathered; hard; crystalline; with calcite vugs and petroleum vugs; fractures at 2127.1', 2133.9', and 2130.9'.		2126.9 / 236.4	278											
2135																
2140	NQ Core	**2137.1 ft to 2147.4 ft (Run No. 279) DOLOMITE** - Gray and tan; very slight weathering; slightly fractured with fractures at 2142.9' to 2143.3' with iron staining; hard; crystalline; wide joint spacing.		2137.1	279									Azimuth: 313.87 Inclination: -2.49		14445
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
2145	NQ Core	**2137.1 ft to 2147.4 ft (Run No. 279)** **DOLOMITE** - Gray and tan; very slight weathering; slightly fractured with fractures at 2142.9' to 2143.3' with iron staining; hard; crystalline; wide joint spacing.		234.7	279			235								
2150		**2147.4 ft to 2157.5 ft (Run No. 280)** **DOLOMITE** - Same as previous run; all breaks mechanical.		2147.4 / 233.1	280											
2155																
2160		**2157.5 ft to 2167.5 ft (Run No. 281)** **DOLOMITE** - Gray; very slight weathering; sound; hard; crystalline; with pressure solution features and occasional calcite veins.		2157.5 / 231.4	281											
2165																
2170		**2167.5 ft to 2177.5 ft (Run No. 282)** **DOLOMITE** - Same as previous run; all breaks mechanical.		2167.5	282									Azimuth: 313.87 Inclination: -2.49		
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 70 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
2175	NQ Core	**2167.5 ft to 2177.5 ft (Run No. 282)** **DOLOMITE** - Same as previous run; all breaks mechanical.		229.8	282			230								
2180	NQ Core	**2177.5 ft to 2187.5 ft (Run No. 283)** **DOLOMITE** - Same as previous run; fracture at 2182.8' to 2183.1'.		2177.5 / 228.1	283											
2185	6/17/2011															
2190	NQ Core	**2187.5 ft to 2197.5 ft (Run No. 284)** **DOLOMITE** - Gray; very slight weathering; slightly fractured with fracture at 2188.5'; hard; crystalline; with stylolitic features.		2187.5 / 226.5	284											
2195	NQ Core															
2200		**2197.5 ft to 2207.5 ft (Run No. 285)** **DOLOMITE** - Same as previous run; all breaks mechanical.		2197.5	285									Azimuth: 313.65 Inclination: -2.45		
2205		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 71 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR / % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
	NQ Core	**2197.5 ft to 2207.5 ft (Run No. 285)** **DOLOMITE** - Same as previous run; all breaks mechanical.		224.8	285			225								
2210	NQ Core	**2207.5 ft to 2217.5 ft (Run No. 286)** **DOLOMITE** - Same as previous run; all breaks mechanical.		2207.5 / 223.2	286											
2215	NQ Core	**2217.5 ft to 2227.5 ft (Run No. 287)** **DOLOMITE** - Same as previous run; all breaks mechanical.		2217.5 / 221.5	287											
2220	NQ Core	**2227.5 ft to 2237.5 ft (Run No. 288)** **DOLOMITE** - Same as previous run; all breaks mechanical.		2227.5	288									Azimuth: 313.65 Inclination: -2.45		
2225								220								
2230		*--- CONTINUED NEXT PAGE ---*														
2235																

6/18/2011

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
				219.9	288											
				2237.5												
2240		**2237.5 ft to 2247.5 ft (Run No. 289)** **DOLOMITE** - Gray; very slight weathering; slightly fractured with fractures at 2239.7' and 2242.3'; hard; crystalline; with stylolitic features.			289											
2245	NQ Core															
				218.2												
				2247.5												
2250		**2247.5 ft to 2257.5 ft (Run No. 290)** **DOLOMITE** - Same as previous run; fracture with iron staining at 2250.4'.			290											
2255	6/19/2011															
				216.6												
				2257.5												
2260		**2257.5 ft to 2267.5 ft (Run No. 291)** **DOLOMITE** - Same as previous run; fracture at 2267.3' to 2267.5'.			291									Azimuth: 313.98 Inclination: -2.69		
2265	NQ Core															
				214.9				215								
				2267.5	292											
		--- CONTINUED NEXT PAGE ---														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

SHEET 73 OF 75

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
2270	NQ Core	**2267.5 ft to 2277.5 ft (Run No. 292)** **DOLOMITE** - Same as previous run; fracture at 2271.1'.														
		2267.5 ft to 2277.5 ft (Run No. 292) **DOLOMITE** - Same as previous run; fracture at 2271.1'.			292											
2275				213.3												
				2277.5												
2280		**2277.5 ft to 2287.5 ft (Run No. 293)** **DOLOMITE** - Same as previous run; all breaks mechanical.			293											
2285	6/20/2011			211.6												
				2287.5												
2290	NQ Core	**2287.5 ft to 2297.5 ft (Run No. 294)** **DOLOMITE** - Gray and tan; slightly weathered; slightly fractured with fracture at 2289.2'; hard; crystalline.			294											
2295				210.0				210								
		2297.5 ft to 2307.5 ft (Run No. 295) **DOLOMITE** - Gray and tan; slightly weathered; slightly fractured with fracture at 2300.2'; hard; crystalline; with petroleum vugs.		2297.5	295								Azimuth: 313.98 Inclination: -2.69			
2300		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
2300		*--- CONTINUED FROM PREVIOUS PAGE ---*														
	NQ Core	**2297.5 ft to 2307.5 ft (Run No. 295)** **DOLOMITE** - Gray and tan; slightly weathered; slightly fractured with fracture at 2300.2'; hard; crystalline; with petroleum vugs.		208.3	295											
2305				2307.5												
	NQ Core	**2307.5 ft to 2317.5 ft (Run No. 296)** **DOLOMITE** - Same as previous run; fracture at 2310.1'.			296											
2310				206.7												
2315				2317.5												
	NQ Core	**2317.5 ft to 2327.5 ft (Run No. 297)** **DOLOMITE** - Same as previous run; fractures at 2320.2' (iron stained) and at 2323.3' (iron stained).			297											
2320				205.0												
	6/21/2011			2327.5				205								
2325	NQ Core	**2327.5 ft to 2337.5 ft (Run No. 298)** **DOLOMITE** - Same as previous run; fractures at 2332.0', 2334.3', and 2337.3'.			298								Azimuth: 313.76 Inclination: -2.94			
2330		*--- CONTINUED NEXT PAGE ---*														

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

PROJECT: Jefferson County, Louisville Tunnel

RECORD OF DRILLHOLE: Pillar Boring

LOCATION: Louisville, Kentucky

DRILLING DATE: 3/28/2011

NORTHING:302753.77

DATUM: NAVD 88

PROJECT NUMBER: 1831-10-5629

DRILL RIG: LM75

EASTING:1247574.84

DRILLING METHOD: HQ/NQ/AQ

INCLINATION: -9.49°

AZIMUTH: N 304°E

FR-FRACTURE | F-FAULT | SM-SMOOTH | FL-FLEXURED | BC-BROKEN CORE
CL-CLEAVAGE | J-JOINT | R-ROUGH | UE-UNEVEN | MB-MECH. BREAK
SH-SHEAR | P-POLISHED | ST-STEPPED | W-WAVY | B-BEDDING
VN-VEIN | S-SLICKENSIDED | PL-PLANAR | C-CURVED

DISTANCE SCALE FEET	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DISTANCE (ft)	RUN No.	PENETRATION RATE (ft/min)	COLOR % RETURN / FLUSH	ELEVATION	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER FT	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (psi)
		--- CONTINUED FROM PREVIOUS PAGE ---														
2335	NQ Core	**2327.5 ft to 2337.5 ft (Run No. 298)** **DOLOMITE** - Same as previous run; fractures at 2332.0', 2334.3', and 2337.3'.			298											
				203.4										Azimuth: 313.76 Inclination: -2.94		
				2337.5												
		Pillar Boring Terminated at 2337.5 feet.														
2340																
2345																
2350																
2355																
2360																

SME_ROCK GLO NEW.GPJ GLDR_LDN.GDT 9/1/11 DATA INPUT:

DISTANCE SCALE
1 inch to 4 feet

DRILLING CONTRACTOR:Major Drilling
DRILLER:J. Gilson

S&ME ENGINEERING INTEGRITY

LOGGED: NJP
CHECKED: CSL

Louisville Tunnel Project
Louisville, Jefferson County, Kentucky
Project # 1831-10-5629
Sheet 1 of 87

S&ME
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Lexington, KY 40509

Photo 1

3/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 1, 0.0 ft to 14.5 ft
Remarks	Clay, concrete and rock fill material out to a distance of 12.0'. Louisville Limestone begins at a distance of 12.0 feet.

Photo 2

3/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 2, 14.5 ft to 24.3 ft
Remarks	Louisville Limestone

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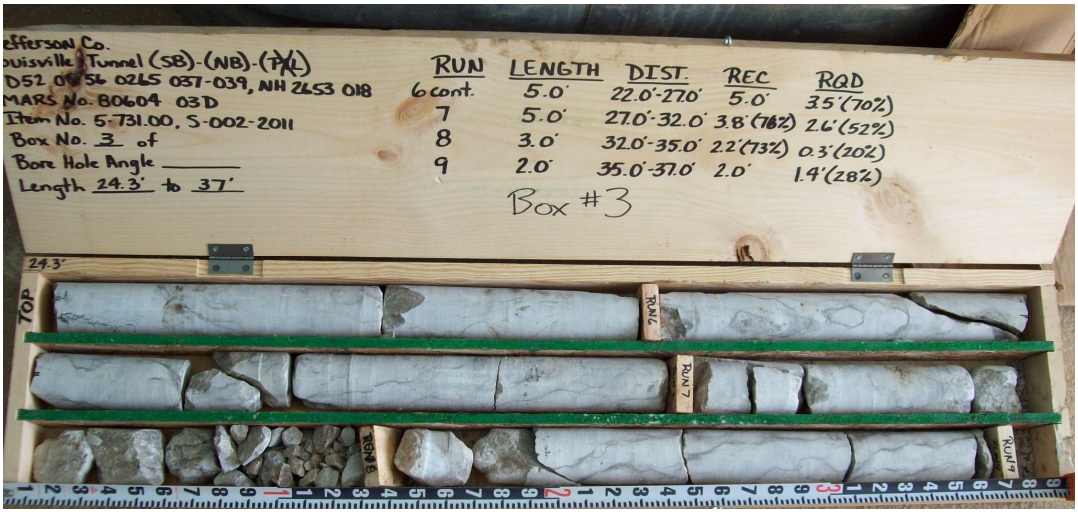
Photo 3

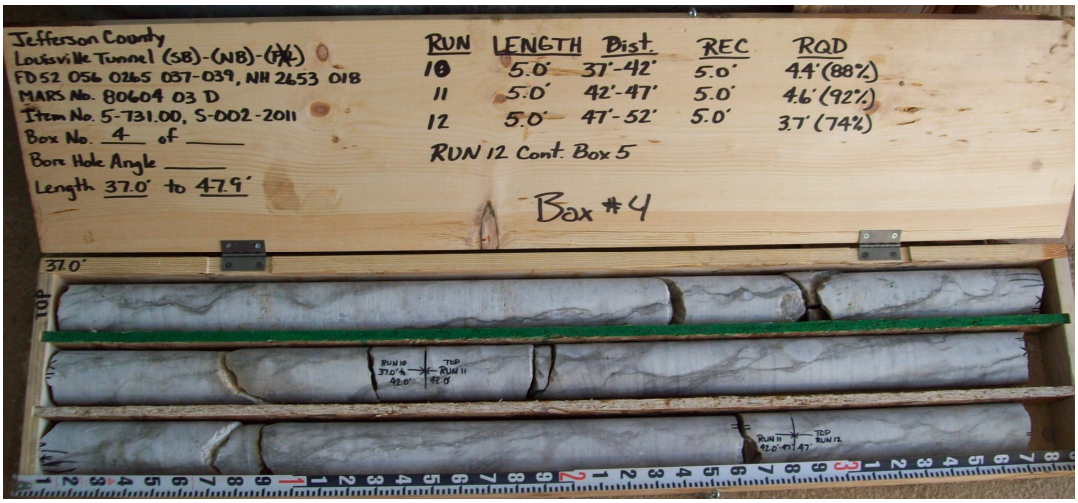


3/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 3, 24.3 ft to 37.0 ft
Remarks	Louisville Limestone

Photo 4



3/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 4, 37.0 ft to 47.9 ft
Remarks	Louisville Limestone

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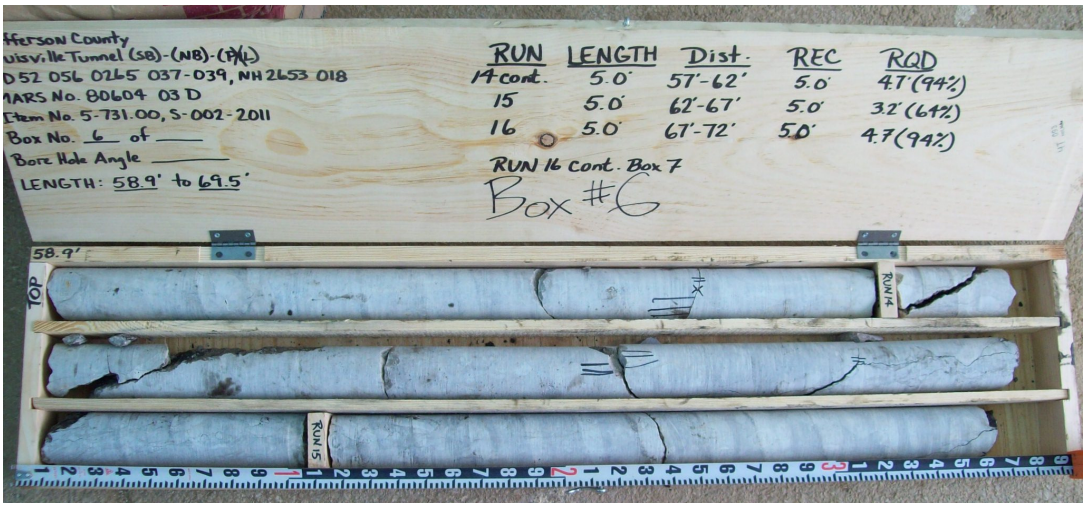
Photo 5

3/29/2011

Photographer : N. Peterson

Location / Orientation	Pillar Boring, Box 5, 47.9 ft to 58.9 ft
Remarks	Louisville Limestone

Photo 6



3/29/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 6, 58.9 ft to 69.5 ft
Remarks	Louisville Limestone

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Photo 7

3/29/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 7, 69.5 ft to 80.1 ft
Remarks	Louisville Limestone

Photo 8

3/29/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 8, 90.8 ft to 80.1 ft
Remarks	Louisville Limestone

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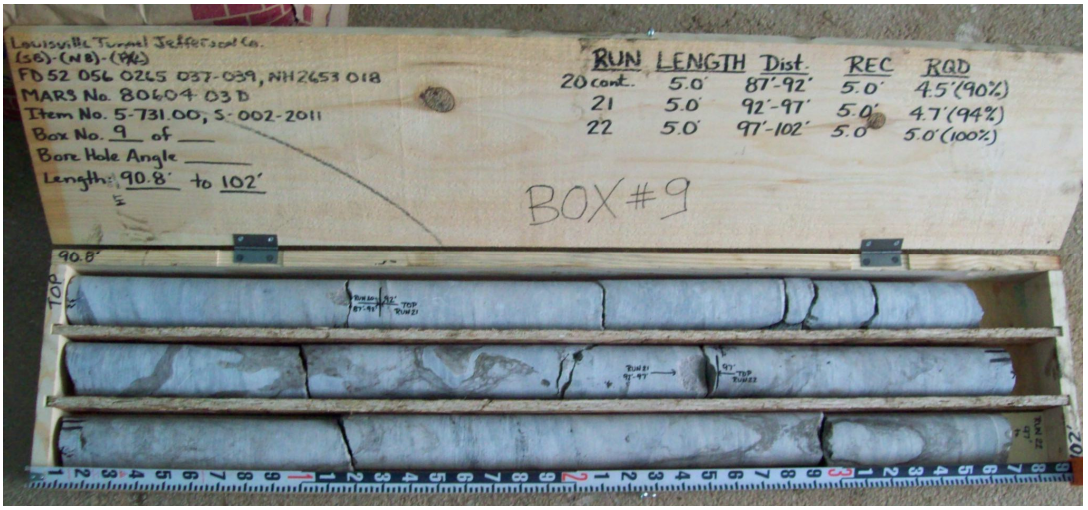
Photo 9

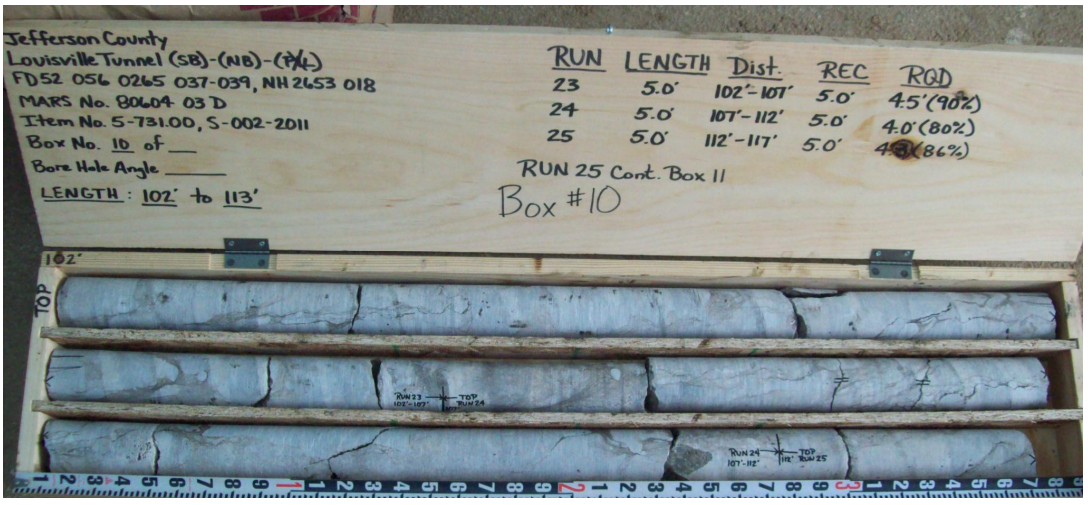


3/29/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 9, 90.8 ft to 102.0 ft
Remarks	Louisville Limestone

Photo 10



3/29/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 10, 102.0 ft to 113.0 ft
Remarks	Louisville Limestone

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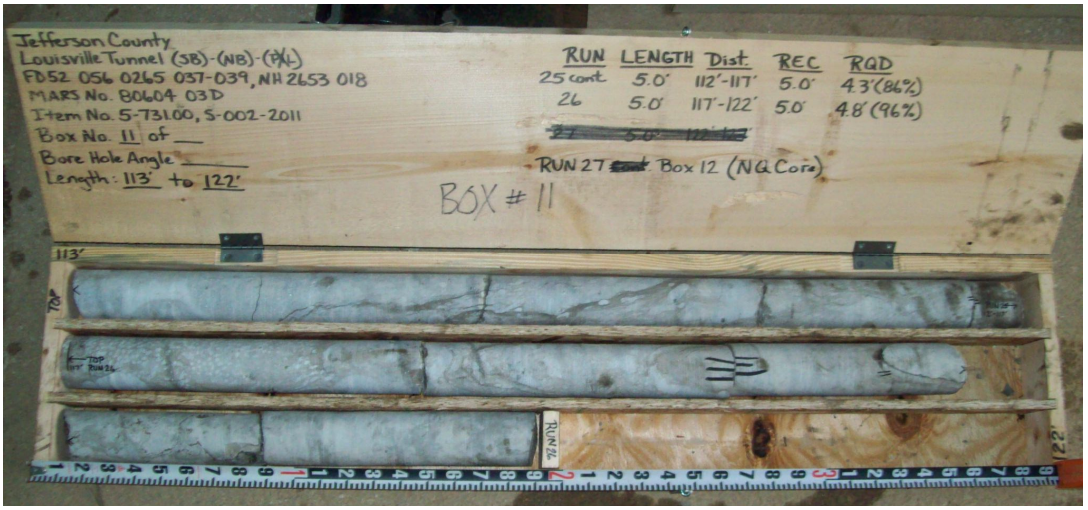
Photo 11



3/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 11, 113.0 ft to 122.0 ft
Remarks	Louisville Limestone

Photo 12

3/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 12, 122 ft to 137 ft
Remarks	Louisville Limestone – Begin NQ size rock core at 122 feet.

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Photo 13

3/31/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 13, 137.0 ft to 152.3 ft
Remarks	Louisville Limestone – Begin AQ size core and directional drilling at 137.0 feet.

Photo 14

3/31/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 14, 152.3 ft to 167.3 ft
Remarks	Louisville Limestone – AQ size core.

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Photo 15

4/1/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 15, 167.3 ft to ft 182.1 ft
Remarks	Louisville Limestone. AQ size core to a 175.5 ft. NQ size core to 180.5 ft. Resume AQ size core at 180.5 ft.

Photo 16

4/1/2011

Photographer : N. Peterson

Location / Orientation	Pillar Boring, Box 16, 182.1 ft to 197.0 ft
Remarks	Louisville Limestone

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Photo 17

4/1/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 17, 197.0 ft to 212.1 ft
Remarks	Louisville Limestone

Photo 18

4/4/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 18, 212.1 ft to 227.2 ft
Remarks	Louisville Limestone

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Photo 19

4/5/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 19, 227.2 ft to 242.3 ft
Remarks	Louisville Limestone

Photo 20

4/5/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 20, 242.3 ft to 257.4 ft
Remarks	Louisville Limestone

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Photo 21

4/5/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 21, 257.4 ft to 272.2 ft
Remarks	Louisville Limestone

Photo 22

4/5/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 22, 272.2 ft to 287.4 ft
Remarks	Louisville Limestone

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Photo 23

4/5/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 23, 287.4 ft to 302.3 ft
Remarks	Louisville Limestone

Photo 24

4/5/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 24, 302.3 ft to 317.4 ft
Remarks	Louisville Limestone

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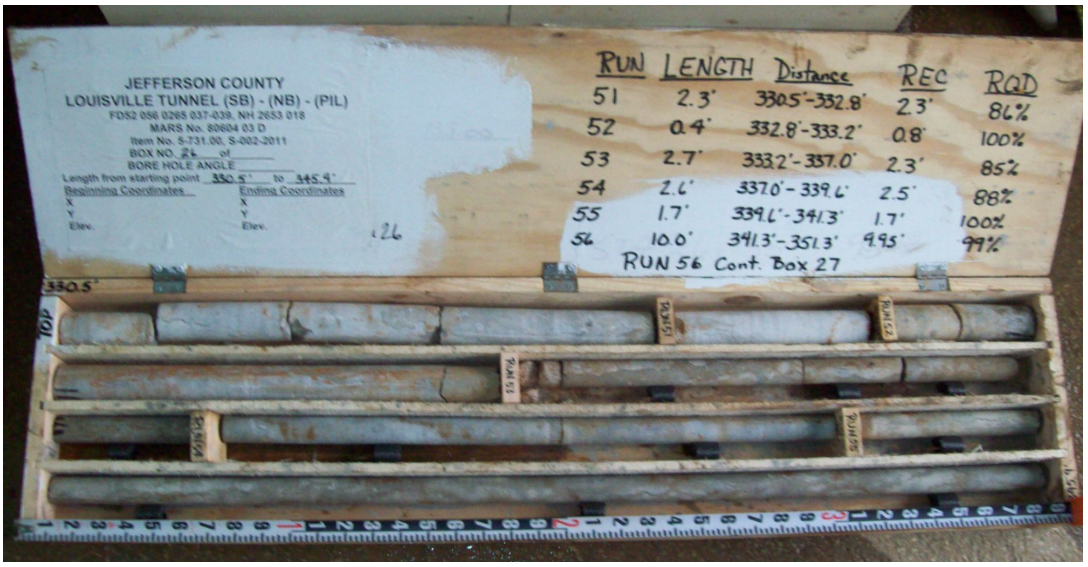
Photo 25

4/6/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 25, 317.4 ft to 330.5 ft
Remarks	Louisville Limestone

Photo 26



4/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 26, 330.5 ft to 345.9 ft
Remarks	Louisville Limestone – NQ size core from 330.5 ft to 337.0 ft to open bore hole for HQ casing advancement.

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Photo 27

4/11/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 27, 345.9 ft to 360.9 ft
Remarks	Louisville Limestone – AQ size core.

Photo 28

4/12/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 28, 360.9 ft to 376.1 ft
Remarks	Louisville Limestone

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Photo 29

4/12/2011

Photographer : N. Peterson

Location / Orientation	Pillar Boring, Box 29, 376.1 ft to 390.9 ft
Remarks	Louisville Limestone

Photo 30

4/12/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 30, 390.9 ft to 405.8 ft
Remarks	Louisville Limestone – Face of tunnel begins at 400.0 feet.

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Photo 31

4/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 31, 405.8 ft to 420.7 ft
Remarks	Louisville Limestone

Photo 32

4/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 32, 420.7 ft to 435.5 ft
Remarks	Louisville Limestone

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Photo 33

4/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 33, 435.5 ft to 450.9 ft
Remarks	Louisville Limestone

Photo 34

4/14/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 34, 443.5 ft to 462.3 ft
Remarks	Louisville Limestone – Run 67 core (NQ size) was cut below Run 66 to correct over steer by directional tool.

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Photo 35

4/18/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 35, 462.5 ft to 477.5 ft
Remarks	Louisville Limestone – Complete over steer correction at 468.4 ft and resume AQ directional core.

Photo 36

4/18/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 36, 477.5 ft to 92.4 ft
Remarks	Louisville Limestone

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Photo 37

4/18/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 37, 492.4 ft
Remarks	Louisville Limestone – Begin NQ size core at 498.6 to correct directional core over steer.

Photo 38

4/18/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 38, 493.9 ft to 508.8 ft
Remarks	Louisville Limestone – Complete over steer correction at 506.8 feet and resume directional core.

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Photo 39

4/22/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 39, 508.8 ft to 523.4 ft
Remarks	Louisville Limestone – Begin standard NQ core for over steer correction at 521.0 feet.

Photo 40

4/22/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 40, 523.4 ft to 538.1 ft
Remarks	Louisville Limestone – Run 79 cored during advancement of the HQ casing.

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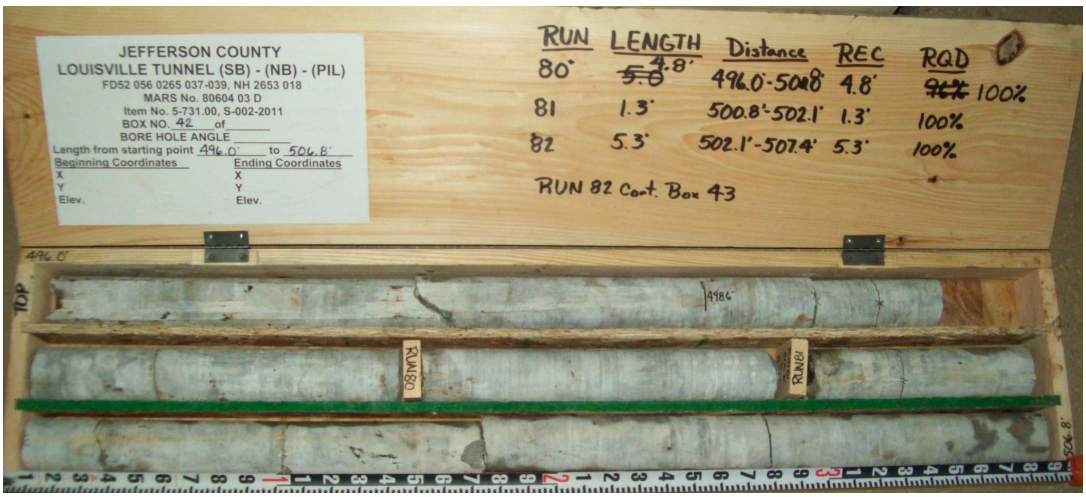
Photo 41

4/22/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 41, 538.1 ft to 541.0 ft
Remarks	Louisville Limestone – NQ core recovered during HQ casing advancement.

Photo 42



4/22/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 42, 496 ft to 506.8 ft
Remarks	Louisville Limestone – Begin HQ core to correct casing off set at 496.0 feet.

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Photo 43

4/22/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 43, 506.8 ft to 510.9 ft
Remarks	Louisville Limestone – HQ core completed at 510.9 feet and begin NQ core at 510.9.

Photo 44

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 44, 510.9 ft to 525.9 ft
Remarks	Louisville Limestone – Begin standard NQ core for placement of directional barrel.

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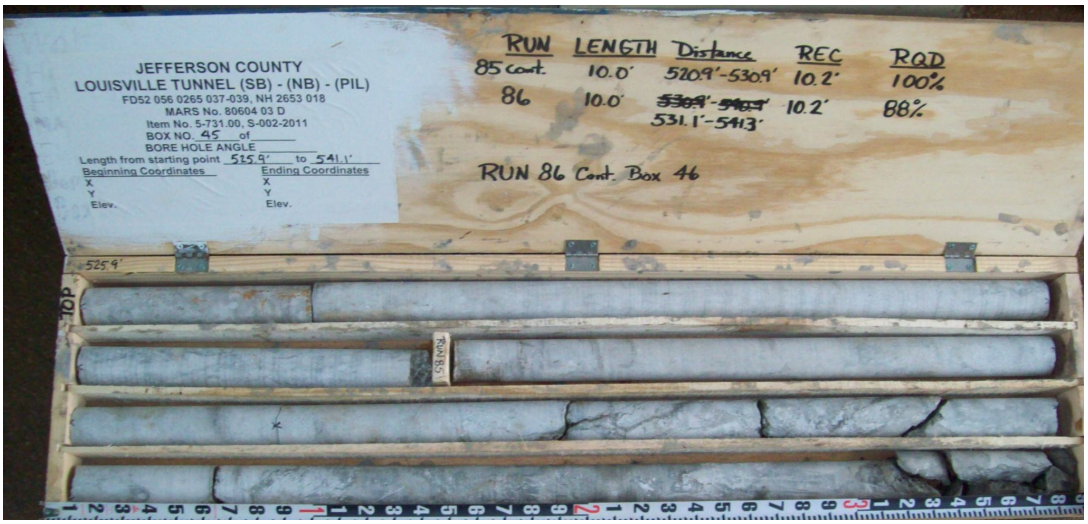
Photo 45



4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 45, 525.9 ft to 541.1ft
Remarks	Louisville Limestone

Photo 46

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 46, 541.1 ft to 556.2 ft
Remarks	Louisville Limestone – NQ core drilled out to 541.3 and begin directional AQ core at the same distance.

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Photo 47

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 47, 556.2 ft to 571.3 ft
Remarks	Louisville Limestone

Photo 48

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 48, 571.3 ft to 586.4 ft
Remarks	Louisville Limestone

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Photo 49

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 49, 586.4 ft to 601.5 ft
Remarks	Louisville Limestone

Photo 50

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 50, 601.5 ft to 616.7 ft
Remarks	Louisville Limestone

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Photo 51	
	4/25/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 51, 616.5 ft to 621.5 ft
Remarks	Louisville Limestone

Photo 52	
	4/25/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 52, 621.5 ft to 632.0 ft
Remarks	Louisville Limestone – Begin HQ core at completion of directional drilling at 621.5 feet.

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Photo 53

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 53, 632.0 ft to 643.3 ft
Remarks	Louisville Limestone

Photo 54

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 54, 643.3 ft to 654.5 ft
Remarks	Louisville Limestone

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Photo 55

4/25/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 55, 654.5 ft to 665.2 ft
Remarks	Louisville Limestone

Photo 56

4/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 56, 665.2 ft to 670.8 ft
Remarks	Louisville Limestone

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Photo 57

4/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 57, 670.8 ft to 686.6 ft
Remarks	Louisville Limestone

Photo 58

4/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 58, 686.6 ft to 697.0 ft
Remarks	Louisville Limestone

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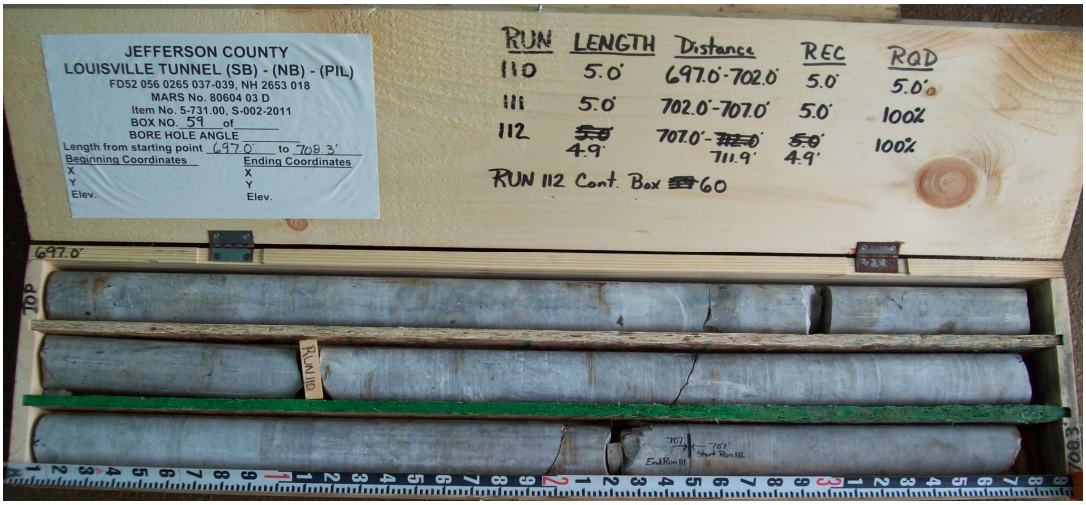
Photo 59



4/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 59, 697.0 ft to 708.3 ft
Remarks	Louisville Limestone

Photo 60

4/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 60, 708.3 ft to 719.3 ft
Remarks	Louisville Limestone

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Photo 61

4/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 61, 719.3 ft to 722.0 ft
Remarks	Louisville Limestone – Terminate HQ core at 722.0 feet. Begin NQ standard core at 722.0 feet.

Photo 62

4/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 62, 722.0 ft to 737.1 ft
Remarks	Louisville Limestone

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Photo 63

4/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 63, 737.1 ft to 751.6 ft
Remarks	Louisville Limestone – Begin directional AQ core at 741.6 feet.

Photo 64

4/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 64, 751.6 ft to 766.8 ft
Remarks	Louisville Limestone

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Photo 65

4/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 65, 766.8 ft to 781.6 ft
Remarks	Louisville Limestone

Photo 66

4/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 66, 781.6 ft to 796.7 ft
Remarks	Louisville Limestone

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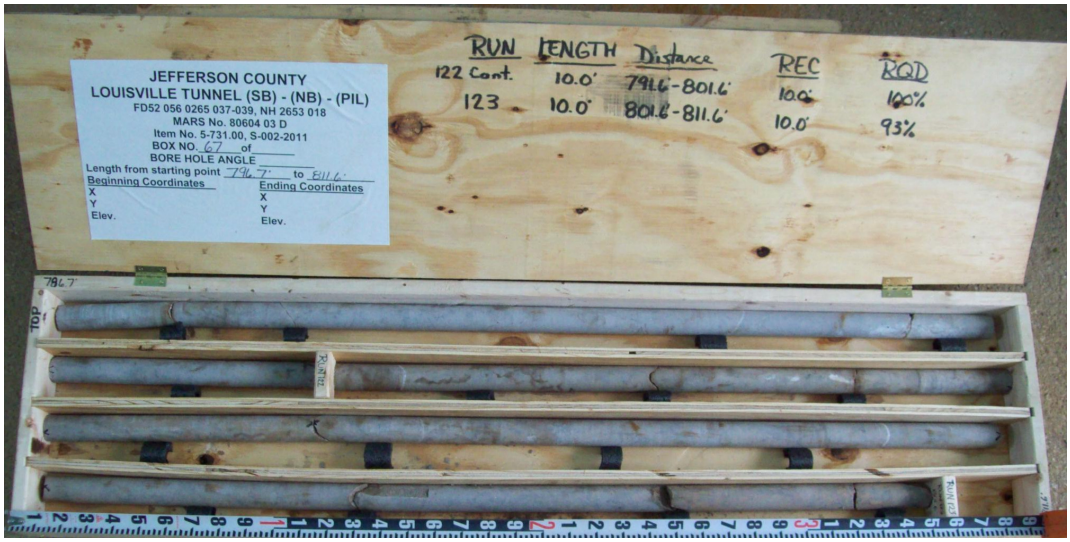
Photo 67



4/28/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 67, 796.7 ft to 811.6 ft
Remarks	Louisville Limestone

Photo 68

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 68, 811.6 ft to 821.0 ft
Remarks	Louisville Limestone – Terminate AQ directional core at 821.6 and begin HQ core.

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Photo 69

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 69, 821.0 ft to 832.4 ft
Remarks	Louisville Limestone

Photo 70

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 70, 832.4 ft to 843.3 ft
Remarks	Louisville Limestone

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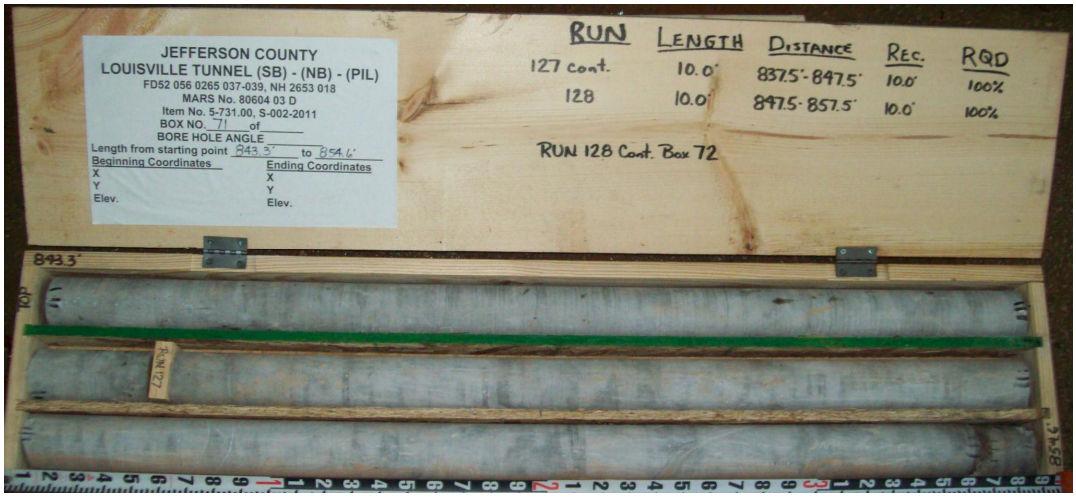
Photo 71



5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 71, 843.3 ft to 854.6 ft
Remarks	Louisville Limestone

Photo 72

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 72, 854.6 ft to 865.6 ft
Remarks	Louisville Limestone

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Photo 73

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 73, 865.6 ft to 876.8 ft
Remarks	Louisville Limestone

Photo 74

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 74, 876.8 ft to 887.3 ft
Remarks	Louisville Limestone

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Photo 75

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 75, 887.3 ft to 898.7 ft
Remarks	Louisville Limestone

Photo 76

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 76, 898.7 ft to 910.0 ft
Remarks	Louisville Limestone

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Photo 77

5/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 77, 910.0 ft to 921.0 ft
Remarks	Louisville Limestone

Photo 78

5/3/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 78, 921.0 ft to 932.2 ft
Remarks	Louisville Limestone

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Photo 79

5/3/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 79, 932.2 ft to 943.5 ft
Remarks	Louisville Limestone

Photo 80

5/3/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 80, 943.5 ft to 954.7 ft
Remarks	Louisville Limestone

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Photo 81

5/3/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 81, 954.7 ft to 965.8 ft
Remarks	Louisville Limestone

Photo 82

5/3/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 82, 965.8 ft to 967.5 ft
Remarks	Louisville Limestone – Terminate HQ core at 967.5 feet and begin NQ core.

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Photo 83

5/4/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 83, 967.5 ft to 981.7 ft
Remarks	Louisville Limestone

Photo 84

5/6/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 84, 981.7 ft to 997.9 ft
Remarks	Louisville Limestone – Terminate NQ core at 983.1 feet and begin directional AQ core.

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Photo 85

5/6/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 85, 997.9 ft to 1012.9 ft
Remarks	Louisville Limestone

Photo 86

5/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 86, 1012.9 ft to 1027.8 ft
Remarks	Louisville Limestone

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Photo 87

5/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 87, 1027.8 ft to 1043.2 ft
Remarks	Louisville Limestone

Photo 88

5/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 88, 1043.2 ft to 1058.4 ft
Remarks	Louisville Limestone

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Photo 89

5/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 89, 1058.4 ft to 1073.5 ft
Remarks	Louisville Limestone – Terminate AQ directional core at 1061.3 feet and begin NQ core.

Photo 90

5/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 90, 1073.5 ft to 1088.6 ft
Remarks	Louisville Limestone – Terminate NQ core at 1077.2 feet and begin AQ directional core.

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Photo 91	
	5/9/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 91, 1088.6 ft to 1103.7 ft
Remarks	Louisville Limestone

Photo 92	
	5/9/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 92, 1103.7 ft to 1118.8 ft
Remarks	Louisville Limestone

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Photo 93

5/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 93, 1118.8 ft to 1134.1 ft
Remarks	Louisville Limestone

Photo 94

5/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 94, 1134.1 ft to 1141.3 ft
Remarks	Louisville Limestone – Terminate AQ directional core at 1141.3 feet.

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Photo 95	
	5/16/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 95, 1141.3 ft to 1155.7 ft
Remarks	Louisville Limestone – Terminate AQ core at 1141.3 feet and begin NQ core.

Photo 96	
	5/16/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 96, 1155.7 ft to 1170.8 ft
Remarks	Louisville Limestone out to a distance of 1170.0 feet. Waldron Shale begins at 1170.0 feet.

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Photo 97

5/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 97, 1170.8 ft to 1185.8 ft
Remarks	Waldron Shale

Photo 98

5/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 98, 1185.8 ft to 1200.0 ft
Remarks	Waldron Shale

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Photo 99

5/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 99, 1200.0 ft to 1214.7 ft
Remarks	Waldron Shale

Photo 100

5/9/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 100, 1214.7 ft to 1229.6 ft
Remarks	Waldron Shale

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Photo 101

5/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 101, 1229.6 ft to 1244.5 ft
Remarks	Waldron Shale

Photo 102

5/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 102, 1244.5 ft to 1259.3 ft
Remarks	Waldron Shale

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Photo 103

5/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 103, 1259.3 ft to 1274.6 ft
Remarks	Waldron Shale

Photo 104

5/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 104, 1274.6 ft to 1289.3 ft
Remarks	Waldron Shale

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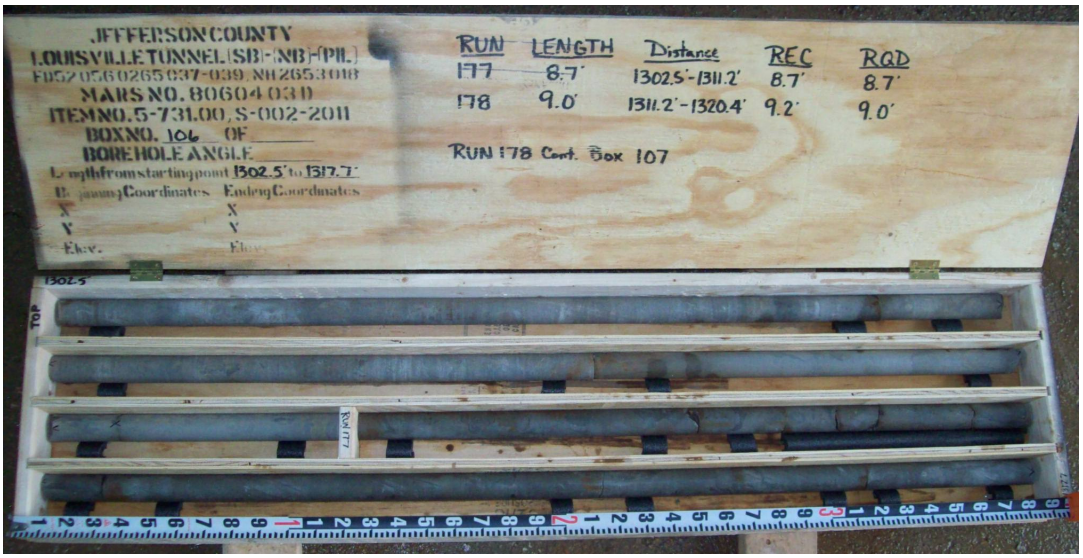
Photo 105

5/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 105, 1289.3 ft to 1302.5 ft
Remarks	Waldron Shale – Terminate NQ core at 1302.5 feet and begin AQ directional core.

Photo 106



5/19/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 106, 1302.5 ft to 1317.7 ft
Remarks	Waldron Shale

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Photo 107

5/19/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 107, 1317.7 ft to 1332.6 ft
Remarks	Waldron Shale

Photo 108

5/19/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 108, 1332.6 ft to 1347.7 ft
Remarks	Waldron Shale

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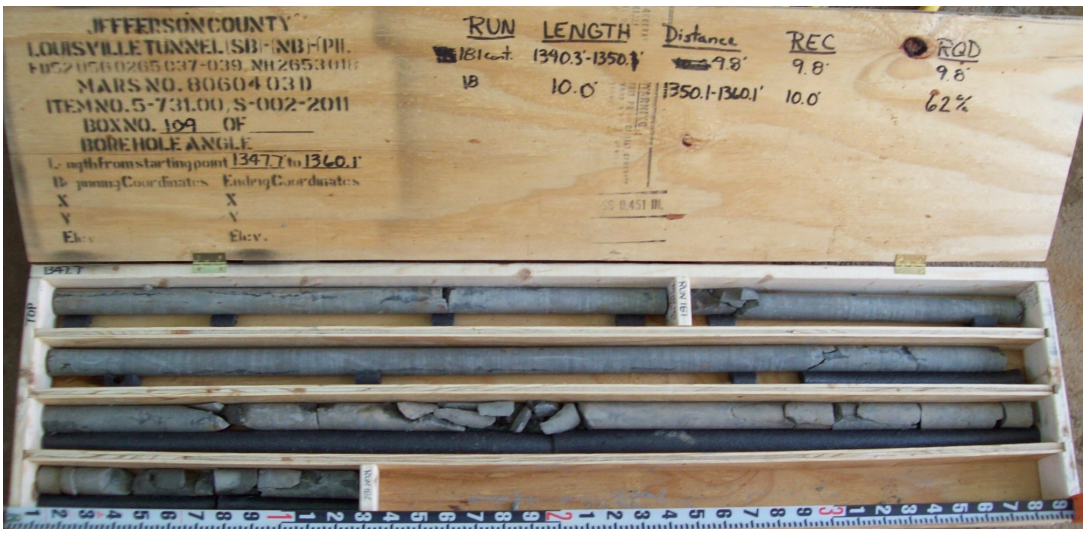
Photo 109



5/19/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 109, 1347.7 ft to 1360.1 ft
Remarks	Waldron Shale

Photo 110

5/23/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 110, 1362.5 ft to 1377.6 ft
Remarks	Waldron Shale

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Photo 111

5/23/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 111, 1377.6 ft to 1392.6 ft
Remarks	Waldron Shale

Photo 112

5/23/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 112, 1392.6 ft to 1407.0 ft
Remarks	Waldron Shale – Terminate NQ core at 1393.1 feet and resume AQ directional core.

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Photo 113

5/23/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 113, 1407.0 ft to 1421.1 ft
Remarks	Waldron Shale

Photo 114

5/23/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 114, 1421.1 ft to 1435.8 ft
Remarks	Waldron Shale

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Photo 115

5/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 115, 1435.8 ft to 1453.8 ft
Remarks	Waldron Shale

Photo 116

5/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 116, 1453.8 ft to 1472.1 ft
Remarks	Waldron Shale

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Photo 117

5/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 117, 1472.1 ft to 1487.2 ft
Remarks	Waldron Shale

Photo 118

5/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 118, 1487.2 ft to 1506.7 ft
Remarks	Waldron Shale

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Photo 119

5/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 119, 1506.7 ft to 1518.0 ft
Remarks	Waldron Shale

Photo 120

5/26/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 120, 1518.0 ft to 1531.2 ft
Remarks	Waldron Shale – Terminate AQ directional core at 1531.2 ft Begin NQ core at 1531.2 ft.

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Photo 121

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 121, 1531.2 ft to 1546.2 ft
Remarks	Waldron Shale

Photo 122

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 122, 1546.2 ft to 1561.0 ft
Remarks	Waldron Shale

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Photo 123

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 123, 1561.0 ft to 1576.2 ft
Remarks	Waldron Shale

Photo 124

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 124, 1576.2 ft to 1585.9 ft
Remarks	Waldron Shale

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Photo 125

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 125, 1585.9 ft to 1604.3 ft
Remarks	Waldron Shale

Photo 126

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 126, 1604.3 ft to 1619.4 ft
Remarks	Waldron Shale

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Photo 127

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 127, 1619.4 ft to 1634.0 ft
Remarks	Waldron Shale

Photo 128

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 128, 1634.0 ft to 1648.4 ft
Remarks	Waldron Shale

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Photo 129

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 129, 1648.4 ft to 1663.3 ft
Remarks	Waldron Shale

Photo 130

5/30/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 130, 1663.3 ft to 1677.0 ft
Remarks	Waldron Shale

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Photo 131

5/31/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 131, 1677.0 ft to 1690.0 ft
Remarks	Waldron Shale

Photo 132

5/31/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 132, 1690.0 ft to 1708.1 ft
Remarks	Waldron Shale

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Photo 133

5/31/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 133, 1708.1 ft to 1722.6 ft
Remarks	Waldron Shale

Photo 134

6/1/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 134, 1722.6 ft to 1737.9 ft
Remarks	Waldron Shale

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Photo 135

6/1/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 135, 1737.9 ft to 1756.8 ft
Remarks	Waldron Shale

Photo 136

6/2/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 136, 1756.8 ft to 1770.3 ft
Remarks	Waldron Shale

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Photo 137

6/6/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 137, 1770.3 ft to 1785.3 ft
Remarks	Waldron Shale

Photo 138

6/6/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 138, 1785.3 ft to 1799.4 ft
Remarks	Waldron Shale

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Photo 139

6/6/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 139, 1799.4 ft to 1817.0 ft
Remarks	Waldron Shale

Photo 140

6/6/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 140, 1817.0 ft to 1832.1 ft
Remarks	Waldron Shale

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Photo 141

6/6/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 141, 1832.1 ft to 1847.6 ft
Remarks	Waldron Shale

Photo 142

6/10/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 142, 1847.6 ft to 1865.5 ft
Remarks	Waldron Shale

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Photo 143

6/10/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 143, 1865.5 ft to 1881.8 ft
Remarks	Waldron Shale – Very soft clay shale encountered in Run 246 and was wrapped for preservation immediately.

Photo 144

6/10/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 144, 1881.8 ft to 1897.7 ft
Remarks	Waldron Shale

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Photo 145

6/10/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 145, 1897.7 ft to 1921.1 ft
Remarks	Waldron Shale

Photo 146

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 146, 1921.1 ft to 1935.7 ft
Remarks	Waldron Shale

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Photo 147

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 147, 1935.7 ft to 1950.8 ft
Remarks	Waldron Shale

Photo 148

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 148, 1950.8 ft to 1965.8 ft
Remarks	Waldron Shale

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Photo 149

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 149, 1965.8 ft to 1981.2 ft
Remarks	Waldron Shale

Photo 150

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 150, 1981.2 ft to 1993.7 ft
Remarks	Waldron Shale

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Photo 151

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 151, 1993.7 ft to 2010.4 ft
Remarks	Waldron Shale

Photo 152

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 152, 2010.4 ft to 2025.7 ft
Remarks	Waldron Shale

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Photo 153

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 153, 2025.7 ft to 2040.5 ft
Remarks	Waldron Shale

Photo 154

6/13/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 154, 2040.5 ft to 2055.4 ft
Remarks	Waldron Shale

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Photo 155

6/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 155, 2055.4 ft to 2064.7 ft
Remarks	Waldron Shale

Photo 156

6/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 156, 2064.7 ft to 2083.4 ft
Remarks	Waldron Shale

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Photo 157	
	6/16/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 157, 2083.4 ft to 2098.2 ft
Remarks	Waldron Shale

Photo 158	
	6/16/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 158, 2098.2 ft to 2112.9 ft
Remarks	Waldron Shale out to a distance of 2109.8 feet. Dolomite encountered at 2109.8 feet.

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Photo 159

6/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 159, 2112.9 ft to 2126.9 ft
Remarks	Dolomite

Photo 160

6/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 160, 2126.9 ft to 2141.9 ft
Remarks	Dolomite

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Photo 161

6/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 161, 2141.9 ft to 2157.2 ft
Remarks	Dolomite

Photo 162

6/16/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 162, 2157.2 ft to 2172.0 ft
Remarks	Dolomite

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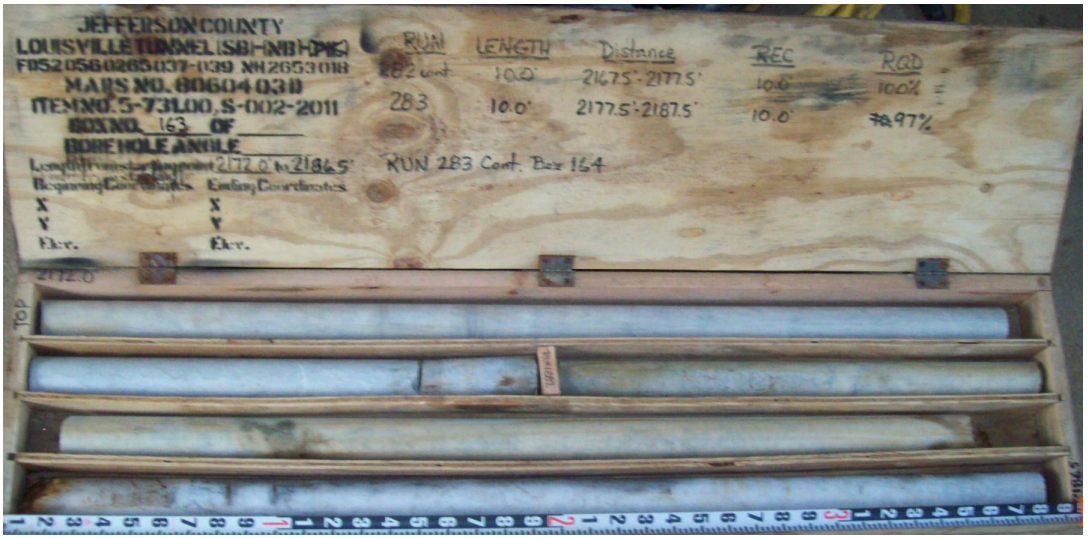
Photo 163



6/20/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 163, 2172.0 ft to 2186.5 ft
Remarks	Dolomite

Photo 164

6/20/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 164, 2186.5 ft to 2201.3 ft
Remarks	Dolomite

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Photo 165	
	6/20/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 165, 2201.3 ft to 2216.3 ft
Remarks	Dolomite

Photo 166	
	6/20/2011 Photographer: N. Peterson
Location / Orientation	Pillar Boring, Box 166, 2216.3 ft to 2231.4ft
Remarks	Dolomite

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Photo 167

6/20/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 167, 2231.4 ft to 2245.8 ft
Remarks	Dolomite

Photo 168

6/20/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 168, 2231.4 ft to 2260.4 ft
Remarks	Dolomite

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Photo 169

6/20/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 169, 2260.4 ft to 2274.9 ft
Remarks	Dolomite

Photo 170

6/20/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 170, 2274.9 ft to 2289.7 ft
Remarks	Dolomite

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Photo 171

6/20/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 171, 2289.7 ft to 2304.7 ft
Remarks	Dolomite

Photo 172

6/20/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 172, 2304.7 ft to 2319.2 ft
Remarks	Dolomite

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Photo 173

6/21/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 173, 2319.2 ft to 2334.3 ft
Remarks	Dolomite

Photo 174

6/21/2011

Photographer: N. Peterson

Location / Orientation	Pillar Boring, Box 174, 2334.3 ft to 2337.5 ft
Remarks	Dolomite – Pillar Boring Terminated at 2337.5 feet.

APPENDIX B

GRAPH "Unconfined Compression versus Distance"

Graph "Point Load Index versus Distance"

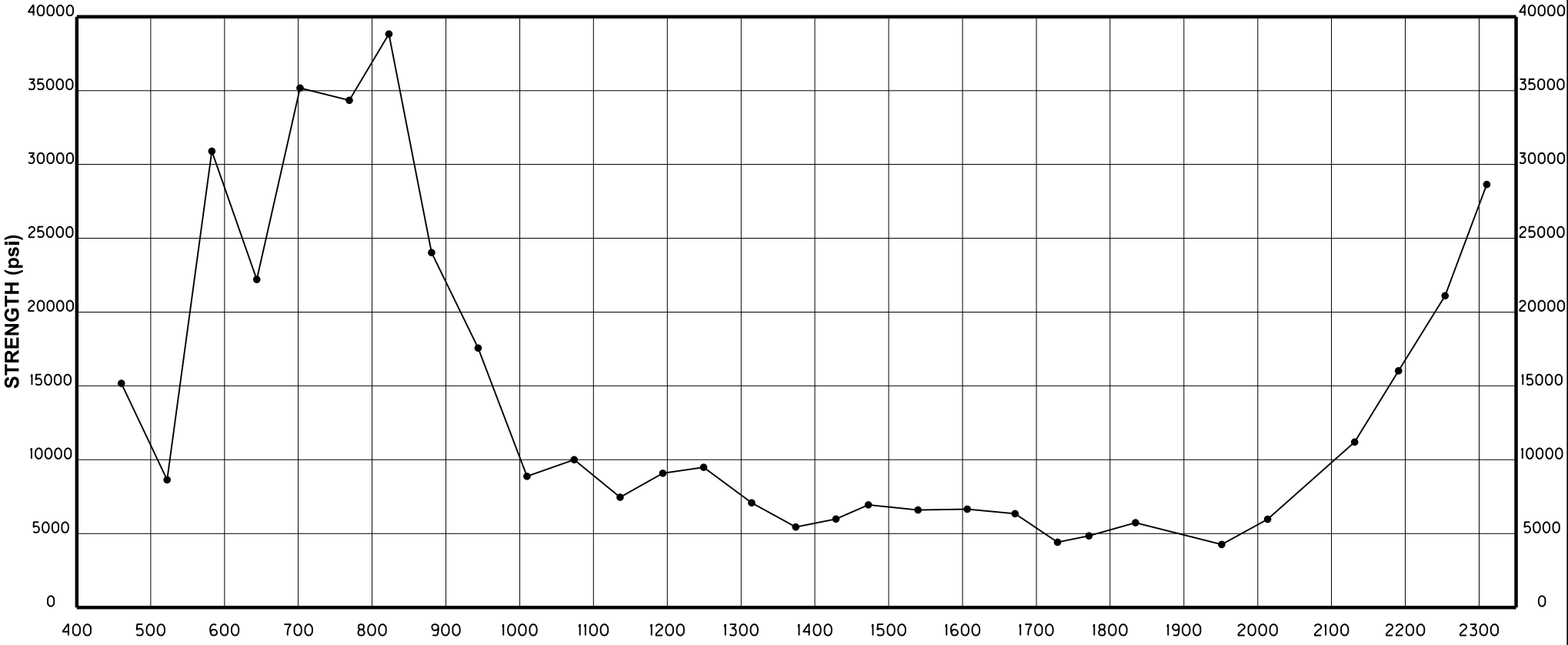
Graph "Split Tensile Strength – Diametral versus Distance"

Graph "Split Tensile Strength – Axial versus Distance"

TABULATION OF ROCK CORE SAMPLE LOCATIONS

LABORATORY TEST REPORTS

SAMPLE COLLECTION LOCATIONS



SCALE:	1"=200' Horiz, 1"=10,000 Vert.
DATE:	8/11/11
DRAWN BY:	CAC
PROJECT NO:	1831-10-5629

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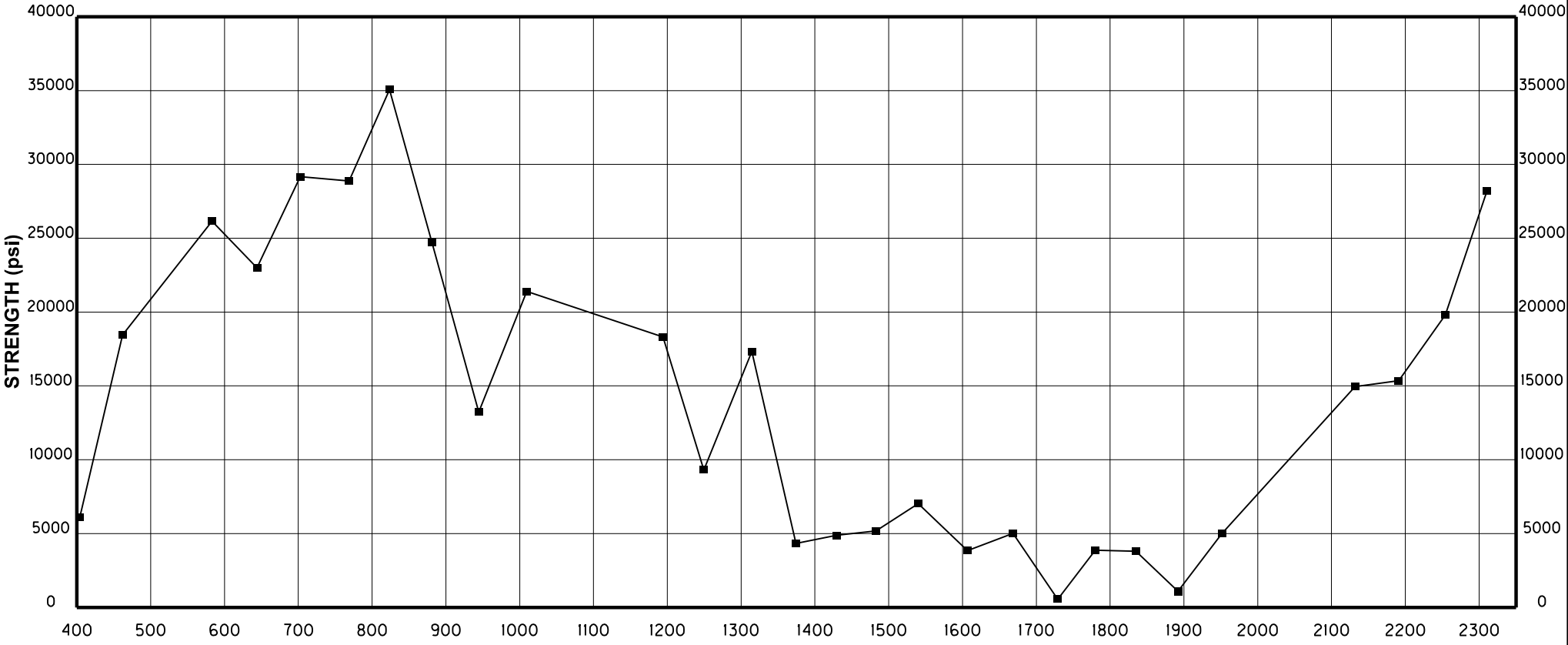
422 CODELL DRIVE, LEXINGTON, KY 40509
PHONE: 859.293.5518

LOUISVILLE - SOUTHERN INDIANA
OHIO RIVER BRIDGES TUNNEL - PILLAR HOLE
ROCK UNCONFINED COMPRESSIVE STRENGTH

FIGURE NO.



SCALE:	1"=200' Horiz, 1"=10,000 Vert.
DATE:	8/11/11
DRAWN BY:	CAC
PROJECT NO:	1831-10-5629

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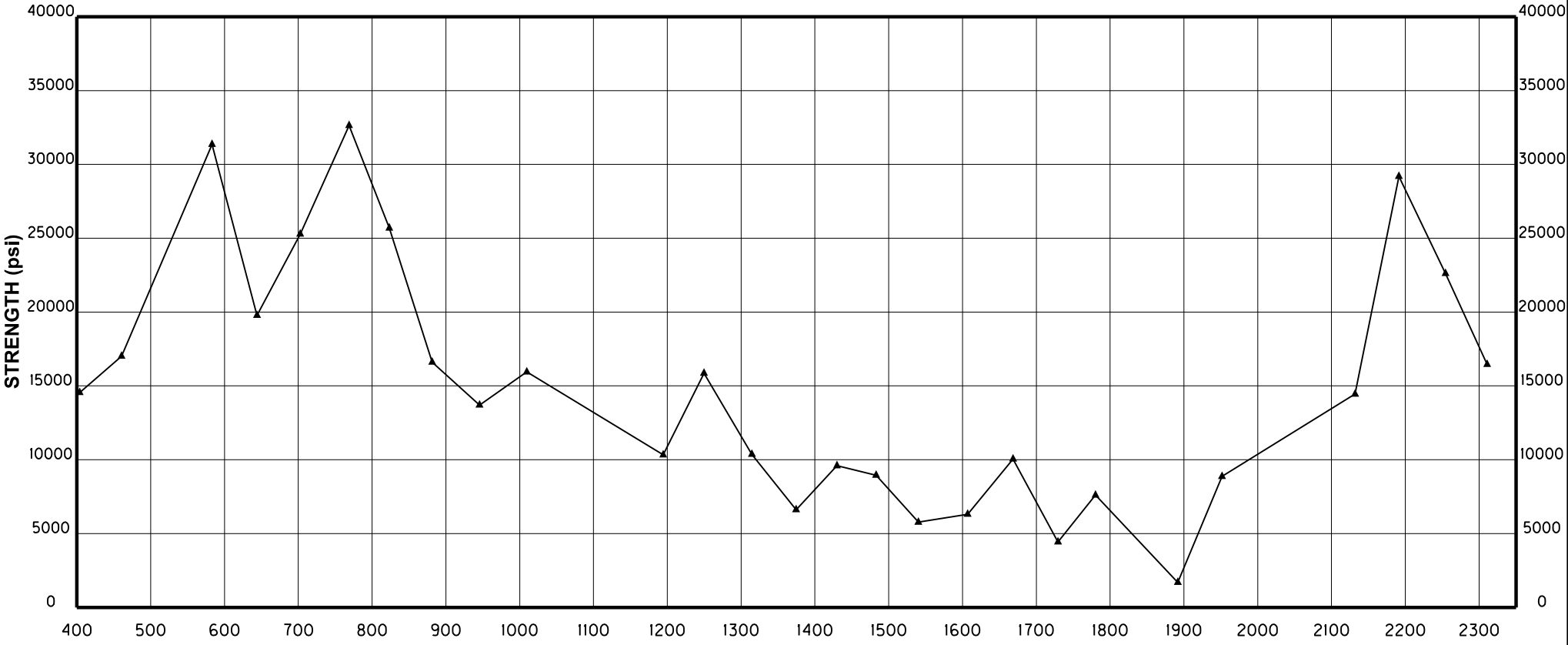
LOUISVILLE - SOUTHERN INDIANA
OHIO RIVER BRIDGES TUNNEL - PILLAR HOLE
POINT LOAD STRENGTH INDEX - AXIAL

FIGURE NO.



SCALE:	1"=200' Horiz, 1"=10,000 Vert.
DATE:	8/11/11
DRAWN BY:	CAC
PROJECT NO:	1831-10-5629

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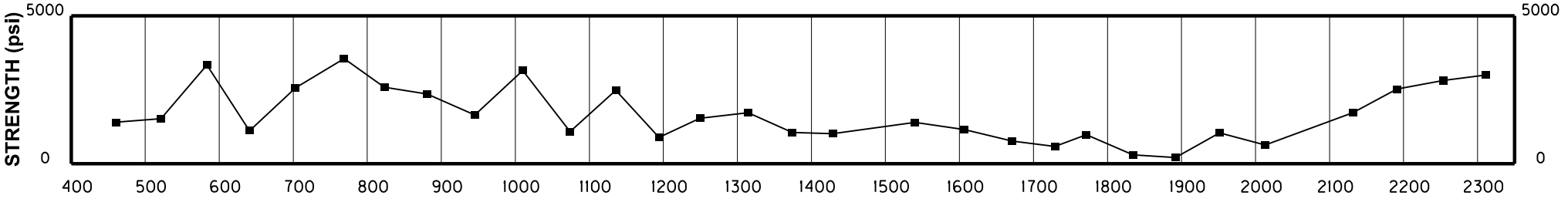
LOUISVILLE - SOUTHERN INDIANA
OHIO RIVER BRIDGES TUNNEL - PILLAR HOLE
POINT LOAD STRENGTH INDEX - DIAMETRAL

FIGURE NO.



DISTANCE (ft)
FROM COLLAR LOCATION

SCALE:	1"=200' Horiz, 1"=10,000 Vert.
DATE:	8/11/11
DRAWN BY:	CAC
PROJECT NO:	1831-10-5629

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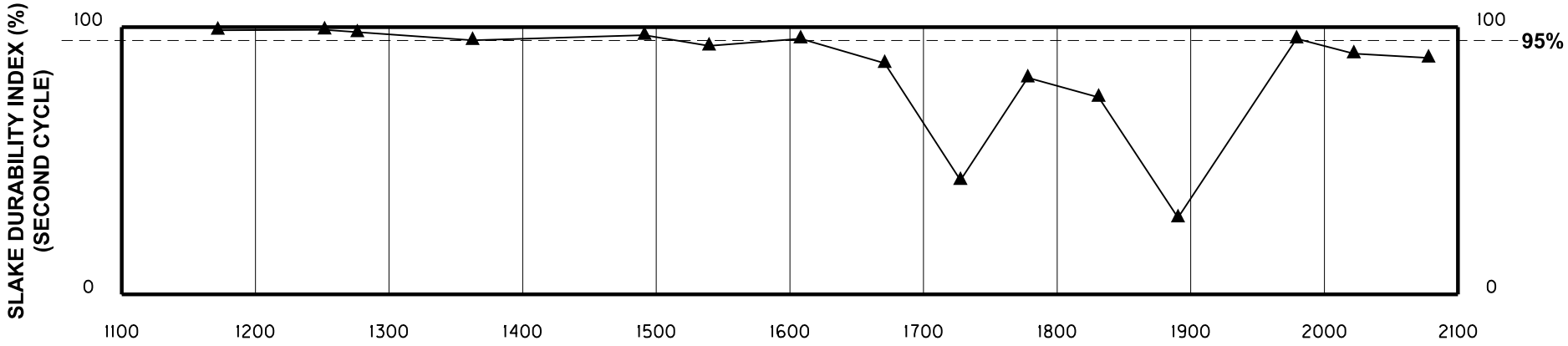
LOUISVILLE - SOUTHERN INDIANA
OHIO RIVER BRIDGES TUNNEL - PILLAR HOLE
SPLITTING TENSILE STRENGTH

FIGURE NO.



DISTANCE (ft)
FROM COLLAR LOCATION

KYTC GEOTECHNICAL MANUAL
DURABLE SHALE ≥ 95
NONDURABLE SHALE ≤ 95

SCALE:	NONE
DATE:	8/11/11
DRAWN BY:	CAC
PROJECT NO:	1831-10-5629

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PHONE: 859.293.5518

LOUISVILLE - SOUTHERN INDIANA
OHIO RIVER BRIDGES TUNNEL - PILLAR HOLE
SLAKE DURABILITY INDEX (SECOND CYCLE)

FIGURE NO.

SUMMARY OF LABORATORY DATA

Sample	Distance	Northing	Easting	Elevation	Unconfined Compression Distance (ft)	Unconfined Compression Strength (psi)	Point Load Strength Index Distance A (ft)	Point Load Strength Index Strength A (psi)	Point Load Strength Index Distance D (ft)	Point Load Strength Index Strength D (psi)	Splitting Tensile Strength Distance (ft)	Splitting Tensile Strength Strength (psi)	Slake Durability Slake Durability Index (Second Cycle)
1	402.8-404.2	302987.33	1247254.86	529.94			404.0	6,135	403.8	14,552			
2	460.0-462.3	303022.87	1247210.14	527.02	460.2	15,178	461.8	18,448	460.5	17,011	460.8	1,407	
3	521.0-522.4	303060.83	1247162.46	524.50	522.2	8,643					521.3	1,524	
4	582.8-584.8	303099.66	1247114.42	522.60	582.9	30,893	583.1	26,158	583.1	31,353	583.3	3,337	
5	640.5-641.1	303135.80	1247069.45	521.89							641.0	1,118	
6	643.6-644.8	303137.75	1247067.04	521.87	643.8	22,207	644.1	23,005	644.1	19,774			
7	702.1-703.2	303174.82	1247021.79	521.21	702.3	35,175	702.6	29,164	702.6	25,285	703.1	2,569	
8	766.9-769.2	303216.42	1246972.12	520.24	769.1	34,347	768.8	28,873	768.8	32,633	768.7	3,552	
9	822.3-823.9	303251.66	1246929.39	519.18	822.8	38,829	823.5	35,066	823.3	25,693	823.1	2,592	
10	880.4-883.3	303288.41	1246884.41	517.74	880.6	24,023	881.1	24,712	881.4	16,610	880.9	2,361	
11	943.6-945.6	303328.26	1246835.41	515.62	943.8	17,568	944.5	13,229	945.5	13,701	945.3	1,650	
12	1009.2-1009.8	303369.43	1246784.42	512.68			1009.6	21,398	1009.7	15,948			
13	1009.8-1011.1	303369.81	1246783.96	512.66	1009.9	8,876					1010.1	3,155	
14	1073.5-1075.5	303410.11	1246734.67	510.65	1073.7	10,004					1073.9	1,085	
15	1134.1-1136.1	303448.92	1246688.14	509.81	1136.0	7,462					1135.8	2,486	
16	1171.9-1173.3	303473.57	1246659.48	509.82									98.9%
17	1193.7-1196.5	303487.80	1246642.97	509.85	1193.9	9,082	1194.2	18,316	1194.4	10,330	1194.1	892	
18	1249.0-1251.8	303524.10	1246601.26	509.61	1249.2	9,493	1249.5	9,313	1249.7	15,860	1249.4	1,540	
19	1251.8-1253.0	303525.92	1246599.12	509.59									99.0%
20	1314.1-1315.9	303566.20	1246551.61	508.97	1314.3	7,084	1314.5	17,325	1314.6	10,364	1314.4	1,725	
21	1362.5-1364.5	303598.33	1246515.43	507.61									95.1%
22	1373.8-1375.8	303605.88	1246507.03	507.26	1374.0	5,450	1374.3	4,338	1374.5	6,614	1374.2	1,061	
23	1428.4-1429.7	303642.73	1246466.81	505.12	1428.5	5,983					1428.7	1,017	
24	1429.7-1430.6	303643.62	1246465.87	505.05			1429.7	4,884	1429.9	9,597			
26	1472.2-1473.4	303673.07	1246435.29	502.98	1472.3	6,942							
27	1482.7-1483.4	303680.45	1246427.84	502.57			1482.7	5,186	1482.9	8,949			
29	1491.2-1493.2	303686.51	1246421.89	502.36									97.0%
30	1539.5-1542.1	303720.99	1246388.08	501.40	1539.7	6,592	1540.0	7,030	1540.2	5,773	1539.9	1,402	93.0%
31	1606.2-1608.0	303768.73	1246341.50	501.27	1606.4	6,654	1606.7	3,849	1606.9	6,304	1606.6	1,158	
32	1608.2-1609.4	303770.01	1246340.24	501.28									95.7%
33	1668.2-1668.8	303812.93	1246298.02	501.46			1668.3	5,014	1668.5	10,051			
34	1670.9-1672.7	303814.85	1246296.13	501.46	1671.1	6,342					1671.3	766	86.5%
36	1727.6-1728.6	303855.36	1246256.45	501.55									42.7%
37	1728.6-1730.1	303856.07	1246255.75	501.55	1728.8	4,417	1729.1	556	1729.4	4,431	1729.0	584	
38	1771.0-1772.1	303886.32	1246226.04	501.30	1771.2	4,848					1771.4	982	
39	1778.0-1780.3	303891.30	1246221.13	501.24			1780.0	3,871	1780.2	7,608			81.1%
41	1831.0-1831.8	303928.89	1246183.77	500.55									73.8%
42	1834.3-1835.2	303931.23	1246181.44	500.50	1834.5	5,739	1834.8	3,809			1834.7	305	
43	1890.5-1892.5	303970.80	1246141.55	499.37			1891.9	1,093	1891.7	1,689	1892.0	213	28.7%
44	1950.9-1952.0	304012.89	1246098.28	497.40	1951.1	4,264	1951.4	5,004	1951.6	8,870	1951.3	1,049	
45	1979.2-1981.0	304032.57	1246077.97	496.31									95.7%
46	2012.7-2014.4	304055.85	1246053.92	494.94	2013.4	5,974					2013.2	633	
47	2022.0-2023.4	304062.28	1246047.21	494.54									90.1%
49	2077.9-2079.2	304100.83	1246006.81	492.10									88.5%
50	2131.2-2132.7	304137.54	1245968.24	489.77	2131.4	11,202	2131.7	14,957	2131.9	14,445	2131.6	1,728	
51	2190.5-2192.5	304178.48	1245925.42	487.20	2190.7	16,018	2191.0	15,350	2191.2	29,185	2190.9	2,523	
52	2253.7-2255.7	304222.17	1245879.83	484.43	2253.9	21,110	2254.2	19,805	2254.4	22,609	2254.1	2,818	
53	2310.2-2311.9	304261.27	1245839.13	481.74	2310.4	28,640	2310.7	28,204	2310.9	16,458	2310.6	2,996	

UNCONFINED COMPRESSION
(ASTM D7012 Method C)

S&ME

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

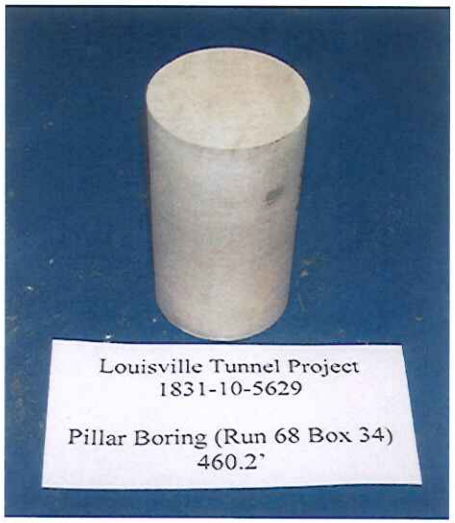
Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 4/15/2011

Report Date: 5/3/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
2	PIL, Run 68 Box 34	460.2	4.01	1.85	2.69	163.4	79	40,830	15,178	0.2

NOTE: Bulk Density includes any moisture that is within the specimen.



UNCONFINED COMPRESSION
(ASTM D7012 Method C)

S&ME

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 4/22/2011

Report Date: 5/6/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
3	PIL, Run 78 Box 39	522.2	4.04	1.85	2.69	165.9	65	23,250	8,643	0.5

NOTES: Bulk Density includes any moisture that is within the specimen.
The loading rate was outised the specified rate (72.5 - 145 psi/sec), but the stress rate selected did produce failure within the specified time (2 - 15 minutes).

UNCONFINED COMPRESSION
(ASTM D7012 Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

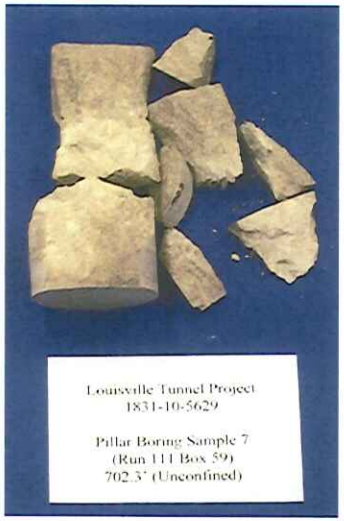
Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 4/29/2011

Report Date: 5/13/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
7	PIL, Run 111 Box 59	702.3	5.41	2.50	4.91	171.8	83	172,710	35,175	0.1
8	PIL, Run 119 Box 65	769.1	2.57	1.24	1.21	169.1	81	41,560	34,347	0.0

NOTES: Bulk Density includes any moisture that is within the specimen.



UNCONFINED COMPRESSION
(ASTM D7012 Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

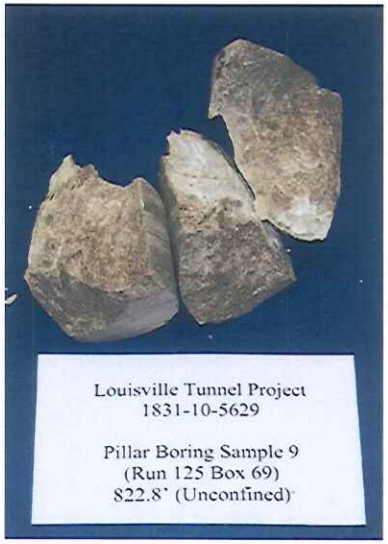
Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 5/6/2011

Report Date: 5/20/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
9	PIL, Run 125 Box 69	822.8	5.41	2.50	4.91	171.1	95	190,650	38,829	0.1
10	PIL, Run 131 Box 74	880.6	5.41	2.49	4.87	171.8	98	116,990	24,023	0.1

NOTES: Bulk Density includes any moisture that is within the specimen.



UNCONFINED COMPRESSION
(ASTM D7012 Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

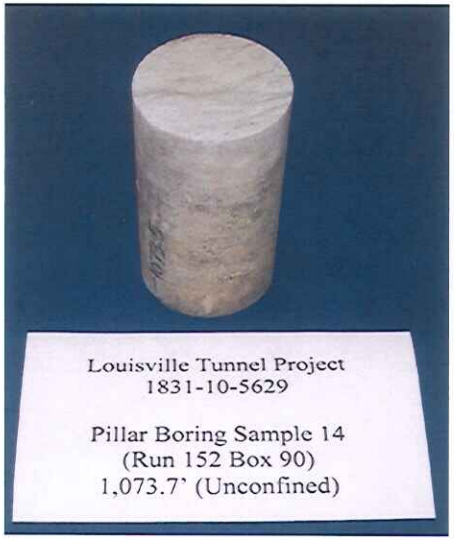
Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

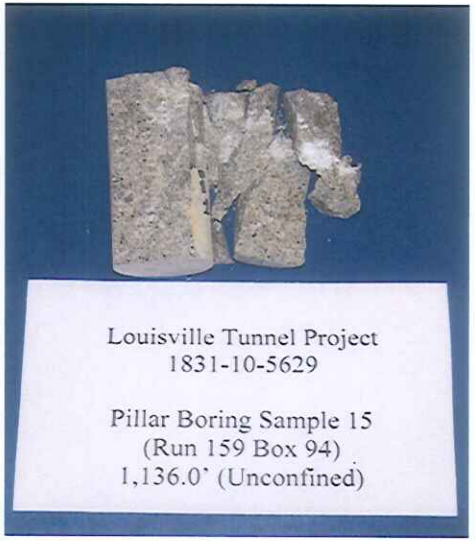
Sample Date: 5/13/2011

Report Date: 6/6/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
14	PIL, Run 152 Box 90	1073.7	4.07	1.85	2.69	166.9	88	26,910	10,004	0.2
15	PIL, Run 159 Box 94	1136.0	2.72	1.23	1.19	172.5	66	8,880	7,462	0.1

NOTES: Bulk Density includes any moisture that is within the specimen.





UNCONFINED COMPRESSION
(ASTM D7012 Method C)

S&ME

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

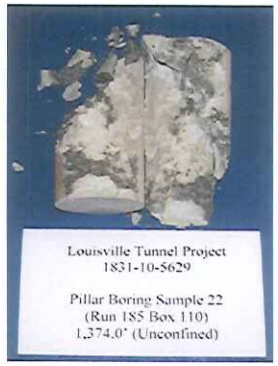
Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 5/20/2011

Report Date: 6/7/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
17	PIL, Run 165 Box 98	1193.9	4.09	1.85	2.69	165.0	101	24,430	9,082	0.2
18	PIL, Run 171 Box 102	1249.2	4.04	1.86	2.72	166.8	93	25,820	9,493	0.2
20	PIL, Run 178 Box 102	1314.3	2.68	1.23	1.19	160.4	67	8,430	7,084	0.1
22	PIL, Run 185 Box 110	1374.0	4.04	1.85	2.69	160.2	75	14,660	5,450	0.6

NOTES: Bulk Density includes any moisture that is within the specimen.



UNCONFINED COMPRESSION
(ASTM D7012 Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

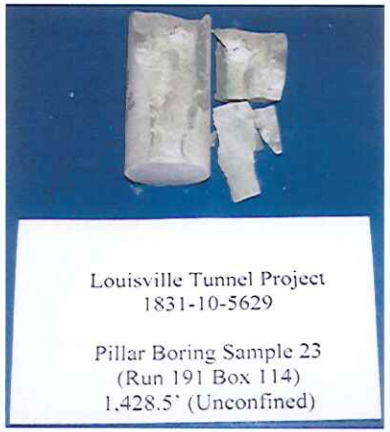
Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 5/27/2011

Report Date: 6/7/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
23	PIL, Run 191 Box 114	1428.5	2.74	1.23	1.19	163.5	81	7,120	5,983	0.9
26	PIL, Run 197 Box 117	1472.3	2.69	1.24	1.21	161.0	78	8,400	6,942	0.8

NOTES: Bulk Density includes any moisture that is within the specimen.



UNCONFINED COMPRESSION
(ASTM D7[illegible] Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 6/3/2011

Report Date: 6/16/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
30	PIL, Run 205 Box 121	1539.7	4.00	1.86	2.72	162.6	58	17,930	6,592	1.1
31	PIL, Run 212 Box 126	1606.4	3.99	1.86	2.72	163.2	95	18,100	6,654	1.3
34	PIL, Run 219 Box 130	1671.1	4.02	1.85	2.69	162.6	101	17,060	6,342	1.5
37	PIL, Run 227 Box 134	1728.8	3.97	1.80	2.54	165.4	100	11,220	4,417	2.5
38	PIL, Run 234 Box 137	1771.2	3.94	1.85	2.69	163.6	90	13,040	4,848	1.5

NOTES: Bulk Density includes any moisture that is within the specimen.

UNCONFINED COMPRESSION
(ASTM D7[illegible] Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 6/10/2011

Report Date: 6/30/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
PIL-42	Run 241 Box 141	1834.5	3.79	1.81	2.57	166.0	72	14,750	5,739	2.4

NOTES: Bulk Density includes any moisture that is within the specimen.

The specimen from PIL-43 Run 249 Box 144 1890.5' - 1892.5' immeidately cracked down the center following sawing. No test sample could be obtained.

UNCONFINED COMPRESSION
(ASTM D7[illegible] Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 6/17/2011

Report Date: 7/8/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
PIL-44	Run 258 Box 148	1951.1	4.05	1.85	2.69	163.3	85	11,470	4,264	1.9
PIL-46	Run 265 Box 152	2013.4	4.05	1.85	2.69	165.5	79	16,070	5,974	2.2
PIL-50	Run 278 Box 160	2131.4	4.02	1.86	2.72	156.9	84	30,470	11,202	0.4

NOTES: Bulk Density includes any moisture that is within the specimen.

A test specimen from PIL-48 Run 272 Box 156 could not be obtained due to bedding seams opening up.

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 44
(Run 258 Box 148)
1,951.1' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 46
(Run 265 Box 152)
2,013.4' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 50
(Run 278 Box 160)
2,131.4' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 44
(Run 258 Box 148)
1,951.1' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 46
(Run 265 Box 152)
2,013.4' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 50
(Run 278 Box 160)
2,131.4' (Unconfined)

UNCONFINED COMPRESSION
(ASTM D7[illegible] Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629
Project Name: Louisville Tunnel Project

Sample Date: 6/24/2011

Report Date: 7/20/2011

Sample No.	Boring Location	Distance (ft)	Specimen Dimension, in.		Area (in^2)	Bulk Density (lb/ft^3)	Loading Rate (psi/sec)	Max. Load (lb)	Strength (psi)	Moisture (%)
			Length	Diameter						
PIL-51	Run 284 Box 164	2190.7	4.04	1.86	2.72	171.4	85	43,570	16,018	0.1
PIL-52	Run 290 Box 168	2253.9	4.02	1.86	2.72	170.9	88	57,420	21,110	0.1
PIL-53	Run 296 Box 172	2310.4	4.06	1.87	2.75	167.1	80	78,760	28,640	0.1

NOTES: Bulk Density includes any moisture that is within the specimen.

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 51
(Run 284 Box 164)
2,190.7' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 52
(Run 290 Box 168)
2,253.9' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 53
(Run 296 Box 172)
2,310.4' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 51
(Run 284 Box 164)
2,190.7' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 52
(Run 290 Box 168)
2,253.9' (Unconfined)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 53
(Run 296 Box 172)
2,310.4' (Unconfined)

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **4/15/2011** Report Date: 05/03/11

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C-11-014	PIL-2 Run 68 Box 34	461.8	Limestone	As-Received	A	N/A	M	1.85	1.46	1.42	3.34	1.83	2787	834	0.968	807	3	18448
C-11-014	PIL-2 Run 68 Box 34	460.5	Limestone	As-Received	D	N/A	M	N/A	1.85	1.81	3.35	1.83	2576	769	0.968	744	2	17011
C-11-013	PIL-1 Run 62 Box 30	404.0	Limestone	As-Received	A	∥ 1	P	1.24	0.98	0.98	1.55	1.24	426	275	0.812	223	1, 3	5294
C-11-013	PIL-1 Run 62 Box 30	404.1	Limestone	As-Received	D	∥	P	N/A	1.22	1.22	1.49	1.22	542	364	0.806	293	1,3	6976
C-11-013	PIL-1 Run 62 Box 30	403.8	Limestone	As-Received	D	⊥	P	N/A	1.22	1.20	1.46	1.21	1111	761	0.803	611	2	14552

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

1. Test could not be performed in perpendicular direction due to location of pressure solution feature.

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **4/22/2011** Report Date: 5/6/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C-11-027	PIL-3 Run 78 Box 39	521.7	Limestone	As-Received	A	Note 1	P	1.85	1.57	1.54	3.63	1.91	1187	327	0.987	323	1, 3	7400
C-11-027	PIL-3 Run 78 Box 39	521.5	Limestone	As-Received	D	Note 1	P	N/A	1.85	1.81	3.35	1.83	1105	330	0.968	319	1,2,3	7300
C-11-027	PIL-3 Run 78 Box 39	522.0	Limestone	As-Received	D	Note 1	P	N/A	1.85	1.81	3.35	1.83	930	278	0.968	269	1, 3 Note 2	6149

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

1. Load applied parallel to PSF but not through the feature itself.
2. Failure plane did not go through both contact points due to PSF.

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **4/29/2011** Report Date: 5/13/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-047	PIL-4 Run 91 Box 48	583.1	Limestone	As-Received	A	N/A	M	1.24	1.04	1.02	1.61	1.27	2174	1350	0.821	1108	3	26,158
C11-047	PIL-4 Run 91 Box 48	583.1	Limestone	As-Received	D	N/A	M	N/A	1.24	1.20	1.49	1.22	2438	1636	0.806	1319	2, 3	31,353
C11-049	PIL-6 Run 99 Box 54	644.1	Limestone	As-Received	A	N/A	M	2.50	1.61	1.57	5.00	2.24	4745	949	1.060	1006	3	23,005
C11-049	PIL-6 Run 99 Box 54	644.1	Limestone	As-Received	D	N/A	M	N/A	2.48	2.44	6.05	2.46	4687	775	1.106	857	3	19,774
C11-050	PIL-7 Run 111 Box 59	702.6	Limestone	As-Received	A	N/A	M	2.50	1.63	1.59	5.06	2.25	6082	1202	1.062	1277	3	29,164
C11-050	PIL-7 Run 111 Box 59	702.6	Limestone	As-Received	D	N/A	M	N/A	2.50	2.44	6.10	2.47	6021	987	1.108	1094	2	25,285
C11-051	PIL-8 Run 119 Box 65	768.8	Limestone	As-Received	A	N/A	M	1.24	1.12	1.10	1.74	1.32	2565	1474	0.835	1231	3	28,873
C11-051	PIL-8 Run 119 Box 65	768.8	Limestone	As-Received	D	N/A	M	N/A	1.24	1.22	1.51	1.23	2565	1699	0.809	1374	2, 3	32,633

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **5/6/2011** Report Date: 5/20/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-063	PIL-9 Run 125 Box 69	823.5	Limestone	As-Received	A	N/A	M	2.50	1.26	1.22	3.88	1.97	5913	1524	1.000	1524	3	35,066
C11-063	PIL-9 Run 125 Box 69	823.3	Limestone	As-Received	D	N/A	M	N/A	2.48	2.44	6.05	2.46	6093	1007	1.106	1114	3	25,693
C11-064	PIL-10 Run 131 Box 74	881.1	Limestone	As-Received	A	N/A	M	2.49	1.26	1.22	3.87	1.97	4158	1074	1.000	1074	3	24,712
C11-064	PIL-10 Run 131 Box 74	881.4	Limestone	As-Received	D	N/A	M	N/A	2.48	2.44	6.05	2.46	3937	651	1.106	720	2	16,610
C11-065	PIL-11 Run 137 Box 65	944.5	Limestone	As-Received	A	N/A	M	2.49	1.38	1.34	4.25	2.06	2384	561	1.021	573	3	13,229
C11-065	PIL-11 Run 137 Box 65	945.5	Limestone	As-Received	D	N/A	M	N/A	2.48	2.44	6.05	2.46	3249	537	1.106	594	2	13,701
C11-066	PIL-12 Run 144 Box 85	1009.6	Limestone	As-Received	A	N/A	M	1.24	0.94	0.93	1.47	1.21	1645	1119	0.803	899	3	21,398
C11-066	PIL-12 Run 144 Box 85	1009.7	Limestone	As-Received	D	N/A	M	N/A	1.22	1.20	1.46	1.21	1217	834	0.803	670	2	15,948

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **5/13/2011** Report Date: 6/6/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-080	PIL-14 Run 152 Box 90	1074	Limestone	As-Received	A	∥ to PSF	P	1.86	1.46	1.46	3.46	1.86	1156	334	0.975	326	1, 3	7,452
C11-080	PIL-14 Run 152 Box 90	1074.2	Limestone	As-Received	D	⊥ to PSF	P	N/A	1.85	1.75	3.24	1.80	2821	871	0.961	837	2	19,101
C11-081	PIL-15 Run 159 Box 94	1135.7	Limestone	As-Received	A	N/A	P	1.23	0.93	0.91	1.43	1.20	1408	985	0.800	788	3	18,794
C11-081	PIL-15 Run 159 Box 94	1135.6	Limestone	As-Received	D	N/A	P	N/A	1.22	1.20	1.46	1.21	1434	982	0.803	789	2	18,778

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **5/20/2011** Report Date: 6/7/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-092	PIL-17 Run 165 Box 98	1194.2	Shale	As-Received	A	N/A	M	1.86	1.46	1.42	3.36	1.83	2782	828	0.968	802	3	18,316
C11-092	PIL-17 Run 165 Box 98	1194.4	Shale	As-Received	D	N/A	M	N/A	1.85	1.81	3.35	1.83	1564	467	0.968	452	3, 4	10,330
C11-093	PIL-18 Run 171 Box 102	1249.5	Shale	As-Received	A	∥ to PSF	MP	1.86	1.46	1.42	3.36	1.83	1413	421	0.968	408	1, 3	9,313
C11-093	PIL-18 Run 171 Box 102	1249.7	Shale	As-Received	D	⊥ to PSF	MP	N/A	1.85	1.81	3.35	1.83	2403	717	0.968	694	2	15,860
C11-095	PIL-20 Run 178 Box 106	1314.5	Shale	As-Received	A	N/A	M	1.24	0.94	0.91	1.44	1.20	1307	908	0.800	726	3	17,325
C11-095	PIL-20 Run 178 Box 106	1314.6	Shale	As-Received	D	N/A	M	N/A	1.22	1.20	1.46	1.21	791	542	0.803	435	1, 2	10,364
C11-097	PIL-22 Run 185 Box 110	1374.3	Shale	As-Received	A	N/A	MP	1.86	1.46	1.44	3.41	1.85	666	195	0.972	190	3	4,338
C11-097	PIL-22 Run 185 Box 110	1374.5	Shale	As-Received	D	N/A	MP	N/A	1.85	1.81	3.35	1.83	1000	299	0.968	289	2	6,614

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **5/27/2011** Report Date: 6/7/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-109	PIL-24 Run 191 Box 114	1429.7	Shale	As-Received	A	∥ PSF	MP	1.24	0.94	0.91	1.44	1.20	368	256	0.800	205	1, 3	4,884
C11-109	PIL-24 Run 191 Box 114	1429.9	Shale	As-Received	D	⊥ PSF	MP	N/A	1.22	1.18	1.44	1.20	724	503	0.800	402	2	9,597
C11-112	PIL-27 Run 199 Box 117	1482.7	Shale	As-Received	A	∥ PSF	MP	1.24	0.98	0.96	1.52	1.23	411	270	0.809	218	1, 3	5,186
C11-112	PIL-27 Run 199 Box 117	1482.9	Shale	As-Received	D	⊥ PSF	MP	N/A	1.22	1.18	1.44	1.20	676	469	0.800	375	2	8,949

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **5/27/2011** Report Date: 6/7/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-109	PIL-24 Run 191 Box 114	1429.7	Shale	As-Received	A	∥ PSF	MP	1.24	0.94	0.91	1.44	1.20	368	256	0.800	205	1, 3	4,884
C11-109	PIL-24 Run 191 Box 114	1429.9	Shale	As-Received	D	⊥ PSF	MP	N/A	1.22	1.18	1.44	1.20	724	503	0.800	402	2	9,597
C11-112	PIL-27 Run 199 Box 117	1482.7	Shale	As-Received	A	∥ PSF	MP	1.24	0.98	0.96	1.52	1.23	411	270	0.809	218	1, 3	5,186
C11-112	PIL-27 Run 199 Box 117	1482.9	Shale	As-Received	D	⊥ PSF	MP	N/A	1.22	1.18	1.44	1.20	676	469	0.800	375	2	8,949

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **6/3/2011** Report Date: 6/17/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{s(50)}$ (psi)	Failure Type	s_c (psi)
C11-118	PIL-30 Run 205 Box 121	1540.0	Shale	As-Received	A	∥ PSF	MP	1.86	1.48	1.44	3.41	1.85	1076	316	0.972	307	3	7,030
C11-118	PIL-30 Run 205 Box 121	1540.2	Shale	As-Received	D	∥ PSF	MP	N/A	1.85	1.81	3.35	1.83	875	261	0.968	253	1, 3	5,773
C11-119	PIL-31 Run 212 Box 126	1606.7	Shale	As-Received	A	∥ PSF	MP	1.85	1.44	1.42	3.34	1.83	580	174	0.968	168	3	3,849
C11-119	PIL-31 Run 212 Box 126	1606.9	Shale	As-Received	D	∥ PSF	MP	N/A	1.85	1.81	3.35	1.83	954	285	0.968	276	1, 3	6,304
C11-121	PIL-33 Run 219 Box 130	1668.3	Shale	As-Received	A	∥ PSF	MP	1.85	1.34	1.30	3.06	1.75	709	232	0.948	220	3	5,014
C11-121	PIL-33 Run 219 Box 130	1668.5	Shale	As-Received	D	⊥ PSF	MP	N/A	1.83	1.79	3.28	1.81	1500	457	0.963	440	4	10,051
C11-125	PIL-37 Run 227 Box 134	1729.1	Shale	As-Received	A	∥ PSF	MP	1.81	1.50	1.48	3.41	1.85	86	25	0.972	24	3	556
C11-125	PIL-37 Run 227 Box 134	1729.4	Shale	As-Received	D	⊥ PSF	MP	N/A	1.77	1.73	3.06	1.75	628	205	0.948	194	2, 4	4,431
C11-127	PIL-39 Run 234 Box 137	1780.0	Shale	As-Received	A	∥ PSF	MP	1.82	1.46	1.42	3.29	1.81	580	176	0.963	169	3	3,871
C11-127	PIL-39 Run 234 Box 137	1780.2	Shale	As-Received	D	⊥ PSF	MP	N/A	1.77	1.73	3.06	1.75	1076	352	0.948	334	2	7,608

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Specimen, PIL-37 Run 227 Box 134, 1729.1 contained a seam that was partially opening up prior to test.

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **6/10/2011** Report Date: 6/30/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-187	PIL-42 Run 241 Box 141	1834.8	Waldron Shale	As-Received	A	∥ bed	B	1.81	1.06	1.02	2.35	1.53	436	186	0.893	166	3	3,809
C11-188	PIL-43 Run 249 Box 144	1891.9	Waldron Shale	As-Received	A	∥ bed	B	1.84	1.50	1.48	3.47	1.86	169	49	0.975	48	3	1,093
C11-188	PIL-43 Run 249 Box 144	1891.7	Waldron Shale	As-Received	D	⊥ bed	B	N/A	1.83	1.77	3.24	1.80	249	77	0.961	74	2	1,689

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Unable to obtain a diametral test for PIL-42 Run 241 Box 141 due to insufficent intact core length available.

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **6/17/2011** Report Date: 7/8/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-171	PIL-44 Run 258 Box 148	1951.4	Waldron Shale	As-Received	A	N/A	M	1.85	1.54	1.50	3.53	1.88	786	223	0.980	219	3	5,004
C11-171	PIL-44 Run 258 Box 148	1951.6	Waldron Shale	As-Received	D	N/A	M	N/A	1.85	1.81	3.35	1.83	1343	401	0.968	388	2	8,870
C11-177	PIL-50 Run 278 Box 160	2131.7	Dolomite	As-Received	A	N/A	M	1.86	1.57	1.54	3.65	1.91	2413	661	0.987	652	3	14,957
C11-177	PIL-50 Run 278 Box 160	2131.9	Dolomite	As-Received	D	N/A	M	N/A	1.85	1.81	3.35	1.83	2189	653	0.968	632	4	14,445

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

Tests specimens assigned for samples (PIL-46 Run 265 Box 152 2012.7 - 2014.4) and (PIL-48 Run 272 Box 156 2071.7 - 2072.9) could not be obtained due to material bedding seams opening up prior to testing.

Point Load Strength Index of Rock (for Horizontal Borings)

ASTM D5731, ISRM Point Load Test

Quality Assurance

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: **1831-10-5629** Sample Date: **6/24/2011** Report Date: 7/20/2011

Project Name: **Louisville Tunnel Project**

Lab ID	Boring ID	Distance (ft)	Rock Type	Moisture Condition	Test Type	Aniso. Load	Folliation / Joint Dip	W (in)	D (in)	D' (in)	D_e^2 (in)	D_e (in)	Load (lbs)	I_s (psi)	F	$I_{S(50)}$ (psi)	Failure Type	s_c (psi)
C11-189	PIL-51 Run 284 Box 164	2191.0	Dolomite	As-Received	A	N/A	M	1.87	1.38	1.34	3.19	1.79	2238	702	0.958	673	3	15,350
C11-189	PIL-51 Run 284 Box 164	2191.2	Dolomite	As-Received	D	N/A	M	N/A	1.85	1.77	3.27	1.81	4338	1327	0.963	1278	2	29,185
C11-190	PIL-52 Run 290 Box 168	2254.2	Dolomite	As-Received	A	∥ PSF	MP	1.86	1.36	1.32	3.13	1.77	2851	911	0.953	868	3	19,805
C11-190	PIL-52 Run 290 Box 168	2254.4	Dolomite	As-Received	D	∥ PSF	MP	N/A	1.85	1.77	3.27	1.81	3363	1028	0.963	990	2	22,609
C11-191	PIL-53 Run 296 Box 172	2310.7	Dolomite	As-Received	A	N/A	M	1.86	1.34	1.30	3.08	1.75	4020	1305	0.948	1237	3	28,204
C11-191	PIL-53 Run 296 Box 172	2310.9	Dolomite	As-Received	D	N/A	M	N/A	1.85	1.81	3.35	1.83	2492	744	0.968	720	2	16,458

Nomenclature

Test Type: D = Diametral, A = Axial, B = Block, and I = Irregular

Anisotropic Load: ⊥ = Load applied perpendicular to anisotropic planes ∥ = Load applied parallel to anisotropic planes.

Folliation / Joint Dip: Angle measured from plane perpendicular to core axis, F = Foliation, J = Joint, B = Bedding, M = Massive (no apparent folliation of joints), P = Pressure Solution Feature

Failure Type: 1 = Along joint, folliation or other feature, 2 = across core axis, 3 = along core axis, 4 = pop-out (invalid), 5 = failure prior to loading (invalid)

Sc calculated using generalized strength conversion factors interpolated from Table 1 in ASTM D5731 and values of I_s and D_e.

Notes / Deviations / References: ASTM D5731

SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 4/15/2011 Report Date: 5/3/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-2 Run 68 Box 34	460.8	1.85	1.23	0.66	162.0	0.3	5,030	361	1,407

NOTE: Bulk Density includes any moisture that is within the specimen.

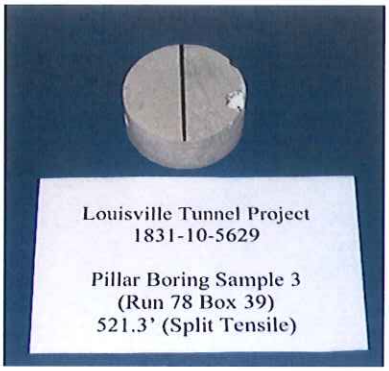
SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 4/22/2011 Report Date: 5/6/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-3 Run 78 Box 39	521.3	1.85	0.91	0.49	163.1	0.5	4,030	575	1,524

NOTE: Bulk Density includes any moisture that is within the specimen.



SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 4/29/2011 Report Date: 5/13/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-4 Run 91 Box 48	583.3	1.24	0.86	0.69	168.6	0.1	5,590	1,112	3,337
PIL-5 Run 99 Box 53	641.0	2.49	1.21	0.49	164.4	0.3	5,290	771	1,118
PIL-7 Run 111 Box 59	703.1	2.50	1.60	0.64	169.4	0.1	16,140	1,142	2,569
PIL-8 Run 119 Box 65	468.7	1.24	0.86	0.69	166.1	0.0	5,950	1,522	3,552

NOTE: Bulk Density includes any moisture that is within the specimen.

SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 5/6/2011 Report Date: 5/20/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-9 Run 125 Box 69	823.1	2.50	1.23	0.49	170.3	0.1	12,520	1,206	2,592
PIL-10 Run 131 Box 74	880.9	2.50	1.40	0.56	169.2	0.0	12,980	944	2,361
PIL-11 Run 137 Box 80	945.3	2.49	1.32	0.53	168.8	0.1	8,520	952	1,650
PIL-13 Run 144 Box 85	1010.1	1.24	0.83	0.67	167.9	0.1	5,100	1,270	3,155

NOTE: Bulk Density includes any moisture that is within the specimen.

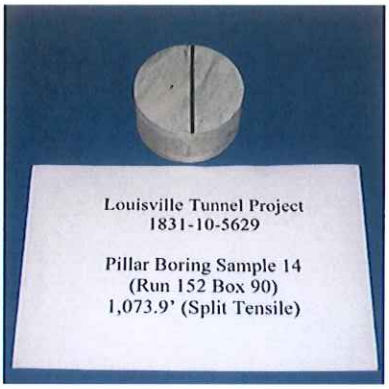
SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 5/13/2011 Report Date: 6/6/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-14 Run 152 Box 90	1,073.9	1.86	1.17	0.63	164.4	0.2	3,710	904	1,085
PIL-15 Run 159 Box 94	1,135.8	1.23	0.76	0.62	171.3	0.3	3,650	1,332	2,486

NOTE: Bulk Density includes any moisture that is within the specimen.



SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 5/20/2011 Report Date: 6/7/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-17 Run 165 Box 98	1,194.1	1.86	1.04	0.56	161.0	0.2	2,710	510	892
PIL-18 Run 171 Box 102	1,249.4	1.86	1.10	0.59	169.0	0.1	4,950	856	1,540
PIL-20 Run 178 Box 106	1,314.4	1.23	0.78	0.63	161.5	0.3	2,600	1,150	1,725
PIL-22 Run 185 Box 110	1,374.2	1.85	1.08	0.58	161.4	0.5	3,330	656	1,061

NOTE: Bulk Density includes any moisture that is within the specimen.

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SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 5/27/2011 Report Date: 6/7/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-23 Run 191 Box 114	1,428.7	1.23	0.85	0.69	161.1	0.5	1,670	1,237	1,017

NOTE: Bulk Density includes any moisture that is within the specimen.

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SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

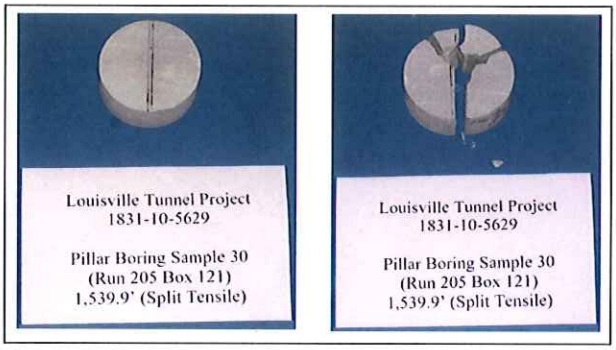
S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

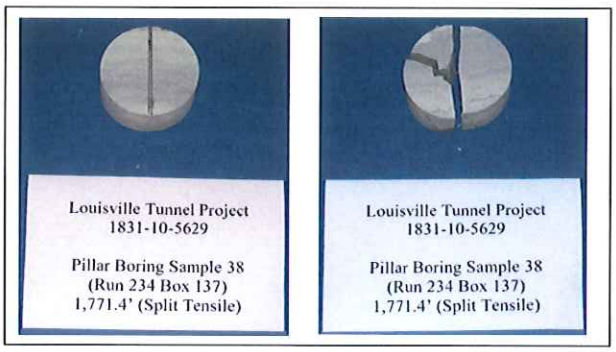
Project #: 1831-10-5629 Sample Date: 6/3/2011 Report Date: 6/17/2011

Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-30 Run 205 Box 121	1,539.9	1.86	1.16	0.62	162.3	1.1	4,750	841	1,402
PIL-31 Run 212 Box 126	1,606.6	1.85	1.12	0.61	165.9	1.4	3,770	655	1,158
PIL-34 Run 219 Box 130	1,671.3	1.85	1.19	0.64	162.5	1.6	2,650	500	766
PIL-37 Run 227 Box 134	1,729.0	1.80	1.03	0.57	164.9	2.6	1,700	389	584
PIL-38 Run 234 Box 137	1,771.4	1.85	1.16	0.63	163.6	1.6	3,310	556	982

NOTE: Bulk Density includes any moisture that is within the specimen.





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SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 6/10/2011 Report Date: 6/30/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-42 Run 241 Box 141	1,834.7	1.81	0.83	0.46	164.0	2.2	720	300	305
PIL-43 Run 249 Box 144	1,892.0	1.83	1.21	0.66	161.9	3.1	740	178	213

NOTES: Bulk Density includes any moisture that is within the specimen.

Specimen PIL-43 Run 249 Box 144 had began to dry out and had exhibited some cracking. Specimen tested perpendicular to bedding.

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 42
(Run 241 Box 141)
1,834.7 (Split Tensile)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 42
(Run 241 Box 141)
1,834.7 (Split Tensile)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 43
(Run 249 Box 144)
1,892.0' (Split Tensile)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 43
(Run 249 Box 144)
1,892.0' (Split Tensile)

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SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

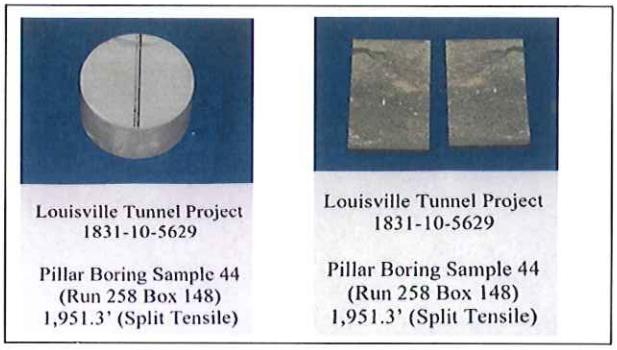
Project #: 1831-10-5629 Sample Date: 6/17/2011 Report Date: 7/8/2011

Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-44 Run 258 Box 148	1,951.3	1.85	1.22	0.66	163.5	1.6	3,720	732	1,049
PIL-46 Run 265 Box 152	2,013.2	1.84	0.82	0.45	165.1	2.2	1,500	633	633
PIL-50 Run 278 Box 160	2,131.6	1.86	1.22	0.66	158.7	0.4	6,160	715	1,728

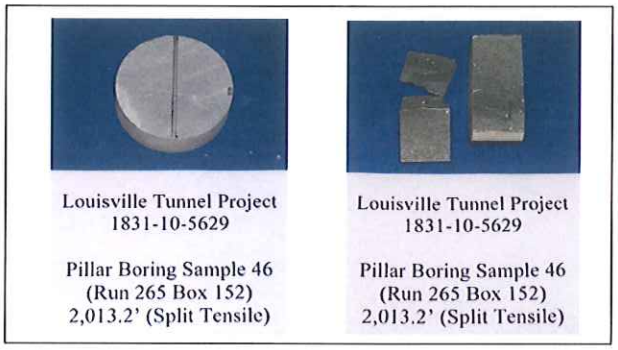
NOTE: Bulk Density includes any moisture that is within the specimen.

A test specimen from PIL-48 Run 272 Box 156 could not be obtained due to bedding seams opening up.



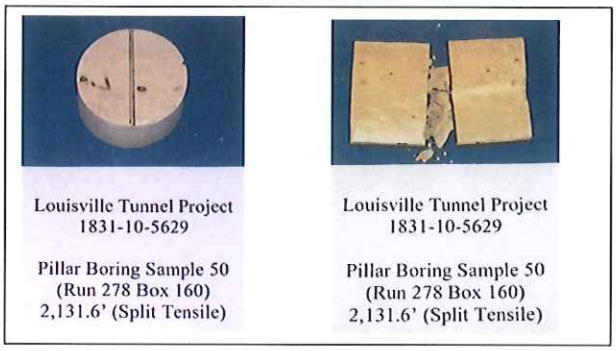
Louisville Tunnel Project 1831-10-5629
Pillar Boring Sample 44 (Run 258 Box 148) 1,951.3' (Split Tensile)

Louisville Tunnel Project 1831-10-5629
Pillar Boring Sample 44 (Run 258 Box 148) 1,951.3' (Split Tensile)



Louisville Tunnel Project 1831-10-5629
Pillar Boring Sample 46 (Run 265 Box 152) 2,013.2' (Split Tensile)

Louisville Tunnel Project 1831-10-5629
Pillar Boring Sample 46 (Run 265 Box 152) 2,013.2' (Split Tensile)



Louisville Tunnel Project 1831-10-5629
Pillar Boring Sample 50 (Run 278 Box 160) 2,131.6' (Split Tensile)

Louisville Tunnel Project 1831-10-5629
Pillar Boring Sample 50 (Run 278 Box 160) 2,131.6' (Split Tensile)

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SPLITTING TENSILE STRENGTH OF INTACT ROCK CORE
(ASTM D3967)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project #: 1831-10-5629 Sample Date: 6/24/2011 Report Date: 7/20/2011
Project Name: Louisville Tunnel Project

Hole ID (Sample #)	Distance (ft)	Specimen Dimension			Bulk Density (lb/ft^3)	Moisture Content (%)	Maximum Load (lbs)	Load Rate (psi/min)	Strength (psi)
		Diameter (in)	Thickness (in)	t/D Ratio					
PIL-51 Run 284 Box 164	2,190.9	1.87	1.00	0.53	168.7	0.1	7,410	1,941	2,523
PIL-52 Run 290 Box 168	2,254.1	1.86	1.03	0.55	171.5	0.1	8,480	2,225	2,818
PIL-53 Run 296 Box 172	2,310.6	1.87	1.00	0.53	168.0	0.1	8,800	2,247	2,996

NOTE: Bulk Density includes any moisture that is within the specimen.

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 51
(Run 284 Box 164)
2,190.9' (Split Tensile)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 51
(Run 284 Box 164)
2,190.9' (Split Tensile)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 52
(Run 290 Box 168)
2,254.1' (Split Tensile)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 52
(Run 290 Box 168)
2,254.1' (Split Tensile)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 53
(Run 296 Box 172)
2,310.6' (Split Tensile)

Louisville Tunnel Project
1831-10-5629

Pillar Boring Sample 53
(Run 296 Box 172)
2,310.6' (Split Tensile)

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

Project:	Louisville Tunnel	Sample Date:	5/20/2011
S&ME Project No.	1831-10-5629	Report Date:	6/7/2011
Material:	Shale		
Sample ID:	PIL-16 Run 163 Box 97 (1171.9' - 1173.3')		
Date Tested:	6/03/2011 to 6/04/2011		

Slake Durabiltiy Index (Second Cycle)	98.9	%
Range of water temperature (Cycle 1)	1.5	°F
Average water temperature (Cycle 1)	75.3	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	75.8	°F
Natural Moisture Content	0.36	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	☑
II	Retained specimen consists of large and small fragments	
III	Retained specimen is exclusively small fragments	

Before Test

After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

1413 Topside Road, Louisville, Tennessee 37777

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

Project:	Louisville Tunnel	Sample Date:	5/20/2011
S&ME Project No.	1831-10-5629	Report Date:	6/7/2011
Material:	Shale		
Sample ID:	PIL-19 Run 171 Box 102 (1251.8' - 1253.0')		
Date Tested:	6/03/2011 to 6/04/2011		

Slake Durabiltiy Index (Second Cycle)	99.0	%
Range of water temperature (Cycle 1)	1.0	°F
Average water temperature (Cycle 1)	75.0	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	75.8	°F
Natural Moisture Content	0.37	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	☑
II	Retained specimen consists of large and small fragments	
III	Retained specimen is exclusively small fragments	

Before Test

After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

1413 Topside Road, Louisville, Tennessee 37777

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

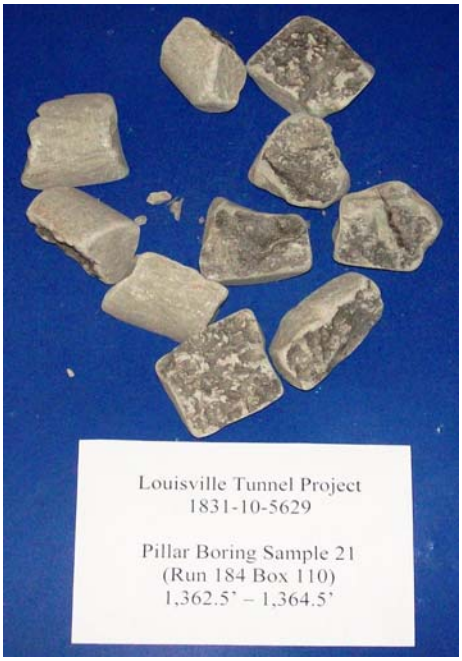
Project:	Louisville Tunnel	Sample Date:	5/20/2011
S&ME Project No.	1831-10-5629	Report Date:	6/7/2011
Material:	Shale		
Sample ID:	PIL-21 Run 184 Box 110 (1362.5' - 1364.5')		
Date Tested:	6/03/2011 to 6/04/2011		

Slake Durabiltiy Index (Second Cycle)	95.1	%
Range of water temperature (Cycle 1)	3.5	°F
Average water temperature (Cycle 1)	76.3	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	75.8	°F
Natural Moisture Content	0.93	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	☑
II	Retained specimen consists of large and small fragments	
III	Retained specimen is exclusively small fragments	

Before Test



After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

1413 Topside Road, Louisville, Tennessee 37777

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

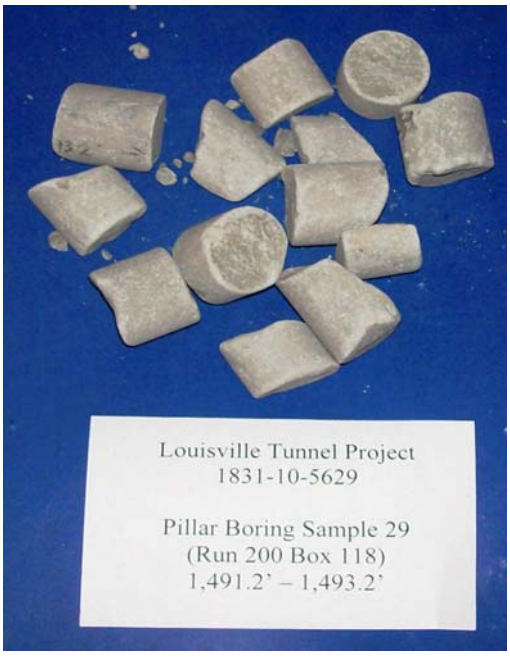
Project:	Louisville Tunnel	Sample Date:	5/27/2011
S&ME Project No.	1831-10-5629	Report Date:	6/7/2011
Material:	Shale		
Sample ID:	PIL-29 Run 200 Box 118 (1491.2' - 1493.2')		
Date Tested:	6/03/2011 to 6/04/2011		

Slake Durabiltiy Index (Second Cycle)	97.0	%
Range of water temperature (Cycle 1)	3.5	°F
Average water temperature (Cycle 1)	76.3	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	75.8	°F
Natural Moisture Content	2.00	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	☑
II	Retained specimen consists of large and small fragments	
III	Retained specimen is exclusively small fragments	

Before Test



After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

1413 Topside Road, Louisville, Tennessee 37777

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

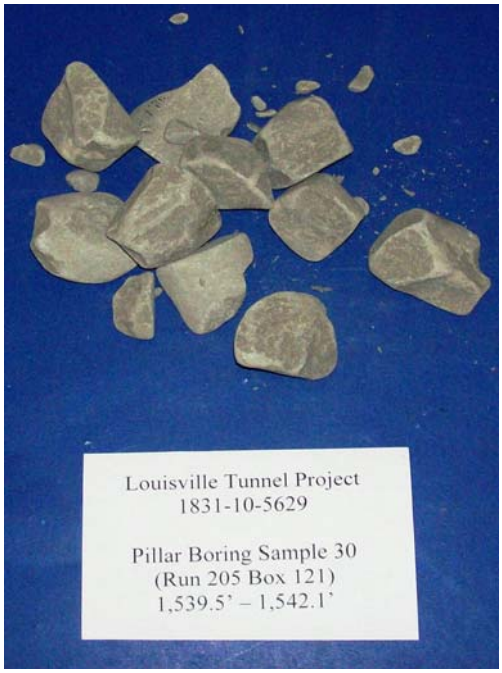
Project:	Louisville Tunnel	Sample Date:	6/3/2011
S&ME Project No.	1831-10-5629	Report Date:	6/17/2011
Material:	Shale		
Sample ID:	PIL-30 Run 205 Box 121 (1539.5' - 1542.1')		
Date Tested:	6/15/2011 to 6/16/2011		

Slake Durability Index (Second Cycle)	93.0	%
Range of water temperature (Cycle 1)	0.5	°F
Average water temperature (Cycle 1)	74.3	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	74.3	°F
Natural Moisture Content	1.22	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	☑
II	Retained specimen consists of large and small fragments	
III	Retained specimen is exclusively small fragments	

Before Test



After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

1413 Topside Road, Louisville, Tennessee 37777

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

Project:	Louisville Tunnel	Sample Date:	6/3/2011
S&ME Project No.	1831-10-5629	Report Date:	6/17/2011
Material:	Shale		
Sample ID:	PIL-32 Run 212 Box 126 (1608.2' - 1609.4')		
Date Tested:	6/15/2011 to 6/16/2011		

Slake Durability Index (Second Cycle)	95.7	%
Range of water temperature (Cycle 1)	0.5	°F
Average water temperature (Cycle 1)	73.8	°F
Range of water temperature (Cycle 2)	0.0	°F
Average water temperature (Cycle 2)	74.0	°F
Natural Moisture Content	1.22	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	☑
II	Retained specimen consists of large and small fragments	
III	Retained specimen is exclusively small fragments	

Before Test

After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

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Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

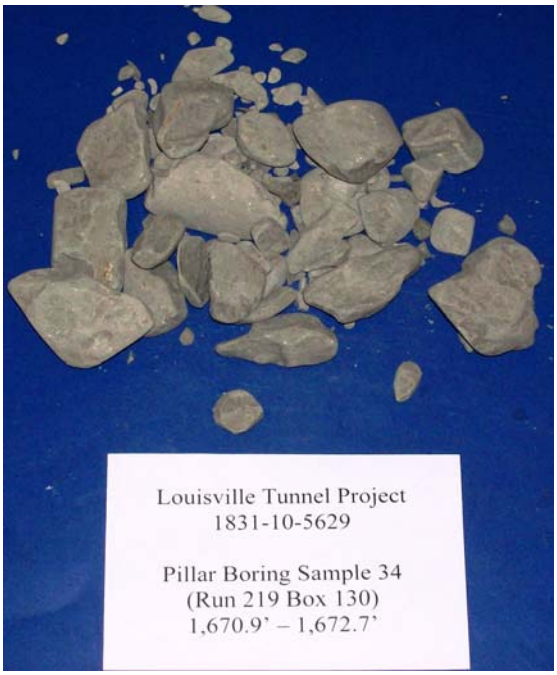
Project:	Louisville Tunnel	Sample Date:	6/3/2011
S&ME Project No.	1831-10-5629	Report Date:	6/17/2011
Material:	Shale		
Sample ID:	PIL-34 Run 219 Box 130 (1670.9' - 1672.7')		
Date Tested:	6/15/2011 to 6/16/2011		

Slake Durability Index (Second Cycle)	86.5	%
Range of water temperature (Cycle 1)	0.5	°F
Average water temperature (Cycle 1)	73.8	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	73.8	°F
Natural Moisture Content	2.01	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	
II	Retained specimen consists of large and small fragments	☑
III	Retained specimen is exclusively small fragments	

Before Test



After Second Cycle

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Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

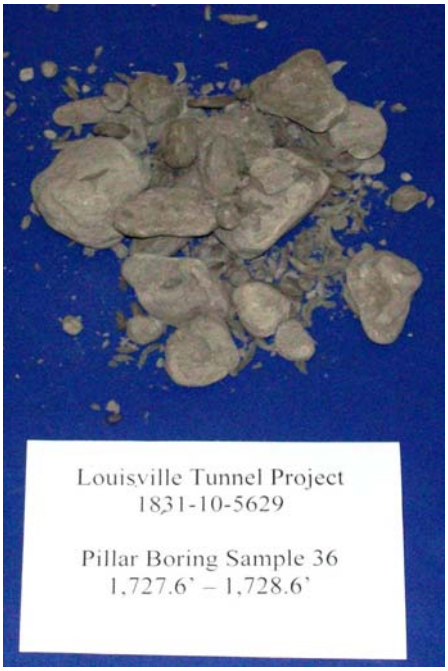
Project:	Louisville Tunnel	Sample Date:	6/3/2011
S&ME Project No.	1831-10-5629	Report Date:	6/17/2011
Material:	Shale		
Sample ID:	PIL-36 (1727.6' - 1728.6')		
Date Tested:	6/15/2011 to 6/16/2011		

Slake Durability Index (Second Cycle)	42.7	%
Range of water temperature (Cycle 1)	0.5	°F
Average water temperature (Cycle 1)	73.8	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	73.8	°F
Natural Moisture Content	2.17	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	
II	Retained specimen consists of large and small fragments	☑
III	Retained specimen is exclusively small fragments	

Before Test



After Second Cycle

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Phone: 865-970-0003 Fax: 865-970-2312

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

Project:	Louisville Tunnel	Sample Date:	6/3/2011
S&ME Project No.	1831-10-5629	Report Date:	6/17/2011
Material:	Shale		
Sample ID:	PIL-39 Run 234 Box 137 (1778.0' - 1780.3')		
Date Tested:	6/16/2011 to 6/17/2011		

Slake Durability Index (Second Cycle)	81.1	%
Range of water temperature (Cycle 1)	0.0	°F
Average water temperature (Cycle 1)	74.0	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	73.8	°F
Natural Moisture Content	1.56	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	
II	Retained specimen consists of large and small fragments	☑
III	Retained specimen is exclusively small fragments	

Before Test

After Second Cycle

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Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

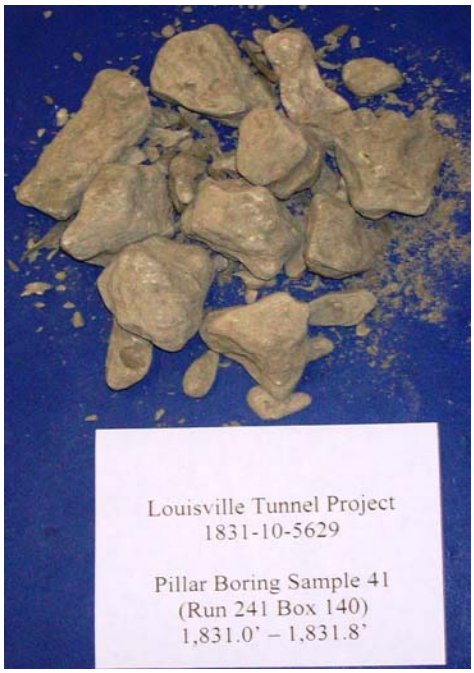
Project:	Louisville Tunnel	Sample Date:	6/10/2011
S&ME Project No.	1831-10-5629	Report Date:	6/30/2011
Material:	Shale		
Sample ID:	PIL-41 Run 241 Box 140 (1831.0' - 1831.8')		
Date Tested:	6/28/2011 to 6/29/2011		

Slake Durability Index (Second Cycle)	73.8	%
Range of water temperature (Cycle 1)	1.5	°F
Average water temperature (Cycle 1)	75.3	°F
Range of water temperature (Cycle 2)	1.0	°F
Average water temperature (Cycle 2)	76.0	°F
Natural Moisture Content	1.72	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	
II	Retained specimen consists of large and small fragments	☑
III	Retained specimen is exclusively small fragments	

Before Test



After Second Cycle

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Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

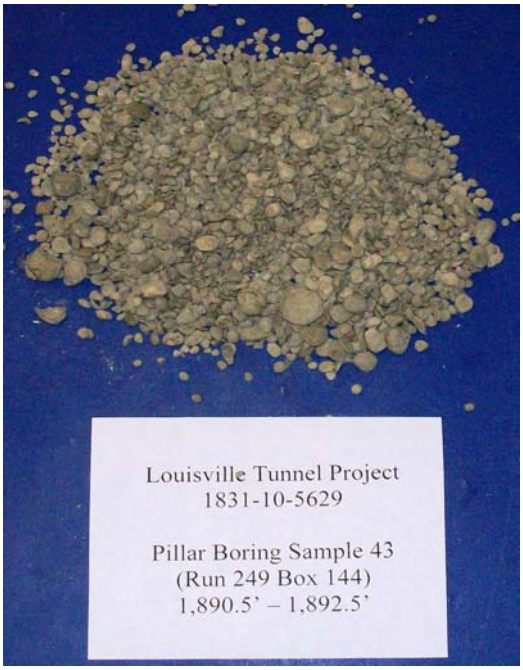
Project:	Louisville Tunnel	Sample Date:	6/10/2011
S&ME Project No.	1831-10-5629	Report Date:	6/30/2011
Material:	Shale		
Sample ID:	PIL-43 Run 249 Box 144 (1890.5' - 1892.5')		
Date Tested:	6/28/2011 to 6/29/2011		

Slake Durability Index (Second Cycle)	28.7	%
Range of water temperature (Cycle 1)	2.0	°F
Average water temperature (Cycle 1)	75.5	°F
Range of water temperature (Cycle 2)	2.0	°F
Average water temperature (Cycle 2)	75.5	°F
Natural Moisture Content	4.51	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	
II	Retained specimen consists of large and small fragments	
III	Retained specimen is exclusively small fragments	☑

Before Test



After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

1413 Topside Road, Louisville, Tennessee 37777

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

Project:	Louisville Tunnel	Sample Date:	6/17/2011
S&ME Project No.	1831-10-5629	Report Date:	7/8/2011
Material:	Shale		
Sample ID:	PIL-45 Run 262 Box 149 (1979.2' - 1981.0')		
Date Tested:	7/01/2011 to 7/05/2011		

Slake Durability Index (Second Cycle)	95.7	%
Range of water temperature (Cycle 1)	1.0	°F
Average water temperature (Cycle 1)	75.5	°F
Range of water temperature (Cycle 2)	0.5	°F
Average water temperature (Cycle 2)	77.8	°F
Natural Moisture Content	2.43	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	
II	Retained specimen consists of large and small fragments	☑
III	Retained specimen is exclusively small fragments	

Before Test

After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

1413 Topside Road, Louisville, Tennessee 37777

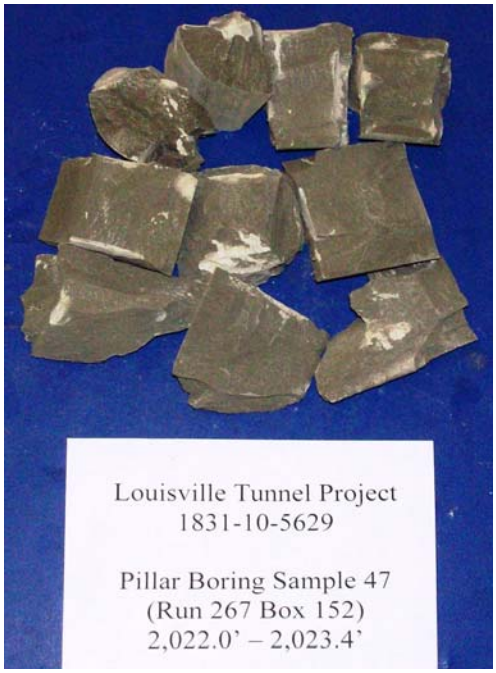
Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

Project:	Louisville Tunnel	Sample Date:	6/17/2011
S&ME Project No.	1831-10-5629	Report Date:	7/8/2011
Material:	Shale		
Sample ID:	PIL-47 Run 267 Box 152 (2022.0' - 2023.4')		
Date Tested:	7/01/2011 to 7/05/2011		

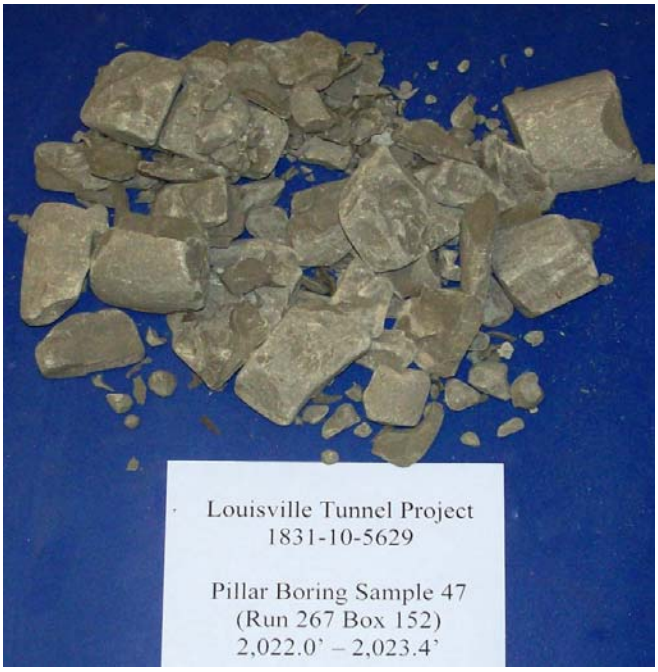
Slake Durability Index (Second Cycle)	90.1	%
Range of water temperature (Cycle 1)	1.0	°F
Average water temperature (Cycle 1)	75.5	°F
Range of water temperature (Cycle 2)	0.0	°F
Average water temperature (Cycle 2)	77.5	°F
Natural Moisture Content	2.75	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	
II	Retained specimen consists of large and small fragments	☑
III	Retained specimen is exclusively small fragments	



Before Test



After Second Cycle

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1413 Topside Road, Louisville, Tennessee 37777

Slake Durability of Shales of Similar Weak Rocks (ASTM D4644)

Project:	Louisville Tunnel	Sample Date:	6/17/2011
S&ME Project No.	1831-10-5629	Report Date:	7/8/2011
Material:	Shale		
Sample ID:	PIL-49 Run 273 Box 156 (2077.9' - 2079.2')		
Date Tested:	7/01/2011 to 7/05/2011		

Slake Durability Index (Second Cycle)	88.5	%
Range of water temperature (Cycle 1)	1.0	°F
Average water temperature (Cycle 1)	75.5	°F
Range of water temperature (Cycle 2)	0.0	°F
Average water temperature (Cycle 2)	77.5	°F
Natural Moisture Content	3.16	%

Sample Description (Check which applies)

Type	Description	
I	Retained specimen remain virtually unchanged	
II	Retained specimen consists of large and small fragments	☑
III	Retained specimen is exclusively small fragments	

Before Test

After Second Cycle

Phone: 865-970-0003 Fax: 865-970-2312

1413 Topside Road, Louisville, Tennessee 37777

pH of Soil

Sample Log No.: 8156 | *AASHTO T 289* | *Quality Assurance*

S&ME, Inc., 1413 Topside Road, Louisville, TN 37777

Project #:	**1831-10-5629**	Report Date:	6/20/11
Project Name:	Louisville Tunnel Project	Test Date(s):	6/14/2011
Client Name:	Kentucky Department of Transportation		
Client Address:	Frankfort, KY		

Sample ID:	PIL 35	Type: Rock Core		Sample Date:	6/3/2011
Location:	Pillar Boring	Sample: 35		Depth (ft):	1691.3 - 1692.3
Sample Description:	Rock Core				

Equipment:

Balance		*S&ME ID#*	*18435*	*Cal. Date:*	*4/11/11*	*Due:*	*4/11/12*
Sieve:	*#10*	*S&ME ID#*	*2482*	*Cal. Date:*	*4/1/11*	*Due:*	*10/1/11*
pH Meter:		*S&ME ID#*	*16576*	*Cal. Date:*	*6/14/11*	*Due:*	*as needed*

pH Meter Calibration

Buffer Solution	*Results*
pH buffer 4.0	***4.01***
pH buffer 7.0	***7.00***
pH buffer 10.0	***10.01***
Buffer Temperature ^{0}C	***23.1°C***

Measuring pH of Soil

Measurements	
Weigtht of Air Dry Soil (g)	***30.4***
Distilled Water (ml)	***30.3***
Temperature ^{0}C	***23.7°C***
pH Reading	***9.1***

Notes / Deviations / References: AASHTO T 289 Determining pH of Soil for Use in Corrosion Testing

Rock core was crused down to minus No. 10 size fraction.

Michael Kelso	6/15/2011		
Technician Name	*Date*		
N. Randy Rainwater		Laboratory Department Manager	6/20/2011
Technical Responsibility	*Signature*	*Position*	*Date*

Method of Determining Effective (As Received) and Dry Unit Weights and Total Porosity of Rock Cores RTH 109-80

Job Name: **Louisville Twin Tunnels**

Job Number: **1831-10-5629**

Sampl Date: **5/20/2011**

Operator: MDK

Checked By: NRR

.

Specimen ID:	**PIL 17**	**PIL 18**	**PIL 20**	**PIL 22**
Depth (ft):	1193.7-1196.5	1249.0-1251.8	1314.1-1315.9	1373.8-1375.8
Specimen Mass (g):	447.1	461.2	148.8	427.3
Specimen Volume:				
Avgerage Dia. (mm)	**47.29**	**47.30**	**31.50**	**47.00**
Average Length (mm)	**96.42**	**98.17**	**74.28**	**95.77**
Area (cm^2)	**17.56**	**17.57**	**7.79**	**17.35**
Volume (cm^3), V	**169.36**	**172.53**	**57.87**	**166.18**
Water Content (ratio)	0.0020	0.0020	0.001	0.006
Crushed Minus No. 4 Mass				
Mass of Solids (g)	**443.50**	**459.40**	**147.12**	**424.88**
Effective Unit Weight (g/cm^3)	**2.64**	**2.67**	**2.57**	**2.57**
Dry Unit Weight (g/cm^3)	**2.62**	**2.66**	**2.54**	**2.56**
Dry Unit Weight (lb/ft^3)	**163.5**	**166.2**	**158.7**	**159.6**
Specific Gravity of Solids from RTH 108	2.85	2.85	2.86	2.84
Grain Unit Weight (lb/ft^3)	**177.7**	**177.7**	**178.2**	**177.0**
Total Porosity (%), $n=V_v/V$	**7.99**	**6.47**	**10.93**	**9.82**
Volume of Solids (cm^3), V_s	155.82	161.35	51.55	149.86
Volume of Voids (cm^3), V_v	13.54	11.17	6.33	16.32
Volume of Water (cm^3), V_w	0.89	0.92	0.15	2.55
[1]Void Ratio, $e=V_v/V_s$	**0.0869**	**0.0692**	**0.1227**	**0.1089**
[1]Degree of Saturation (%), $S=V_w/V_v$	**7%**	**8%**	**2%**	**16%**

Corps of Engineers Rock Testing Handbook RTH 109-80, RTH 108-89
ASTM D854, D2216

Notes: [1]These parameters are not a part of RTH 109 or RTH 108, they are included at the request of the client

The water content was determined from separate specimens.

Lab No. 10602594

Date Rec'd 06/02/11

Date Sampled 06/02/11

Sampled By YOURSELVES

STANDARD LABORATORIES
PO BOX 606
WHITESBURG, KY 41858
TEL: (606) 633-9373
FAX: (606) 633-8136

S & ME, INC.
422 CODELL DRIVE
LEXINGTON,KY. 40509

Sample ID: LOUISVILLE TUNNEL
1831-10-5629
PILLAR BORING
RUN 215 BOX 128
SAMPLE #1
1634.0-1635.5

	% DRY BASIS
TOTAL SULFUR:	0.11
PYRITIC SULFUR:	0.08

Cerchar

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CERCHAR Abrasiveness test

Test procedure: ASTM D7625

The University of Texas at Austin

Geotechnical Engineering Center
Department of Civil, Architectural and Environmental Engineering

Project Name	Louisville Tunnel
Client Project No.	1831-10-5629
UT reference	2011_SME_001_01
Test Date	6/6/11
Test Performer	Moo Yeon Kim
Checked by	Mahdi Heidari
Location	Louisville, Kentucky
Specimen location	PIL @ 1473.4-1474.8 ft, sample 1
Core ID	GR09_14_B-1@1474.1
Rock Type	Shale
Formation	Waldron Shale
Pin Rockwell Hardness	55/56

Surface condition	Cut by slab saw	
Direction of scratch	Perpendicular to core axis	
Pin Wear	Max width (mm)	Min width (mm)
	0.072	0.04
	0.058	0.031
	0.081	0.049
	0.049	0.022
	0.058	0.049
Average (mm)	0.051	
CAI	0.51	
Equipment	Ergo Tech CERCHAR Test Apparatus No.100225	

Note:

Reference: G.West (1989) *Rock Abrasiveness testing for tunneling* International Journal of Rock Mechanics and Mining Sciences & Geomechanics Abstracts, Volume 26, Issue 2, March 1989, 151-160.

R.Plinninger, H.K.asling, K.Thuro, G.Spaun (2003) *Testing conditions and geomechanical properties in influencing the CERCHAR abrasiveness index (CAI) value.* Journal of Rock Mechanics and Mining Sciences, 40(2003) 159-263.

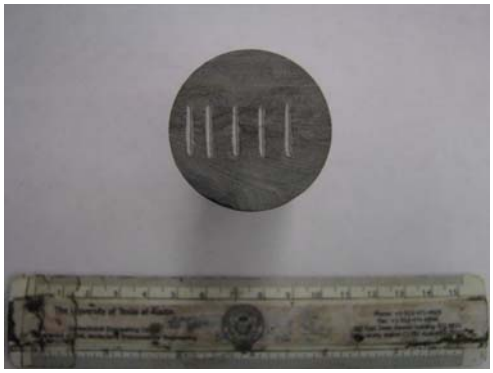

Photo after test

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CERCHAR Abrasiveness test

Test procedure: ASTM D7625

The University of Texas at Austin

Geotechnical Engineering Center
Department of Civil, Architectural and Environmental Engineering

Project Name	Louisville Tunnel
Client Project No.	1831-10-5629
UT reference	2011_SME_001_01
Test Date	6/15/11
Test Performer	Moo Yeon Kim
Checked by	Mahdi Heidari
Location	Louisville, Kentucky
Specimen location	1914.6-1916.0 ft
Core ID	PIL@1915.3, sample 4
Rock Type	Shale
Formation	Waldron Shale
Pin Rockwell Hardness	55/56

Surface condition	Cut by slab saw	
Direction of scratch	Perpendicular to core axis	
Pin Wear	Max width (mm)	Min width (mm)
	0.027	0.027
	0.031	0.027
	0.049	0.036
	0.031	0.022
	0.04	0.036
Average (mm)	0.033	
CAI	0.33	
Equipment	Ergo Tech CERCHAR Test Apparatus No.100225	

Note:

Reference: G.West (1989) *Rock Abrasiveness testing for tunneling* International Journal of Rock Mechanics and Mining Sciences & Geomechanics Abstracts, Volume 26, Issue 2, March 1989, 151-160.

R.Plinninger, H.K.asling, K.Thuro, G.Spaun (2003) *Testing conditions and geomechanical properties in influencing the CERCHAR abrasiveness index (CAI) value.* Journal of Rock Mechanics and Mining Sciences, 40(2003) 159-263.

Photo after test

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Project Name	Louisville Tunnel		Rock Type	Shale	
Project location	Louisville, Kentucky		Formation	Waldron Shale	
GEC reference	2011_SME_001_01		Moisture condition	As received	
Drill hole & depth (ft)	PIL@1915.3, sample 4		Data from drill log (if available):	Orientation: Not Available Infillings: Not Available Roughness: Not Available	
Specimen received	June, 2011		Type of encapsulating material:	Bolt anchor cement	
Tested by:	Moo Yeon Kim	Date: 06/16/11	JRC	-	
Calculated by:	Moo Yeon Kim	Date: 06/17/11	Checked by:	Mahdi Heidari	Date: 06/17/11

Cross-section	Diameter	46.54 mm	1.83 in	Angle	-	°
	Area	1701.15 mm^2	2.63 in^2			

Since the sample did not contain a fracture, the test was carried out in two stages.

In Stage1, normal load (9700 psf, 464.44 kPa) was applied, and then the sample was sheared under shear displacement control. The obtained shear displacement/shear stress curve is given below ("Initial" curve). The maximum shear stress to break the intact rock was equal to 1061.06 kPa (22160.7 psf).

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Before Test:

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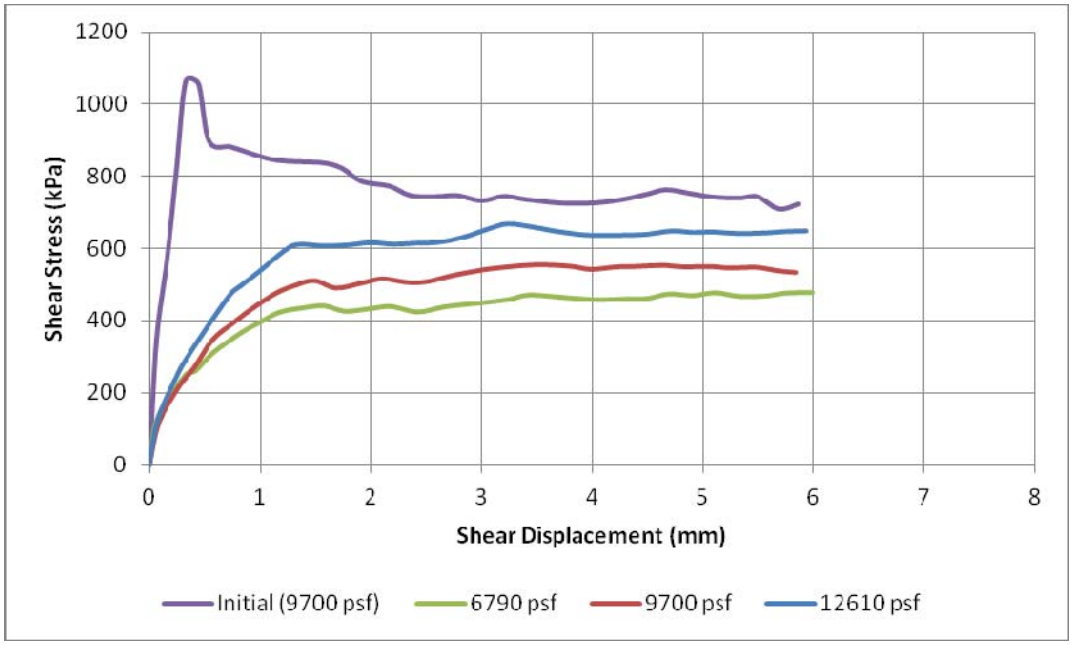
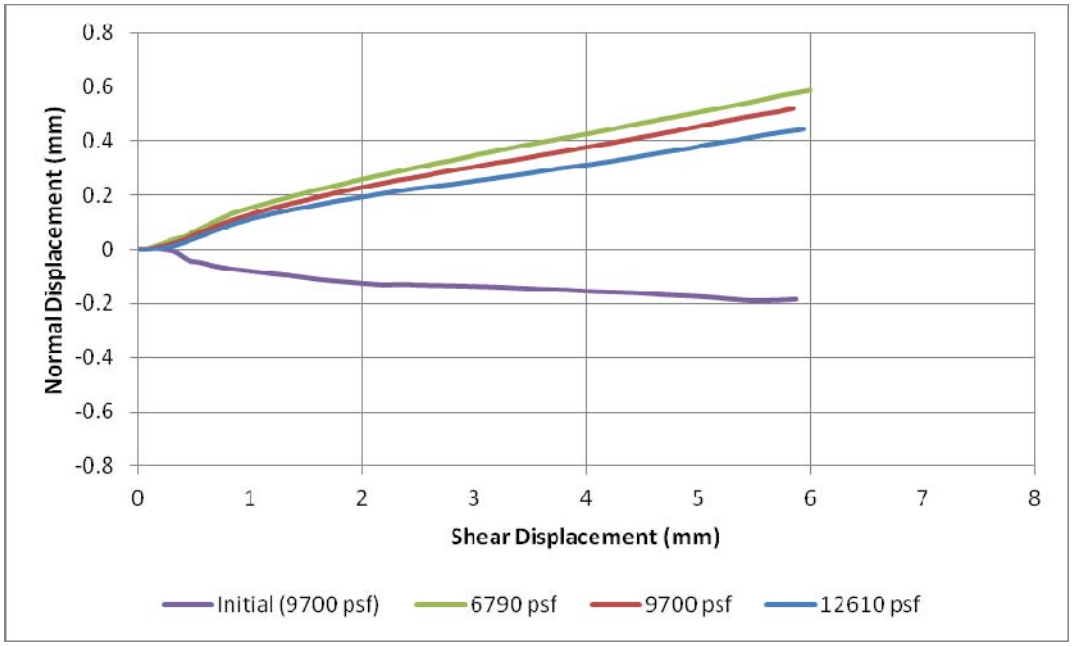
Department of Civil, Architectural
and Environmental Engineering





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In Stage 2, the shear box was returned to its initial configuration (zero shear displacement), and the test proceeded as a standard direct shear test on the fracture produced in Stage 1 with normal stresses equal to 70%, 100% and 130% of 9700 psf. Here below are the results from the direct shear test in Stage 2.

σ_n kPa (psf)	δ_{peak} mm (in)	τ_{peak} kPa (psf)	$\delta_{residual}$ mm (in)	$\tau_{residual}$ kPa (psf)
325.11 (6790)	5.99 (0.24)	477.51 (9973)	- -	- -
464.44 (9700)	3.58 (0.14)	555.34 (11598.52)	- -	- -
603.77 (12610)	3.24 (0.13)	666.80 (13926.41)	5.94 (0.23)	647.34 (13519.98)

Cohesion (c)	251.07 kPa	5243.71 psf	Friction angle (φ)	34.2 °

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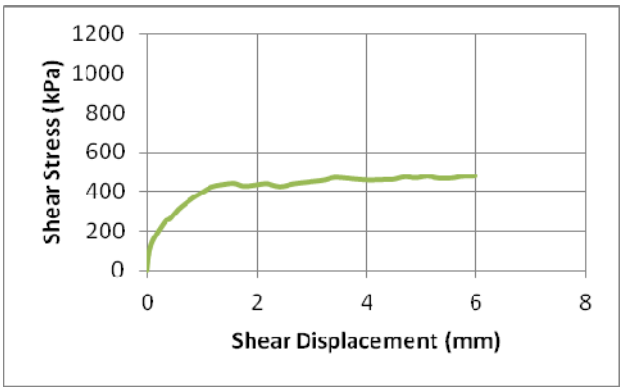
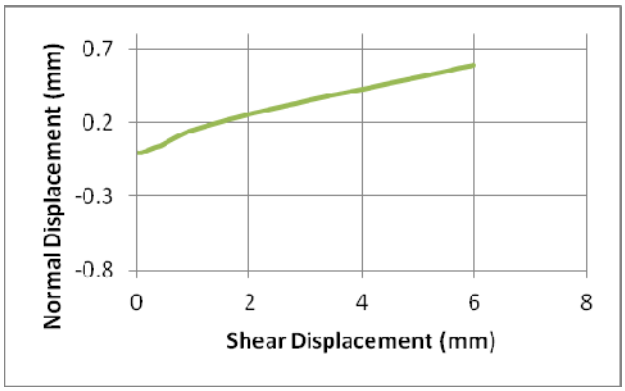
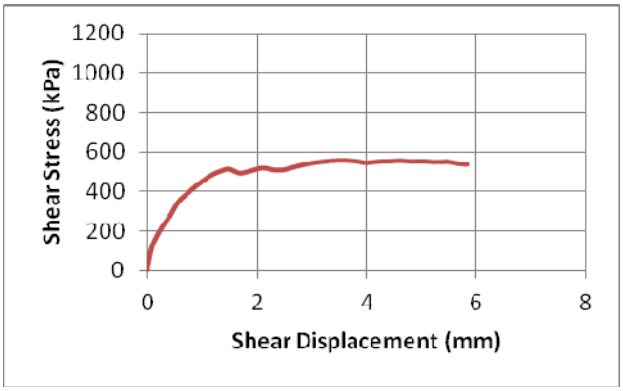


Shear Stress versus Shear displacement

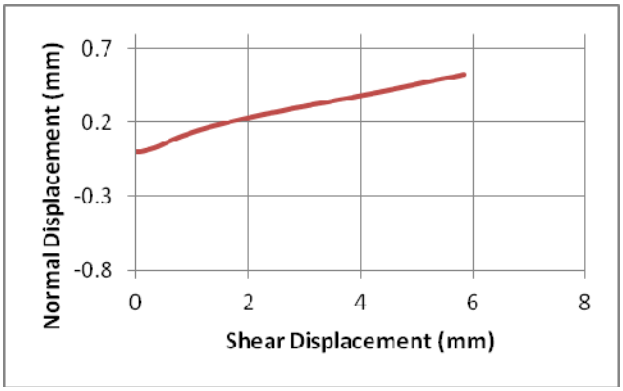


Normal Displacement versus Shear Displacement

Normal Stress: 325.11 kPa (6790 psf)

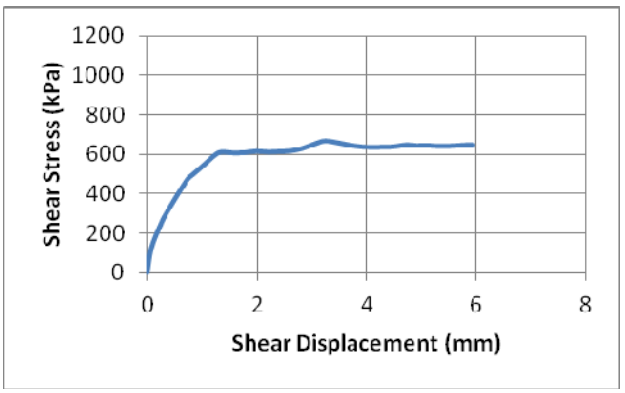


Shear Stress versus Shear displacement

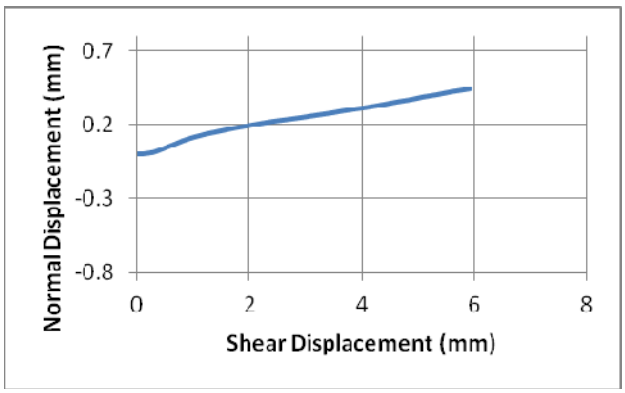


Normal Displacement versus Shear Displacement

Normal Stress: 464.44 kPa (9700 psf)



Shear Stress versus Shear displacement



Normal Displacement versus Shear Displacement

Normal Stress: 603.77 kPa (12610 psf)

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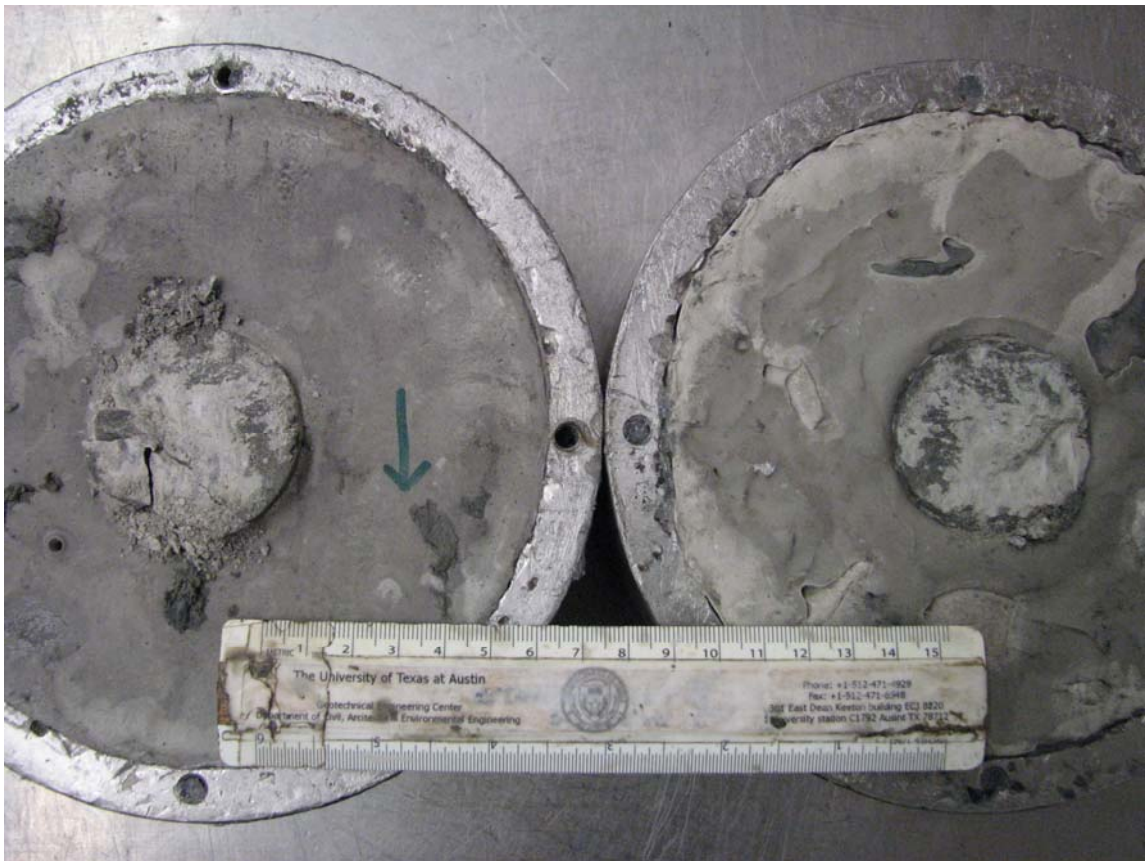
After Test:



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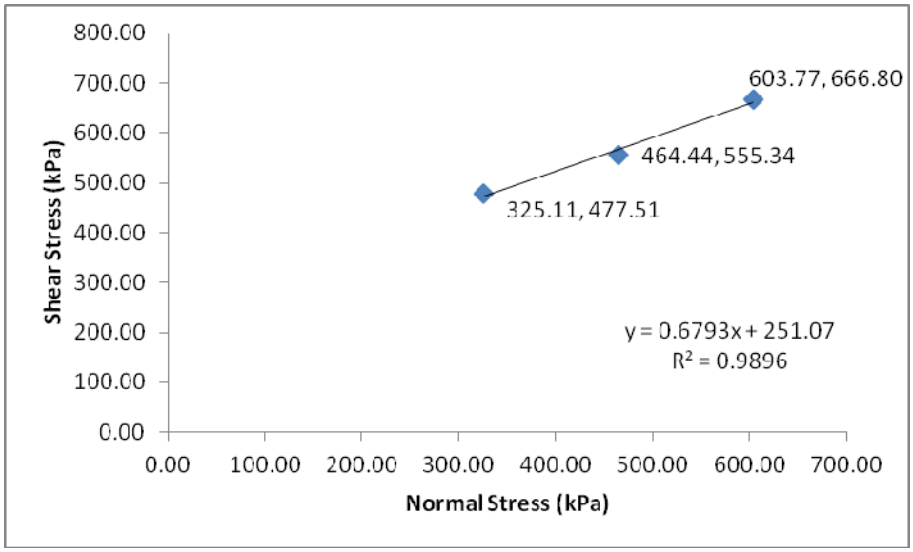
Cohesion and friction angle calculation



Linear Regression Analysis:

$$y = m.x + c$$

In this problem y is used instead of τ_f; x is used instead of σ_n; and m is used instead of $\tan\phi$.

$$m = \frac{\bar{y}.\sum_{i=1}^{N} x_i^{\,2} - \bar{x}.\sum_{i=1}^{N} x_i y_i}{\sum_{i=1}^{N} x_i^{\,2} - N.\bar{x}^2} \qquad c = \bar{y} - m.\bar{x} \qquad R^2 = 1 - \frac{\sum_{i=1}^{N} (y_i - c - mx_i)^2}{\sum_{i=1}^{N} (y_i - \bar{y})^2}$$

In which $\bar{x}$ and $\bar{y}$ are mean values of x and y, respectively. R^2 is correlation coefficient.

$\tan\phi = m \;\rightarrow\; \phi = ArcTan(m)$

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THIN SECTION PETROGRAPHIC ANALYSIS

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Geotechnical Engineering Center
Department of Civil, Architectural and Environmental Engineering

Project Name	Louisville Tunnel	Alteration	Dolomitized
Job No.	1831-10-5629	Texture	Partially crystalline shale
GEC reference		Rock name	Dolomitized shale/mudstone
Drill hole and depth	PIL 1401.3-1402.8	Studied by	K. Surpless
Specimen number	1401.3-1402.8	Date Studied	July 27, 2011
Formation	Waldron Shale Formation	Reviewed by	Tonon, Fulvio
Rock Type	Shale/mudstone		

Description of Individual Minerals:

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Microcrystalline silica	2%	7	<0.01	Low relief, clear in plane light, irregular extinction, possibly chalcedony (not clay minerals or micrite); very small proportion of minerals
Dolomite	90%	3.5-4	0.02-0.09; ave 0.05	Dolomite in well-formed, distinctive rhombs of varying sizes; evenly distributed throughout slide
Opaque minerals	3%	4.5-5	variable	Probably iron oxide minerals; irregular shape, formed through diagenesis
porosity	5%	NA	variable	Spread throughout, no preferred distribution
Weighted Average:		3.8	Excludes porosity	

Remarks: nearly complete dolomitization of silicic matrix; no preferred orientation or texture visible in the slide

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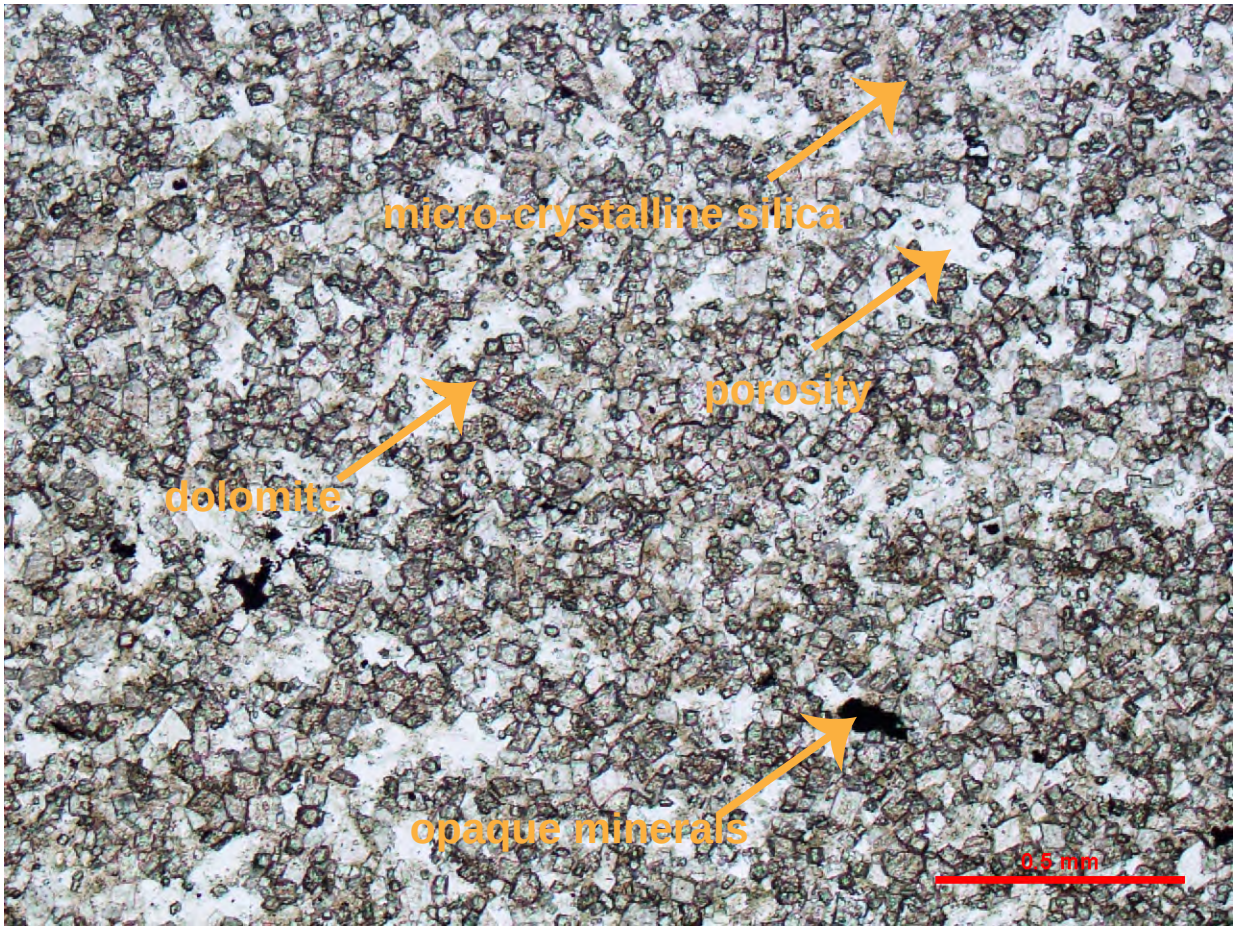
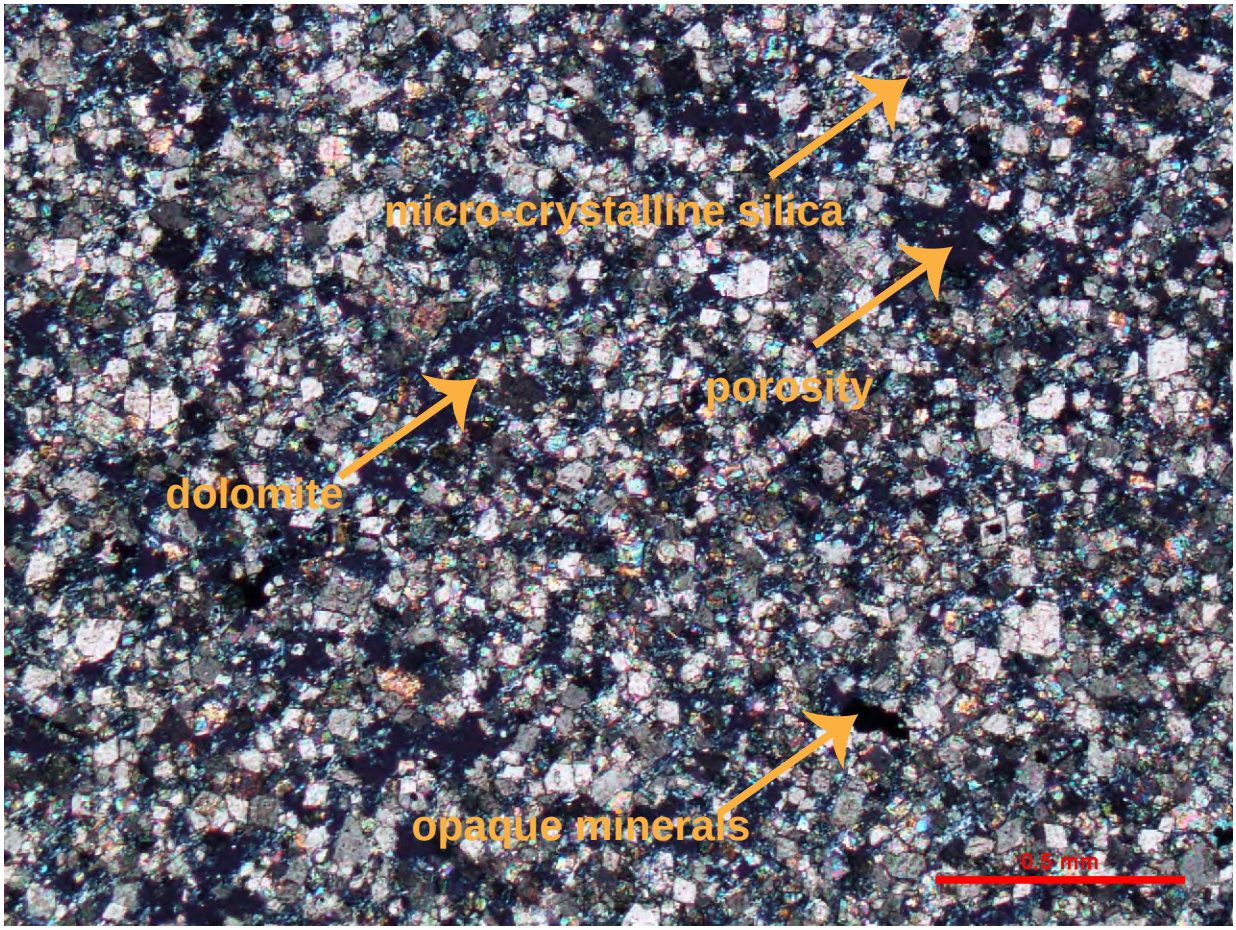
PIL 1401.3-1402.8 ft

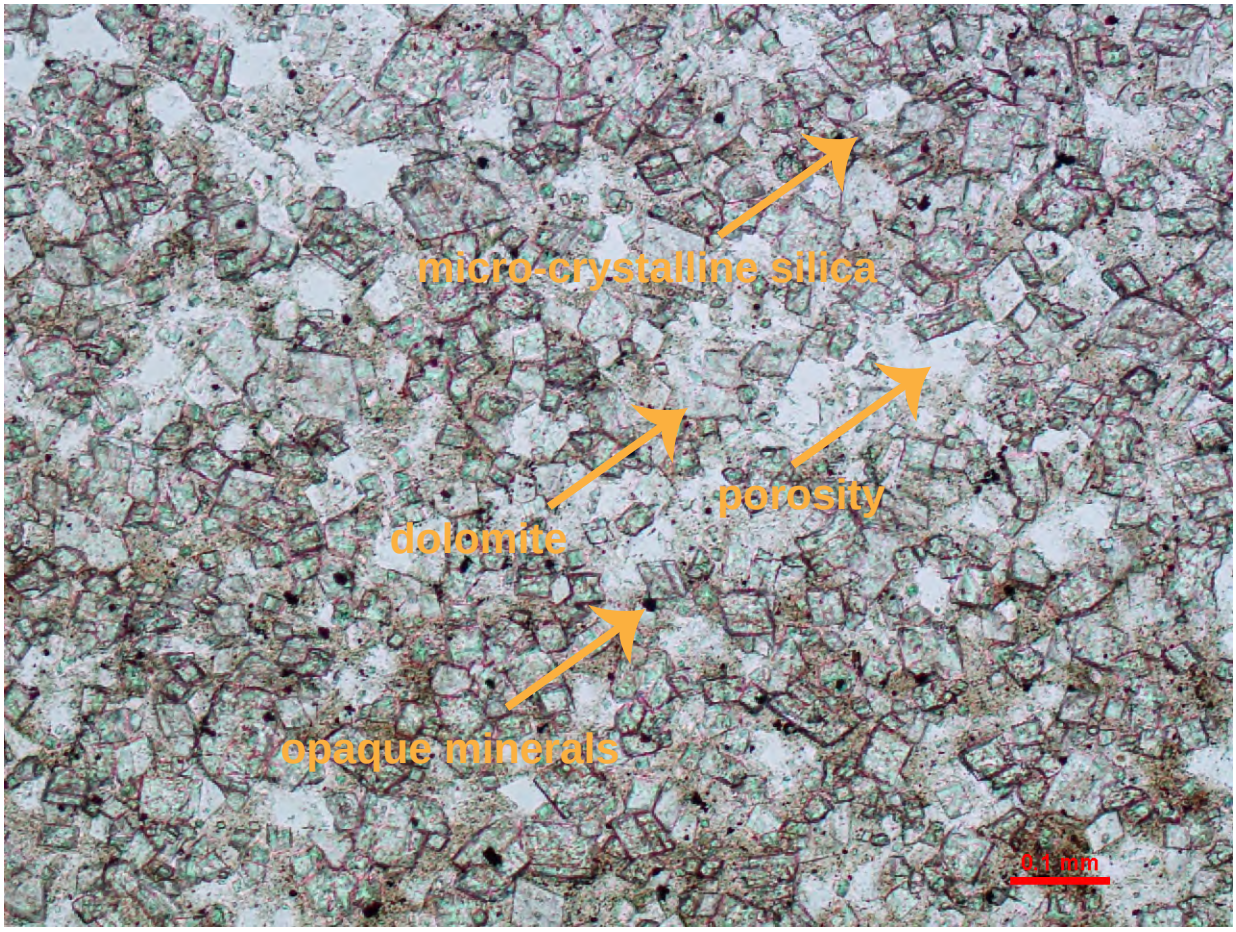


plane light

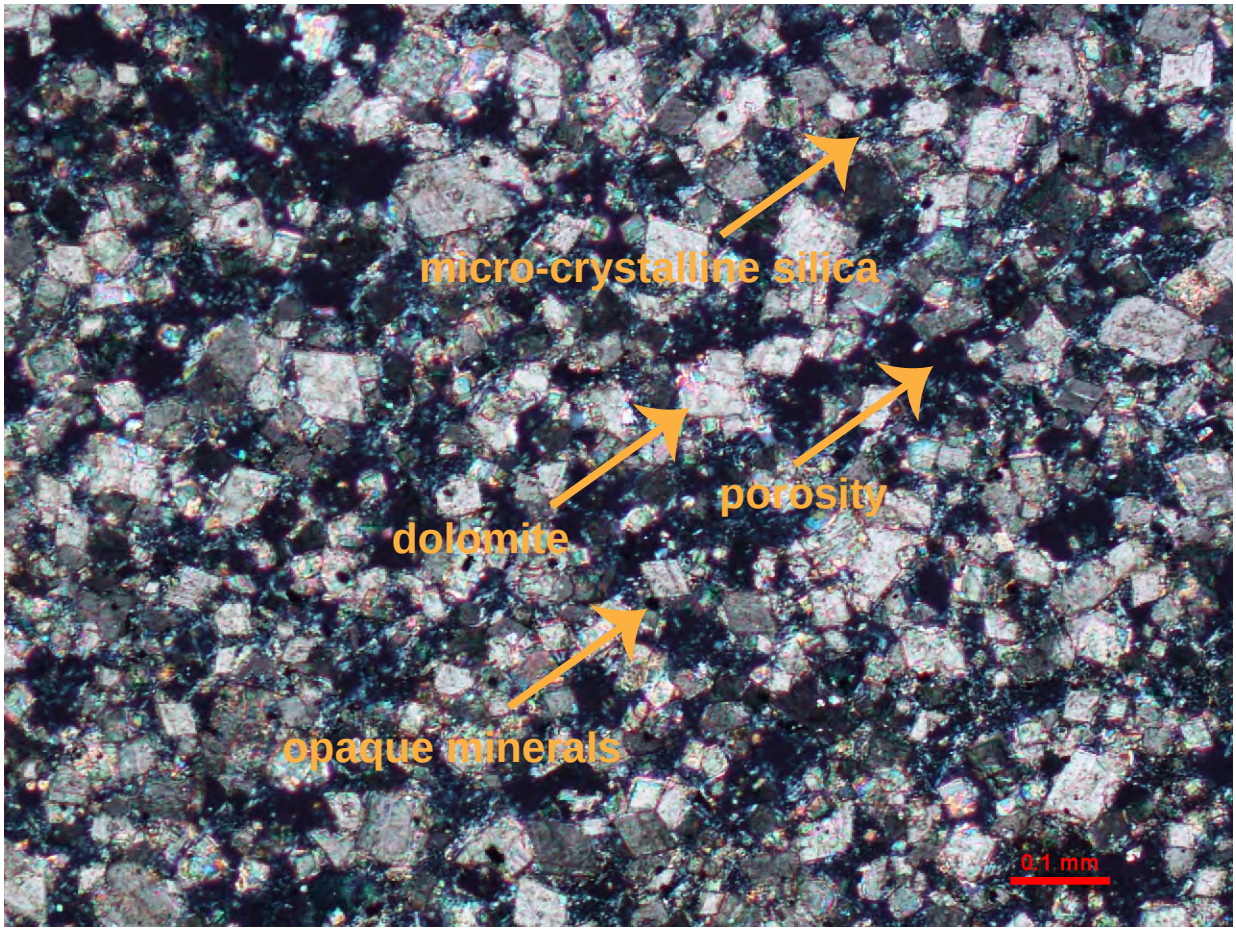


crossed polars

PIL 1401.3-1402.8 ft



plane light



crossed polars

THIN SECTION PETROGRAPHIC ANALYSIS

The University of Texas at Austin
Geotechnical Engineering Center
Department of Civil, Architectural and Environmental Engineering

Project Name	Louisville Tunnel	Alteration	Dolomitized
Job No.	1831-10-5629	Texture	Partially crystalline shale
GEC reference		Rock name	Dolomitized shale/mudstone
Drill hole and depth	PIL 1916.0-1917.4	Studied by	K. Surpless
Specimen number	1916.0-1917.4	Date Studied	July 22, 2011
Formation	Waldron Shale Formation	Reviewed by	Tonon, Fulvio
Rock Type	Shale/mudstone		

Description of Individual Minerals:

Minerals	Mineral Content (%)	Mohs Hardness	Grain Size (mm)	Description and Comments
Microcrystalline silica	20%	7	<0.01	Low relief, clear in plane light, irregular extinction, possibly chalcedony (not clay minerals or micrite)
Dolomite	30%	3.5-4	0.02-0.09; ave 0.05	Zones of more intense and less intense dolomitization; dolomite in well-formed, distinctive rhombs
Opaque minerals	5%	4.5-5	variable	Probably iron oxide minerals; irregular shape, formed through diagenesis
porosity	45%	NA	variable	Throughout slide
Weighted Average:		5.0	Excludes porosity; for this high-porosity sample, this number is essentially meaningless	

Remarks: partial dolomitization of silicic matrix in high-porosity shale or mudstone; no preferred orientation visible in slide; some variability in the intensity of dolomitization

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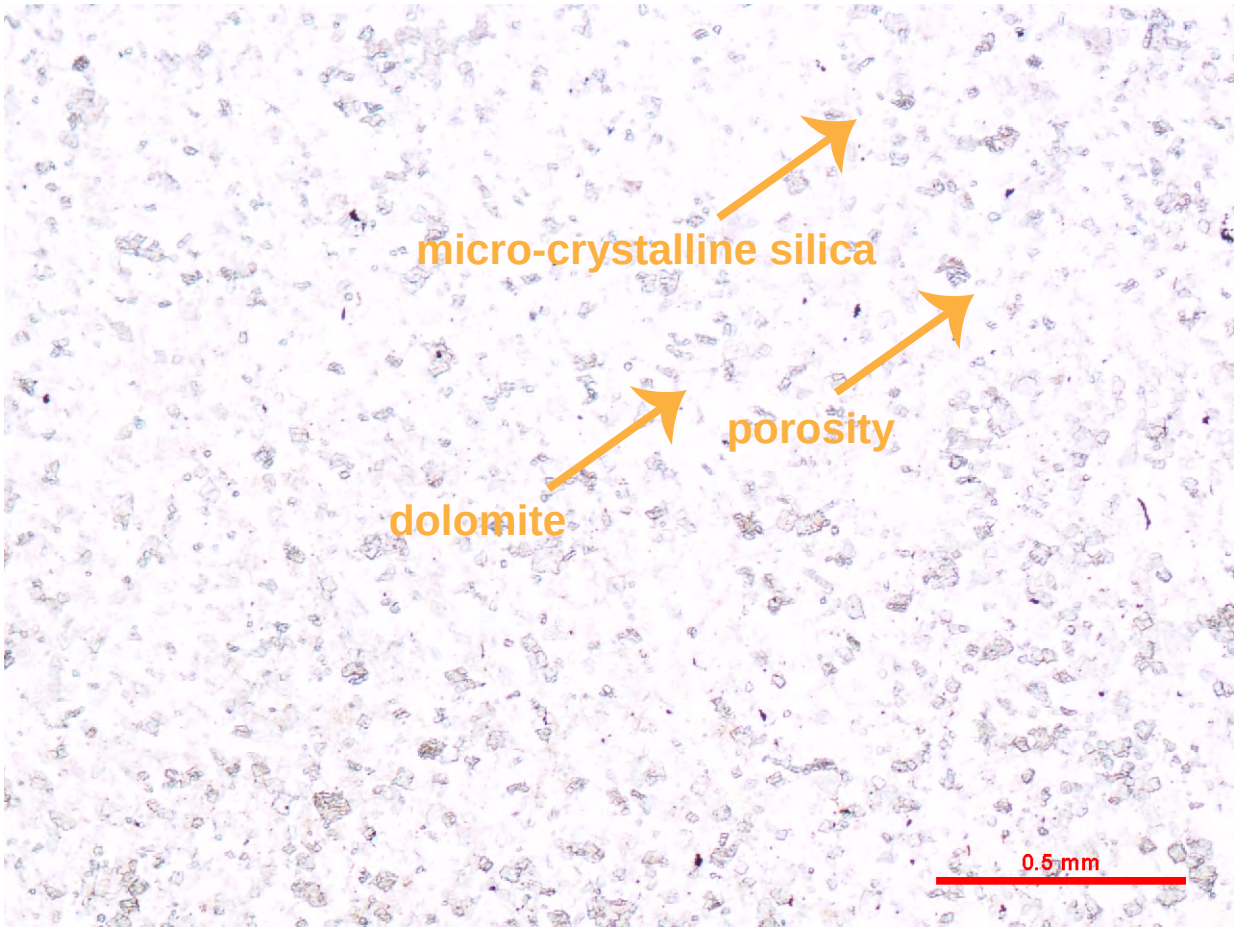
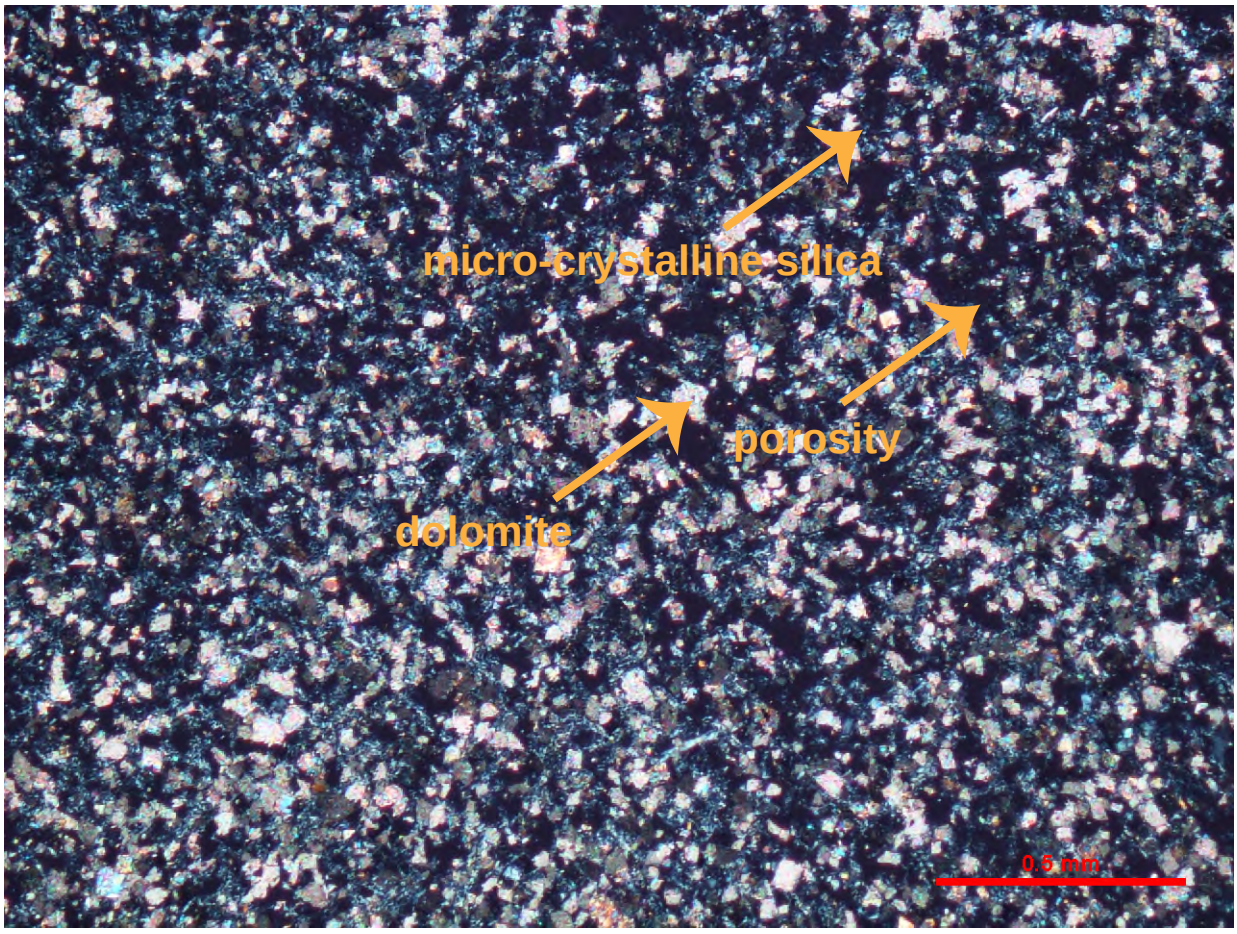
PIL 1916.0-1917.4 ft

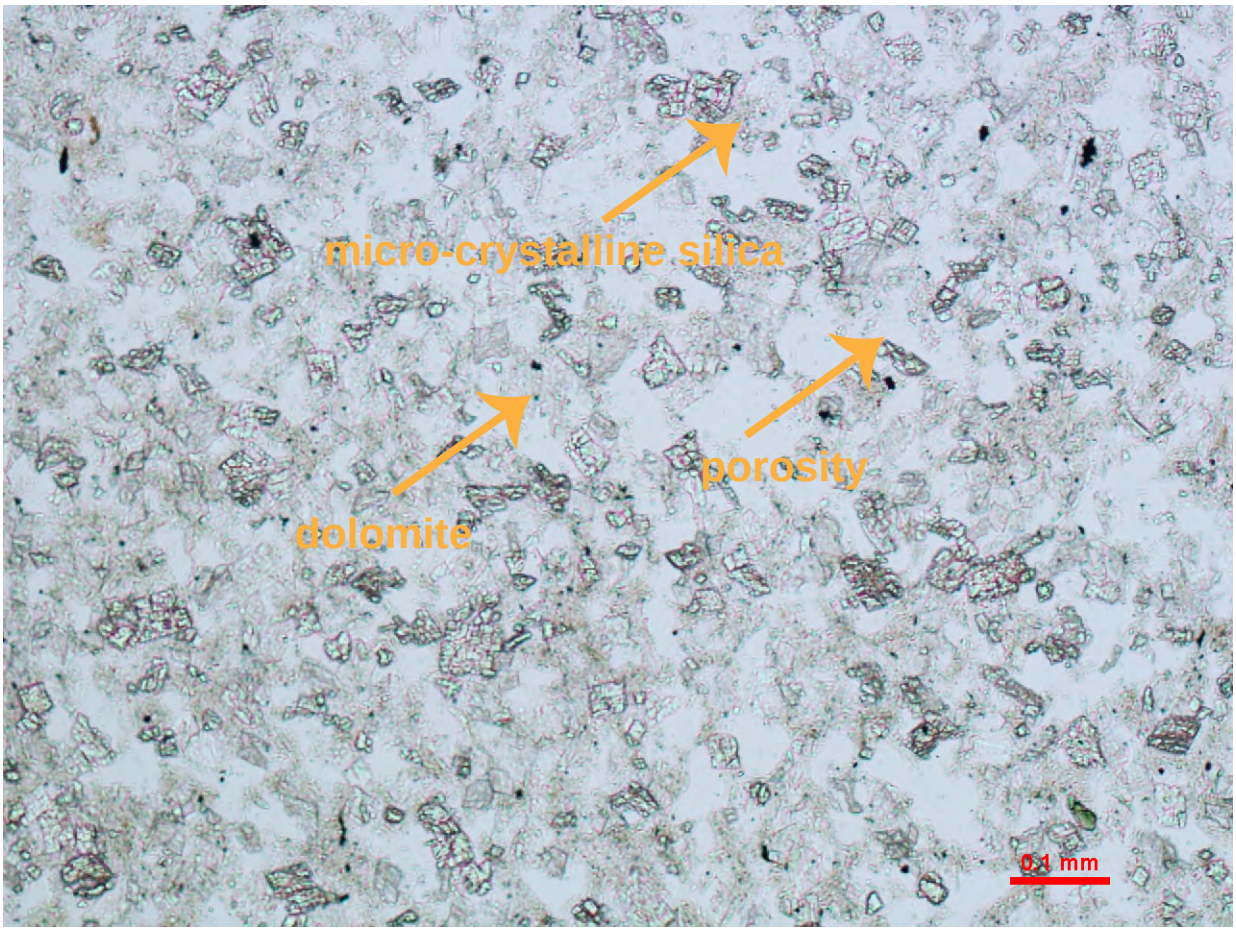
plane light



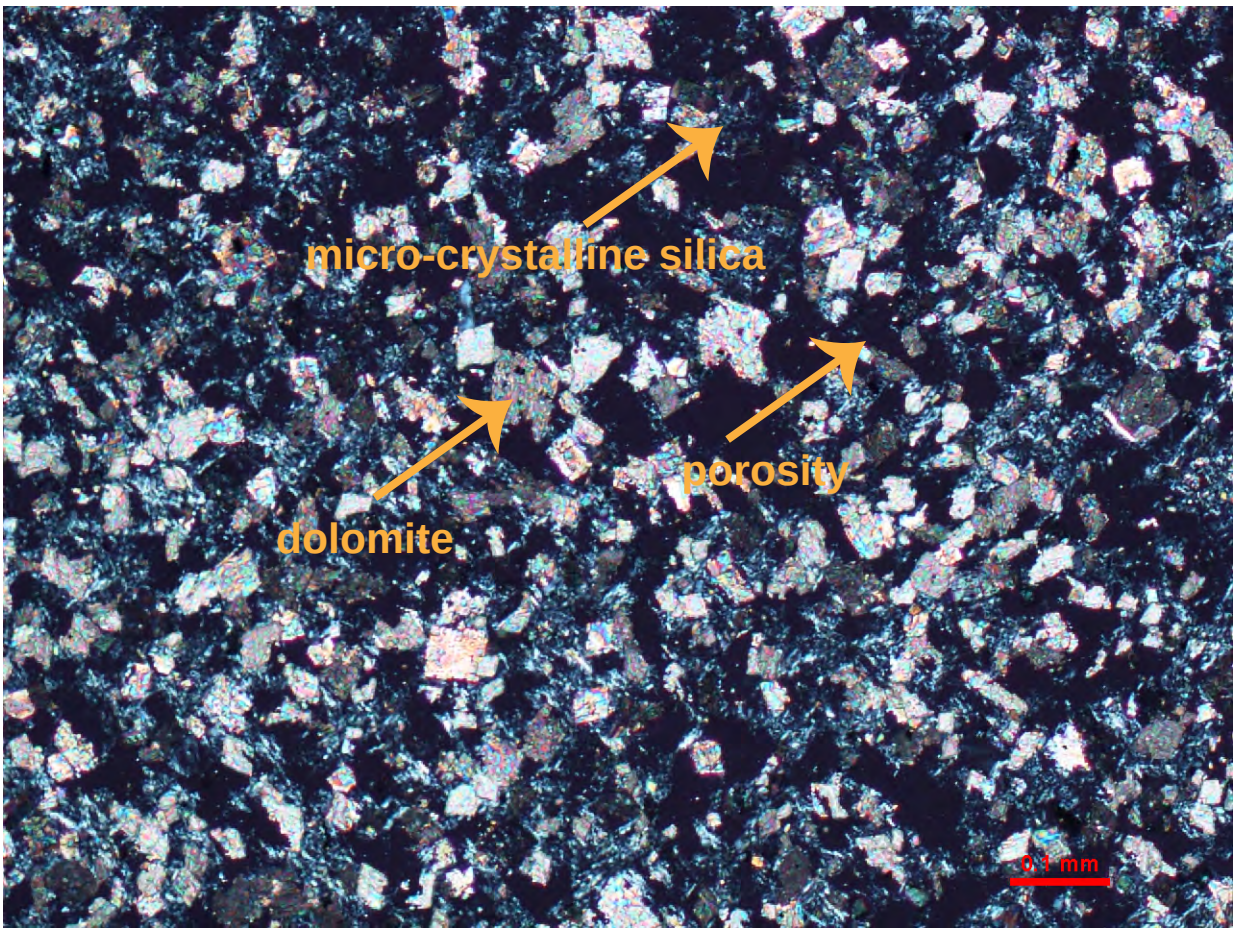
crossed polars



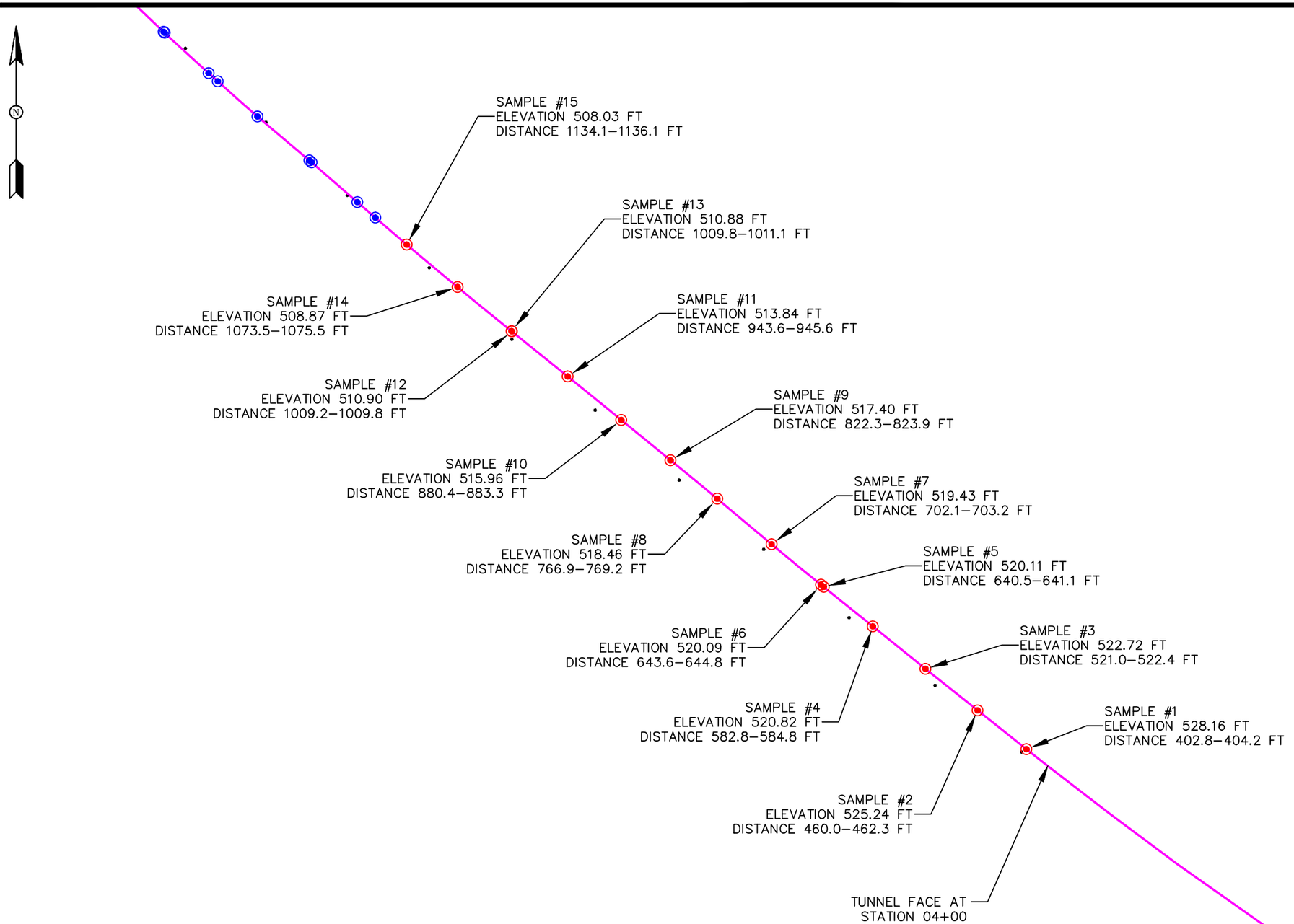
PIL 1916.0-1917.4 ft



plane light



crossed polars



LEGEND:

- LIMESTONE SAMPLE LOCATION
- SHALE SAMPLE LOCATION

DATE: 07–28–11
DRAWN BY: BCW
CHECKED BY:
SCALE: 1"=100'
PROJECT NO. 1831–10–5629

S&ME
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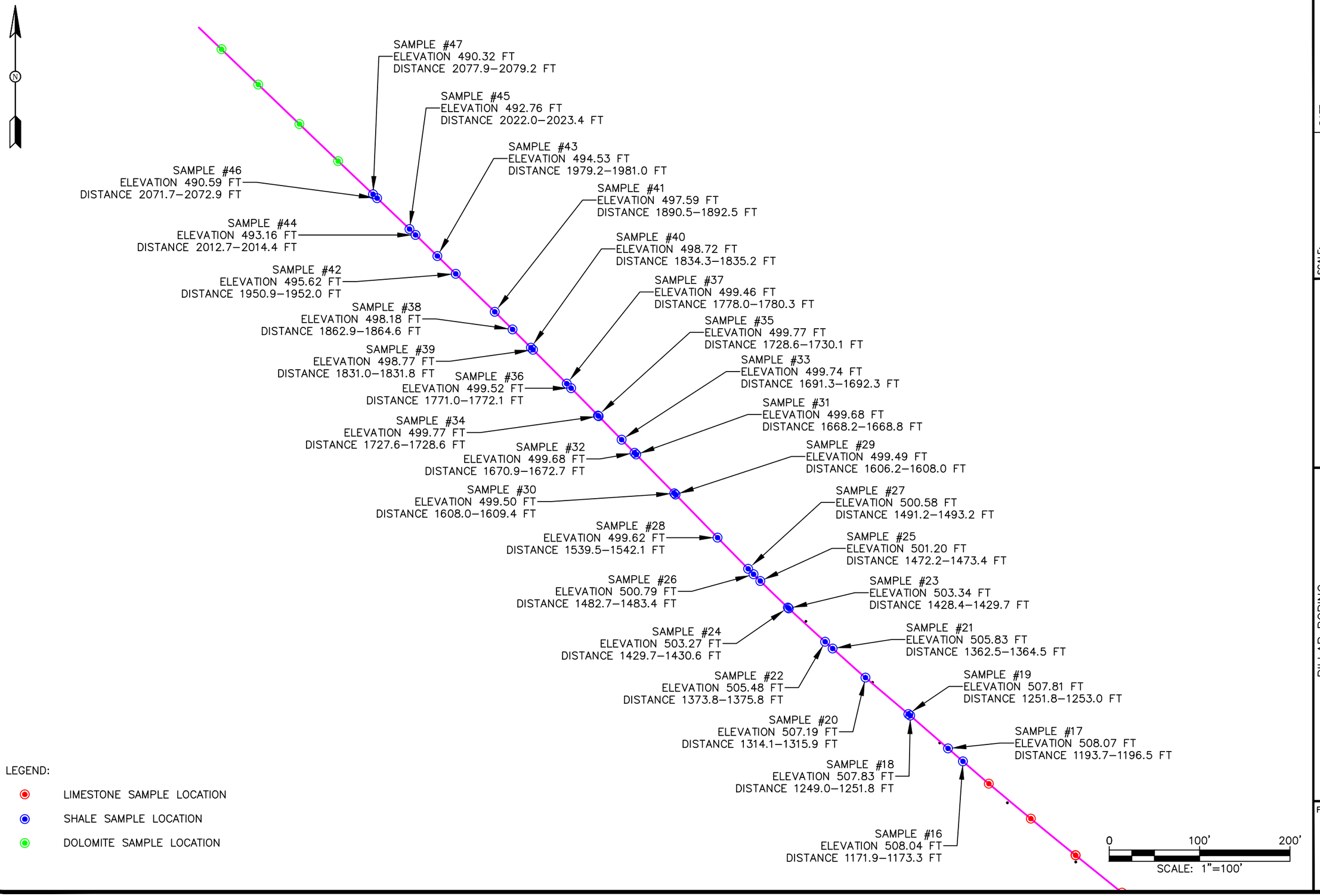
PILLAR BORING
LIMESTONE SAMPLE LOCATIONS
STA 04+00 TO STA 11+70

LOUISVILLE TUNNELS
LOUISVILLE, KENTUCKY

FIGURE NO.
1



DATE: 07–28–11
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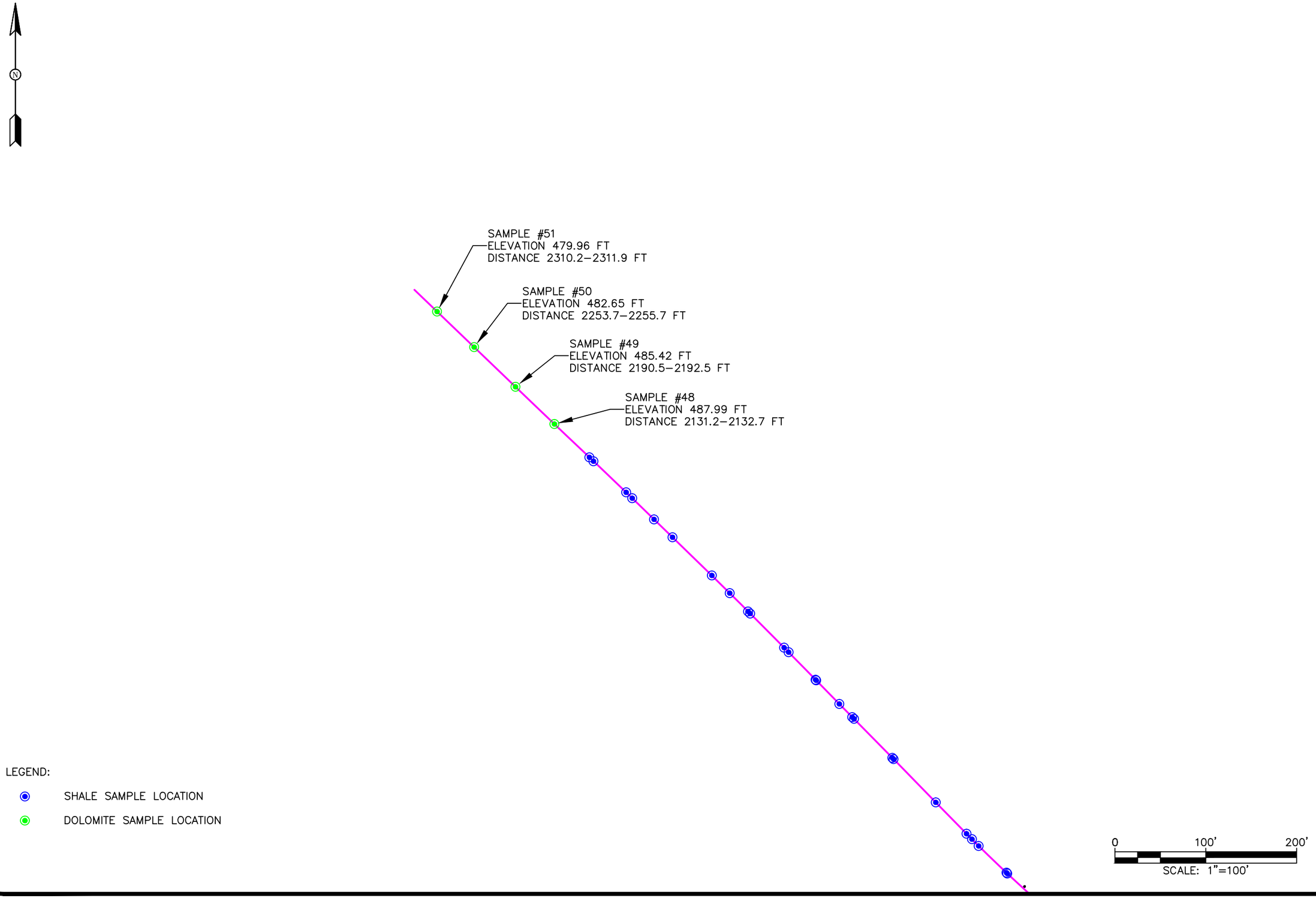
CHECKED BY:
SCALE: 1”=100’
PROJECT NO. 1831–10–5629

S&ME
WWW.SMEINC.COM

PILLAR BORING
SHALE SAMPLE LOCATIONS
STA 11+70 TO STA 21+10
LOUISVILLE TUNNELS
LOUISVILLE, KENTUCKY

FIGURE NO.
2



SCALE: 1"=100'
PROJECT NO. 1831-10-5629
DATE: 07-28-11
DRAWN BY: BCW
CHECKED BY:

S&ME
WWW.SMEINC.COM

PILLAR BORING
DOLOMITE SAMPLE LOCATIONS
STA 21+10 TO STA 23+37.50

LOUISVILLE TUNNELS
LOUISVILLE, KENTUCKY

FIGURE NO.
3